NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT SECTION 7
BIOLOGICAL OPINION

Title: *Environmental Protection Agency's Registration of Pesticides containing Chlorpyrifos, Diazinon, and Malathion*

Action Agency: *Environmental Protection Agency*

Consultation Conducted By: Endangered Species Act Interagency Cooperation Division, Office of Protected Resources

Approved:

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Executive Summary

Key Findings

This Biological Opinion (Opinion) evaluated the effects of the Environmental Protection Agency's (EPA) registration of the pesticides chlorpyrifos, diazinon, and malathion on the Endangered Species Act (ESA) -listed species and designated critical habitats under the National Marine Fisheries Service (NMFS) jurisdiction. These three pesticides belong to the organophosphate class of insecticides and are highly toxic to mammals, fish, and aquatic invertebrates. Current product labels permit use on a variety of sites including agricultural, developed, and forested lands. Additionally, malathion and chlorpyrifos are registered for use as mosquitocides that can be applied to a wide array of land types nationwide. Current application rates and application methods are expected to produce aquatic concentrations of all three pesticides that are likely to harm aquatic species as well as contaminate their designated critical habitats. Species and their prey residing in shallow aquatic habitats proximal to pesticide use sites are expected to be the most at risk.

As shown in Chapters 7 and 8, we concurred with the "not likely to adversely affect" (NLAA) determinations for the three pesticides that were made in EPA's Biological Evaluations. Therefore, our subsequent jeopardy and adverse modification analyses focused on species for which a "likely to adversely affect" (LAA) determination was made. In this Opinion we concluded that EPA's proposed registration of pesticides containing chlorpyrifos is likely to jeopardize the continued existence of 38 of the 77 listed species, and adversely modify 37 of the 50 designated critical habitats. Likewise, for diazinon, we found jeopardy for 25 of the 77 listed species and adverse modification of 18 of the 50 designated critical habitats. Furthermore, we concluded that registration of pesticides containing malathion is likely to jeopardize 38 of the 77 listed species and adversely modify 37 of the 50 designated critical habitats. The details of our jeopardy and adverse modification determinations for each species can be found in Chapters 19-24. In sum, this Opinion reaches "jeopardy" and "adverse modification" conclusions regarding 38 different species and 37 critical habitat units.

Analysis and Methods

We followed an ecological risk assessment framework that relied upon multiple lines of evidence to determine effects to populations, species, and their designated critical habitats. The Assessment Framework in Chapter 3 provides a description of the methodology used throughout this Opinion. The core of our analysis utilized information presented in EPA's Biological Evaluations, namely pesticide exposure estimates and toxicological response data, to predict the resulting risk to the species. When determining the effects of the action (i.e., the registration of pesticides containing chlorpyrifos, diazinon, and malathion) on listed species, we considered many pieces of information including: the direct and indirect toxicity of each chemical to aquatic taxa groups (e.g. fish, mammals, invertebrates); specific chemical characteristics of each pesticide (e.g. degradation rates, bioaccumulation rates, sorption affinities, etc.); expected environmental concentrations calculated for generic aquatic habitats; authorized pesticide product labels; maps showing the spatial overlap of listed species' habitats with pesticide use areas; and species' temporal use of those lands and/or aquatic habitats on which each pesticide has permitted uses.

The Effects Analysis focused around risk hypotheses, or statements of anticipated effects to life stage groupings of a species. We employed a weight-of-evidence approach to determine for each risk hypothesis whether the expected risk from pesticide exposure to groups of individuals organized by life stage was high, medium or low. To arrive at that rating for each risk hypothesis, we addressed not only the effect and likelihood of exposure, but also our level of confidence in the risk level. We utilized multiple data sources to evaluate both the likelihood of exposure and the magnitude of effect to groups of individuals occupying similar aquatic habitats. This allowed us to assess the body of evidence that either supported or refuted the risk hypotheses. For each species, all identified risk hypotheses were qualitatively combined into a single determination of risk at the population scale (i.e., the effect of the action) and represented graphically. A similar, yet separate, analysis was conducted for designated critical habitats where risk hypotheses were developed based on potential pesticide effects to physical or biological features of critical habitat. Generally, these included effects to water quality and species' prey items. Detailed Effects Analyses for both species and critical habitats can be found in Chapters 12-17.

The final determinations of jeopardy and adverse modification of designated critical habitat were made by combining the Effects of the Action with risk modifiers, namely the Status of the Species, Cumulative Effects, and Environmental Baseline. These bodies of information were combined qualitatively, described narratively, and presented graphically as a Species Scorecard (Chapters 19-24).

Avoiding Jeopardy and Adverse Modification

As prescribed by the ESA, our findings of jeopardy and adverse modification of designated critical habitat required the production of Recommended Prudent Alternatives (RPAs). These RPAs were drafted using the best available information on current agricultural practices and pesticide reduction strategies to reduce pesticide exposure to aquatic species and their habitats. RPAs include a flexible list of chemical-specific alternatives built upon listed species life histories and other characteristics. In addition to avoiding jeopardy and adverse modification of critical habitat, the RPAs are intended to reduce loading of pesticide chemicals into aquatic habitats, incorporate landowners' current stewardship efforts, and protect vulnerable aquatic habitats from adverse effects of pesticide exposure. RPAs are presented in Chapter 26 of the Opinion.

For species where the action, or implementation of an RPA, is not likely to jeopardize listed species or cause adverse modification of designated critical habitat, we have also prepared an Incidental Take Statement with associated Terms and Conditions to minimize such take. This discussion can be found in Chapter 26 of the Opinion.

Collaborations and Future Consultations

Federal agencies (NMFS, EPA, the U.S. Fish and Wildlife Service, and the U.S. Department of Agriculture) are collaborating to respond to the National Academy of Sciences' National Research Council report on specific scientific and technical issues related to pesticide risk assessments for listed species that was released on April 30, 2013. We expect this iterative process to take several years. Notably, this Opinion represents the first consultation using newly developed approaches and the first to assess all listed species throughout the U.S., its territories, and protectorates. Future Opinions regarding pesticides may utilize different analyses and approaches as the interagency consultation effort proceeds.

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Background and Consultation History

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1 BACKGROUND

The Environmental Protection Agency (EPA) has requested consultation from the National Marine Fisheries Service (NMFS) on its registration pursuant to the Federal Insecticide Fungicide and Rodenticide Act (FIFRA) of the three active ingredients chlorpyrifos, diazinon and malathion (organophosphates). This Biological Opinion (Opinion) on EPA's three actions replaces a NMFS 2008 Opinion that was vacated by the Fourth Circuit Court of Appeals in Dow AgroSciences LLC v. NMFS, 707 F.3d (4th Cir. 2013). NMFS issued the 2008 Opinion in response to a settlement agreement entered in Northwest Coalition for Alternatives to Pesticides (NCAP) v. NMFS, Civ. No. 07-1971 (W.D. Wa.). NCAP had sued NMFS for failure to complete consultations on 37 pesticide active ingredients. NMFS had settled the case by agreeing to a schedule for completion of the consultations, with the consultation on the organophospates to be completed first. After the Fourth Circuit vacated the 2008 organophosphates biological opinion NCAP and NMFS revised the settlement agreement so that NMFS would complete this opinion by December 31, 2017.

Pursuant to FIFRA, before a pesticide product may be sold or distributed in the U.S., it must be exempted or registered with a label identifying approved uses by EPA's Office of Pesticide Programs (OPP). Pesticide registration is the process through which EPA examines the ingredients of a pesticide; the site or crop on which it is to be used; the amount, frequency and timing of its use; and storage and disposal practices. Pesticide products (also referred to as "formulated products") may include active ingredients (a.i.s) and other ingredients, such as adjuvants and surfactants. EPA authorization of pesticide uses are categorized as FIFRA Sections 3 (new product registrations), 4 (re-registrations and special review), 18 (emergency use), or 24(c) Special Local Needs (SLN).

On July 30, 2008, NMFS entered a settlement agreement with the Northwest Coalition for Alternatives to Pesticides (NCAP). NCAP had sued NMFS for failing to complete consultation on 37 pesticide active ingredients for impacts to listed salmon ESUs. In the settlement agreement NMFS agreed on a schedule for completion of consultation on each active ingredient, with the final consultation due in early 2013. This schedule has been revised, with the final consultation now due by December 31, 2020.

On November 18, 2008, NMFS issued the first opinion under this schedule for three organophosphates: chlorpyrifos, diazinon, and malathion. This opinion concluded that EPA's action was likely to jeopardize all but one of the listed salmon ESUs, and likely to adversely modify their designated critical habitat. NMFS included a reasonable and prudent alternative (RPA) that would allow the action to proceed without likely jeopardy and likely adverse modification. The RPA included no-application buffers, as well as other measures. This opinion was vacated and remanded by the Fourth Circuit Court of Appeals in 2013. Dow AgroSciences LLC v. NMFS, 707 F.3d (4th Cir. 2013).

While the challenge to this 2008 opinion was proceeding, in September 2010, EPA, FWS, NMFS and the United States Department of Agriculture (USDA) asked the National Academy of Science (NAS) to provide advice on a range of subjects related to risk assessment and the consultation process including the following:

- Identifying best available scientific data and information,
- Considering sub-lethal, indirect and cumulative effects,

- Assessing the effects of chemical mixtures and inert ingredients,
- Using models to assist in analyzing the effects of pesticide use,
- Incorporating uncertainties into the evaluations effectively, and
- Use of geospatial information and datasets in the course of these assessments.

On April 30, 2013, the NAS provided its report and recommendations on ESA pesticide consultations, in a report entitled "Assessing Risks to Endangered and Threatened Species from Pesticides."

The NAS report contained recommendations on scientific and technical issues related to pesticide consultations under the ESA and FIFRA. Since then the Agencies have worked to implement the recommendations. Joint efforts to date include: collaborative relationship building between EPA, NMFS, FWS and USDA; clarified roles and responsibilities for the EPA, FWS, NMFS and USDA; agency processes designed to improve stakeholder engagement and transparency during review and consultation processes; multiple joint agency workshops resulting in interim approaches to assessing risks to threatened and endangered species from pesticides; a plan and schedule for applying the interim approaches to a set of pesticide compounds; and multiple workshops and meetings with stakeholders to improve transparency as the pesticide consultation process evolves. As a result of the ongoing collaborative efforts, EPA, FWS and NMFS are moving forward with developing and applying their interim approach to pesticide consultations. Specifically the Agencies have been working on the report's overarching recommendation to implement a three-step risk assessment and consultation approach.

In step 1, EPA makes the no effect/may affect determination. If EPA determines that a pesticide's registration/re-registration will have no effect on a threatened or endangered species, or designated critical habitat, it may move forward with a pesticide's registration without further consultation with FWS or NMFS. If EPA determines that the pesticide may affect a listed species, the potential impact is assessed in step 2 to determine if it is likely to adversely affect the species. EPA initiates formal consultation for species that are likely to be adversely affected, and seeks concurrence on its "not likely to adversely affect" determinations. In step 3, using the information provided by EPA in its step 2 analysis, FWS and NMFS make determinations as to whether the action is likely to cause jeopardy to listed species or adverse modification of critical habitat for the species and habitats that EPA determined are likely to be adversely affected. At this step, NMFS may also conclude after its own review that the species in question are not likely to be adversely affected, and that no further analysis is required.

The NAS report and recommendations are available at:

http://www.nap.edu/catalog.php?record_id=18344

On May 21, 2014, NMFS and NCAP revised the settlement agreement with NMFS to issue a new organophosphates opinion by December 31, 2017. The agreement noted that NMFS, FWS, and EPA were working to develop a common approach to risk assessment in pesticides consultations that would implement the recommendations of the 2013 National Academies of Sciences report. In addition, the new opinion will address all of NMFS' listed species and designated critical habitat.

2 CONSULTATION HISTORY

Since receiving the NAS report, the Agencies have been working collaboratively to develop shared scientific approaches that reflect the advice provided by the NAS for completing these pesticide consultations. Working together, scientists from the Agencies have met, analyzed the recommendations and have developed interim approaches they will implement as part of a phased iterative process. They are also identifying future tools, models and approaches that will need to be developed over a period of years.

The following is an overview of the consultation process, highlighting the coordination and collaboration that have occurred over the past several years:.

Date	**Event**	**Attendees**
August 5-9, 2013	Interagency ESA NAS Implementation Workshop	EPA, NMFS, FWS USDA

Purpose:
A week-long meeting convened by the Agencies in order to reach a preliminary set of agreements on an approach to implement the NAS recommendations for conducting all three steps in the consultation process.

Date	**Event**	**Attendees**
November 13, 2013	1st Interagency Stakeholder Meeting on Joint Interim Approaches to the NAS Recommendations	EPA, NMFS, FWS USDA, registrant representatives, non-governmental organizations (NGO)

Purpose:
The Stakeholder meeting was an open forum to enable all interested parties to discuss the proposed interim approaches suggested by the NAS April 2013 report. A question and answer session was conducted and FWS made a transcript of the discussion.

Date	**Event**	**Attendees**
December 5, 2013	Federal Advisory Committee Act, Pesticide Program Dialogue Committee meeting	EPA, NMFS, FWS USDA, registrant representatives, NGOs

Purpose:
The Pesticide Program Dialogue Committee is a Federal Advisory Committee that typically meets with EPA biannually to discuss pesticide regulatory, policy, and program implementation issues and is comprised of a diverse group of stakeholders from environmental and public interest groups, pesticide manufacturers, trade associations, commodity groups, public health and academic institutions, and Federal and State agencies.

Date	**Event**	**Attendees**
April 8-9, 2014	Crop Life America Annual Spring	Stakeholders from

	Meeting	NGOs and other entities

Purpose:
A conference was structured to exchange information about the current status of population models and how they could be used in ecological risk assessments and, in particular, endangered species assessments for pesticide use. The following was discussed at the forum:

- Available model types (e.g. Matrix models, Toxicokinetic/Toxicodynamic models, Energy-budget, Individual-based, etc.) and their applicability to the assessment process.
- Species-specific and generic models and use for certain life history types.
- Availability of required inputs for different population model types.
- Which models are closer to implementation in the U.S. and which may need more work and
- Practicality of implementing population models in large scale risk assessments (e.g., national level risk assessments, wide distribution of species, potentially multiple populations of the species may exist).

Date	**Event**	**Attendees**
April 22, 2014	2nd Interagency Workshop on Joint Interim Approaches to NAS Recommendations	EPA, NMFS, FWS USDA

Purpose:
To develop a process-oriented work plan and analysis plan to facilitate effects determinations for diazinon, chlorpyrifos and malathion for all currently listed species in the U.S. (including U.S. territories and the Commonwealth of the Northern Mariana Islands). These efforts will follow Steps 1, 2 and 3 of the interim method.

Date	**Event**	**Attendees**
Twice a month Changed to weekly	One-hour conference call with senior managers from each Agency	EPA, NMFS, FWS, USDA

Purpose:
A weekly (originally twice a month) call was initiated for the senior managers from each Agency to discuss and share information regarding the pesticide consultations. This weekly call was to help ensure the completion of the BEs and the Opinions were moving forward in a timely fashion. In addition, the call provides a forum to discuss any issues between staff as they work on the consultations. The senior management's goal is to resolve any problems or roadblocks expediently and efficiently.

Approximately twice to three times a year, the senior managers meet in person to discuss major issues that may arise and work to keep the consultations moving forward.

Date	**Event**	**Attendees**
October 6, 2014	3rd Stakeholder Workshop on Joint Interim Approaches to NAS	EPA, NMFS, FWS USDA

Purpose:
On October 6, 2014, EPA and its Federal partners, FWS, NMFS, and USDA, held a one-day workshop to provide a forum for stakeholders to offer scientific and technical feedback on the joint interim approaches proposed by EPA, FWS, NMFS and USDA in response to the NAS report. The workshop was an opportunity for stakeholders and the Agencies to continue their dialogue on the technical aspects of implementing the NAS recommendations, specifically to provide scientific and technical information that could potentially be used by the Agencies to inform various scientific determinations that will be made during the course of the pesticide consultations.

Date	Event
December 15, 2014	Status Report to Congress on Endangered Species Act Implementation in Pesticide Regulation

Purpose:
The *Report to Congress* describes the approaches and actions taken by EPA, NMFS and the FWS in response to the NAS report recommendations. In addition, as directed by the Agricultural Act of 2014, this final report informs Congress of actions that have been, and will be taken, to establish that: (1) the Agencies utilize the best available science; (2) Reasonable and Prudent Alternatives will be technologically and economically feasible; (3) Reasonable and Prudent Measures will be necessary and appropriate; and (4) the Agencies will ensure public participation and transparency in developing these measures.

Date	Event
January 2015	Draft Project Formulation, Effects Characterizations, Appendices, Fate Assessment, and modeling documents were received from EPA for initial comments, edits and questions from the Services

Purpose:
The Services reviewed all above mentioned documents and provided comments, editorial and content edits.

Date	Event	Attendees
April 15, 2015	4th Stakeholder Workshop on Joint Interim Approaches to NAS	EPA, NMFS, FWS USDA

Purpose:
On April 15, 2015, the Agencies held a one-day Stakeholder Workshop. This workshop provided a forum for all interested stakeholders to offer scientific and technical feedback on the ongoing efforts to develop draft Biological Evaluations (BEs) for the three pilot chemicals (chlorpyrifos, diazinon, and malathion).

Topics of Discussion
Description of the Federal Action/Opportunities for Refinement (PDF)
Geospatial Data for Mapping Pesticide Use Patterns (PDF)
Species Range Data (PDF)
Risk Hypothesis and Weight-of-Evidence Approach (PDF)
Aquatic Example (PDF)
Terrestrial Example (PDF)
CBD Presentation on Problem Formulation and Weight of Evidence (PDF)
CLA presentation (PDF)

Date	**Event**	**Attendees**
July 14, 2015	FESTF meeting	EPA, NMFS, FWS, USDA

Topic of Discussion
FIFRA Endangered Species Task Force (FESTF) presented to the Agencies their proposed approach for data gathering and delineation of species locations for refining species ranges maps. FESTF also discussed the Information Management System database they maintain and the next steps FESTF will take to gather data on species profiles, and additional data needs. FESTF is working to modernize and revamp the Information Management System. They want to work with the Agencies to ensure the improvements are compatible with our needs and useful to us. In addition, FESTF has completed species profiles for all listed species and they would like to work with FWS to figure out the best method is using the Information Management System and species information. There was a discussion of additional data as FESTF wants to facilitate access to any additional data we need.

Date	**Event**
June 2015	Draft Problem Formulation, Effects Characterizations, Appendices, Fate assessment, and modeling approaches documents received from EPA second round of revisions

Purpose:
The Services provided their second review of the above-mentioned documents.

Date	**Event**	**Attendees**
July 2015-2017	Ongoing weekly ESA Steering Committee calls	EPA, NMFS, FWS USDA

Purpose:
Weekly meetings held among the participants to discuss review of draft documents for the Biological Evaluations (BE), outstanding issues, and upcoming tasks that all participants in the process need to be aware of.

Date	Event
August 2015	Problem Formulation issues

Purpose:
FWS agreed to edit the Problem Formulation section with regards to drafting an update to the data quality guidelines to capture our agreements to date.

Date	Event
October 2015	EPA provides the Services with a final set of BE appendices for review

Date	Event	Attendees
November 1, 2015	Society of Environmental Toxicology and Chemistry (SETAC) North America Meeting All day platform pesticide session	EPA, NMFS, FWS USDA, FESTF and industry representatives

Purpose:
Presentations provided at SETAC gave an update and our process for this consultation as agreed to by the Agencies. In additions, there were presentations on the Step 1-3 process, methods for analyzing the information such as the weight of evidence approach to determining effects and constructing species sensitivity distributions.

Date	Event	Attendees
November 29, 2015	Presentation on Step 3 (NMFS)	EPA, NMFS, FWS USDA

Purpose:
NMFS provided a webinar to EPA and FWS to introduce how they will approach the Step 3 process based on how they have done their Biological Opinions in the past. Major topic areas of discussion in the webinar were the following:

1) What the BE provides
2) What additional information is needed for the Biological Opinions
3) What a Biological Opinion contains (sections required and what they add to the analysis)
4) Case example from previous Biological Opinions (Middle Columbia River Steelhead)
5) How this information informs the analysis and conclusion

Date	Event	Attendees
January 25-28, 2016	5th Interagency Workshop on Joint Interim Approaches to NAS	EPA, NMFS, FWS USDA

Purpose:
The Agencies discussed ideas for streamlining Steps 1 and 2 from Stakeholders and from interviews with Steering Committee members; decided which to adopt and/or consider further; made decisions on steps needed BEs to be completed in April; and determined how information

in the BEs would be transferred to the Services. The Agencies also discussed approaches and analytical methods for the Step 3 analyses, including: 1) a general process for the Step 3 analyses to include species groupings; 2) how to address species with little or no data; 3) how to incorporate weight-of-evidence information into the process; 4) qualitative versus quantitative information; and 5) how the magnitude of effect data would be used to estimate effect on a population scale.
These discussions helped to set the stage for future work on mitigation and monitoring issues related to Step 3, and discussed what opportunities exist for risk reduction discussion with registrants at the end of Step 2.

Date	Event
April 4, 2016	Public Release of Draft BEs

Purpose:
EPA released the draft BEs to the public for comment. The public comment period was for 60 days concluding on July 9, 2016. EPA compiled comments and questions and responded in December 2016, prior to the January 2017 release of the final BE.

Date	Event	Attendees
May 12, 19/June 16, 2016	Pesticide Webinars to representatives from FWS Regions/Field Offices	Regions 1-8

Purpose:
The Branch of National Consultations pesticide team requested assistance from the field offices to review a set of documents for accuracy and clarity to be used in the BEs and Opinions. These documents included the following:

1) Biological information on all taxa groups to be assessed in the BEs/Opinions (fishes, birds, reptiles, marine mammals, mammals, amphibians, plants, mussels, terrestrial invertebrates, aquatic invertebrates)
2) Habitat Bin assignments included requesting assistance from the field offices to review these data to ensure the species were placed in the correct habitat bins (static or flowing water bodies or both) based on their knowledge of life history of the species. This would ensure the species would have the correct Estimated Exposure Concentrations (EECs) calculated for exposure.
3) Pesticide Use Overlap assignment included our request for information from the field to determine if a particular species would enter a given use site (area where a pesticide might be used) if found within that species' range. Because pesticide concentrations will generally be higher on the use site itself (where pesticide application occurs) rather than in adjacent areas (where pesticide spray drift or runoff may occur), this information will greatly help us in assessing potential exposure to species.

Based on an overwhelming number of responses, the pesticide team decided to hold three webinars to discuss with field office biologists the process and why this information was requested. The outreach to the field included a walk-through of the specific instructions of what information the pesticide team required for the consultations.

Date	Event	Attendees
June 29-30, 2016	Two-day Interactive Stakeholder Workshop	EPA, NMFS, FWS USDA, NGOs, pesticide companies

Purpose:

The purposes of this workshop was to meet and discuss topic areas on short-term and long-term goals for the pesticide Section 7 consultations.

Date	What	Attendees
July 2016-August 2016	Methods Development for Step 3	EPA, NMFS, FWS

Purpose:

Meeting to address the methods be focused on for the transition from Step 2 to Step 3. The following topic areas were agreed upon and representatives from each agency participated in each group and held meetings that were scheduled once a week on different days from July 11-August 25:

- Magnitude of Response
- General Exposure
- Aquatic Exposure
- Terrestrial Exposure
- Mixtures
- Population Level Assessments
- Weight of Evidence Assessments
- Mitigation, Conservation Measures/Take Tracking

Some topic areas had already been discussed such as the aquatic exposure approaches for FWS aquatic species and terrestrial exposure for FWS species. A deadline of September 15, 2016 was set to have methods developed and in place to proceed for Step 3.

Date	What	Attendees
August 25, 2016	Managers meeting with Agency staff	EPA, NMFS, FWS

Purpose:

A senior managers' meeting was helped along with representatives from Agency staff (those leading the workgroups from EPA or FWS as well as all of NMFS staff) to discuss the progress of the workgroups. As a result of this meeting, the workgroups were put on hold and a decision was made to have a three day workshop to discuss the procedures that FWS and NMFS would use to make final conclusions on the jeopardy determination.

Date	What	Attendees
September 19-21, 2016	6th Interagency Workshop to to discuss transition to Step 3 and Step 3 methods development	EPA, NMFS, FWS

Purpose:
This 6th Interagency Workshop involved discussions regarding how the Services would approach determining jeopardy based on requests from EPA for a framework on this process. FWS and NMFS presented overviews of their respective approaches, covering details on progress made during the workgroup sessions on methods development. Topics covered included aquatic and terrestrial exposure, percent of population exposed (discussing spatial overlap issues), how EECs should be estimated for exposure (what percentiles are most demonstrative or useful to the analysis), estimating the magnitude of response on lines of evidence (mortality and sub-lethal) by using existing data and comparing these data to generated EECs, and briefly how to assess/characterize risk after determining a magnitude of response for the different lines of evidence. The workshop also included a brief discussion of usage data presented by EPA.

During the discussions on the magnitude of response, EPA suggested the development of a tool that would be able to automate the review of the EEC data with the magnitude of response data to provide a mortality assessment that would include the exposure route specifics (for a terrestrial or aquatic species) and calculate the percent mortality accordingly. Using Geographic Information System (GIS) inputs, percent use overlap (six years of Cropland Data Layer data aggregated), species range and HUC 12 as well as associated species bins for aquatics and dietary items for terrestrial species, the tool could calculate the mortality of the population on field or off (using AgDrift calculations). Some of the flexibilities of the tool discussed were if it could calculate only a percent of the population exposed, then an adjustment factor for seasonality could be integrated into the tool. For the percent of the population not exposed directly to EECs on the field, spray drift analysis will be conducted using the spray drift curves, magnitude of effect information, highest application information, aggregated percent use overlap (percent of species exposed) and Euclidian distance information to determine effects at 30 meter increments from a treated field. This tool has been named the MagTool.

Date	**What**	**Attendees**
November 29, 30, Dec 1, 2016	7th Interagency Workshop to discuss Integration and Synthesis	EPA OPP, NMFS, FWS

The Agencies met for a three-day Integration and Synthesis Workshop with the goal of developing and agreeing to a process for Step 3. We discussed how to address the effects analyses using species specific examples and shared the Services' draft process for Step 3 frameworks. We discussed how best to work through the MagTool and other effect considerations (ear tags, dermal exposure, etc.). We reviewed the MagTool as a group to generate information and troubleshoot challenges related to defining effects and estimating percent of population exposed. Discussed challenges from example species, how to extrapolate methods to other groups of species and how the effects of the action and weighting would work before including in the integration and synthesis section.

CHAPTER 3

ASSESSEMENT FRAMEWORK

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3 ASSESSMENT FRAMEWORK

Section 7(a)(2) of the Endangered Species Act (ESA) requires federal agencies, in consultation with the National Marine Fisheries Service (NMFS), to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species; or adversely modify or destroy their designated critical habitat.

"Jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of an ESA-listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 C.F.R. §402.02).

"Destruction or adverse modification" means a direct or indirect alteration that appreciably diminishes the value of designated critical habitat for the conservation of an ESA-listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features (PBFs) essential to the conservation of a species or that preclude or significantly delay development of such features (50 C.F.R. §402.02). An ESA section 7 assessment involves the following steps:

3.1 **Effects of the Action**

To conduct effects analyses, we follow an ecological risk assessment framework based on the National Research Council National Academies of Sciences report on pesticides and endangered species (NRC NAS 2013). The Environemental Protection Agency (EPA), United States Department of Agriculture (USDA), Fish and Wildlife Service (FWS), and NMFS adapted the report's framework to meet the specific needs of an ESA consultation. The framework divides the pesticide ESA consultation process into three steps (***Figure 1***). Each step builds upon analyses and findings from a previous step. The interagency group worked together to produce a transparent, systematic, and rigorous analysis based on ecological risk assessment principles.

EPA combined Steps 1 and 2 in their Biological Evaluations (BEs) (***Figure 1***). EPA wrote separate BEs for chlorpyrifos, diazinon, and malathion (USEPA 2017a,b,c). The ecological risk assessment used in the BEs contained a problem formulation, an exposure analysis, a response analysis, and a risk characterization that supported EPA's effect determination.

EPA made species' effect determinations i.e., no effect; not likely to adversely affect (NLAA); or likely to adversely affect (LAA) for each pesticide-species combination (USEPA 2017a,b,c). A "no effect" determination indicates that the stressors of the proposed action will not affect an individual of a listed species or designated critical habitat. A "not likely to adversely affect" determination indicates that the effects of the proposed action on the fitness (survival or reproduction) of an individual of a listed species is expected to be discountable[1], insignificant[2], or completely beneficial[3]

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[1] Dicountable effects are those extremely unlikely to occur.

[2] Insignificant effects relate to the size of the impact, and are effects a person would not be able to meaningfully measure, detect or evaluate. They should never reach the scale where take occurs.

[3] Benefical effects are contemporeaneous positive effects without any adverse effect to the species.

(Endangered Species Consultation Handbook). Note that if EPA concludes in its Step 2 determination that its action is "not likely to adversely affect" a particular species or habitat, and NMFS concurs, then the consultation process ends at Step 2. If individuals of a listed species are not adversely affected, then listed species and the populations that comprise them are not adversely affected and no further analysis is needed. EPA made a "likely to adversely affect" determination if it found any adverse effect to any individual of a listed species may occur as a direct or indirect result of the proposed action and the effect is not discountable, insignificant, or beneficial (Endangered Species Consultation Handbook).

Within the Risk Characterization section of the BEs, EPA conducted a weight-of-evidence analysis to determine whether lines of evidence were supported (i.e., an adverse effect was identified). In EPA's analysis, lines of evidence are used to determine if an individual of a listed species is adversely affected. The lines of evidence are based on toxicological endpoints such as mortality and reproduction. The lines of evidence are analogous to risk hypotheses. EPA based each line of evidence on either adverse effects to an individual (direct effects) or adverse effects to species' habitats (indirect effects such as effects on prey). In this manner, a supported line of evidence indicated that an ESA-listed individual's fitness (its survival or reproduction) would likely be compromised. EPA weighed each line of evidence to determine the risk to individuals and the confidence they had in their conclusion for each line of evidence. Thus, EPA conducted a weight-of-evidence analysis in the BEs. If a line of evidence was supported, EPA made an LAA determination for that species-pesticide combination. If EPA found all lines of evidence to be unsupported, EPA made an NLAA determination. NMFS reviewed each of EPA's NLAA determinations and concurred, thus concluding informal consultation on those species.

For species where EPA concluded LAA, the consultation moved on to Step 3, the Biological Opinion (formal consultation). With regard to effects on listed species, the fundamental difference between Step 2, Biological Evaluation, and Step 3, Biological Opinion, is we evaluate whether the anticipated adverse effects to individuals (described in the BEs) negatively affect populations and the species they comprise. Using the ecological risk assessment framework, described below, we conducted two distinct analyses within an Opinion. The first evaluated the risk to populations of listed species, when identified, and to entire listed species and provides the jeopardy analysis for each species; and the second evaluated the risk to a species' designated critical habitat, and provided the adverse modification of designated critical habitat analysis. The analyses were based on the best commercial and scientific data available.

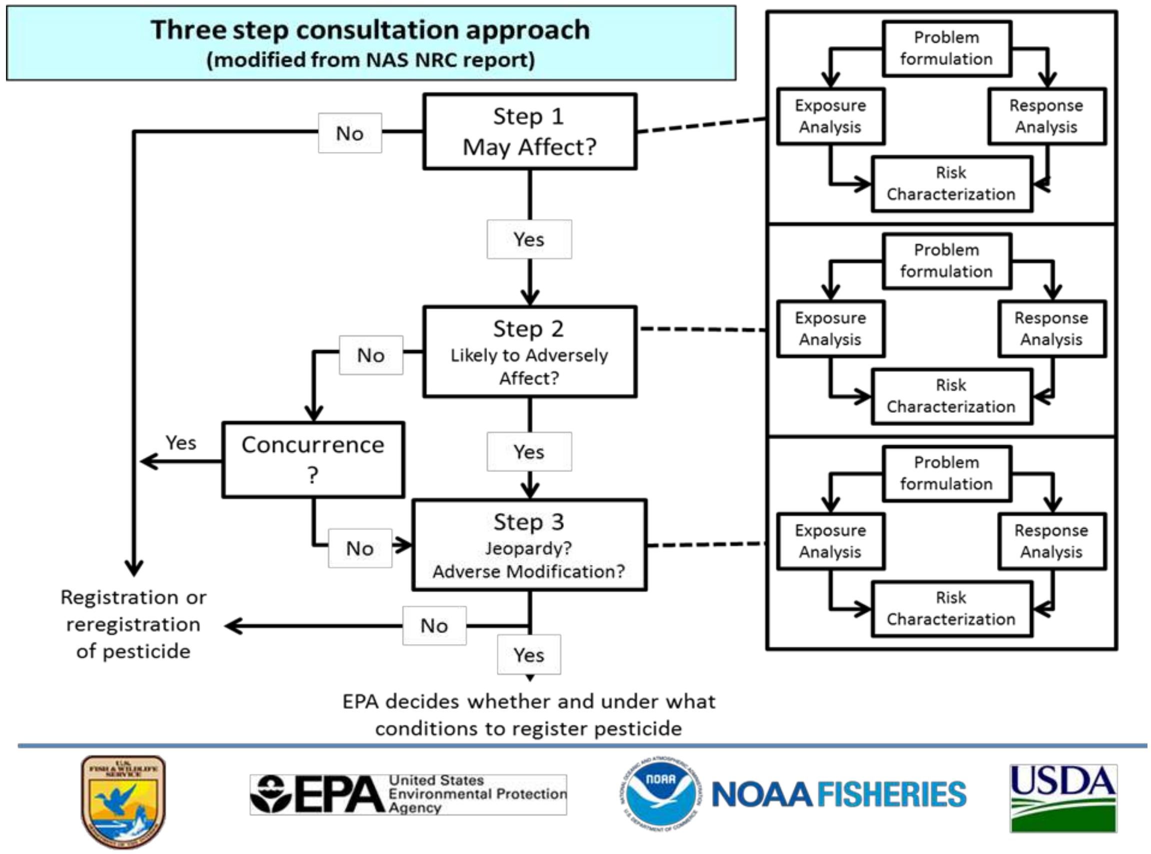

Figure 1. Three step consultation process

3.2 Information used in Biological Opinion

To comply with our obligation to use the best scientific and commercial data available, we collected information from a variety of sources. This opinion is based on our review and analysis of various information sources, including:

- EPA's Biological Evaluations
    - Pesticide label information found in Description of the Action section
    - Exposure outputs (estimated environmental concentrations) from EPA's fate and transport modeling
    - Toxicity data found in Response sections
- EPA's ECOTOX database; contains published scientific studies and pesticide manufacturer studies
- Published Scientific literature
- Other scientific literature, such as reports of government agencies or non-governmental organizations
- Correspondence (with experts on the subject from EPA and others)
- Available biological and chemical surface water monitoring data and other local, county, and state information

- Pesticide registrant generated data and information
- Pesticide exposure models, i.e. mathematical models that estimate exposure of resources to pesticides
- MagTool outputs: an Excel spreadsheet-based model, developed by EPA, which integrates exposure, response, and geographic information systems (GIS) analyses to provide effects probabilities, i.e. probabilities of effects to listed species and the populations that comprise (see description below)
- Salmonid population models
- R-Plots; NMFS' tool based on R-code that summarizes exposure and toxicity information by use site and is used to determine likelihood of exposure and effect of exposure to groups of individuals and designated critical habitat (see description below).
- Comments, information and data provided by the registrants identified as applicants
- Comments and information submitted by EPA
- Pesticide incident reports and field data

Collectively, the above information provided the basis for our determinations as to whether the EPA can insure that its authorization of chlorpyrifos, diazinon, and malathion is not likely to jeopardize the continued existence of threatened and endangered species, and is not likely to result in the destruction or adverse modification of designated critical habitat.

3.3 **Problem Formulation**

Problem formulation includes conceptual models based on the initial evaluation of the relationships between stressors of the action (pesticides and other identified chemical stressors) and listed species and their habitats. We consider the toxic mode and mechanism of action of the three pesticide active ingredients (a.i.s) to provide insight into potential consequences following exposure. Identification of the mode and mechanism of action allows us to identify other chemicals that might co-occur and affect species and their habitats (*i.e.,* identify potential toxic mixtures in the environment).

We utilize the same conceptual models presented in the Step 2 analysis in EPA BEs. Chlorpyrifos, diazinon, and malathion conceptual model examples are shown in ***Figure 2, Figure 3***, and ***Figure 4***. The models identify the stressors associated with the proposed actions, the pathways and routes of exposure, the effects to be evaluated, and relationships between exposures and effects (USEPA 2017 a,b,c). As noted above, the fundamental difference between Step 2, Biological Evaluation, and Step 3, Biological Opinion, is we evaluate whether the anticipated adverse effects to individuals (described in the BEs) negatively affect populations and the species they comprise. However, we begin our Step 3 analysis by building on the Step 2 analysis. Additionally, we evaluate whether adverse effects to primary biological features (PBFs) reduce designated critical habitat's conservation value.

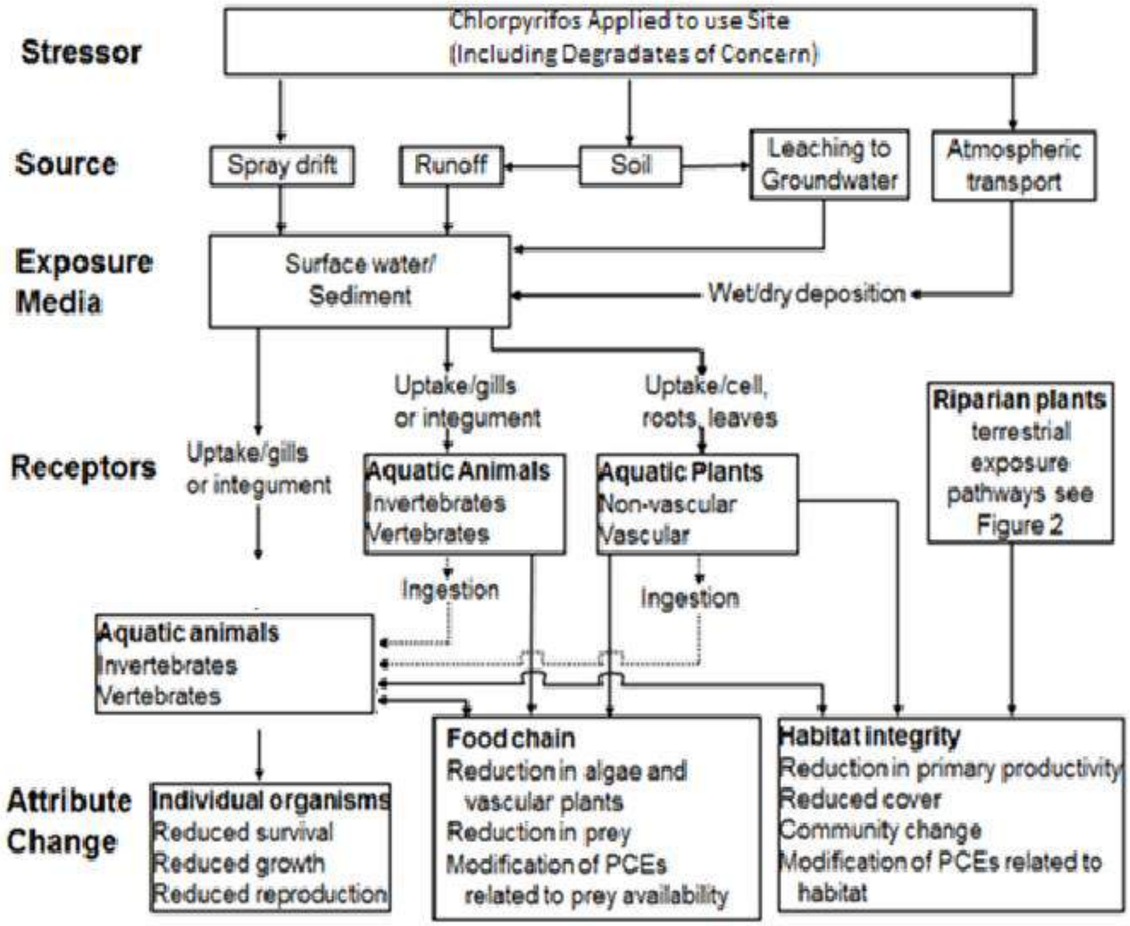

Figure 2. Conceptual model for chlorpyrifos effects to aquatic organisms (USEPA 2017a; Chapter 1)

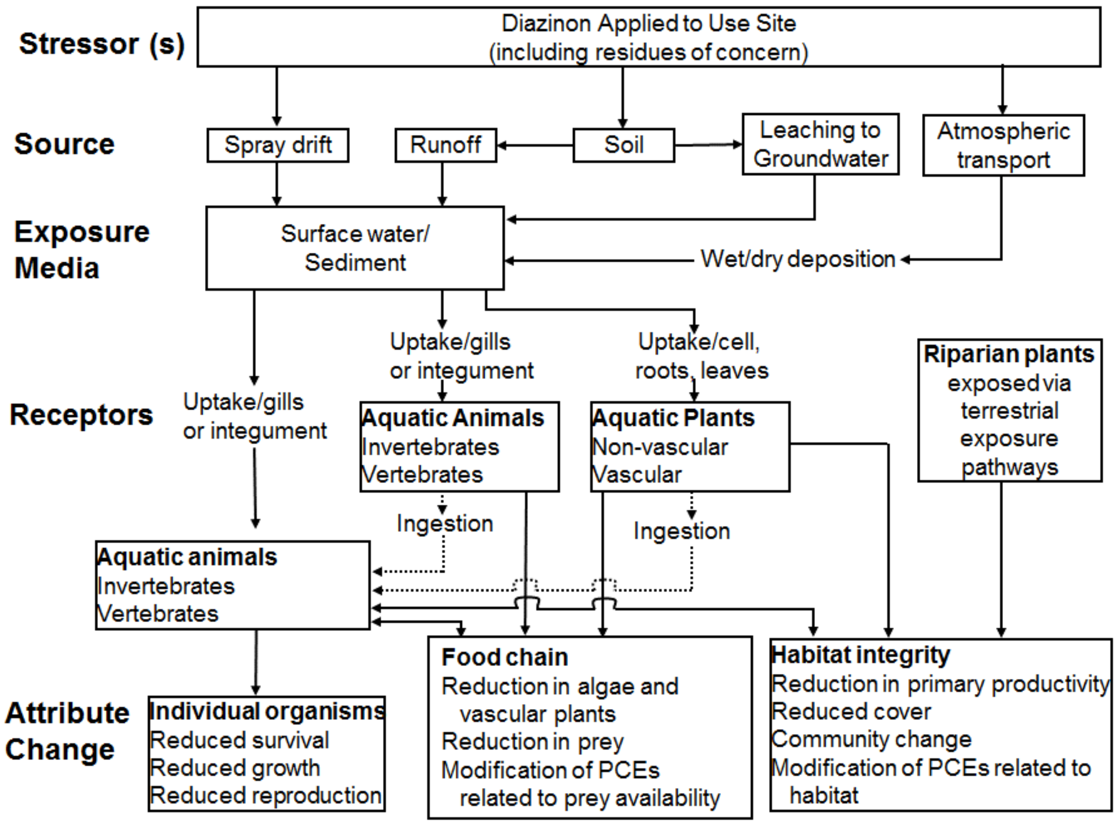

Figure 3. Conceptual model for diazinon effects to aquatic organisms (USEPA 2017b, Chapter 1)

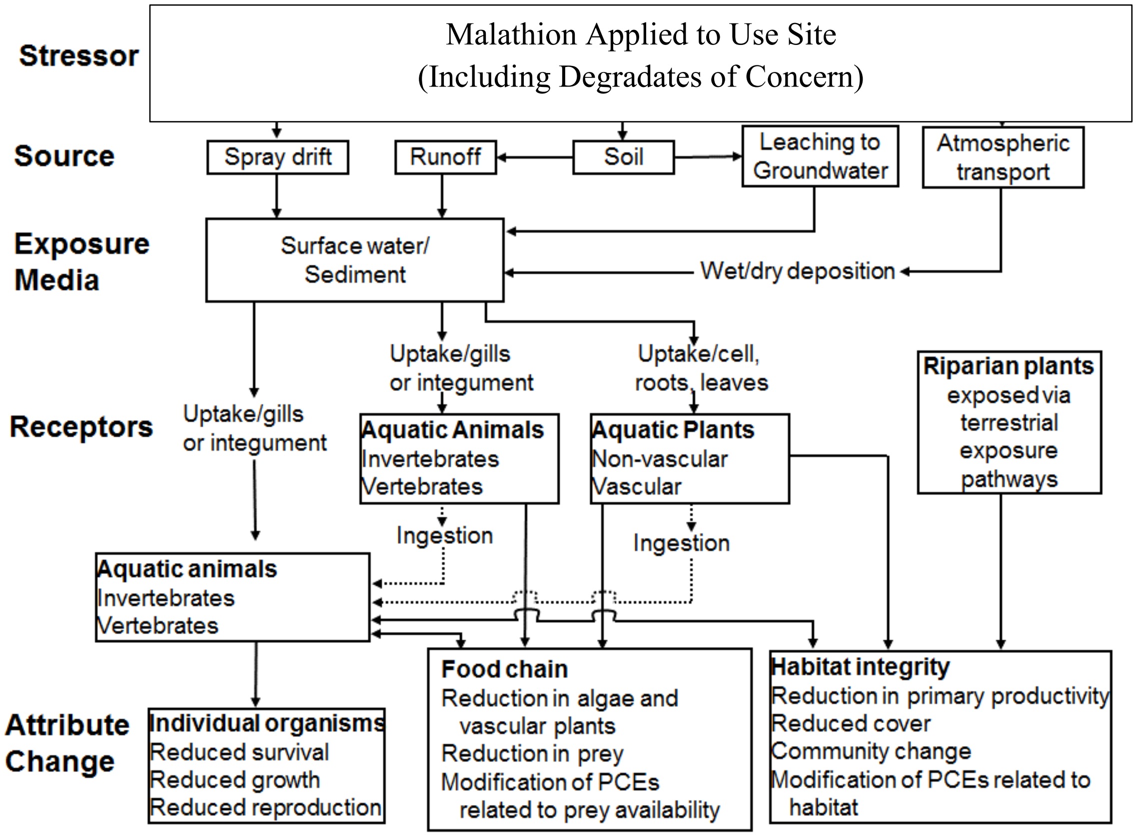

Figure 4. Conceptual model of malathion effects to aquatic organisms (USEPA 2017c, Chapter 1)

Direct deposition of chlorpyrifos, diazinon, and malathion onto treated sites as well as transport via spray drift, runoff and volatilization resulting in atmospheric (including long-range) transport are depicted in the conceptual models as sources that result in the movement of the pesticides into aquatic and terrestrial habitats. The movement away from the site of application in turn represents exposure pathways for a broad range of biological receptors of concern (non-target organisms) and the potential attribute changes, *i.e.*, effects such as reduced survival, growth and reproduction.

Where EPA determined that individual fitness is likely compromised by the action (lines of evidence were supported), and therefore made an LAA determination then we determined for the Step 3 analysis if those fitness reductions are likely to be sufficient to reduce the viability of the populations those individuals represent (assessed using changes in the populations' abundance, reproduction, spatial structure and connectivity, growth rates, or variance in these measures to make inferences about the population's extinction risks). Reductions in a population's abundance, reproductive rates, or growth rates (or increased variance in one or more of these rates) based on effects to individuals represents a *necessary* condition for reductions in a population's viability, which is itself a *necessary* condition for reductions in a species' viability. Finally, our assessment determines if changes in population viability structured as risk hypotheses are likely to be sufficient to reduce the viability of the species those populations comprise. In this step of our analyses, we consider the Environmental Baseline and Cumulative Effects, and consider the species' pre-action condition, established in the Status of the Species.

For designated critical habitat, we determined if adverse effects (primarily, effects on water quality and prey availability) are likely to be sufficient to appreciably reduce the value of the critical habitat for the conservation of the species. To determine whether this occurs, we consider the designated critical habitat's pre-action condition, established in the Status of the Listed Resources, as well as Cumulative Effects and the Environmental Baseline.

3.4 Analysis Plan

Our analysis plan applies information from EPA's Biological Evaluations to develop an assessment plan to conduct Step 3 population level analyses within the risk characterization section of this Opinion.

We took the exposure and response information directly from EPA's Biological Evaluations. As noted above, we worked closely with EPA in its preparation of this information, and our work builds on this Step 2 analysis. In the Exposure Section we describe species life history information and aggregate the species into seven taxa groups based on shared life histories and habitat uses. The taxa groupings include: anadromous fish, marine fish, marine invertebrates, sea turtles, cetaceans (whales), pinnipeds (seals and sea lions), and marine plants.

In the response section (Chapter 11), we present the mode and mechanism of toxic action for each pesticide; identify the other stressors of the action such as other chemicals within pesticide formulations; describe a pesticide's chemical and physical properties that influence its persistence in the environment; and identified key assumptions and associated uncertainties of the analytical tools and models used in the effects analyses.

The risk characterization section includes the bulk of our Step 3 analyses where we integrate the exposure and response information developed in EPA's Step 2 Biological Evaluations. We employed a weight-of-evidence approach to determine for each risk hypotheses whether the risk from the action (without consideration of the species status, the environmental baseline or cumulative effects) was high, medium or low. A risk hypothesis is a statement of anticipated effects to life stage groupings of a species such as reductions in a population's abundance or productivity following exposure to the stressors of the action. To arrive at that level of risk for each risk hypothesis, we addressed not only effect of exposure and the likelihood of exposure, but also our level of confidence in the risk level. We developed rule-based criteria to provide a systematic approach for assessing the likelihood of exposure and the effect of the exposure. We constructed risk hypotheses for each species grouping and designated critical habitats; an example is shown in ***Table 1***.

Table 1. Example risk hypotheses for adults of a species and designated critical habitat

Risk Hypotheses for Adults:
Exposure to chlorpyrifos is sufficient to reduce adult abundance via direct exposure (mortality)
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction (reproduction)
Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors. (behavior; sensory)
Exposure to chlorpyrifos is sufficient to reduce cholinesterase activity; the identified mechanism of toxicity (enzyme).
Mixtures: Formulated products and tank mixtures containing chlorpyrifos are anticipated to increase risk to direct and indirect effects to fish in freshwater habitats
Abiotic Stressors: Exposure to elevated temperatures enhances the toxicity of the stressors of the action.
Risk hypotheses for designated critical habitat:
1. Exposure to the stressors of the action is sufficient to reduce the conservation value via reductions in prey in rearing sites.
2. Exposure to the stressors of the action is sufficient to reduce the conservation value via degradation of water quality in migration, spawning, and rearing sites.

To evaluate risk hypotheses we used R-plot graphics, the MagTool, and when available, salmon population modelling. The R-plots are a NMFS' analytical tool that overlays toxicity data, i.e. values at which adverse effects are detected, with exposure information, i.e. estimated environmental concentrations (EECs) in differing types of aquatic habitats (referred to as bins in EPA's Biological Evaluations). The aquatic habitats were developed to reflect different exposure ranges based on species' use of a variety of aquatic habitats. We describe the R-plot tool immediately below.

3.4.1 R-plot Tool

The R-plot summarizes several types of information used in the Risk Characterization section. An R-Plot displays pesticide exposure output (i.e. EECs) for aquatic habitats and toxicity data. As noted above, the exposure output and the toxicity data are taken from EPA's Biological Evaluations. We use the data presented in the R-plots to determine whether effect of exposure to chlorpyrifos, diazinon, or malathion is low, medium or high for each use. We also use R-Plots to aid in evaluating the likelihood of exposure for species and critical habitat. The sample R-plot below shows data for Ozette Lake Sockeye salmon (***Figure 5)***. The R code used to generate the plots and additional information on the code is included in Appendix F.

An R-plot graphic is read by (1) selecting an EEC for a use from the center of the plot; (2) reading up to a toxicity row associated with an endpoint e.g., mortality, to determine the level of effect predicted from the EEC; and (3) looking on the right side of the plot to identify the percentage of area that overlaps with the species range.

Note that the toxicity rows are constructed two different ways, depending on the assessment endpoint and the number of toxicity studies. For the first five rows (enzyme, sensory, behavior, reproduction and growth), the rows include the assessment endpoints from all relevant studies presented in EPA's BEs, from the lowest concentration that resulted in an effect to the endpoint on the left to the highest concentration that resulted in an effect on the right, thereby capturing the range of concentrations causing effects to the associated endpoint. For these five endpoints, there were not enough studies to conduct a species sensitivity distribution. The concentrations eliciting effects for each endpoint typically varied due to a variety of issues including the studies were conducted using different species of animals, different experimental regimes, different aged animals, etc.

For mortality and prey, we had a sufficient number of toxicity studies to establish species sensitivity distributions, which show the distribution of the various concentrations eliciting death to fish and prey to the same chemical. To insure that our evaluation is sufficiently protective for the mortality and prey we constructed the toxicity row to consider the more sensitive species within the distribution, in this case, the 5th percentile of species that respond at the lowest concentrations for fish and 10th percentile of species for prey.

The bottom four lines of the R-plot indicate the following:

- The first line shows the chemical and the text file selected containing the toxicity data shown on the plot.
- The second line shows the aquatic EEC averaging periods that are being summarized.
- The third line provides the HUC-12 region(s)[4] and the aquatic habitats (bins) that individuals of a listed species occupy. EPA generated EECs for each aquatic bin. Aquatic habitats, referred to as bins, include three static freshwater habitats of varying volume, three flowing water habitats of variable volume and flow rates, and three marine/estuarine habitats representative of nearshore tidal, nearshore subtidal, and offshore habitats.

[4] HUC stands for "hydrologic unit code," and refers to a hierarchical system of geographic units employed by the U.S. Geological Survey. HUC-12 is a subwatershed level area.

- The bottom line shows the species name, EPA assigned ID number, and the spatial extent (number of HUC-12's) over which the data is summarized. In this example, data for the entire range for the Ozette Lake Sockeye salmon is being aggregated, which consists of five HUC-12 regions.

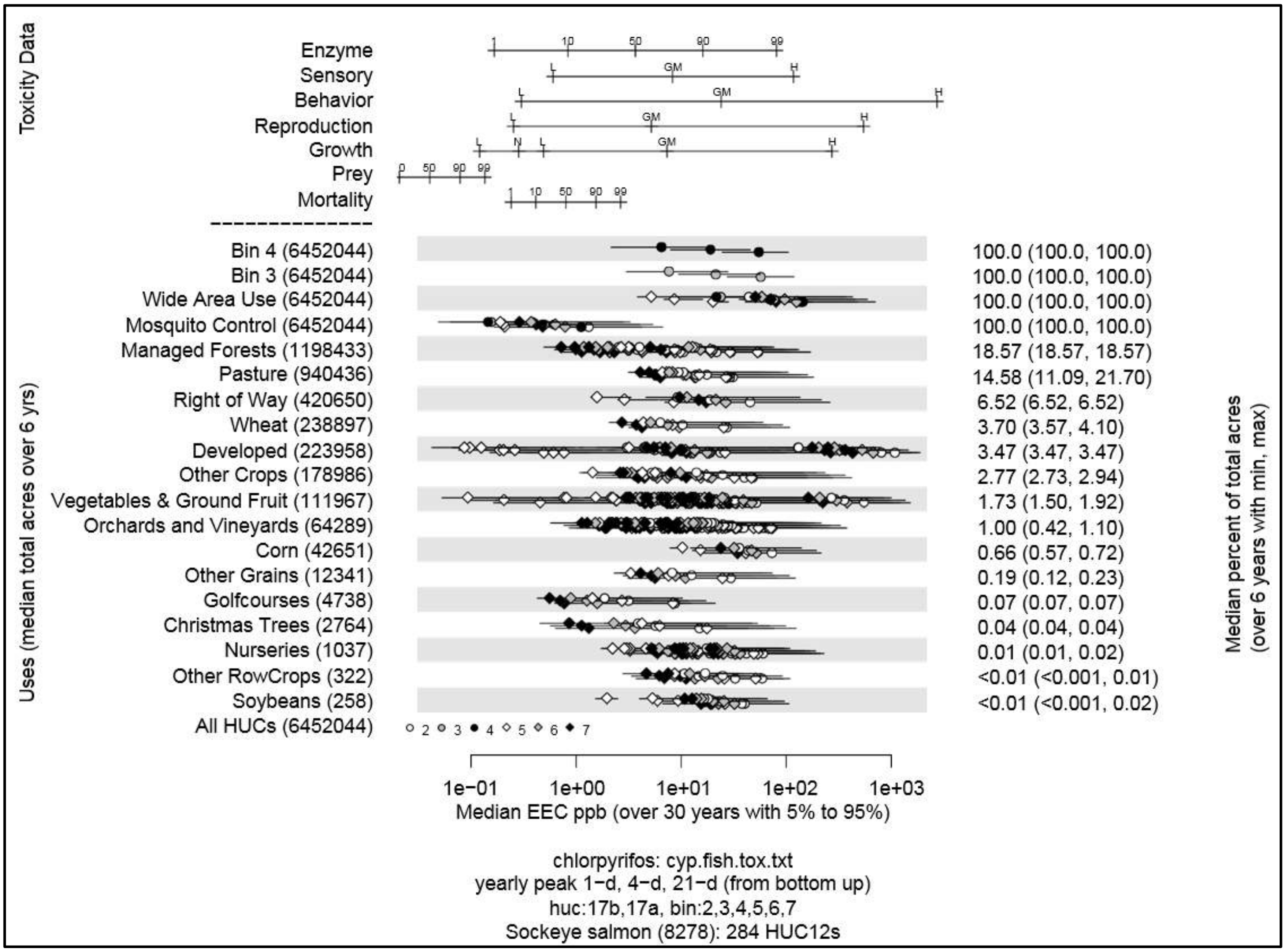

Figure 5. R-plot

The remainder of the plot is organized into several components:

1) The upper portion of the plot presents the toxicity data in a series of rows based on toxicological endpoints e.g., growth, mortality, etc. For endpoints such as growth, along the row "N" denotes a no observed effect concentration (NOEC), "L" the lowest observed effect concentration (LOEC), "GM" the geometric mean of LOECs, and "H" the highest LOEC value for a given endpoint. For endpoints such as mortality, the bar indicates concentrations that produce the specified effect levels (e.g. 90% mortality) based on the dose-response relationship for the lowest 5th percentile of species tested.
2) The center of the plot shows EECs grouped by use, aquatic habitat (bin), and averaging period (i.e., 1-d (one day), 4-d (four day), 21-d (twenty-one day).

Each EPA Pesticide Water Calculator (PWC)[5] run for each use is shown as the median EEC with the 5-5% confidence interval[6] depicted as a horizontal line. Each aquatic bin is shown as a different symbol. The legend at the bottom denotes the symbols used aside each bin number. The four rows of points for each use show the different averaging periods for the aquatic EECs. From bottom to top, they are 1-d, 4-d, and 21-d. EECs for aquatic habitat bins 3 and 4 are plotted separately, since they represent watershed-scale exposures aggregated across all uses (excluding Wide Area and Mosquito Control).

3) The acreages for the uses located within the HUC-12s are listed on the lower left Y-axis. The numbers display the median value of the total acres across all the HUC-12s for the particular use across the six years of Cropland Data Layer (CDL)[7] data; shown in the parentheses.
4) The lower right portion of the Y-axis displays the median, minimum and maximum percent of the total acres of the HUC-12s represented by the total acres of the use for each of the six years.

3.4.2 Effect of Exposure Using R-plots

Each use/use site is evaluated to determine whether the effect of exposure is low, medium, or high based on the aquatic habitat bin EECs and the toxicity information. We apply the following rules:

- A "low" rank is achieved when all EECs are below the lowest effect level identified in EPA BEs.
- A "medium" is achieved when any EEC from an aquatic bin falls between the lowest effect level and the median or the 50% effect level.
- A "high" is achieved when any EEC from an aquatic bin exceeds the median or the 50% effect level for a given toxicity range. Next, we evaluate the likelihood of exposure.

3.4.3 Likelihood of Exposure

The likelihood of exposure analysis evaluates seven factors to arrive at a low, medium, or high finding ***Table 2***. The factors include:

1) Percent overlap of a species' U.S. range with a pesticide's approved uses. Each use is assigned a category of 1, 2, or 3 depending on the degree of geographic overlap of use acreage with the species' U.S. range acreage (aggregation of HUC-12s that delineate the species range). Use acreage comes from EPA-derived GIS layers and is presented on the left Y-axis of the R-plot. Species range comes from NMFS listing documents.

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[5] An integration of USEPA pesticide fate models PRZM5 and VWM as described in USEPA's Biological Evaluations.
[6] the 5-95% confidence interval line represents the range of values within which we are 95% confident that the true value falls, given the variability of the data.
[7] National Agricultural Statistics Service GIS data layers on cropland for all the lower forty -eight conterminous states.

2) Seasonal analysis based on allowable application timing overlaid with species' timing to determine co-occurrence. EPA provided application timing of pesticides based on authorized labels. We provided species timing of occupancy for aquatic areas. The co-occurrence addresses whether pesticides are allowed to be applied during species presence.
3) Persistence of the pesticide based on environmental fate issues. We evaluated the environmental fate information provided in the BE to determine whether the pesticide is considered persistent. As a rule of thumb, we answered yes to persistence if the pesticide would remain in aquatic areas after 100 days.
4) Number of applications allowed. We reviewed EPA's description of the action from the BE to determine whether multiple applications were allowed on each use site.
5) Proximity analysis, for use sites with less than 1% overlap within a species range. We used GIS maps to determine whether use sites were within 300 meters of listed species aquatic habitats at sub HUC-12 scales. This allowed us to visually assess whether species habitats could be substantially exposed to a use site with <1% overlap.
6) Duration of species occupancy in aquatic systems. We review the species life history to determine the approximate duration for residency and migration.
7) Portion of species range within US territories/jurisdiction.

Table 2. Criteria used to determine likelihood of exposure

Factor	Criteria Description	Criteria
Percent overlap of use site within species HUC-12 watersheds	low overlap = <1% = category 1 Medium overlap = 1-5% = category 2 High overlap = >5% = category 3	category (1;2;3)
Seasonal Analysis (proportion of year life stages are potentially exposed)	Are any species life-stages present in overlapping areas when pesticide application are allowed? (Y/N)	Yes or No
Persistence of pesticide	Is pesticide considered persistent? (Y/N) Rule of thumb: pesticide lasts for more than 100 days in an aquatic habitat	Yes or No
Number of applications	Are multiple applications authorized per year? (Y/N)	Yes or No
Proximity of use sites to sensitive areas	Are use sites within 300 meters sensitive areas within the species life-stage grouping? (Y/N)	Yes or No

Time spent occupying aquatic areas	Species residency: Days, months, years <30 days=1 ; 1-6 months(1-2 seasons) = 2; multiple years = 3 Species migration: Days <7 days =1; 7-21 days =2 ; >21 days = 3	category (1;2;3) category (1;2;3)
Portion of species range within US territories/jurisdiction	Use site overlaps are reduced qualitatively (or by a factor if data allows). Portion of species range within U.S. must not be disproportionately important to species life history for this factor to apply.	category (small; medium; large) or percent if available

For each species assessed, NMFS has characterized the "likelihood of exposure" relative to each use site (e.g. corn, wheat) within that species' range. The likelihood of exposure for each use site is characterized as either low, medium or high depending on the criteria determined for each of the seven likelihood factors. Unique combinations of the seven likelihood factors result directly in the likelihood of exposure being characterized as either low, medium, or high according to the decision key in ***Table 3.***

The likelihood factor, "Proximity to sensitive area" was assessed qualitatively for each use site layer that represented less than 1% of the species range. NMFS used GIS mapping and species distribution/life history information to determine whether sites were aggregated in proximity to sensitive areas (e.g., known spawning streams or nursery areas). When evaluating a map, we considered aggregation of use sites within a HUC-12 as "in proximity" when they were within 300 meters where we had anticipate the pesticides would either runoff or drift to those habitats. For many of the salmonids assessed, NMFS determined sensitive areas by identifying those streams which support populations that have been identified in recovery plans as "core populations."

The likelihood factor "Portion of species range in US territories" was considered for 23 of the listed species including: all coral species (14), leatherback sea turtle, hawksbill sea turtle, Central West Pacific DPS green sea turtle, East Pacific DPS green sea turtle, North Atlantic DPS green sea turtle, South Atlantic DPS green sea turtle, Nassau grouper, Gulf grouper, and Guadalupe fur seal. Of these species, 15 had quantitative data available representing the portion of their range within the US: all corals (14) and the East Pacific DPS green sea turtle. In these cases, NMFS modified the use site percent overlaps by applying an adjustment factor corresponding to the portion of the species range within the US. Once modified, the percent overlap categories were assessed according to the rule outlined in ***Table 3***.

Table 3. Likelihood of exposure decision key*

Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range in US territories**	Likelihood of Exposure
3	yes	yes	yes	NA	3		**High**
3	yes	yes	yes	NA	2		**High**
3	yes	yes	yes	NA	1		**High**
3	yes	no	yes	NA	3		**High**
2	yes	yes	yes	NA	3		**High**
1	yes	no	yes	yes	3		**High**
1	yes	yes	yes	yes	3		**High**
3	yes	yes	yes	NA	3	Medium	**Medium**
2	yes	no	yes	NA	3		**Medium**
3	yes	yes	yes	NA	3		**Medium**
2	yes	no	yes	NA	3		**Medium**
2	yes	no	yes	NA	2		**Medium**
3	yes	no	yes	NA	2		**Medium**
1	yes	no	yes	yes	2		**Medium**
1	no	yes	yes	yes	3		**Medium**
NA	yes	yes	yes	NA	3		**Medium**
1	yes/no	yes/no	yes/no	no	1/2/3		**Low**
1	yes/no	yes/no	yes/no	yes/no	1		**Low**
1	no	no	yes	yes	3		**Low**
NA	yes	yes	yes	NA	3	Medium	**Low**
1/2/3	yes/no	yes/no	yes/no	no	1/2/3	Small	**Low**

**The combinations provided in this key are not exhaustive, rather they represent only those combinations which were encountered in this Opinion.*
***This factor is only considered when the criteria are "small", "medium" or when a precise portion is known. See narrative below for additional information regarding this factor.*

At this point in the analysis, we've determined the "likelihood of exposure" and the "effect of exposure" for each category of use (use site) or habitat bin, for the identified toxicity endpoints. For example, for each species, the above determines the effect of exposure and likelihood of exposure by use/ use site (e.g., "Managed Forests"), and each toxicity endpoint (e.g., "Reproduction").

3.4.4 Risk Determination for Each Risk Hypothesis

In this step, we evaluate each risk hypothesis using the combined results of the "likelihood of exposure" and "effect of exposure" determinations. As noted earlier, risk hypotheses are based on population level effects (abundance and productivity) which manifest when a group of individuals exhibit compromised fitness. For example, a risk hypothesis might be: "Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors." The use-specific "likelihood of exposure" and "effect of exposure" evaluations are compiled to rate each risk hypothesis as posing a high, medium, or low risk. This is illustrated in ***Figure 6***. A "high" risk determination for a risk hypothesis is assessed when, for any toxicity endpoint relevant to a risk hypothesis, one or more use sites had a high "effect of exposure" and a high "likelihood of exposure" ("high/high") and/or use sites with a high/medium combination (red squares in ***Figure 6***). For example, taking the above example of a risk hypothesis involving "impairments to ecologically significant behaviors," the toxicity endpoints labeled "Enzyme," "Sensory, and "Behavior" apply to this risk hypothesis. If one or more of the uses showed a high "likelihood of exposure" and a high "effect of exposure" for such an endpoint, we would assess that there was a "high" risk associated with this particular risk hypothesis for this particular species. In similar fashion, a medium risk determination for a risk hypothesis stems from likelihood of exposure and effect of exposure combinations of high/low; medium/low; and medium/ medium (yellow squares in ***Figure 6***). A low risk determination for a risk hypothesis stems from likelihood of exposure and effect of exposure combinations of low/low, low/medium, or low/high (green squares in ***Figure 6***).

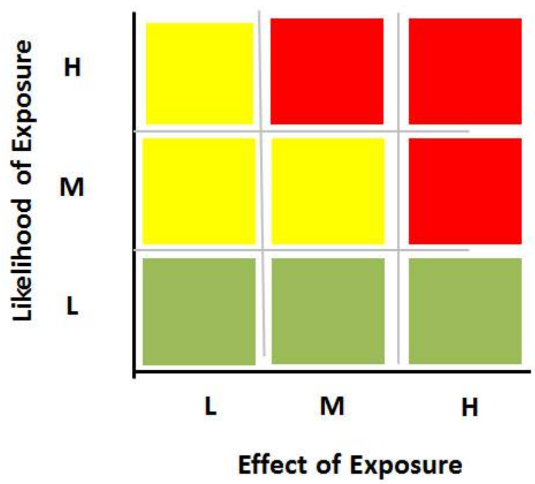

Figure 6. Ranking Risk Hypotheses Based on Uses. Each use is plotted based on Likelihood of Exposure finding and Effect of Exposure finding. L=low, M=medium, H=high; Red squares indicate a risk hypothesis has high risk; yellow squares indicate medium risk; and green squares indicate low risk.

3.4.5 Confidence Ranking for Each Risk Hypothesis

Once we have determined the risk ranking for a risk hypothesis, we then evaluate the level of confidence we have in that ranking. The confidence underscores the level of certainty or strength we have in the risk determination. The confidence level in the risk determination is evaluated and assigned a low, medium, or high level of confidence after evaluating four factors:

1) Number of similar combinations of likelihood of exposure and effect of exposure e.g., the more uses and toxicity endpoints for which there is the same combination of "likelihood of exposure" and "risk of exposure" (e.g.,

"high/high," ("low/medium"), the more confidence we have in the low/medium/high risk assignment for the associated risk hypothesis.

2) Percentage of use site overlapping with species' range (e.g., the greater the percentage of overlap between use sites and the species' range, the more confidence we have in a risk hypothesis ranking of "high risk"; and the lower the percentage, the greater confidence we have in a risk hypothesis ranking of "low risk").
3) Representativeness of EPA's pesticide estimates as realistic exposure values for species' habitats (see Chapter 11.6.4). For example, we ascribed lower confidence in pesticide estimates for estuarine, nearshore marine and offshore marine habitats because EPA's models were not developed for these types of aquatic habitats. EPA and NMFS had greater confidence in pesticide estimated developed for edge of field aquatic habitats as these were the focus of EPA's modeling and therefore we ascribed higher confidence in these values. We also ascribed lower confidence in EPA's pesticide estimates for larger watersheds because all use sites would not be treated at the same time although EPA's estimates assumes this. For additional reasons we have a lack of confidence in EPA's watershed estimates (see Chapter 11).
4) Representativeness of toxicity information for threatened and endangered species. We reviewed the BEs weight of evidence tables to evaluate the level of confidence in the toxicity information used to determine effects to a listed species and its habitats. We ascribed more confidence to the toxicity data when EPA's ranking was "high" for data robustness and relevance. We had lower confidence for those data ranked as low by EPA. Additionally, we ascribed higher confidence for a toxicity endpoint when a robust species sensitivity distribution (SSD) was available and lower confidence when one was not available. We also evaluated how representative an SSD was for the species being assessed. If the species was part of the SSD or other species in the same Genera were in the SSD that gave us more confidence that the species would be represented by the toxicity information. In many cases listed marine species (e.g., corals, rock fish, abalone) were not well represented by the available SSDs and therefore we had less confidence in the toxicity information. For sublethal effects there were few if any SSDs, therefore we evaluated confidence by reviewing the distribution of LOECs and the number of studies. The narrower the distribution of LOECs, the higher confidence we had in the effect and the more studies that were conducted the higher our confidence.

3.4.6 Overall Risk

Once we assessed each individual risk hypothesis for its level of risk and confidence, we then translated these values into an assessment of the overall risk posed to the species (low, medium, or high) based on all of the risk hypotheses. To make this conclusion, we plotted the risk hypotheses on a graph based on the risk and confidence determinations for each risk hypothesis. This is illustrated in ***Figure 7*** below. For example, if one or more risk hypotheses had high risk and high confidence then we determined that the overall risk to the species was high, placing it in the red squares in ***Figure 7***. We also determined the overall risk to the species as "high" if, for any risk hypothesis, one of the variables (level and confidence of risk) was high and the other was medium. If all risk hypotheses landed in the yellow and green squares in ***Figure 7***, than the conclusion was determined to be medium risk for the species. If all risk hypotheses landed in the green squares the conclusion was determined to be low risk for the species.

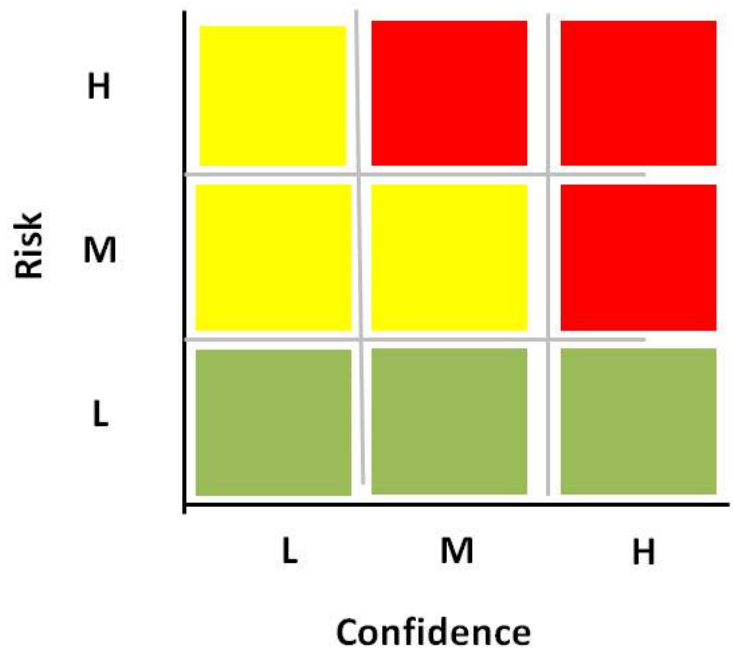

Figure 7. Each individual risk hypothesis is plotted based on its associated risk and confidence. Overall Risk is determined based on where the risk hypotheses fall within the matrix.

In our effects analysis, we also considered evidence provided by two other important sources of data: the MagTool, and two salmonid population models developed by NMFS to evaluate four life histories of salmon. This evidence informed our determination of the overall confidence we had in the assignment of overall risk from the Effects of the Action to species.

3.4.7 The MagTool

EPA created a spreadsheet-based tool to estimate population effects from uniformly distributed individuals exposed to each of the pesticides. We use the MagTool outputs as another approach to analyze effects that we considered (see Appendix D).
The MagTool is an Excel-based tool created by EPA that utilizes Python programming language to integrate EECs, the extent of pesticide use sites within a species range, and mortality effects data to estimate potential reductions in population abundance. The MagTool predicts an anticipated magnitude of mortality to all individuals within a defined geographic location. The magnitude of mortality is based on estimates of exposure and assumed dose-response relationships. Probabilistic output is reported reflecting variability in EECs derived by incorporating geographically-specific estimates

accounting for two sources of variability: (1) the occurrence of pesticide use sites within the species range (six year data set), and (2) daily precipitation (30 year data set). Inputs include median lethal concentrations (LC50s) and corresponding slopes of dose-response curves for each taxa group of interest (e.g. anadromous fish, marine fish, etc.). The output from the MagTool is an estimate of the percentage of fish that would die from acute exposures to EECs within aquatic bins (aquatic habitats with different dimensions and flow). We report the range in the median percentages of fish deaths as an estimate of mortality risk to the population. The mortality risk to the population reflects the percentage of the entire population that would die as a result of all authorized use sites within the species range (excluding mosquito and wide area use). We present the MagTool output as a range representing the lowest anticipated mortality to the highest anticipated mortality based on EPA's use of acute (4-day) exposures to species ***Table 4***.

3.4.8 Salmon Population Models

For certain salmon, we applied peer-reviewed, published population models as a tool to estimate population level responses to the three insecticides (see Appendix B). The salmon model outputs were used as an additional source to confirm the results we obtained through the R-Plots.

Sufficient data were available to construct population models for four Pacific salmon life history strategies. We ran life-history matrix models for ocean-type and stream-type Chinook salmon (*O. tshawytscha*), coho salmon (*O. kisutch*), and sockeye salmon (*O. nerka*). The basic salmonid life history we modeled consisted of hatching and rearing in freshwater, smoltification in estuaries, migration to the ocean, maturation at sea, and returning to the natal freshwater stream for spawning followed shortly by death. For specific information on the construction and parameterization of the models, see Appendix B. Potential impacts resulting from freshwater exposure to pesticides were integrated into the models as alterations in the first year survival rate. Effects of acute mortality or changes in somatic growth rate were evaluated using independent models discussed below. Population level impacts for both types of models were assessed as changes in the intrinsic population growth rate and quantified as the percent change in population growth rate. Changes that exceeded the variability in the baseline (*i.e.,* one standard deviation) were considered significant.

An acute toxicity model was constructed that estimated the population-level impacts of sub-yearling juvenile mortality resulting from exposure to concentrations of the single active ingredients. The acute toxicity models excluded sublethal and indirect effects of the pesticide exposures and focused on the population-level outcomes resulting from a once per year 96 hr exposure of all juveniles in the population to the active ingredients. Death of juveniles was implemented as a change in first-year survival rate for each of the salmon life-history strategies modeled. We also evaluated population level responses resulting from varying the proportion of the population exposed to a single event equivalent to the 96 hr LC50.

We developed a somatic growth model to evaluate the potential for adverse effects to juvenile growth resulting from exposure to the active ingredients (see Appendix B). The model links AChE inhibition, feeding behavior, prey availability, and somatic growth of individual salmon to the productivity of salmon populations expressed as a percent change in lambda (a population's intrinsic rate of growth). The model scenarios assume annual exposure of sub-yearling juveniles and their prey to the pesticide. We integrated two avenues of effect to juvenile salmonids' growth from exposure to the three a.i.s (see Appendix B). The first avenue is a result of AChE inhibition on the feeding success and subsequent effects to growth of juvenile salmonids. Study results with juvenile salmonids show that feeding success is reduced following exposures to AChE inhibitors. The second avenue the model addresses is the potential for reductions in juvenile growth due to reduction in available prey. Salmon are often found to be food limited in freshwater aquatic habitats, suggesting that a reduction in prey due to insecticide exposure may further stress salmon and lead to reduced growth rates. Field mesocosm data support this assertion, showing reduced growth of juvenile fish following exposure to the AChE inhibitor, chlorpyrifos.

We used the model results to estimate population level effects from mortality to juveniles and from effects to juvenile growth from reductions in prey as well as sublethal effects to juveniles. The salmon population modelling results are reported as percent reductions in a population's growth rate, lambda ***Table 4***.

The R-plot, the MagTool, and population modeling results are considered when determining whether a risk hypothesis is supported or not. If results from one of the three tools indicated that abundance or productivity would be reduced, then we answered "yes"; the risk hypothesis was supported. In this manner, we gave the benefit of the doubt to species. If results from two or three of the tools indicated that abundance or productivity would be reduced, we answered "yes". If results from the three tools indicated that neither abundance nor productivity were reduced, we answered "no". We followed this systematic approach for each species. We reported findings for each species with in a summary table (***Table 4).***

3.4.9 Confidence in Risk Hypotheses

If the MagTool results mirrored R-plot results, we found greater support for the level of risk that was determined for the associated hypotheses. If the MagTool results conflicted with R-Plot results, we found less support for the level of risk for the specific risk hypothesis, i.e., less confidence. For salmonid populations with modeling results we compared the findings in reductions in lambda to the R-plot and the MagTool results. If the three agreed, we found high confidence in the risk ranking and if there were differences, we found low or medium confidence for the associated risk ranking.

Each risk hypothesis and associated risk and confidence assignments are presented in a summary table along with model results from the MagTool (where the MagTool results are available), and population modeling results (where population modeling results are available).

Table 4. Example summary table of risk hypotheses

	R-plot Derived		MagTool Results	Population Model Results: Sockeye Salmon		Risk Hypothesis Supported? Yes/No
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**			
Risk Hypothesis						
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via direct exposure	High/ medium/ low	High/ medium/ low	4-day: x-x	**Portion of juveniles exposed to chlorpyrifos EECs; 0.75-100 µg/l**	**Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles**	Yes/no
				25%	x-x% (x-x)	
				50%	x-x% (x-x)	
				75%	x-x% (x-x)	
				100%	x-x% (x-x)	
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High/ medium/ low	High/ medium/ low	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**		Yes/no
Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability	High/ medium/ low	High/ medium/ low	4-day invert: x-x	x-x% (x-x)		Yes/no
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High/ medium/ low	High/ medium/ low	Not Available			Yes/no
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High/ medium/ low	High/ medium/ low	Not Available	Not Applicable		

3.4.10 Summary of Effects Analyses

Based on the arrangement of risk and confidence pairings of the risk hypotheses (indicated in ***Figure*** *7*), a bar is placed along a risk continuum (less risk to more risk) to graphically denote the overall risk identified in the effects analysis section of the species or designated critical habitat. Each pesticide and chemical pairing receives a risk bar. An example is shown in ***Figure 8*** .

We also ascribe an overall level of confidence to the risk finding based on the aggregation of confidence rankings for the individual risk hypotheses.

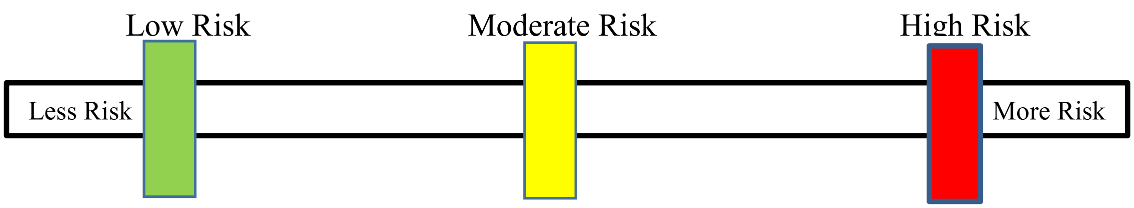

Figure 8. Depiction of risk associated with the stressors of the action

We conclude the Effects of the Action analysis for species and designated critical habitat by composing a narrative to summarize our evaluation and findings of risk hypotheses.

The statement of risk for a species and chemical is carried forward in the Integration and Synthesis

Figure 9. The risk statement is presented as a horizontal bar to denote the overall finding for risk and confidence found at the top of a scorecard. The possible permutations for risk and confidence are High Risk/ High Confidence; High Risk/ Medium Confidence; High Risk/Low Confidence; Medium Risk/ High Confidence; Medium Risk/ Medium Confidence; Medium Risk/ Low Confidence; Low Risk/ High Confidence; Low Risk/ Medium Confidence; Low Risk/ Low Confidence.

Figure 9. Example statement of risk summarizing results of effects analyses

3.4.11 Designated Critical Habitat Analyses

We translated each primary biological feature (PBF) into a risk hypothesis to assess potential impacts on designated critical habitat. The analysis of risk hypotheses is based on: 1) the likely concentrations of the three pesticides that would be observed in critical habitat; and 2) the response of PBFs to those anticipated concentrations. The two PBFs for the majority of species that could be altered/affected by the stressors of the action are water quality and prey availability. We evaluated each risk hypothesis to determine the level of risk and the level of confidence we had in the risk finding (***Table 5)***.

Table 5 Example summary of designated critical habitat risk hypotheses

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
1. Exposure to the stressors of the action is sufficient to reduce the conservation value via reductions in prey in rearing sites.	low, medium, high	low, medium, high	Yes/no
2. Exposure to the stressors of the action is sufficient to reduce the conservation value via degradation of water quality in migration, spawning, and rearing sites.	low, medium, high	low, medium, high	Yes/no

To determine the effect of exposure, we used R-plots, when available, to evaluate the support for effects to species' primary biological features (PBFs).

For designated critical habitat, NMFS has characterized the "likelihood of exposure" relative to each use site (e.g. corn, wheat) within that species' designated critical habitat. The likelihood of exposure for each use site is characterized as either low, medium or high depending on the criteria determined for each of the three likelihood factors. Unique combinations of the three likelihood factors result directly in the likelihood of exposure being characterized as either low, medium, or high according to the decision key ***Figure 10***.

Likelihood of exposure to designated critical habitats was assessed using the following criteria:

1) Percent overlap of a designated critical habitat range with a pesticide's approved uses. Each use is assigned a category of 1, 2, or 3 depending on the degree of geographic overlap of use acreage with the species' U.S. range acreage (aggregation of HUC-12s that delineate the species range). Use acreage comes from EPA-derived GIS layers and is presented on the left Y-axis of the R-plot. Designated critical habitat range comes from NMFS listing documents.
2) Persistence of the pesticide based on environmental fate issues. We evaluated the environmental fate information provided in the BE to determine whether the pesticide is considered persistent. As a rule of thumb, we answered yes to persistence if the pesticide would remain in aquatic areas after 100 days.
3) Number of applications allowed. We reviewed EPA's description of the action from the BE to determine whether multiple applications were allowed on each use site.

Percent Overlap Category	Persistence	Multiple Applications	Likelihood of Exposure
3	yes	yes	**High**
2	yes	yes	**High**
3	no	yes	**High**
2	no	yes	**Medium**
1	yes	yes	**Low**
1	no	yes	**Low**

Figure 10. Decision key for likelihood of exposure finding for designated critical habitat

The level of confidence underscores the level of certainty we have in the risk determination for each risk hypothesis. The confidence level in the risk determination is evaluated and assigned a low, medium, or high level of confidence after evaluating three factors:

1) Agreement or disagreement among risk hypotheses findings e.g., the more risk hypotheses that had similar combinations of risk and confidence increased our confidence in the overall risk call;
2) Whether incident data were available and demonstrated real-world toxicity to similar aquatic species; and
3) Whether available field studies or field experiments demonstrated toxicity to similar aquatic species.

Similar to the effects of the action on the species, the arrangement of risk and confidence pairing of the risk hypotheses dictated the placement of a risk bar along a risk continuum. The graphic denotes the overall risk identified in the effects analysis section of designated critical habitat ***Figure 11***. Each pesticide and chemical pairing receives a risk bar.

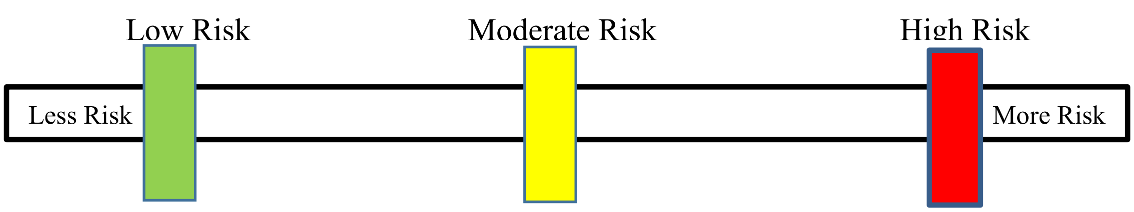

Figure 11. Depection of risk to designated critical habitat from the stressors of the action

We ascribe an overall level of confidence to the risk finding based on the aggregation confidence rankings for the individual risk hypotheses.

We conclude the Effects of the Action analysis for designated critical habitat by composing a narrative to summarize our evaluation and findings of risk hypotheses. The statement of risk for a species and chemical is carried forward in the integration and synthesis section. The risk statement is presented as a horizontal bar to denote the overall finding for risk and confidence found at the top of a score card. The possible permutations for risk and confidence are High Risk/ High Confidence; High Risk/ Medium Confidence; High Risk/Low Confidence; Medium Risk/ High Confidence; Medium Risk/ Medium Confidence; Medium Risk/ Low Confidence; Low Risk/ High Confidence; Low Risk/ Medium Confidence; Low Risk/ Low Confidence**.**

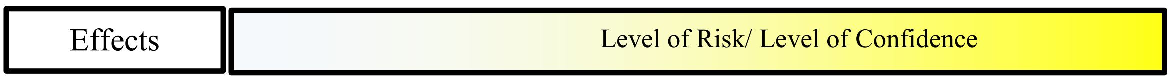

Figure 12. Example Statement of Risk Summarizing Results of Effects Analysis

Following our Effects of the Action analysis for species and for designated critical habitats; we then consider Cumulative Effects, Status of the Species, and the Environmental Baseline. These are treated as “risk modifiers” that we combine with Effects of the Action in our Integration and Synthesis, in order to reach our conclusions as to whether the action is likely to jeopardize listed species or destroy or adversely modify critical habitat.

3.5 **Integration and Synthesis**

In this section, we integrate the previous analyses in the opinion to summarize the consequences to ESA-listed species and designated critical habitat under NMFS’ jurisdiction. We integrate information from the Status of the Species, Environmental Baseline, and Cumulative Effects sections. We treat the information from these three sections as “risk modifiers” in that the risk described in the Effects Analysis section can be modified by the condition of the species, the condition of environmental baseline, and the anticipated cumulative effects. The key questions addressed within these sections include:

1) Status of the Species:
    - Are abundance, spatial distribution, and productivity trends increasing, decreasing or stable?
    - Is the species listed as threatened or endangered?
    - Have recovery goals been met, or are they on a sustained positive trajectory toward recovery?
2) Environmental Baseline:
    - Are freshwater temperatures elevated?
    - Are pesticide mixtures present, or anticipated based on current land use?

3) Cumulative Effects:
   - Will future temperatures impair species aquatic habitats?
   - Will future hydrologic flows impair freshwater species habitats?

We evaluated the available information to determine whether the answers to the above questions on Status of the Species, Environmental Baseline, and Cumulative Effects supported a low or high magnitude of influence on the effects of the action.

Once each of the risk modifiers is evaluated, (i.e., questions answered), we characterized the magnitude of influence (as low or high) indicated with one of two lengths of arrows ***Figure 13***. The shorter of the two arrows, indicates a low magnitude while the longer of the two arrows indicates a high magnitude as a risk modifier. The direction an arrow is pointed indicates the directionality of the risk modifier. For example, an environmental baseline arrow pointing towards more risk indicates that environmental mixtures and elevated temperatures occur in the Environmental Baseline, which further stresses the species in question.

We also assign a level of confidence in our selection of the small and large magnitude indicated by a bold arrow (high confidence) or an un-bolded arrow (low confidence). The final arrow representing the influence on risk is graphically depicted on each species' scorecard shown below.

Figure 13. Example of arrows to represent direction, magnitude, and confidence of risk modifiers used in the species scorecard

3.6 **Conclusion**

With full consideration of the status of the species and the designated critical habitat, we consider the effects of the action within the action area on populations or subpopulations and on essential habitat features when added to the environmental baseline and the cumulative effects to determine whether the action could reasonably be expected to:

- Reduce appreciably the likelihood of survival and recovery of an ESA-listed species in the wild by reducing its numbers, reproduction, or distribution, and state our conclusion as to whether the action is likely to jeopardize the continued existence of such species; or

- Appreciably diminish the value of designated critical habitat for the conservation of an ESA-listed species, and state our conclusion as to whether the action is likely to destroy or adversely modify designated critical habitat.

A "scorecard" is generated for each species and designated critical habitat ***Figure 14, Figure 15***. The effects of the proposed action are characterized as high, medium, or low risk to the species on the top bar ("Effects Analysis") of the scorecard, using the analytical process already described. The scorecard also summarizes how the risk posed by the effects of the action is modified by the environmental baseline, cumulative effects, and status of the species, as depicted by the three arrows below the Effects Analysis bar. At the bottom of the scorecard, the bar labeled Conclusion shows the overall risk and jeopardy determination (the colored bar beginning with green (less risk) to red (more risk)). A narrative is also presented below the scorecard to identify risk drivers and summarize the overall conclusion. The No Jeopardy/ Jeopardy determination and the no adverse modification/ Adverse modification determination for each species or designated critical habitat is ultimately a best professional judgement, based on best commercial and scientific data available, following ecological risk assessment principles.

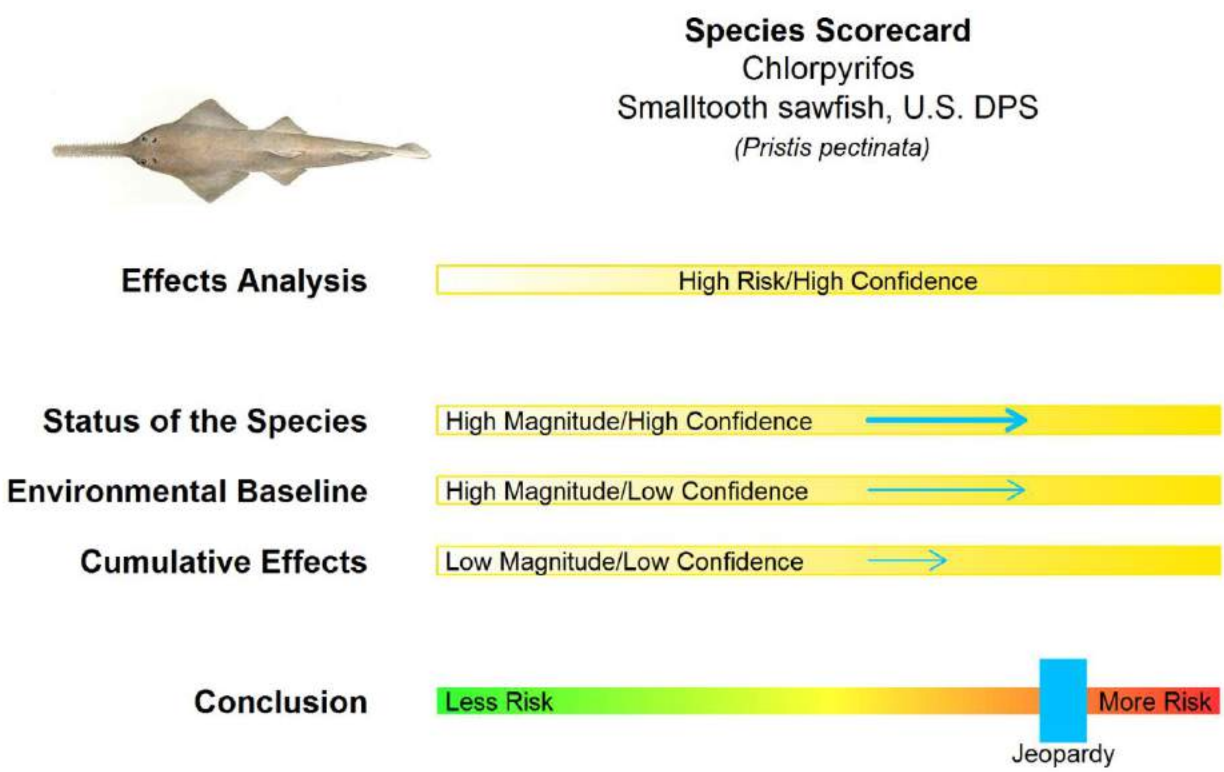

Figure 14. Example species scorecard

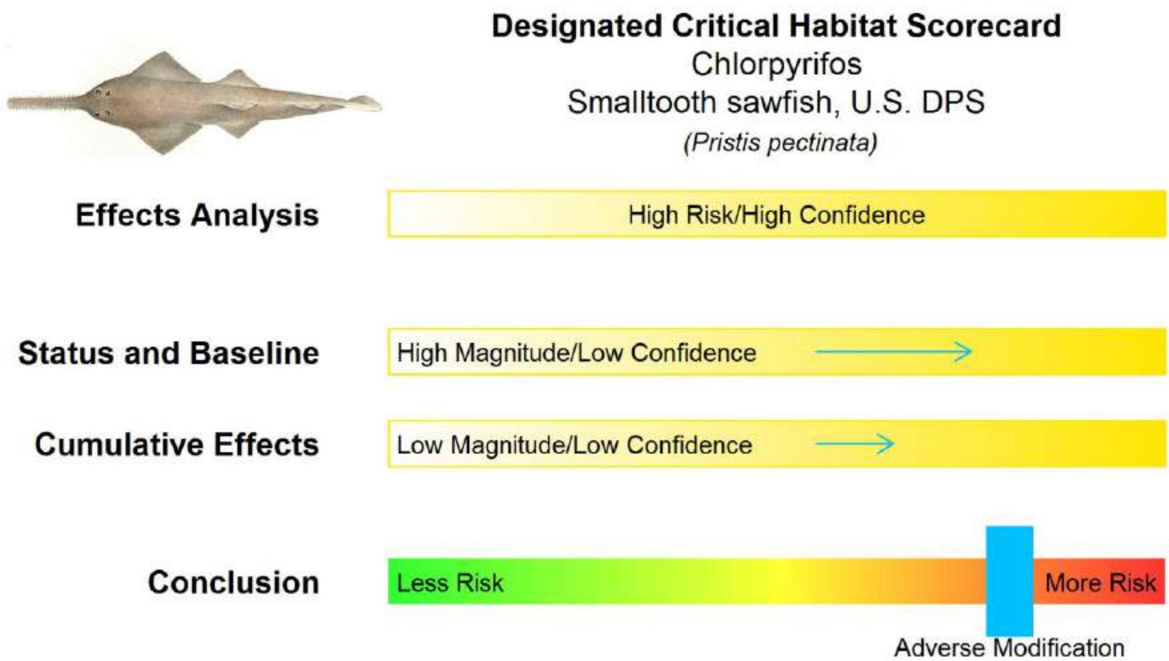

Figure 15. Example critical habitat scorecard

If, in completing the last step in the analysis we determine that the action under consultation is likely to jeopardize the continued existence of ESA-listed species or destroy or adversely modify designated critical habitat, then we must identify reasonable and prudent alternative(s) to the action, if any, or indicate that to the best of our knowledge there are no reasonable and prudent alternatives (See 50 C.F.R. §402.14). In addition, we include an incidental take statement that specifies the impact of the take, reasonable and prudent measures to minimize the impact of the take, and terms and conditions to implement the reasonable and prudent measures (ESA section 7 (b)(4); 50 C.F.R. §402.14(i)). We also provide discretionary conservation recommendations that may be implemented by action agency (50 C.F.R. §402.14(j)). Finally, we identify the circumstances in which reinitiation of consultation is required (50 C.F.R. §402.16).

“Take” means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct (16 U.S.C. § 1532). "Harass” is further defined as an act that would “create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering” (NMFSPD 02-110-19).

Chapter 4, 5, 6:

Description of the Proposed Action, Action Area, Interrelated and Interdependent Actions

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4 Description of the Proposed Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies.

The Federal Action

Under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), the purpose of the Environmental Protection Agency's (EPA) proposed action is to provide pest control that does not cause unreasonable adverse effects to the environment throughout the U.S. and its affiliated territories. Under FIFRA, before a pesticide product may be sold or distributed in the U.S. it must be registered with a label identifying approved uses by EPA's Office of Pesticide Programs (OPP). Once registered, a pesticide may not legally be used unless the use is consistent with directions on its approved label(s) (http:www.epa.gov/pesticides/regulating/registering/index.htm). EPA authorization of pesticide uses are categorized as FIFRA sections 3 (new product registrations), 4 (re-registrations and special review), 18 (emergency use), or 24(c) Special Local Needs (SLN).

The proposed action for this consultation is EPA's registrations of all pesticides containing chlorpyrifos, diazinon and malathion for use as described on product labels.[1] The proposed action includes (1) approved product labels containing chlorpyrifos, diazinon and malathion, (2) degradates and metabolites of chlorpyrifos, diazinon and malathion, (3) formulations, including other ingredients within formulations, (4) adjuvants, and (5) tank mixtures. EPA's is required to reassess each registered pesticide at least every 15 years.

EPA's pesticide registration process involves an examination of the ingredients of a pesticide, the site or crop on which it will be used, the amount, frequency and timing of its use, and its storage and disposal practices. Pesticide products may include a.i.s and other ingredients, such as adjuvants, and surfactants (described in greater detail below). The EPA evaluates the pesticide to ensure that it will not have unreasonable adverse effects on humans, the environment, and non-target species. An unreasonable adverse effect on the environment is defined in FIFRA as, "(1) any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of the pesticide, or (2) a human dietary risk from residues that result from a use of a pesticide in or on any food inconsistent with the standard under" section 408 of the United States Federal Food, Drug, and Cosmetic Act (FFDCA) (21 U.S.C. §346a; 7 U.S.C. 136(bb)).

After registering a pesticide, EPA retains discretionary involvement and control over such registration. EPA must periodically review the registration to ensure compliance with FIFRA and other federal laws (7 U.S.C. §136d). A pesticide registration can be canceled whenever "a pesticide or its labeling or other material does not comply with the provisions of FIFRA or, when used in accordance with widespread and commonly recognized practice, generally causes unreasonable adverse effects on the environment" (7 U.S.C. §136d(b)).

EPA, the National Marine Fisheries Service (NMFS), and the Fish and Wildlife Service (FWS) agreed on December 12, 2007 that the federal action for EPA's FIFRA registration actions will be defined as the "authorization for use or uses described in labeling of a pesticide product

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[1] EPA's registrations are three separate actions that we have combined in one Opinion. We considered the effects of each of EPA's actions separately and independently. For convenience, we will refer to one action.

containing a particular pesticide ingredient." In order to ensure that EPA's action will not jeopardize listed species or destroy or adversely modify critical habitat, NMFS' analysis encompasses the impacts to listed species of all uses authorized by EPA, regardless of whether those uses have historically occurred.

Pesticide Labels. For this consultation, EPA's proposed action encompasses all approved product labels containing chlorpyrifos, diazinon, and malathion, including their degradates, metabolites, and formulations, other ingredients within the formulations, adjuvants, and tank mixtures. The effects of these comprise the stressors of the action. These a.i.'s combined are labeled for a variety of uses including applications to croplands and non-crop areas.

Active and Other ingredients. Chlorpyrifos, diazinon, and malathion are the a.i.'s that kill or otherwise affect targeted organisms (listed on the label). However, pesticide products that contain these a.i.'s also contain other ingredients (referred to as "inerts" or "other" ingredients on the labels). Inert ingredients are ingredients which EPA defines as not "pesticidally" active. The specific identification of the compounds that make up the inert fraction of a pesticide is not required on the label. However, this does not necessarily imply that inert ingredients are non-toxic, non-flammable, or otherwise non-reactive. EPA authorizes the use of chemical adjuvants to make pesticide products more efficacious. An adjuvant aides the operation or improves the effectiveness of a pesticide. Examples include wetting agents, spreaders, emulsifiers, dispersing agents, solvents, solubilizers, stickers, and surfactants. A surfactant is a substance that reduces surface tension of a system, allowing oil-based and water-based substances to mix more readily. A common group of non-ionic surfactants is the alkylphenol polyethoxylates (APEs), which may be used in pesticides or pesticide tank mixes, and also used in many common household products.Nonylphenol (NP), one of the APEs, has been linked to endocrine-disruption effects in aquatic animals.

Formulations. Pesticide products come in a variety of solid and liquid formulations. Examples of formulation types include dusts, dry flowables, emulsifiable concentrates, granulars, solutions, soluble powders, ultra-low volume concentrates, water-soluble bags, powders, and baits. The formulation type can have implications for product efficacy and exposure to humans and other non-target organisms.

Tank Mix. A tank mix is a combination by the user of two or more pesticide formulations as well as any adjuvants or surfactants added to the same tank prior to application. Typically, formulations are combined to reduce the number of spray operations or to obtain better pest control then if the individual products were applied alone. The compatibility section of a label may advise on tank mixes known to be incompatible or provide specific mixing instructions for use with compatible mixes. Labels may also recommend specific tank mixes. Pursuant to FIFRA, EPA has the discretion to prohibit tank mixtures. Applicators are permitted to include any combination of pesticides in a tank mix as long as each pesticide in the mixture is permitted for use on the application site and the label does not explicitly prohibit the mix.

Pesticide Registration. In 2006, EPA commenced a new program called registration review to reevaluate all pesticides on a regular cycle. EPA is required to review each pesticide at least every 15 years to make sure that as the ability to assess risks to human health and the environment evolves and as policies and practices change, all pesticide products in the marketplace can still be used safely. Registration review includes Sections 3, 24(c), and 18 labels. The label on a pesticide package or container is legally enforceable. The label provides information about how to handle and safely use the pesticide product and avoid harm to human health and the environment. Using a pesticide in a manner that is inconsistent with the use directions on the label is a violation of FIFRA and can result in enforcement actions to correct the violations. Pesticide registration is the process through which EPA evaluates product labels; EPA examines the ingredients of a pesticide; the site or crop on which it is to be used; the amount, frequency and timing of its use; and storage and disposal practices. Pesticide products (also referred to as "formulated products") may include active ingredients (a.i.s) and other ingredients, such as adjuvants and surfactants. The eligibility for continued registration may be contingent on label modifications to mitigate risk and can include phase-out and cancellation of uses and pesticide products. Registrants can submit applications for the registration of new products and new uses following reregistration of an active ingredient. Several types of products are registered, including the pure (or nearly pure) active ingredient, often referred to as technical grade active ingredient (TGAI), technical, or technical product. This is generally used in manufacturing and testing, and not applied directly to crops or other use sites. Products that are applied to crops or other use sites (e.g., rights of way, landscaping), either on their own or in conjunction with other products or surfactants in tank mixes are called end-use products (EUPs).Sometimes companies will also register the pesticide in a manufacturing formulation, intended for sale to another registrant who then includes it into a separately registered EUP. Manufacturing formulations are not intended for application directly to use sites. The EPA may also cancel product registrations. EPA typically allows the use of canceled products, and products that do not reflect registration review label mitigation requirements, until those products have been exhausted. Labels that reflect current EPA mitigation requirements are referred to as "active labels." Products that do not reflect current label requirements are referred to as "existing stocks." EPA's actions includes all authorizations for use of pesticide products including use of existing stocks, and active labels, of products containing the three a.i.s for the duration of the proposed action.

Duration of the Proposed Action. EPA is required to reassess registered pesticide active ingredients is at least every 15 years. Given EPA's timeframe for pesticide registration reviews, NMFS' evaluation of the proposed action is also 15 years, although NMFS considers any effects that continue beyond the end of the 15 years.

Monitoring and Reporting. The current Federal Action does not include any specific provision for monitoring. However, Section 6(a)(2) of the Federal Insecticide, Fungicide and Rodenticide Act requires pesticide product registrants to report adverse effects information, such as incident data involving fish and wildlife to EPA (40 CFR part 159, https://www.ecfr.gov/cgi-bin/text-idx?SID=680dff323249c84b0f88ddd044793a71&mc=true&node=pt40.24.159&rgn=div5).

The following description of chlorpyrifos, diazinon, and malathion registrations (the action) represents information acquired from EPA's Biological Evaluations (BE) (EPA 2017).

4.1 Chlorpyrifos

Chlorpyrifos is an organophosphate insecticide first registered in the United States in 1965. An overview of the regulatory history and past risk assessments for chlorpyrifos can be found in Appendix 1-1 of EPA's BE. Chlorpyrifos is used on a wide variety of terrestrial food and feed crops, terrestrial non-food crops, greenhouse food/non-food, and non-agricultural indoor and outdoor sites. There are currently 31 active registrants of chlorpyrifos with 135 active product labels (86 Section 3s, 48 Special Local Needs, and 1 Section 18), which include formulated products and technical grade chlorpyrifos (EPA BE, Appendix 1-2). Chlorpyrifos can be applied in a liquid, granular, or encapsulated form or as a cattle ear tag or seed treatment.Aerial and ground application methods (including broadcast, soil incorporation, orchard airblast, and chemigation) are allowed.

Registered labels for flowable products require 25-foot (ground boom and chemigation), 50-foot (orchard airblast), or 150-foot (aerial) no-spray buffer zones adjacent to waterbodies.

Currently, there are 13 multi-active ingredient products registered that contain chlorpyrifos. Other active ingredients co-formulated with chlorpyrifos include: zeta-cypermethrin, cyfluthrin, bifenthrin, permethrin, gamma-cyhalothrin, lamda-cyhalothrin, and diazinon (***Table 1***).

Table 1. Multi-Active Ingredient Products Containing Chlorpyrifos

REGISTRATION #	NAME	PERCENT ACTIVE INGREDIENT	ACTIVE INGREDIENT
279-9545	F9047-2 EC INSECTICIDE	3.08	Zeta-Cypermethrin
		30.8	Chlorpyrifos
499-405	WHITMIRE PT 1920 TOTAL RELEASE INSECTICIDE	1.6	Cyfluthrin
		8	Chlorpyrifos
1381-243	TUNDRA SUPREME	28.6	Chlorpyrifos
		9	Bifenthrin
8329-36	ULV MOSQUITO MASTER 412	4	Permethrin
		12	Chlorpyrifos
8329-73	ULV MOSQUITO MASTER 2+6	6	Chlorpyrifos
		2	Permethrin
34704-1086	MATCH-UP INSECTICIDE	9	Bifenthrin
		28.6	Chlorpyrifos
39039-6	WARRIOR INSECTICIDE CATTLE EAR TAG	10	Chlorpyrifos
		30	Diazinon
62719-575	COBALT	30	Chlorpyrifos
		0.54	gamma-Cyhalothrin
62719-615	Cobalt Advanced	1.44	lambda-Cyhalothrin
		28.12	Chlorpyrifos
66222-259	MANA 24301	2.02	Bifenthrin
		19.8	Chlorpyrifos
67760-112	BOLTON INSECTICIDE	30	Chlorpyrifos
		0.99	gamma-Cyhalothrin

REGISTRATION #	NAME	PERCENT ACTIVE INGREDIENT	ACTIVE INGREDIENT
86363-11	BIFENCHLOR	9	Bifenthrin
		28.6	Chlorpyrifos
89168-20	LIBERTY CHLORPYRIFOS BIFENTHRIN	28.6	Chlorpyrifos
		9	Bifenthrin

Chlorpyrifos may be applied as part of a tank mix with other pesticides (*i.e.*, insecticides, miticides and fungicides). In general, chlorpyrifos products can be mixed with other pesticide products and adjuvants unless specifically prohibited on the label(s).

Product labels describe where pesticides can be applied (use sites), application methods, and application rates. ***Table 2*** summarizes label restrictions for all chlorpyrifos products registered in the United States. This table reflects all currently registered labels and any agreed upon changes to these labels from the registrants as described in the BE. In general, current single maximum chlorpyrifos application rates do not exceed 4 lb a.i./A nationwide; however, single application rates greater than 4 lb a.i./A are currently permitted for some specific use patterns. For example, a single chlorpyrifos application of 6 lb a.i./A is permitted on citrus in a limited number of counties in California. Aerial applications are not permitted at rates higher than 2.0 lb a.i./A with the exception of treatment of Asian citrus psyllid (citrus use). In this situation, chlorpyrifos application may be applied at a rate of up to 2.3 lb a.i./A by aerial equipment. The maximum annual rate of chlorpyrifos that may be applied to a crop site is 14 lb a.i./A for tart cherries.

Table 2. Chlorpyrifos Master Use Summary

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
AGRICULTURAL FARM PREMISES Livestock housing and holding areas (such as hog barns, empty chicken houses, dairy areas, milkrooms, calf hutches, calving pens and parlors).		✓		Indoor general surface spray	backpack sprayer; high and low sprayer (pressure or volume)	0.075 lb a.i./ 1000 ft sq 1.2 EC, ME	[14.4] NS	NA	12	NA	NA	NS	NS		
ALFALFA		✓		At plant	groundboom	1.0 G	1.0	1.0	[1] NS	1	21	24	[10] NS	Missouri only	Lower PHI permitted for EC rates 0.33 lb a.i./A (7 d) and 0.67 lb a.i./A (14 d) e.g. Reg. No. 62719-591 Stand is in production 3-5 years. Planted ¼” to ½” deep.

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
		✓		Foliar	aerial or ground/ broadcast, chemigation	1.0 EC	[4.0] NS	4.0	[4] NS	4	21	24	10		Lower PHI permitted for EC rates 0.33 lb a.i./A (7 d) and 0.67 lb a.i./A (14 d) *e.g.*, Reg. No. 62719-591 Multiple harvests (or cuttings) per year when used for feed/fodder and 1 harvest per year when grown for seed.Cuttings occur about every 30 days. Only 1 crop cycle per year but up to 9 cuttings, varies by geography.
				Total		**1.0**	**5.0**	**5.0**	**[5] NS**	**5**	**21**	**24**	**[10] NS**		Represents Missouri scenario otherwise 4.0 lb

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
															a.i./A per is max.
ALMOND		✓		**dormant/ delayed dormant**; broadcast	aircraft, airblast	2.0 WDG, WP	2.0	NA	1	NA	NA		10	Restricted use in California.	
		✓		**foliar**; broadcast	aircraft, airblast	2.0 WDG,WP	6.0	NA	3	NA	14		10		
		✓		pre-plant, foliar; **trunk spray/drench or pre-plant dip**	handheld, backpack, drench/dip, handgun, and low pressure hand wand	2.5 (3.0/100 gal) WDG	2.5	NA	1	NA	14	24	NS		
		✓		Dormant/ delayed dormant; foliar; **orchard floors** broadcast	ground boom, handgun, chemigation	4.0 EC*	4.0	NA	2	NA	14		10	Restricted use in California. Only one dormant application can be made.	
				Total	**--**	**4.0**	**14.5**	**NA**	**7**	**NA**	**14**		**NS**		Excludes nursery applications

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
															(See general "Fruits" listing)
APPLE		✓		**dormant/ delayed dormant**; broadcast	aircraft, airblast	2.0 EC 2.0 WDG 1.5 WP	2	2.0	1	1	NA	24/ 4 d	10d		Reflects spray drift mitigation measures.
		✓		pre-plant, foliar; **trunk spray/drench or pre-plant dip**; ground	handheld, backpack, drench/dip, handgun, and low pressure hand wand	1.5 (1.5 lb ai/100 gal) WDG	1.5	NA	1	1	28	4d	NS	Use permitted in states east of the Rockies except Mississippi.	
				Total		**2.0**	**3.5**		**2**						

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
ASPARAGUS		✓		Foliar, pre-harvest; broadcast	aircraft, ground boom	1.0 EC, WDG	1.0	1.0	1	1	1	24	10		
		✓		Postharvest, broadcast	aircraft, ground boom	1.0 EC, WDG	2.0	2.0	2	1	1	24	10		
					granular soil band treatment ground boom	1.5 G	3.0	3.0	2	2	180	24	[10] NS	Permitted in California, the Midwest, and the Pacific Northwest 19713-505, 19713-521, 5481-525, 62719-34, 83222-34	Do not apply more than 3.0 lb a.i./A between harvests.
				Total		**1.5 G**	**3.0**	**3.0**	3	3	1	24	10		
BEANS		✓		Preplant; Seed treatment	Seed Treatment	*0.016-0.348* 0.000798 lb ai/lb seed ME *0.013-0.272*	NS	[0.348] NS	NS	[1] NS	NS	NS	NS	ME is SLN only for ID	Italics highlight the range of application rates depending on the number of seeds per lb and the number of seeds planted

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
						0.000625 lb ai/lb seed WP *0.012-0.253* 0.00058 lb ai/lb seed EC									per acre. Seeding rate information provide by BEAD.[4]
BEEF/RANGE/ FEEDER CATTLE (MEAT)/ DAIRY CATTLE (NON-LACTATING)				Summer, late fall, spring; impregnated collar/tag	Animal treatment (ear tag)	0.0066 lb/animal	[0.0099] NS	NA	3	NA	NS	NS	NS		Reg. No. 39039-6 Cattle ear tags are assumed to last 4-6 months Two tags per animal at 0.0033 lb a.i./tag in the summer and one tag per animal at 0.0033 lb a.i./A.
BEETS (UNSPECIFIED; TABLE OR SUGAR)		✓		At plant, soil band treatment	Ground boom	1.0 EC	NS	1	NS	1		24		Allowed in Oregon Court ordered buffer of 60	Minimum Incorporation: 2 inches

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
"grown for seed"														ft for ground chlorpyrifos application is required for "affected waterways".	
		✓		Preplant, soil incorporated treatment	Broadcast/ ground boom	1.9 EC	NS (2.8 ID)	NS	1	NS				Allowed in Oregon and Idaho	OR-09007; 62719-591 ID-090002; 62719-591
				Total		**1.9**	**2.8**	**NS**	**2**	**NS**		**24**			One or the other type of application.
SUGAR BEETS		✓		Preplant, soil incorporated treatment	Broadcast/ ground boom	1.0 EC 2.0 G	3.0	2.0	1	1	NA	24	10		Minimum Incorporation: 1 inch
		✓		At plant, soil band treatment	Broadcast/ ground boom	1.0 EC, WDG 2.0 G	3.0	2.0	1	1	30	24	10		

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
		✓		Postplant, soil band	Broadcast/ ground boom	2.0 G	3.0	2.0	1	1	30	24	10		
		✓		Post-emergence band treatment; broadcast	Broadcast/ ground boom	1.0 EC, WDG	3.0	1.0	3	1	30	24	10		
		✓		broadcast	Aircraft, ground boom, chemigation	1.0 EC, WDG	3.0	1.0	3	1	30	24	10		EC is not for use in MS
				Total		**1.0 EC 2.0 G**	**4.0**	**[4.0] NS**	**3**	**[3] NS**	**30**	**24**	**10**		One granular application at 2.0 a.i./A and two liquid applications at 1.0 a.i./A per year. Also assumed per crop cycle.
CARROT Grown for Seed (INCLUDING TOPS)		✓		Foliar pre-bloom broadcast	aircraft, ground boom	0.94 EC	0.94	1	1	1	7	24	NA	forest	OR090011 SLN Expires: 12/31/2018 WA090011

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
															SNL Expires: 12/31/2016 Carrots take two years to produce seed.All commercial production of the carrot (vegetable) takes place in the first year when the plant is nowhere near blooming.
CHERRIES		✓		**dormant/ delayed dormant**; broadcast	aircraft, airblast	2.0 WDG, EC 1.5 WP	2.0	NA	1	NA	NS	24	10		
		✓		**foliar**; broadcast	airblast	4.0 EC	10.0	NA	5	NA	14	24	10		Tart cherry only
					aircraft	2.0									Reflects spray drift mitigation

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
		✓		Foliar, post harvest; **trunk spray/drench**	handheld, backpack, drench/dip, handgun, and low pressure hand wand	2.5 (3.0/100 gal) WDG, EC	2.5	NA	1	NA	2	24	[10] NS		Only some labels specify a 10 d MRI.
				Total	**--**	**4.0**	**4.5 (sweet)** **14.5 (tart only)**		**6**						Excludes nursery applications (See general "Fruits" listing) The foliar applications only apply to tart cherries, thus, sweet cherry scenarios (*e.g.*, Pacific NW) annual application rate would be 4.5 lb total a.i./year.
CHRISTMAS TREE PLANTATIONS		✓		**foliar**; broadcast	helicopter, orchard blast	1.0 EC, WDG, WP	3.0	NA	3	NA	[0] NS	24	7	Aerial applications via helicopter	

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
														are only permitted in Washington and Oregon.	
		✓		post harvest; **Stump Treatment**	handheld, backpack, drench/dip, handgun, and low pressure hand wand	2.5 (3.0/100 gal) EC, WDG	2.5	NA	1	NA	NA		7		
				Total		**2.5**	**5.5**		**4**						
CITRUS		✓		**foliar**; broadcast	airblast, ground boom	6.0 WP, WSP, EC	7.5	NA	2	NA	35 (21 for low rates)	5d	30 (10 for low rates)	6.0 lb a.i. /A is only permitted in California and Arizona. The max single rate in other states is restricted to 4 lb a.i./A.	
		✓			aircraft	2.3 WP, WSP, EC					21	5	10	Florida, California, and potentially Texas	Aerial application used to control psyllid, the

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
															vector for citrus greening. Reflects spray drift mitigation
		✓		foliar; **orchard floors broadcast**	ground boom, chemigation, handheld, backpack, drench/dip, handgun, and low pressure hand wand	1.0 G*, WSP, EC	3.0	NA	3	NA	28	24/ 5 d	10		
				Total	**--**	**6.0**	**10.5**		**5**						Registered labels permit both foliar and soil applications in the same orchard. Total excludes nursery applications (See general "Fruits" listing)
CLOVER (GROWN FOR SEED)		✓		Preplant	Ground boom	1.9 EC	1.9	1.9	1	1	NS	24	NA	Use only permitted in Oregon.	OR-0900100; master label: 62719-591

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
		✓		Post-Plant Foliar	aircraft and ground boom										Either a preplant or post plant application is allowed.
COLE CROPS (EXCLUDES CAULIFLOWER AND BRUSSELS SPROUTS)		✓		Preplant, soil incorporated treatment	Ground boom	2.0 EC, WDG, G	4.0	2.0	2	1	30	24	10		Min. incorporation: 2 inches
		✓		At plant, soil band treatment	Ground boom					1					One granular application permitted per year.
		✓		Post plant	Ground boom					1					
		✓		Foliar Established Plantings, soil sidedress treatment	Ground boom					1					
		✓		Foliar, broadcast	Aircraft, ground boom, chemigation	1.0 EC, WDG, WP	4.0	3.0	4	3	21		10		Multiple crops per year are possible in some locations.
				Total			**8.0**	**5**	**6**						Some labels restrict the

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
										4					yearly application rate to 3 lb a.i./A. The maximum number of crops per year is 2.
BRUSSELS SPROUTS		✓		At plant, soil band treatment	Ground boom	2.0 EC; G	2.0	[2.0] NS	2	1	21	24	10		
		✓		Preplant, soil incorporated treatment	Ground boom										Minimum incorporation is 2 inches
		✓		Postplant, soil application	Ground boom	2.25 EC, G	2.25	[2.25] NS							
		✓		Foliar broadcast	Aircraft, Ground boom	1.0 EC	[5.3] NS	3.0	NS	3			10		83222-20, 84930-7, 86363-3 specify a 7 day MRI. All other labels specify a 10 day MRI. The PHI stated 84930-7 is conflicting [p. 4

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
															(21 days and p. 19 (30 days)]
				Total		**2.3**	**5.3**		**NS**		**21**	**24**	**7**		Assume one application of either at plant, preplant, or postplant followed with additional foliar applications.
CAULI-FLOWER		✓		At plant, soil band treatment	Ground boom	2.0 EC 2.3 G	2.0 EC 2.25 G	NS	[1] NS	1	21	3d	10		Only one granular application.
		✓		Preplant, soil incorporated treatment	Ground boom	2.3 G 2.0 EC	2.3	NS	[1] NS	1	30, EC, 21 G				Minimum incorporation is 2 inches
		✓		Postplant, soil application	Ground boom										
		✓		Foliar broadcast	aircraft, ground boom	1.0 EC	[5.3] NS	3.0	NS	3	21		10		
				Total		**2.3**	**5.3**	**[5.3]**	**NS**	**[4]**	**21**	**24**	**10**		Assume one application at

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
								NS		**NS**					either plant, preplant, or postplant followed with additional foliar applications.
COMMERCIAL /INSTITUTION-AL/ INDUSTRIAL PREMISES/ EQUIP. (INDOOR)				Broadcast	Product Container	0.4373 lb a.i./100 sq ft 190.5 G	NS	NA	NS	NA	NA	NS	NS		For treatment of fire ants
Non-food areas of manufacturing, industrial, and food processing plants; warehouses; ship holds; railroad boxcars.				Crack and Crevice/Void	Sprayer/ Injection	0.0625 lb a.i./1000 sq ft 2.7 ME	NS	NA	NS	NA	NA	NS	NS		499-419
				Crack and Crevice/Spot	Sprayer/ Injection	0.0424 lb/gal ME	NS	NA	NS	NA	NA	NS	7		
COMMERCIAL /INSTITUTION AL /INDUSTRIAL PREMISES/EQ				Soil broadcast	Low and High Pressure, Backpack, Handgun Sprayers	0.0247 lb a.i./1000 sq ft 1.1 ME	NS [13.2]	NA	NS [12]	NA	NA	NS	NS		

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
UIP. (OUTDOOR) Outdoor commercial use around non-food areas of manufact-uring, industrial, and food processing plants; warehouses; ship holds; railroad boxcars				Directed spray		0.1132 lb a.i./1000 sq ft 4.9 ME	NS	NA	NS	NA	NA	NS	NS		Specific to: Inside and outside dumpsters and other trash holding containers, trash corrals and other trash storage areas.
				Crack and Crevice/void/ general outdoor		0.0424 lb/gal ME [1.1]	NS [13.2]	NA	NS [12]	NA	NA	NS	7		
CONIFERS AND DECIDUOUS TREES; PLANTATION, NURSERY		✓	✓	**foliar**; broadcast	Ground boom	1.0 EC	3.0	NA	6	NA	7	24	7		
		✓	✓	foliar; **stump treatment**	backpack, drencher, low pressure hand wand	0.3 EC	0.3	NA	1	NA	7	24	7		
				Total		**1.0**	**3.0**	**NA**	**6**	**NA**	**7**	**24**	**7**		The total number of applications assumed is either 3 foliar

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
															applications or 2 foliar applications with one stump treatment.
CORN (ALL)		✓		Preplant	ground/ **soil incorporated** conservation tillage, in furrow, broadcast, chemigation, soil band	3.0 EC 2.0 G	3.0	3.0	NS	3	NA	24/ 5 EC	10		19713-520, 19713-599, 33658-26, 34704-857, 72693-11, 83222-20 The minimum incorporation depth is 2 inches.
					soil incorporated aerial conservation tillage	2.0 EC, G									
		✓			ground/ conservation tillage, in furrow, broadcast,	1.0 EC 2.0	3.0	3.0	NS	3	21		10		19713-520

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate Per Year lb a.i./A	Maximum Application Rate Per CC[2] lb a.i./A	Maximum Application Number Per Year	Maximum Application Number Per CC[2]	PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
					chemigation, soil band	G									
		✓		Storage or preplant seed treatment	Seed treatment	*0.001-0.021* 0.000625 lb a.i./ lb seed WP *0.1-1.9* 0.058 lb a.i./ lb seed FC	[7.6] NS	[1.9] NS	[?] NS	1	NS	NS	NS		Italics highlight the range of application rates depending on the number of seeds per lb and the number of seeds planted per acre. Seeding rate information provide by BEAD.[4]
		✓		At plant	soil incorporated, conservation tillage	2.0 G	[8.1] NS	3.0	[?] NS	3	21	24	10		
		✓		Post emergence	Aerial or ground, broadcast, chemigation	1.5 EC 1.0 WDG	[8.1] NS	3.0	NS	3	21	24/ 5d (EC	10		A brush on max single rate is permitted at 1.0 lb ai/a (72693-11)
		✓		Foliar	Aerial or ground/ broadcast,	1.5 EC	3.0	3.0	NS	3	21		10		

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
					granule, seed and chemigation										
				Total		**3.0**	**8.1**	**8.1**	**NS**	**4**	**21**		**10**		Two granular applications are allowed with a maximum single rate of 1.0 lb a.i./A or one granular application at 2 lb a.i./A. Total with seed treatment PHI: 21 d except Delaware and Florida (7 d)
COTTON		✓		Storage or preplant seed treatment	Seed treatment	*0.8-2.2* 0.00116 lb/lb seed EC	[2.2] NS	[2.2] NS	[1] NS	1	NS	NS	NS		264-932 Rates in italics highlight the potential range of application rates depending on the number of seeds per lb and the number

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
															of seeds planted per acre. Seeding rate information provide by BEAD.[2]
		✓		Foliar	aerial, chemigation, ground boom	1.0 EC, WDGP	3.0	3.0	3	3	14	24	10		Except MS
				Total		**1.0**	**3.2**	**3.2**	**3**	**3**	**14**	**24**	**10**		1.6 lb a.i./A is max single rate (seed treatment) **Total with seed treatment** 1 crop cycle per year assumed
CRANBERRY		✓		Foliar	aircraft, ground boom/ broadcast and chemigation	1.5 EC, WDG	3.0	NA	2	NA	60	24	10	Not for use in Mississippi.	Do not apply to bogs when flooded.
CUCUMBER		✓		Storage or preplant seed treatment	Commercial seed treatment	*0.4* 0.00058 lb/lb seed EC	NS	0.1	2	1	NS	NS	NS		Seeding rate information provide by BEAD.[2]

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
															264-932, 62719-221, CA040004 Per registrant 2 CCs per year
FIGS		✓		**dormant/ delayed dormant**; soil application	ground boom	2.0 WDG, EC	2.0	NA	1	NA	217	4 d	NS	Use is restricted to California only.	Incorporation to 3 inches is suggested but not required following application.
FILBERTS/ HAZELNUT		✓		**dormant/ delayed dormant**; broadcast	aircraft, airblast	2.0 WP	2.0	NA	1	NA	14	24	10		
		✓		**foliar**; broadcast	aircraft, airblast	2.0 WDG, WP, EC	6.0	NA	3	NA	14		10		Some labels specify a retreatment interval of 10 days.
				Total		**2.0**	**6.0**	**NS**	**3.0**	**NA**	**14**	**24**	**10**		Excludes nursery applications (See general "Fruits" listing)

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate Per Year lb a.i./A	Maximum Application Rate Per CC[2] lb a.i./A	Maximum Application Number Per Year	Maximum Application Number Per CC[2]	PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
FOOD PROCESSING PLANT PREMISES (NONFOOD CONTACT)				When needed, crack and crevice treatment, spot treatment		0.0424 lb/ gal ME	NS	NA	NS	NA	NA	NS	7		53883-264, 84575-3 Spot Treatment: Do not exceed two square feet per individual spot.
FOREST PLANTINGS (REFORESTATION PROGRAMS) (TREE FARMS, TREE PLANTATION, ETC.)			✓	Foliar, broadcast	ground boom	1.0 EC	6.0	NA	6	NA			7		
			✓	Foliar, stump treatment	direct spray, drencher	0.34 EC	6.0	NA	[18] NS	NA			7		
				Total			6.0	NA	[18]	NA		24			
FOREST TREES (SOFTWOODS, CONIFERS)			✓	Foliar, broadcast	ground boom, drencher	0.61 EC	3.6	NA	[6] NS	NA	24		7		
			✓	Foliar, stump treatment	direct spray	[3.6] 2.4 lb a.i./100 gal EC	3.6	NA	[1] NS	NA			7		Application rate is provided as a dilution factor.
				Total			3.6	NA	[6]	NA					

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
FRUITS & NUTS Non-bearing (not to bear fruit within 1 year) fruit trees innurseries (includes: almonds, citrus, filbert, apple, cherry, nectarine, peach, pear, plum, prune).		✓		Foliar-Non-bearing nursery broadcast	High/low volume spay/ hand held sprayer/power sprayer	4.0 EC	4.0	NA	NS	NA	14	NS	7		For nectarines and peaches, the use is restricted to one application of no more than 3 lb a.i./A per cc. For apples, the max rate is 2 lb a.i./A per crop cycle and the use is restricted to 1 application (either canopy or trunk drench) per year. Example label, 62719-254
		✓		Foliar-Non-bearing nursery trunk drench	drencher, high and low pressure sprayer	2.0 WDG	2.0	NA	NS	1	14		7		
				Total		**4.0**	**6.0**								Maximum Single Rates: 3.0 (nectarines and peaches) 2.0 (apples)

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
															Maximum Yearly Rates: 3.0 (nectarines and peaches) 2.0 (apples)
GINSENG (MEDCINAL)		✓		Preplant, post-emergence	Ground, soil broadcast	2.0 G	2.0	NA	1	NA	365	24	NA	Permitted in Michigan and Wisconsin	MI110006,WI110003) Minimum incorporation: 4 inches Application should be followed by rainfall or overhead watering. Valid until June 29, 2016.
GOLF COURSE TURF				When needed, soil broadcast/ spot treatment	Ground, low pressure	1.0 EC	2.0	NA	2	NA		24	NS		
				Foliar, broadcast,	Ground boom, handgun, low	1.0 EC, G, B	2.0	NA	2	NA			NS		Chemigation not allowed for

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate Per Year lb a.i./A	Maximum Application Rate Per CC[2] lb a.i./A	Maximum Application Number Per Year	Maximum Application Number Per CC[2]	PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
					pressure and backpack										the EC formulation.
					Tractor drawn spreader, push type spreader, belly grinder	1.0 G						[24] NS	7		
				Mound treatment	Granule applicator	1.0 G	2.0	NS	2	NS		NS	7		
				Total		**2.0**	**2.0**	**NA**	**2**	**NA**	**NS**		**NS**		
GRAPES		✓		Dormant/ Delayed Dormant (pre-bloom)	Ground boom, broadcast, drench high/low spray volume	1.0 WDG, EC	1.0	1	1	NA	35	24	NS	East of the continental divide only.	Do not use in conjunction with soil surface applications for grape borer control.
		✓				2.0 EC	2.0	1	1	NA	35			Permitted in Colorado, Idaho, and Washington	CO080008, ID090004, WA090002 Master label: 62719-591
		✓		Foliar	Ground/ broadcast, basal spray and	2.25 EC	2.25	1	1	NA	35		NS	Permitted east of the	

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate Per Year lb a.i./A	Maximum Application Rate Per CC[2] lb a.i./A	Maximum Application Number Per Year	Maximum Application Number Per CC[2]	PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
					drench (soil treatment)									continental divide.	
		✓				1.0 EC	3.0	3	3	NA	35		NS	California	CA080010
		✓		Postharvest, dormant/ delayed dormant	Ground boom, broadca st	2.0 EC	2.0	1	1	NA	NS		NS	California	CA080009
				Total		**2.25**	**2.25**	**1**	**1**	**NA**	**35**	**24**	**NS**	Permitted east of the continental divide.	
						2.0	**5.0**	**4**	**4**	**NA**	**NS**		**NS**	California	
						2.0	**2.0**	**1**	**1**	**NA**	**NA**		**NS**	Permitted in Colorado, Idaho, and Washington	
						2.25	**4.25**	**2**	**2**	**NA**	**NS**		**NS**	Permitted in Colorado, Idaho, and Washington	
GRASS FORAGE/ FODDER/HAY		✓		Foliar, broadcast	Aircraft, ground boom, chemigation	1.0 EC	3.0	NA	3	NA	NS	24		Permitted in Nevada, Oregon,	NV080004, NV940002, OR090009, WA090010,

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
														Washington, and Idaho	ID090003
GREENHOUSE		✓		early evening, aerosol, fog or fumigation	Total release fogger	0.029 0.0066 lb a.i./1000 sq. ft PL	NS	NA	NS	NA	NS	NS	2		
HOUSEHOLD/ **DOMESTIC DWELLINGS INDOOR PREMISES**	✓			When needed	Bait station	0.0003 lb/bait station	NS	NA	NS	NA	NA	NS	NS		9688-67
HYBRID COTTONWOOD/ POPLAR PLANTATIONS		✓		Foliar, dormant, delayed dormant; broadcast	High volume (dilute) Low volume (concentrate)	1.9 EC	[2.0] NS	6.0	[1] NS	3		24	7	Washington	WA090004 Energy wood plantations may be harvested as often as every 2-3 years; pulpwood 5-10 years; and saw timber 15-20 years. (Arkansas production guide). In

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
															Washington the crop takes 2-8 years
LEGUME VEGETABLES		✓		Preplant, soil treatment	Ground boom	1.0 EC, WDG	1.0	NA	1	NA	NS	24	NA		No MRI because application only once a year
		✓		At planting, soil treatment	Ground boom	1.0 EC, WDG	1.0	NA	1	NA	NS		NA		
				Total		**1.0**	**1.0**	**NA**	**1**	**NA**	**NS**	**24**	**NS**		Assumed either a preplant or an at plant treatment.
MINT/ PEPPERMINT/ SPEARMINT		✓		Preplant soil incorporated	Aerial or ground/ broadcast	2.0 EC, WDG	[2.0] NS	2.0	[1] NS	1	90	24	NA	No use in Mississippi.	19713-599, 33658-26, 34704-857, 67760-28, 84229-25, 84930-7, OR940027 MRI NA due to once per crop cycle application

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
		✓		Post-emergence, Postharvest, Foliar	Chemigation, ground/ airblast	2.0 EC	2.0	2.0	[1] NS	2	90		NS	No use in Mississippi.	Postharvest application retreatment not specified on some labels.
				Total		**2.0**	**4.0**	**4.0**	**2.0**	**3**	**90**	**24**	**NS**		Labels allow one growing season application including pre-plant and one post-harvest application per season.
MOSQUITO CONTROL; HOUSEHOLD/ **DOMESTIC DWELLINGS OUTDOOR PREMISES;** **RECREATION AL AREAS**	✓			When needed; broadcast	Ultra low volume air and ground	0.01 EC	0.26	NA	26	NS	NA	NS	24 h	In Florida: Do not apply by aircraft unless approved by the Florida Dept of Ag.	Aerial applications may be made at altitudes ranging from 75-300 ft (see labels for specifics). For use by federal, state, tribal or local government officials or by persons

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate Per Year lb a.i./A	Maximum Application Rate Per CC[2] lb a.i./A	Maximum Application Number Per Year	Maximum Application Number Per CC[2]	PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
															certified in the appropriate category or authorized by the state or tribal lead regulatory agency.
NECTARINE		✓		**dormant/ delayed dormant** broadcast	airblast, handgun	3.0 WDG, EC	3.0	NA	1	NA	NS	24/ 4d	10		83222-20 others at 2 lb a.i./a
					Aircraft	2.0 WDG, EC									Updated to reflect spray drift mitigation.
		✓		pre-plant, foliar; **trunk spray/drench or pre-plant dip**	Handgun, low pressure backpack, dip	2.5 (3.0/100 gal) WDG, EC	2.5	NA	1	NA	14		5		There is no application retreatment interval specified on some of the label. The application rate is provided as a dilution factor.
				Total		**3.0**	**5.5**	**NA**	**2**	**NA**					Some labels limit the amount a.i./A per year.

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
															Multiple types of applications can occur such as preplant, trunk drench and dormant, delayed dormant applications. Excludes nursery applications (See general "Fruits" listing)
NONAGRICULTURAL OUTDOOR BUILDINGS/STRUCTURES to and around outside surfaces of nonresidential buildings and structures. Permitted areas of use include fences, pre-construction				Outdoor general surface/ Band (may be better if called perimeter)	Ground sprayer/ band sprayer	1.0 EC	NS	NA	NS	NA	NA	NS	NS		

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
foundations, refuse dumps, outside of walls, and other areas where pests congregate or have been seen															
NURSERY-STOCK: Ornamental nursery stock annuals, perennials and woody plants being grown in the field, in ball and burlap or in containers outdoor and in greenhouses				Dormant/ Delayed Dormant	high spray	3.0 EC	3.0	NA	1	NA		24	NS		
				Preplant	Ground boom, soil incorporated	4.0 EC, WP	NS	NA	NS	NA					
				foliar, soil directed	Tractor drawn spreader, push type spreader, belly grinder, gravity fed	1.1 G									

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate Per Year lb a.i./A	Maximum Application Rate Per CC[2] lb a.i./A	Maximum Application Number Per Year	Maximum Application Number Per CC[2]	PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
					backpack, spoon										
				Total		**4.0**	**CBD**		**3**						
ONIONS		✓		Post plant (seeding) Broadcast	Ground boom	1.0 EC	1.0	NS	2	NS	60	24	NS		
		✓		At plant, soil drench or basal spray	Ground boom	1.0 EC, WDG, G	1.0		1						Incorporation is not specified on the label.
				Total		2.0	2.0		2		60	24	NS		
ORNAMENTAL AND/OR SHADE TREES, HERBACEOUS PLANTS		✓		Foliar broadcast	Ground boom, air blast, handgun, low and high pressure hand wands	2.0 EC, WP 1.0 G, B	2.0	NA	[2] NS	NA	NS	24	NS		Some labels include a MRI of 7 days.
		✓		Dormant /Delayed Dormant	Handgun, low pressure and backpack	3.0 EC	3.0	NA	1	NA	NS		7		Low volume spray permitted for concentrated solutions and lower rates.
ORNAMENTAL LAWNS AND TURF, SOD FARMS (TURF)		✓		When needed, broadcast,	ground boom (WP only), high pressure hand wand	3.76 EC, WP	7.52	NA	2	NA	NS	24	NS		

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
				soil or spot treatment											
		✓		NS	Tractor drawn spreader, push type spreader, belly grinder	1.0 B	2.0	NA	2	NA	NS	24	NS		Bait is used for fire ant control.
ORNAMENTAL NON-FLOWERING PLANTS		✓		Foliar, broadcast, soil drench	Chemigation, ground boom, low and high pressure handwand, handgun, backpack sprayer, sprinkling can	0.007/gal ME	NS	NA	12	NA	NA	24	NS		Application rate provided as a dilution factor. Restricted use—occupational only
ORNAMENTAL WOODY SHRUBS AND VINES				Foliar broadcast	Ground boom, air blast, handgun, low and high pressure sprayer, backpack	2.0 EC, WDG 0.01 lb/gal EC	2.0 0.01 lb/gal	NA	[1] NS	NA	NS	24	NS		Several labels do not restrict the application rate in lb a.i./A.Examples include 16.5 lb/100 gal (228-625) and 1.0 lb/100 gal (829-280).

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
				Dormant/ delayed dormant		1.0 EC 0.005 lb/gal EC	1.0	NA	[1] NS	NA					
				Preharvest	Tractor drawn spreader, push type spreader, belly grinder	6.0 G	6.0	NA	[1] NS	NA					
				Preplant, potted, bailed-and burlapped, containerized	groundboom, handgun, low and high pressure sprayer, backpack, drench	1.0 EC	NS	1	NS	1					
				Pretransplant	groundboom	4.0 WP	[48.0] NS	4	12	4					
				Total		**6.0 G 4.0 WP**	**CBD**		**CBD**						
PEACH		✓		**dormant/**	airblast	3.0 EC	3.0	NA	1	NA	10	24/ 4d	NS		83222-20 (all other labels

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
				delayed dormant broadcast		2.0 WDG									restrict to 2 lb ai/a)
					aircraft,	2.0 EC 2.0 WDG							NS		Updated to reflect spray drift mitigation.
		✓		**Post-harvest** broadcast	airblast	2.5 (3.0/100 gal) EC	2.5	NA	1	NA	NA		NS	Permitted in Georgia and South Carolina	GA0400001, SC040001 SLN Expires:
					aircraft	2.0 (3.0/100 gal) EC	2.0								GA0400001, SC040001 SLN Expires: Updated to reflect spray drift mitigation
		✓		pre-plant, foliar; **trunk spray/drench or pre-plant dip**; ground	handheld, backpack, drench/dip, handgun, and low pressure hand wand	2.5 (3.0/100 gal) WDG	2.5	NA	1	NA	14	5	NS		Some labels do not specify minimum retreatment interval.

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
				Total		**3.0**	**5.5**	**NA**	**3**	**NA**	**NA**	**24**	**NS**		It is possible that multiple types of applications can occur such as soil, foliar and/or post-harvest and dormant/ delayed dormant applications. Excludes nursery applications (See general "Fruits" listing)
						3.0	**8.0**	**NA**	**3**	**NA**	**NA**	**24**	**NS**	Permitted in Georgia and South Carolina	
PEANUT		✓		Preplant	Aerial or ground/ broadcast	2.0 EC, WDG	[4.0] NS	4.0	[2] NS	2	NA	24	10	Do not apply aerial in Mississippi	Assumes one crop cycle per year.
		✓		At plant, postplant		4.0 G	[4.0] NS	4.0	2	2	21	24	10		
		✓		At pegging		2.0 G EC, WDG	[4.0] NS	4.0	2	[2] NS	21	24	10		

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
				Total		**4.0 G 2.0 EC, WDG**	**4.0**	**4.0**	**2**	**2**	**10**	**24**	**10**		
PEAR		✓		**dormant/ delayed dormant** broadcast	aircraft, airblast	2.0 WDG, EC	2.0	NA	1	NA	NA	24	NA	Restricted use in California.	83222-20 allows 3.0 lb a.i./ A; however, this does not match the 2001 RED.
		✓		**Post-harvest** broadcast	aircraft, airblast	2.0 WDG, EC	2.0	NA	1	NA	NA	24	NS	Permitted in California, Oregon and Washington.	
				Total		**2.0 WDG, EC**	**4.0**	**NA**	**2**	**NA**	**NA**	**24**	**NS**		Multiple types of applications may occur in within a year in California, Oregon and Washington such as a post-harvest application and a dormant,

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate Per Year lb a.i./A	Maximum Application Rate Per CC[2] lb a.i./A	Maximum Application Number Per Year	Maximum Application Number Per CC[2]	PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
															delayed dormant. Excludes nursery applications (See general "Fruits" listing)
PEAS		✓		Preplant Seed treatment	Seed Treatment	0.30 0.000625 lb/lb seed WP 0.28 0.00058 lb/lb seed EC	NS	NS	NS	NS	NS	NS	NS		There is a range of potential application rates depending on the number of seeds per lb and the number of seeds planted per acre. Seeding information provide by BEAD.[2]
PECANS		✓		**dormant/ delayed dormant** broadcast	aircraft, airblast	2.0 EC, WDG	2.0	NA	1	NA	14	24	10		66222-19 and 66222-233

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
		✓		**foliar**; broadcast	airblast	4.3 EC, WDG	6.3	NA	3	NA	14		10		Some labels require a 28 d PHI
					aircraft	2.0 EC, WDG									Updated to reflect spray drift mitigation.
		✓		foliar; **orchard floors broadcast**	Ground boom, chemigation	4.3 EC, WDG	4.3	NA	2	NA	14		10		
				Total		**4.3**	**12.6**	**NA**	**6**	**NA**	**14**	**24**	**10**		Considers multiple type of applications (*e.g.*, dormant, foliar broadcast, and orchard floor) but excluding nursery For nursery applications (See general "Fruits" listing)
PEPPER		✓		Foliar	Ground broadcast	1.0 WDG	[8] NS	8.0	[8] NS	8	7	24	10	Permitted in Florida	FL040005; 1 crop cycle per year.

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate Per Year lb a.i./A	Maximum Application Rate Per CC[2] lb a.i./A	Maximum Application Number Per Year	Maximum Application Number Per CC[2]	PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
PINEAPPLE		✓		Postplant	Ground boom, broadcast	2.0 EC	6.0	6.0	3	NA	365	24	30	Permitted in Hawaii	HI090001 SNL Expires: March 29, 2014. Do not make applications beyond three months after planting.
PLUM/ PRUNE		✓		**dormant/ delayed dormant**; broadcast	Aircraft, airblast	2.0 EC, WDG	2.0	NA	1	NA	NA	24/ 4d	10		
		✓		foliar; **trunk spray/drench**	handheld, backpack, drench/dip, handgun, and low pressure hand wand	2.5 3.0/100 gal WDG	2.5	NA	1	NA	NA		10		
				Total		**2.5**	**4.5**	NA	2	NA					Excludes nursery applications (See general “Fruits” listing)

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate Per Year lb a.i./A	Maximum Application Rate Per CC[2] lb a.i./A	Maximum Application Number Per Year	Maximum Application Number Per CC[2]	PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
POULTRY LITTER		✓		When needed, animal bedding/litter treatment.	Sprayer	0.07126 a.i./1000 sq ft 3.1 ME	NS	NA	NS	NA	NA		NS		53883-264, 84575-3
PUMPKIN		✓		Preplant Seed treatment	Seed treatment	0.3 0.00058 lb /lb seed WP	[0.3] NS	[1] NS	[1] NS	1	NS	NS	NS	California maximum single rate 0.000625 lb a.i./lb.	There is a range of potential application rates depending on the number of seeds per lb and the number of seeds planted per acre. Seeding information provide by BEAD.[4]
RADISH		✓		Foliar	Broadcast ground	1.0 EC	NS	1	NS	1	NS	24	NS	permitted in Oregon	OR090012 on radish grown for seed. Label valid until December 31, 2012. (per registrant SLN still valid)

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
		✓		Preplant	Soil incorporation ground	3.0 EC	12.0	3.0	4	1	NS	NS	10		
		✓		At plant/post-plant	In furrow drench/ treatment	3.0 EC 2.8 G	[12.0] NS	3.0	[4] NS	1	30, EC, 7, G	24	10		Only one granular application permitted.
				Total		**3.0**	**[12.0]** **NS**	**2**	**[5]** **NS**						Only one at plant or in furrow application is assumed.
RIGHTS OF WAY, ROAD MEDIANS				When needed, soil broadcast	Granular or low pressure wand	1.0 EC, G, Bait	[2.0] NS	NA	2	NA	NA	NS	7		Apply when needed
RUTABAGA		✓		Preplant	Chemigation, Groundboom	2.4 EC, WDG	[4.8] NS	2.4	[2] NS	1	30	24	10		
					Aerial	2.0 EC, WDG		2.0							Updated to reflect spray drift mitigation.
		✓		At plant/post-plant	In furrow drench/ treatment	2.4 EC, G WDG	4.8	2.4	[2] NS	1	7	24	10	Disallowed in California and Arizona.	Two crop cycles per year

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
				Total		**2.4**	**[9.6] NS**	**4.8**	**[4] NS**	**2**		**24**	**10**		
SEWER MANHOLE COVERS AND WALLS				When needed	Low pressure	0.31 lb/manhole RTU	NS	NA	NS	NA	NA	NA	NS		3 pints product/ manhole
SEED ORCHARD TREES		✓		**foliar**; broadcast	Ground boom	1.0 EC	3.0	3.0	NS	NA	30	24	7		62719-575, 62719-615
		✓			High volume sprayer	2.5 0.01 a.i./tree 0.02 EC	2.5	NS	[1] NS	NA	30	24	7		Cone worm treatment (62719-575 and 62719-615) Treatment of 1000 trees per acre would results in an single application rate of 10 lb a.i./a. DAS: 1000 is a bit high, typically for orchards 312 trees per acre

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
		✓		foliar; **stump treatment**	backpack, drencher, low pressure hand wand,	0.3 EC	0.3	1.0	NS	NA	30	24	7		62719-575, 62719-615
				Total		**1.0**	**5.8**	**3**	**NS**	**NA**	**30**	**24**	**7**		The total number of applications assumed is either three foliar applications or two foliar applications with one stump treatment.
SORGHUM GRAIN		✓		Seed Treatment	Seed treatment	[0.0009] 0.01- 0.0024 lb ai/ 100 lbs seed EC	0.01	0.01	[1] NS	1	NA	NS	NS		264-932
		✓		Preplant Soil Directed	Ground Spreader/T Band	1.5 G	1.5	1.5	[1] NS	1	60	24	10		
		✓		Foliar/Post emergent	Ground, Aerial, Chemigation	1.0 EC, WDG	1.5	[1.5] NS	[1] NS	3	30	24	10		PHI varies across labels

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate Per Year lb a.i./A	Maximum Application Rate Per CC[2] lb a.i./A	Maximum Application Number Per Year	Maximum Application Number Per CC[2]	PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
				Total		**3.3 G 1.0 EC, WDG**	**3.01**	**3.01**	**[3] CBD**	**3**	30	24	10		One crop cycle per year.
SOYBEAN		✓		foliar , post-emergence soil broadcast	broadcast ground, aerial, chemigation	1.0 EC, WDG	3.0	3.0	3	3	28	24	14		One crop cycle per year.
		✓		At plant/post plant treatment; soil band	ground boom	2.2 G 1.0 EC	3.0	3.0	1 (G), 3 (EC)	1 (G), 3 (EC)	28	24	10		
				Total		**1.0 EC, WDG 2.2 G**	**3.0**	**3.0**	**3**	**3**					One crop cycle per year.
STRAW-BERRIES		✓		Pre-plant	Aerial or ground/ broadcast	2.0 EC	2.0	**NS**	1	NS	NA	24	10	No use in Mississippi	33658-26

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
		✓		Foliar	Aerial or ground/ broadcast, foliar spray	1.0 EC, WDG	2.0	**NS**	2	**NS**	21	24	10		Two applications (2 lb ai) for all products per cc.
		✓		Post harvest	Ground directed spray	1.0 EC, WDG	2.0	**NS**	2	**NS**	21		14		
				Total		**2.0**	**4.0**		**3**						One preplant application and two foliar and/or postharvest application permitted per year.
SUNFLOWER		✓		At plant	Aerial/ground	2.0 G	3.0	3.0	[1] NS	1	42	24	10		Per registrant 1 cc per year
		✓		Preplant		2.0 EC, WDG	3.0	3.0	[1] NS	1	42		10		2 inches min incorporation
		✓		Post emergent or foliar		1.5 EC, WDG	3.0	3.0	[2] NS	2	42		10		
				Total		**2.0**	**5.0**	**5.0**	**3**	**3**					Assumed either an at plant or preplant

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
															application followed with two foliar applications. One crop cycle per year
SWEET POTATO		✓		Preplant, soil broadcast	~~Aircraft~~, ground boom	2.1 G, EC, WDG	2.1	NS	1	1	125	24		LA090002, MS080007, NC090001 permits 60 PHI	
					Aircraft	2.0 G, EC, WDG									Updated to reflect spray drift mitigation.
TOBACCO		✓		Preplant	Aircraft, ground boom	2.0 EC, G, WDG	2.0	NS	1	1	7	24	NA		
TRITICALE		✓		Storage Commercial Slurry Seed Treatment	Seed treatment	0.003 0.0024 lb ai/ 100 lbs seed EC	[0.003] NS	[1] NS	[1] NS	[1] NS	NA	[10] NS	[10] NS		264-932 Seeding information provide by BEAD.[4] One crop cycle per year.

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
TURNIP		✓		Preplant	soil incorporation/ ground boom, handgun	2.3 G, WDG	[4.6] NS	2.3	[2] NS	1	30	24	10		Minimum incorporation: 2 inches.
		✓		Postplant	Soil incorporation/ ground boom, handgun	2.3 G, WDGP	[4.6] NS	2.3	[2] NS	1	30	24	10		Minimum incorporation: 2 inches.
				Total		**2.3**	**4.6**	**2.3**	**2**	**1**	**30**	**24**	**10**		Assumed either a preplant or postplant application. Two crop cycles per year
UTILITIES For use in and around telecommunicatio ns, power, utilities and railroad systems equipment: Buried cables, cable television pedestals, cables, pad-mounted electric power				When needed, broadcast	Product container	1 G 0.44 lba.i./100 sq ft (see comments)	1	NS	[1] NS	NS	NS	NS	NS		Applications permitted as needed. Reg. Nos. 13283-14, 13283-17 Broadcast product onto the ground covering the area of the pad location, plus a two foot perimeter

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
transformers, telephone cables, underground vaults, telecommunications equipment, power and utilities equipment															around the outside of the pad location.
WALNUTS		✓		**dormant/ delayed dormant**; broadcast	Aircraft, airblast	2.0 EC, WDG	2.0	NA	1	NA	14	24	10		62719-301 (12 lb a.i./A)
		✓		**foliar**; broadcast	aircraft, airblast, chemigation	2.0 EC, WDG	4.0	NA	2	NA	14		10		Some labels do not specify retreatment interval.
		✓		foliar; **orchard floors broadcast**	Ground boom, chemigation	4.0 EC, WDG	4.0	NA	1	NA	14		10		
				Total		**4.0**	**10.0**		**4**						Excluding nursery applications; includes dormant, foliar

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate Per Year lb a.i./A	Maximum Application Rate Per CC[2] lb a.i./A	Maximum Application Number Per Year	Maximum Application Number Per CC[2]	PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
															broadcast, and orchard floor. For nursery applications (See general "Fruits" listing)
WIDE AREA/ GENERAL OUTDOOR TREATMENT For ants and other misc. pests.	✓	✓		when needed, Broadcast	Ground sprayer	0.5084 lb ai/100 gal EC	[1.02] NS	NA	2	NA	NA	NS	NS		66222-19
				when needed, Drench	Drench	1.0	NS	NA	NS	NA	NA		NS		228-624
						[1.0] 8.2 lb a.i/100 gal EC	NS	NA	NS	NA	NA		NS		228-625
				Total		[1.0]	[12.0] NS	NA	NS	NA	NA				
WHEAT		✓		Slurry Seed Treatment	Seed treatment	0.003 0.0024 lb ai/ 100 lbs seed EC	[0.006] NS	1	[2] NS	1	NA	NA	NA	Only for use in AZ, CA, CO, ID, KS, MN, MO, NE, NM, NV, ND, OK, OR,	Seeding information provide by BEAD.[4]
		✓		Foliar, soil treatment	Ground, broadcast	0.5 EC	[8.0] NS	4.0	[2] NS	1	14/ 28	24	14		PHI: 14 forage or hay, 28 grain or straw

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate Per Year lb a.i./A	Maximum Application Rate Per CC[2] lb a.i./A	Maximum Application Number Per Year	Maximum Application Number Per CC[2]	PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
		✓		Post-emergence foliar	Ground, Aerial, Chemigation	1.0 EC	[4.0] NS	2.0	[4] NS	2	14/ 28		NS	SD, TX, UT, WA and WY	Label states 1.0 lb ai/A for cereal leaf beetles and then state max rate 0.5 lb ai/A in restriction). Some labels restrict no more than 2 applications per crop/season PHI 14 forage or hay, 28 grain or straw
				Total		**[1]** **4.0** **EC**	[12.006]	**[6.003]** **5.0**	[8] NS	[4] 2					MO otherwise 2.0 plus seed treatment
WOOD PROTECTION TREATMENT TO BUILDINGS/				When needed, Wood surface treatment	Low pressure handwand, backback sprayer, paintbrush	16.65 lb/10,000 sq ft 0.17 lb a.i./gal EC	NS	NA	NS	NA	NS	NS	NS		

Crop/Site	Residential	Agricultural	Forestry	Timing; Application Type	Method/ Equipment	Maximum Single Application Rate by Formulation[1] (lb a.i./A)	Maximum Application Rate		Maximum Application Number		PHI (days)[3]	REI (hours)[3]	MRI (days)[3]	Geographic Restrictions	Comments
							Per Year lb a.i./A	Per CC[2] lb a.i./A	Per Year	Per CC[2]					
PRODUCTS OUTDOOR															
						0.08 lb ai/gal EC, RTU EC, ME	NS	NA	NS	NA	NS	NS	NS		Apply 1 gal per 100 sq ft of wood

1. EC - emulsifiable concentrate; WDG – water dispersible granular in water soluble packet; WP – wettable power in water soluble packet; B – bait (granular), G – granular; ME – microencapsulated; RTU – ready to use.
2. Reported as per crop cycle or per season
3. PHI – Preharvest interval; REI – reentry interval; MRI – Minimum retreatment interval
4. Becker, J.; Ratnayake, S. Acres Planted per Day and Seeding Rates of Crops Grown in the United States, U.S. EPA OPP/BEAD, 2011; example calculations provided below:
   Beans: 0.00058 lb a.i./lb seed / 960 seeds/lb seed x 418,176 seeds/A [pgs. 19, 81 (beans, succulent)]
   Corn: 0.000625 lb a.i./lb seed / 1,800 seeds/lb seed x 59,739 seeds/A [pgs. 24, 81 (corn, sweet)]
   Cotton: 0.00116 lb a.i./lb seed / 4,500 seeds/lb seed x 85,00 seeds/A [pgs. 13, 81]
   Cucumber: 0.00058 lb a.i./lb seed / 12,000 seeds/lb seed x 80,418 seeds/A [pgs. 25, 81]
   Peas: 0.000625 lb a.i./lb seed / 1,361 seeds/lb seed x 653,400 seeds/A [pgs. 34, 82]
   Pumpkin: 0.00058 lb a.i./lb seed / 1,600 seeds/lb seed x 7,260 seeds/A [pgs. 37, 82]
   Sorghum: 0.001 lb a.i./lb seed / 11,000 seeds/lb seed x 100,000 seeds/A [pgs. 16, 39]
   Triticale: 0.003 lb a.i./100 lb seed / 109 lb seed/A [pg.16]
   Wheat: 0.003 lb a.i./100 lb seed /116 lb seed/A [pg. 16]
   [ ] indicate assumptions that are made when the information is not specified but can be inferred

4.2 Diazinon

Diazinon is an organophosphate insecticide first registered in the United States in 1959. Diazinon is registered for use on multiple food crops, outdoor ornamentals grown in nurseries, and cattle ear tags. While most of the uses are allowed across the United States, many of the labeled uses are on Special Local Needs (SLN) labels and are only allowed in one state. There are five registrants with diazinon products with three technical labels, six Section 3 labels for agricultural products applied to crops, ten 24C or SLN Labels that are supplements to the six Section 3 labels, six cattle ear tag labels, and one Section 18 label for control of the fruit fly in the *Tephritidae* family in Florida. All labels are listed in EPA'S BE (Appendix 1-2).

Formulations include wettable powder, emulsifiable concentrate, and ear tags. All agricultural products (except the cattle ear tag) are applied in liquid form. Unless otherwise indicated, all uses of diazinon are permitted anywhere in the United States. Aerial and ground application methods (including broadcast, soil incorporation, orchard airblast, and chemigation) are allowed.

Currently, there are three multi-active-ingredient products registered that contain diazinon (***Table 3***). These are cattle ear tag products co-formulated with other organophosphate insecticides (chlorpyrifos or coumaphos).

Table 3. Multi-Active Ingredient Products Containing Diazinon

REGISTRATION #	NAME	PERCENT ACTIVE INGREDIENT	ACTIVE INGREDIENT
39039-6	WARRIOR INSECTICIDE CATTLE EAR TAGS	30	Diazinon
		10	Chlorpyrifos
11556-123	CO-RAL PLUS INSECTICIDE CATTLE EAR TAG	20	Diazinon
		20	Coumaphos
11556-148	CORATHON	35	Diazinon
		15	Coumaphos

Diazinon may be applied as part of a tank mix with other pesticides (*i.e.*, insecticides, miticides and fungicides) or adjuvants. In general, active ingredients can be mixed with other products unless specifically prohibited on the label(s). Some of the current diazinon labels specify that the diazinon product can be tank mixed with other pesticides, carriers, and adjuvants. Diazinon products do not specify other active ingredient pesticides for tank mixtures. However, to prevent crop injury, some product labels recommend against using the pesticide captan in tank mixtures.

Table 4 summarizes label restrictions for all diazinon products registered in the United States except cattle ear tags. The current maximum annual application rates on the labels are 5 pounds active ingredient per acre (lbs a.i./A) per application, with a maximum number of applications per year of 12, and a maximum of 60 pounds a.i./acre per year applied as a soil drench to containerized nursery stock in California. This maximum use pattern is on a special local needs (SLN label) with EPA registration number CA-050002.It is registered to the California Department of Food and Agriculture, to be used for fruit fly pests subject to State quarantine action. Treatments are for quarantine and eradication purposes, and are limited to applications under direct supervision by federal, state or county authorized persons. This SLN is generally used at large nurseries in southern California to treat fruit fly (in the *Tephritidae* family) infestations. There is a Section 18 label in Florida with a similar use pattern where diazinon is used under host trees.

The next highest annual or seasonal application rate is for a foliar ground application at 9 lbs a.i./A/year (3 lbs a.i./A/application with 3 possible applications per year at a minimum 14 day retreatment interval) registered for use on cranberries.

Diazinon may be applied using the following application methods: aerial, ground, airblast, soil incorporation, spray to base of plant, and soil drench. Depending on the use site and pest, applications may occur at plant, dormant, delayed dormant, foliar, and with infestation. For most use sites, a unique combination of these application methods and timings may occur. Aerial foliar applications are only permitted at 2.0 lb a.i./A on lettuce.

The national maximum annual rate of diazinon that may be applied to a crop site is 9 lbs a.i./A for cranberries. The next highest is for 8 lb a.i./A for tomatoes applied at plant with soil incorporation of 2 to 8 inches immediately after application. The maximum crop cycle rate of diazinon that may be applied to a crop site is 7.75 lbs a.i./A for squash and winter squash and two crop cycles per year are permitted for a maximum annual rate of 15.5 lbs a.i./A. This rate includes an “at plant” application with soil incorporation at 4 lbs a.i./A and possible ground foliar applications with pest infestation at 0.75 lbs a.i./A with up to five applications per crop cycle. Two crop cycles may occur per year. This use combination is only allowed in Texas.

Table 4. Diazinon Master Use Summary

Uses	App Timing	App type**	Formulation	Max App rate / App (ai/A)	# of applications/year unless otherwise specified	Max app rate/year (lbs a.i./A/yr)	CC per yr[e]	MRI (days)	Comments	Labels
Tree Nuts										
Almonds	Dormant	Ground, airblast	WP	3	1	3	1	--	CA only.	66222-10*
			WP, EC	2.99 - 3	1	3		--	CA only.Some labels do not specify a maximum number of applications per year.	5905-248, 66222-9, 19713-492, 19713-91, 66222-103
Filberts	With infestation	Ground, airblast	WP, EC	0.5	1	0.5		--	WA only.Filbert leafroller, aphids	5905-248,66222-9, 66222-10
Stone Fruit										
Apricot	Dormant, Foliar	Ground, airblast	WP, EC	2	2 (1 foliar, 1 dormant)	4*	1	60 Days between Dormant App & In-Season Application; 120 Days between Dormant App & Post Harvest Application		5905-248, 66222-9, 66222-10, 19713-492, 19713-91, 66222-103
Cherries	Dormant, Preharvest, Post-harvest	Ground, airblast	WP, EC	2	2 (1 foliar, 1 dormant)	4	1	30 Days between Dormant App & In-Season Application;90 Days between Dormant App & Post Harvest Application		5905-248, 66222-9, 66222-10, 19713-492, 19713-91, 66222-103
Peaches, Nectarines	Dormant, foliar, post-harvest	Ground, airblast	WP, EC	2	2 (1 foliar, 1 dormant)	4*	1	60 Days between Dormant App & In-Season Application; 120 Days between Dormant App & Post Harvest Application (Postharvest application not labeled for nectarines)		5905-248, 66222-9, 66222-10, 19713-492, 19713-91, 66222-103
Plums, prunes	Dormant and Foliar	Ground, airblast	WP, EC	2	2 (1 foliar, 1 dormant)	4*	1	60 Days between Dormant App & In-Season Application; 120 Days between Dormant App & Post Harvest Application		5905-248, 66222-9 66222-10, 19713-492, 19713-91, 66222-103
Berries										
Blueberries	Foliar and ant control	Ground, Airblast	WP, EC	0.5 - 1	2 (1 foliar, 1 ant control) Yr	2	1	30	0.5 lbs a.i. per ant mound but also has limitation for lbs per acre	5905-248, 66222-9, 66222-10, 19713-492, 19713-91, 66222-103
		Ant mounds		0.5 - 1						

Uses	App Timing	App type**	Formulation	Max App rate / App (ai/A)	# of applications/year unless otherwise specified	Max app rate/year (lbs a.i./A/yr)	CC per yr[e]	MRI (days)	Comments	Labels
Caneberries[g]	Foliar spray or drench to crown and lower canes before bud break	Ground, Airblast	WP, EC	1.99-2	1	2*	1	Single application allowed per year	CA, OH, OR, and WA only	5905-248, 66222-9, 66222-10, 19713-492, 19713-91, 66222-103
Cranberries	Foliar	Ground, Airblast	WP, EC	3	3	9*	1	14	Larval stage for blackheaded fireworm, berry inspection for eggs or larval for cranberry fruitworm, and cranberry tipworm.	5905-248,66222-9, 66222-10, 19713-492, 19713-91, 6222-103
Strawberries	Foliar, before plant	Ground, Soil inc.	WP, EC	1	2 (1 foliar, 1 soil)	2	1	30	For soil application, broadcast before transplant and then incorporate 1-2 inches	5905-248, 66222-9, 66222-10, 19713-492, 19713-91, 66222-103
Figs	With infestation	Ground, Airblast	WP, EC	0.5	1	0.5*	1 (USDA, 1999b)	--	CA only.Vinegar flies-drosphilia spp., dried fruit beetle	5905-248, 66222-9, 66222-10
Vegetable Crops										
Beans, succulent	Before planting	Soil[f] inc.	WP, EC	4	1	4*	1 Spring and 1 Fall Crop	--	Incorporation depth 1-8 inches	5905-248, 66222-9, 66222-10
Parsley	Before planting	Soil[f] inc.	EC	4	1	4	2	NA	TX only. Incorporation depth 2-8 inches depending on pest	TX-040026
Swiss Chard	Before planting	Soil[f] inc.	EC	4	1/cc	4/cc	2	NA	TX only. Incorporation depth 2-8 inches depending on pest	TX-040026
	With infestation	Foliar		0.5	5/cc	2.5*		7	TX only.	
	Aggregate TX	Combined soil inc. and foliar applications allowed in TX.			6/cc	6.5/cc	2	--	Aggregate applies to TX only.	--
Cucumbers,	Before planting	Soil[f] inc.	EC	4	1/	4*	1	NA	TX only.Incorporation depth 2-8 inches.	TX-040026
	With infestation	Foliar		0.5	5/	2.5*		7		
	Aggregate TX	Combined soil inc. and foliar applications allowed in TX.			6/cc	6.5*/cc	1	--	Aggregate applies to TX only.	

Uses	App Timing	App type**	Formulation	Max App rate / App (ai/A)	# of applications/year unless otherwise specified	Max app rate/year (lbs a.i./A/yr)	CC per yr[e]	MRI (days)	Comments	Labels
Summer and winter squash	Before planting	Soil[f] inc.	EC	4	1/cc	4*	2	7	PHI (Summer squash 3) (winter squash and cucumbers 7)	TX-040026
	With infestation	Foliar		0.75	5/cc	3.75*				
	Aggregate TX	Combined soil inc. and foliar applications allowed in TX.			6/cc	7.75/cc	2	--	Aggregate applies to TX only.	
Sweet potato	Before planting	Soil[f] inc.	EC	4	1	NS	1		Sweet potato incorporation depth is 4-8 inches.	TX-040026
Cole crops[a], Endive	Before planting	Soil[f] inc.	WP, EC	4	1	4*	2	--	Incorporation depth 2-8 inches	5905-248,66222-9, 66222-10, 19713-492, 19713-91, 66222-103
				1		1*			Incorporation depth 1-2 inches	
Cole Crops[b]	At transplant	Spray to base of plant with tractor mounted drop nozzle	WP, EC	0.25, 1, 3.75, 4.00	1	4	2	--		5905-248, 66222-9, 66222-10, 19713-492, 19713-91, 66222-103
Ginseng	At infestation	Ground	WP, EC	0.5	1	0.5*	less than 1 (multi year crop)	--	Leafhoppers, aphids, lygus bugs, flea beetles, jumping plant lice	5905-248, 19713-91, 66222-103, 66222-9
Lettuce	Before planting	Aerial or ground to Soil[f] inc.	WP, EC	2	2 (1 foliar, 1 soil)	4	2	30	Incorporate 2-8 inches	5905-248, 66222-9, 66222-10, 19713-492, 19713-91, 66222-103
				1					Incorporate 1 to 2 inches	
	Foliar, with infestation	Aerial or Ground		0.5					Aphids, Dipterous, leafminer	
Melons	Before planting	Soil[f] inc.	WP, EC	4	1 soil only; 2 (1 soil, 1 foliar honeydew only)	4			Incorporate 2-8 inches	5905-248, 66222-9, 66222-10, 19713-492, 19713-91, 66222-103
	Foliar (honeydew only)	Ground		0.74-0.8		0.8		30		
Onions and other bulb vegetables[d]	Before planting	Soil[f] inc.	WP, EC	4	1	4*	2	--	Incorporate 3-8 inches	5905-248, 66222-9, 66222-10, 19713-492, 19713-91, 66222-103

Uses	App Timing	App type**	Formulation	Max App rate / App (ai/A)	# of applications/year unless otherwise specified	Max app rate/year (lbs a.i./A/yr)	CC per yr[e]	MRI (days)	Comments	Labels
peas	Before planting	Soil[f] inc.	EC	4	1	4*/cc		--	TX only.	TX-040026
	With infestation	Foliar		0.5	3	1.5/cc		--	TX only.	
	Aggregate TX	Combined soil inc. and foliar applications allowed in TX.			4	5.5*/cc	1	--	Aggregate only applies to TX.	--
Peppers	Before planting	Soil[f] inc.	EC	4	1/cc	4*/cc	1	NS	May only be used in TX, GA, and CA only.Incorporate 2-8 inches.In CA, do not apply within a distance of 100 feet of lakes, ponds, streams and estuaries unless a suitable method is used to contain or divert runoff waters.In CA, must incorporate 4-8 inches.	TX-040026, GA-020003, CA030014
	Before planting	Soil[f] inc.		1	1/cc	1*/CC		NS	May only be used in TX and GA only. Incorporate 1-2 inches	
	With infestation	Foliar		0.5	5/cc			7	May only be used in TX.	
	Aggregate TX	Combined soil inc. and foliar applications allowed in TX.			6/cc	5*/cc		--	Aggregate only applies to TX.	--
Spinach	Before planting	Soil[f] inc.	WP, EC	4	1	4	2	1	Incorporate 1-2 inches for 1 lb a.i./A and 2-8 inches for 4 lbs a.i./A.	5905-248, 66222-9, 66222-10, 19713-91, 66222-103
Red beet, radishes, carrots, rutabagas	Before planting	Soil[f] inc.	WP, EC	4 (rutabegas 3-4)	1/yr	4*	red beets - 2 radishes 2- 3 carrots and rutabagas - 1 (in California)		Incorporate 2-8 inches for 4 lbs a.i./A.	5905-248, 66222-9, 66222-10, 19713-492, 19713-91, 66222-103,
				1		1*			Incorporate 1-2 inches for 1 lb a.i./A	

Uses	App Timing	App type**	Formulation	Max App rate / App (ai/A)	# of applications/year unless otherwise specified	Max app rate/year (lbs a.i./A/yr)	CC per yr[e]	MRI (days)	Comments	Labels
Turnips	Before planting	Soil[f] inc.	EC	4	1/cc	4*/cc	2-3	3	May only be used in TX and GA.Incorporate 2-8 inches.	TX-040026, GA020002
				1	1/cc	1*/cc		3	May only be used in TX and GA.Incorporate 1-2 inches.	
	As insects occur	Foliar		0.5	5/cc	2.5*/cc		3	May only be used in TX.Treat aphids, flea beetles, leafminers	
	Aggregate TX	Combined soil inc. and foliar applications allowed in TX.			6	6.5*/cc	--		Aggregate only applies to TX.	--
Potatoes	Before planting	Soil[f] inc.	WP, EC	4	1/	4	1	--	WA040034 has a 25 foot buffer (for ground applications) between application and fish bearing water to protect endangered species.DE, ID, OH, OR, TX and WA only.Incorporate 4-8 inches (DE, WA, OR).Incorporate 2-8 inches (ID, OH, TX)	WA040034, ID030018, ID020003, OH070003, DE060001, TX-040026, (supplement to 66222-9 and 5905-248)
Tomatoes	Before planting	Soil[f] inc.	WP, EC	3.75-4	1	3.75-4*	1-2 (not back to back)	--	Incorporate 2-8 inches	5905-248, 66222-9, 66222-10, 19713-91, 19713-492, 66222-103
			WP, EC	1		1*		--	Incorporate 1-2 inches	5905-248, 66222-9, 66222-10, 19713-492, 19713-91
	~~With infestation~~	~~Foliar~~	~~EC~~	~~0.8~~	~~5~~	-	-	~~7~~	~~Vinegar flies~~	~~19713-91~~
	Aggregate US	Combined soil inc. and foliar applications.			6	8		--	--	--
Parsnips	As insects occur	Foliar	EC	0.996	5	5*	1	7		TX-040026
Pome Fruit										
apples	Dormant and Foliar	Ground, airblast	WP	2	2 (1 dormant/ 1 foliar)	4*		14		19713-492
	Dormant, Delayed dormant, Foliar	Ground, airblast	WP, EC	2	2 (1 dormant/1foliar)	4*		60 Days between Dormant App & In-Season Application; 120 Days between Dormant App & Post Harvest Application		66222-10, 66222-103

Uses	App Timing	App type**	Formulation	Max App rate / App (ai/A)	# of applications/year unless otherwise specified	Max app rate/year (lbs a.i./A/yr)	CC per yr[e]	MRI (days)	Comments	Labels
pears	Dormant, Delayed Dormant and foliar	Ground, airblast	WP, EC	2	2 (1 foliar, 1 dormant)	4*		70 Days between Dormant App & In-Season Application		66222-10, 19413-492, 66222-103
Other										
Pineapple	foliar	Ground, airblast	WP	1	2	2*	less than 1 (multi year crop)	28	NS MRID is on 19713-492.	66222-10, 19713-492
Ornamentals grown outdoor in nurseries (trees, bushes, herbs, nonflowering plants, flowers, shrubs, vines)	Nursery stock	Ground, Airblast	WP, EC	1	1/cc	1*/cc	Varies 1 to several	--	Commercial grown ornamentals in outdoor nurseries	5905-248, 66222-9, 66222-10, 19713-492, 19713-91, 66222-103
	Application made when infestation occurs	soil drench of compromised containerized nursery stock in quarantine	EC	5	3	15		14		CA-050002[h]

NS=not specified; inc.=incorporated; CC=Crop Cycle; PHI=Preharvest interval

*Maximum yearly application rate was calculated as the maximum single application rate times the maximum number of applications.

[a] Cole Crops include: broccoli, broccolini, Brussels sprouts, cabbage, cauliflower, broccoflower, kale, mustard greens, and collards.

[b] Includes broccoli, broccolini, Brussels sprouts, cabbage, cauliflower, and broccoflower

[c] Melons include cantaloupes, casabas, crenshaws, honeydews, muskmelons, Persians and hybrids, and watermelons.

[d] Includes bulb and green onion, garlic, leeks, spring onions or scallions, Japanese bunching onions, green shallots, and green escholats.

[f] Broadcast then immediately incorporate into soil.

[g] Caneberries include blackberries, boysenberries, loganberries, raspberries, dewberries.

[h] Apply only with County Ag Commissioner permission to control fruit fly.Fruit must be removed before application.

4.3 Malathion

Malathion is an organophosphate insecticide used on a wide variety of crops, non-agricultural indoor, outdoor sites, and for wide area public health uses. There is currently 1 active technical registrant that sponsors guideline studies on malathion, and there are 96 active registrations (43 Section 3's, 53 Section 24c Special Local Needs, and 0 Section 18 Emergency Exemptions) from 21 registrants, which include formulated end-use products and technical grade malathion (EPA BE Appendix 1-2). Malathion can be applied in a dust, liquid or encapsulated form. Aerial and ground application methods (including broadcast, fogger, and chemigation) are allowed.

Registered labels for agricultural use products require 25-foot (ground and non-ULV aerial applications), or 50-foot (ULV aerial applications) no-spray buffer zones adjacent to "any water body." The interpretation of what constitutes a water body is left to the applicator and the state lead agency for pesticide label enforcement. All registered labels for agricultural use also include the following spray drift requirements when spraying in the vicinity of aquatic areas:

- Droplet Size
  - Use the largest droplet size consistent with acceptable efficacy. Formation of very small droplets may be minimized by appropriate nozzle selection, by orienting nozzles away from the air stream as much as possible, and by avoiding excessive spray boom pressure.
  - For ground boom and aerial applications, use only medium or coarser spray nozzles according to the American Society of Agricultural Engineers (ASAE) (S572) definition for standard nozzles, or a volume mean diameter (VMD) of 300 microns or greater for spinning atomizer nozzles. In conditions of low humidity and high temperatures, applicators should use a coarser droplet size.
- Wind Direction and Speed
  - Make aerial or ground applications when the wind velocity favors on-target product deposition (approximately 3 to 10 mph). Do not apply when wind velocity exceeds 15 mph. Avoid applications when wind gusts approach 15 mph. For all non-aerial applications, wind speed must be measured adjacent to the application site on the upwind side, immediately prior to application
- Temperature Inversion
  - Do not make aerial or ground applications into areas of temperature inversions. Inversions are characterized by stable air and increasing temperatures with increasing distance above the ground. Mist or fog may indicate the presence of an inversion in humid areas. Where permissible by local regulations, the applicator may detect the presence of an inversion by producing smoke and observing a smoke layer near the ground surface. In conditions of low humidity and high temperatures, applicators should use a coarser droplet size.
- Additional Requirements for Ground Applications
  - For ground boom applications, apply with nozzle height no more than 4 feet above the ground or crop canopy.

Currently, there are 4 malathion products that are co-formulated with other pesticidal active-ingredients (***Table 5***). Other active ingredients co-formulated with malathion include: carbaryl, captan, and gamma-cyhalothrin.

Table 5. Multi-Active Ingredient Products Containing Malathion

REGISTRATION #	NAME	PERCENT ACTIVE INGREDIENT	ACTIVE INGREDIENT
4-122	Bonide A Complete Fruit Tree Spray	0.30	Carbaryl
		11.76	Captan
		6.00	Malathion
829-175	SA-50 Brand Malathion-oil Citrus & Ornamental Spray	75.00	Mineral Oil
		5.00	Malathion
67760-108	Fyfanon Plus ULV	1.47	Gamma-cyhalothrin
		92.20	Malathion
67760-131	Malathion 851 g/L + Gamma-Cyhalothrin 12.8 g/L EC	1.11	Gama-cyhalothrin
		73.70	Malathion

Malathion may be applied as part of a tank mix with other pesticides (*i.e.*, insecticides, miticides and fungicides). In general, active ingredients can be mixed with other products unless specifically prohibited on the label(s). Some of the current malathion labels specify that the malathion product can be tank mixed with other products/chemicals. The BE identifies allowable, and in some cases, recommended, tank mixes specified on malathion labels (EPA BE Table 1-2, and EPA Appendix 1-4).

The following tables document all currently registered use sites compiled from all active malathion product labels. These tables (***Table 6***, ***Table 7***, and ***Table 8***) document all currently registered labels and any agreed upon changes to these labels from the registrants.

Malathion is currently registered for use in a variety of non-agricultural settings, including for use on 47 homeowner garden fruit and vegetable varieties, and ornamental uses for commercial and homeowner applications. ***Table 6*** details these uses below.

Table 6. Malathion Master Use Summary for Residential and other Non-Agricultural Uses

Use Site	Method	Maximum Single Application Rate (lb a.i./A)	Maximum Application Rate (per year in lb a.i./acre) (for all formulations combined, unless otherwise noted)	Maximum Applicatio n Number (per year)	Minimum Retreatment Interval
Apples	Ground	NS[1]	NS	2	7
Apricots	Ground	1.5	NS	2	7
Asparagus	Ground	1.25	NS	2	7
Avocado	Ground	1.25	NS	NS	30
Beans	Ground	NS[2]	NS	NS	7
Beets	Ground	1.25	NS	3	7
Blueberry	Ground	1.25	NS	3	5
Broccoli	Ground	1.25	NS	2	7
Brussels sprouts	Ground	1.25	NS	2	7
Cabbage	Ground	1.25	NS	6	7
Caneberries	Ground	2	NS	3	7
Cantaloupe	Ground	1	NS	2	7
Carrots	Ground	1.25	NS	2	7
Cauliflower	Ground	1.25	NS	2	7
Celery	Ground	1.5	NS	2	7
Cherries (tart and sweet)	Ground	1.75	NS	4	3

Use Site	Method	Maximum Single Application Rate (lb a.i./A)	Maximum Application Rate (per year in lb a.i./acre) (for all formulations combined, unless otherwise noted)	Maximum Applicatio n Number (per year)	Minimum Retreatment Interval
Citrus (CA only)	Ground	7.5	NS	1	NA
Citrus (excluding CA)	Ground	4.5	NS	1	NA
Collards	Ground	1	NS	3	7
Corn, sweet/pop	Ground	1	NS	2	5
Cucumber	Ground	1.75	NS	2	7
Dandelion	Ground	1.25	NS	2	7
Eggplant	Ground	1.56	NS	4	5
Endive (escarole)	Ground	1.25	NS	2	7
Flies	Ground	0.18	NS	NS	NS
Garlic	Ground	1.56	NS	3	7
Grapes	Ground	1.88	NS	2	14
Kale	Ground	1	NS	3	5
Kohlrabi	Ground	1.25	NS	2	7
Kumquat	Ground	4.5	NS	1	30
Leek	Ground	1.56	NS	2	7
Lemons (FL only)	Ground	4.5	NS	1	NS
Lettuce (head)	Ground	1.88	NS	2	6
Lettuce (leaf)	Ground	1.88	NS	2	5
Mango	Ground	0.9375	NS	10	7
Melons (other than watermelon)	Ground	1	NS	2	7
Mustard	Ground	1	NS	NS	5
Mustard greens	Ground	1	NS	NS	5
Okra	Ground	1.2	NS	NS	7
Onion (bulb and green)	Ground	1.56	NS	NS	7
Ornamental and/or shade trees	Ground/Spot Treatment	NS	NS	NS	10
Ornamental flowering plants	Ground/Spot Treatment	NS	NS	NS	NS

Use Site	Method	Maximum Single Application Rate (lb a.i./A)	Maximum Application Rate (per year in lb a.i./acre) (for all formulations combined, unless otherwise noted)	Maximum Application Number (per year)	Minimum Retreatment Interval
Ornamental flowers and bushes	Ground/Spot Treatment	NS	NS	NS	NS
Ornamental herbaceous plants	Ground/Spot Treatment	NS[3]	2	NS	NS
Ornamental non-flowering plants	Ground/Spot Treatment	NS[3]	2	NS	NS
Ornamental woody shrubs and vines	Ground/Spot Treatment	NS[3]	NS	NS	NS
Ornamentals (trees, shrubs, flowers)	Ground/Spot Treatment	NS	NS	NS	NS
Ornamentals, all	Ground/Spot Treatment	NS	NS	NS	NS
Outdoor insects	Ground/Spot Treatment	NS	NS	NS	NS
Outdoor ornamentals	Ground/Spot Treatment	NS[4]	6	7	NS
Outdoor residential (mosquitoes, other nuisance insects)	Ground/Spot Treatment	NS	NS	NS	NS
Outdoor residential areas	Ground/Spot Treatment	NS	NS	NS	NS
Outdoor treatment, general (flies, mosquitoes, etc)	Ground	0.125	NS	NS	NS
Parsley	Ground	1.5	NS	NS	7
Peaches	Ground	3	NS	NS	11
Pears	Ground	1.25	NS	NS	7
Peas	Ground	1	NS	NS	7
Pecans	Ground	2.5	NS	NS	7
Peppers	Ground	1.56	NS	NS	5
Potatoes	Ground	1.56	NS	NS	7
Pumpkins	Ground	1	NS	NS	7
Radish	Ground	1	NS	NS	7

Use Site	Method	Maximum Single Application Rate (lb a.i./A)	Maximum Application Rate (per year in lb a.i./acre) (for all formulations combined, unless otherwise noted)	Maximum Application Number (per year)	Minimum Retreatment Interval
Rice	Ground	1.25	NS	NS	7
Rutabagas	Ground	1	NS	NS	7
Shallot	Ground	1.56	NS	NS	7
Spinach	Ground	1	NS	NS	7
Squash, summer	Ground	1.75	NS	NS	7
Squash, winter	Ground	1	NS	NS	7
Strawberry	Ground	2	NS	NS	7
Sweet potatoes	Ground	1.56	NS	NS	7
Swiss chard	Ground	1	NS	NS	7
Tomatoes	Ground	1.56	NS	NS	5
Turnips (greens)	Ground	1.25	NS	NS	5
Turnips (roots)	Ground	1.25	NS	NS	7
Watercress	Ground	1.25	NS	5	3
Watermelons	Ground	1.5	NS	4	7

[1]*Reg. No. 4-122 does not specify a maximum application rate.Reg. No. 4-99 specifies a maximum rate of 2.2 lbs a.i./A.*

[2]*Reg. Nos. 239-739 and 46515-19 do not specify maximum application rates.Reg. Nos. 4-99, 28293-123, 33955-394, and 4-412 specify maximum application rates between 1.1 and 1.5 lbs a.i./A*

[3]*Reg. Nos. 33955-394, 45385-43, and 7401-10 do not specify maximum application rates.Reg. Nos. 4-99 and 4-412 specify maximum rates of 4.5 lbs a.i./A and 4.4 lbs a.i./A, respectively.*

[4]*Reg. No. does not specify a maximum application rate.Reg. No. 28293-123 specifies a maximum rate of 5.1 lbs a.i./A*

Malathion is currently registered for use on 115 agricultural crops. Maximum single application rates on crops are as high as 7.5 lbs a.i./A for citrus in California. Other high single application rates are for avocado (4.7 lbs a.i./A), citrus outside California (4.5 lbs a.i./A), kumquat (4.5 lbs a.i./A), and pine seed orchards (4.5 lbs a.i./A). All other agricultural applications are for 3 lbs a.i./A or less. Though it is not a broadcast use, the highest use rate presented below is for grain storage facilities and transport of 26.14 lbs a.i./A. No limits in application rate or number of applications are specified for several uses, including beans, grain storage facilities and transport, and lentils. ***Table 7*** below details these uses.

Table 7. Malathion Master Use Summary for Agricultural Uses with Conventional Application Methods

Use Site	Method	Maximum Single Application Rate (lb a.i./A)	Maximum Application Rate (per year in lb a.i./acre) (for all formulations combined, unless otherwise noted)	Maximum Application Number (per year)	Minimum Retreatment Interval
Alfalfa	Ground/Aerial	1.25	NS	NS	14
Apricots	Ground/Aerial	1.5	NS	2	7
Asparagus	Ground/Aerial	1.25	NS	2	7
Avocado	Ground/Aerial	4.7	NS	2	30
Barley	Ground/Aerial	1.25	NS	2	7
Beans	Ground/Aerial	NS	NS	NS	NS
Beets	Ground/Aerial	1.25	NS	3	7
Blueberry	Ground/Aerial	1.25	NS	3	5
Broccoli; Chinese Broccoli; Broccoli Rabb	Ground/Aerial	1.25	NS	2	7
Brussels sprouts	Ground/Aerial	1.25	NS	2	7
Cabbage	Ground/Aerial	1.25	NS	6	7
Caneberries	Ground/Aerial	2	NS	3	7
Cantaloupe	Ground/Aerial	1	NS	2	7
Carrots	Ground/Aerial	1.25	NS	2	7
Cauliflower	Ground/Aerial	1.25	NS	2	7
Celery	Ground/Aerial	1.5	NS	2	7
Chayote fruit	Ground/Aerial	1.75	NS	2	7
Chayote root	Ground/Aerial	1.56	NS	2	7
Cherries (tart and sweet)	Ground/Aerial	1.75	NS	4	3

Use Site	Method	Maximum Single Application Rate (lb a.i./A)	Maximum Application Rate (per year in lb a.i./acre) (for all formulations combined, unless otherwise noted)	Maximum Applicatio n Number (per year)	Minimum Retreatment Interval
Chestnut	Ground/Aerial	2.5	NS	3	7
Chinese Cabbage	Ground/Aerial	1.25	NS	2	7
Chinese Cabbage; Mustard	Ground/Aerial	1.25	NS	2	7
Chinese Mustard	Ground/Aerial	1.25	NS	3	7
Christmas tree plantations	Ground/Aerial	3.2	NS	2	NS
Citrus	Ground/Aerial	4.5	NS	1	NA
Citrus (CA only)	Ground/Aerial	7.5	NS	1	NA
Clover	Ground/Aerial	1.25	NS	NS	14
Collards	Ground/Aerial	1	NS	3	7
Corn (field)	Ground/Aerial	1	NS	2	7
Corn (sweet and pop)	Ground/Aerial	1	NS	2	5
Cotton	Ground/Aerial	2.5	NS	3	7
Cucumber	Ground/Aerial	1.75	NS	2	7
Currant	Ground/Aerial	1.25	NS	3	7
Dandelion	Ground/Aerial	1.25	NS	2	7
Eggplant	Ground/Aerial	1.56	NS	4	5
Endive	Ground/Aerial	1.25	NS	2	7
Fence rows/hedge rows	Ground/Aerial	0.24	NS	NS	NS
Figs	Ground/Aerial	2	NS	2	5
Flax	Ground/Aerial	0.5	NS	3	7
Garlic	Ground/Aerial	1.56	NS	3	7
Grain storage facilities (empty)	Ground	26.14	NS	NS	NA
Grain Storage Facilities and Transport (wheat, corn, oats, barley and rye)	Ground	26.14	NA	3	60
Grain Storage Facilities and Transport (wheat, corn, oats, barley and rye)	Ground	NS	NA	NS	NS
Grapes (raisin, table, wine)	Ground/Aerial	1.88	NS	2	14

Use Site	Method	Maximum Single Application Rate (lb a.i./A)	Maximum Application Rate (per year in lb a.i./acre) (for all formulations combined, unless otherwise noted)	Maximum Applicatio n Number (per year)	Minimum Retreatment Interval
Grass (forage)	Ground/Aerial	1.25	NS	NS	NA
Grass, Bermuda	Ground/Aerial	1.25	NS	NS	NA
Guava	Ground/Aerial	1.25	NS	13	3
Honeydew	Ground/Aerial	1	NS	2	7
Hops	Ground/Aerial	0.63	NS	3	7
Horseradish	Ground/Aerial	1.25	NS	3	7
Kale	Ground/Aerial	1	NS	3	5
Kohlrabi	Ground/Aerial	1.25	NS	2	7
Kumquat	Ground/Aerial	4.5	NS	1	30
Leek	Ground/Aerial	1.56	NS	2	7
Lentils	Ground/Aerial	NS	NS	NS	NS
Lespedeza	Ground/Aerial	1.25	NS	NS	14
Lettuce (head)	Ground/Aerial	1.88	NS	2	6
Lettuce (leaf)	Ground/Aerial	1.88	NS	2	5
Macadamia nut	Ground/Aerial	0.94	NS	6	7
Mango	Ground/Aerial	0.9375	NS	10	7
Melons (other than watermelon)	Ground/Aerial	1	NS	2	7
Mint	Ground/Aerial	0.94	NS	3	7
Mushrooms	Ground/Aerial	1.7	NS	4	3
Mustard Greens	Ground/Aerial	1	NS	3	5
Nectarines	Ground/Aerial	3	NS	3	7
Non-agricultural uncultivated areas/soil	Ground/Aerial	0.6	NS	NS	NS
Oats	Ground/Aerial	1	NS	2	7
Okra	Ground/Aerial	1.2	NS	5	7
Onion (bulb and green)	Ground/Aerial	1.56	NS	2	7
Papaya	Ground/Aerial	1.25	NS	8	3
Parsley	Ground/Aerial	1.5	NS	2	7

Use Site	Method	Maximum Single Application Rate (lb a.i./A)	Maximum Application Rate (per year in lb a.i./acre) (for all formulations combined, unless otherwise noted)	Maximum Application Number (per year)	Minimum Retreatment Interval
Parsnip	Ground/Aerial	1.25	NS	3	7
Passion Fruit	Ground/Aerial	1	NS	8	7
Peaches	Ground/Aerial	3	NS	3	11
Pears	Ground/Aerial	1.25	NS	2	7
Peas (dry, succulent)	Ground/Aerial	1	NS	2	7
Pecans	Ground/Aerial	2.5	NS	2	7
Peppers	Ground/Aerial	1.56	NS	2	5
Pine seed orchards	Ground/Aerial	3.2	NS	2	7
Pineapple	Ground/Aerial	2	NS	3	7
Potatoes	Ground/Aerial	1.56	NS	2	7
Pumpkins	Ground/Aerial	1	NS	2	7
Radish	Ground/Aerial	1	NS	3	7
Rice; Wild Rice	Ground/Aerial	1.25	NS	2	7
Rutabagas	Ground/Aerial	1	NS	3	7
Rye	Ground/Aerial	1	NS	3	7
Salsify	Ground/Aerial	1.25	NS	3	7
Shallot	Ground/Aerial	1.56	NS	2	7
Sorghum	Ground/Aerial	1	NS	2	7
Spinach	Ground/Aerial	1	NS	2	7
Squash, summer	Ground/Aerial	1.75	NS	3	7
Squash, winter	Ground/Aerial	1	NS	3	7
Strawberry	Ground/Aerial	2	NS	4	7
Sweet potatoes	Ground/Aerial	1.56	NS	2	7
Swiss chard	Ground/Aerial	1	NS	2	7
Tomatoes; Tomatillos	Ground/Aerial	1.56	NS	4	5
Trefoil (birdsfoot)	Ground/Aerial	1.25	NS	NS	14
Turnips (greens)	Ground/Aerial	1.25	NS	3	5
Turnips (roots)	Ground/Aerial	1.25	NS	3	7

Use Site	Method	Maximum Single Application Rate (lb a.i./A)	Maximum Application Rate (per year in lb a.i./acre) (for all formulations combined, unless otherwise noted)	Maximum Applicatio n Number (per year)	Minimum Retreatment Interval
Vetch	Ground/Aerial	1.25	NS	NS	14
Walnuts	Ground/Aerial	2.5	NS	3	7
Watercress	Ground/Aerial	1.25	NS	5	3
Watermelons	Ground/Aerial	1.5	NS	4	7
Wheat (spring and winter)	Ground/Aerial	1	NS	2	7
Yams	Ground/Aerial	1.56	NS	2	7

Malathion is currently registered for use on 27 agricultural crops for ultra low volume (ULV) applications.It is also registered for use on pine seed orchards and wide area public use for ultra low volume applications in non-agricultural areas.Maximum single application rates on crops are as high as 1.22 lbs a.i./A for cotton. ***Table 8*** details these uses below.

Table 8. Malathion Master Use Summary for Uses with Ultra Low Volume Applications

Use Site	Method[1] (Formulation/ product)[2]	Maximum Single Application Rate (lb a.i./A)	Maximum Application Rate (per year in lb a.i./acre) (for all formulations combined, unless otherwise noted)	Maximum Applicatio n Number (per year)	Minimum Retreatment Interval
Alfalfa	Ground/Aerial	0.61	NS	NS	14
Barley	Ground/Aerial	0.61	NS	2	7
Beans (dry, snap, Lima)	Ground/Aerial	0.61	NS	2	7
Beans (dry, succulent)	Ground/Aerial	0.61	NS	2	7
Blueberry	Ground/Aerial	0.77	NS	3	10
Cherries (sweet)	Ground/Aerial	1.22	NS	4	7
Cherries (tart)	Ground/Aerial	1.22	NS	6	7
Christmas tree plantations	Ground/Aerial	0.9375	NS	2	NS

Use Site	Method[1] (Formulation/ product)[2]	Maximum Single Application Rate (lb a.i./A)	Maximum Application Rate (per year in lb a.i./acre) (for all formulations combined, unless otherwise noted)	Maximum Applicatio n Number (per year)	Minimum Retreatment Interval
Citrus	Ground/Aerial	0.175	NS	3	7
Clover	Ground/Aerial	0.61	NS	NS	14
Corn (field)	Ground/Aerial	0.61	NS	2	7
Corn (sweet and pop)	Ground/Aerial	0.61	NS	2	5
Cotton	Ground/Aerial	1.22	NS	3	7
Fence rows/hedge rows	Ground/Aerial	0.24	NS	NS	NS
Grass, Bermuda	Ground/Aerial	0.92	NS	NS	NA
Kumquat	Ground/Aerial	0.175	NS	2	7
Lespedeza	Ground/Aerial	0.61	NS	NS	14
Lupine	Ground/Aerial	0.61	NS	1	NA
Mosquitoes/Wide Area Public Health	Ground/Aerial	0.23	NS	NS	NS
Non-agricultural uncultivated areas/soil	Ground/Aerial	0.9281	NS	NS	NS
Oats	Ground/Aerial	0.61	NS	2	7
Pasture and Rangeland	Ground/Aerial	0.92	NS	NS	7
Pine seed orchards	Ground/Aerial	0.9375	NS	2	7
Rice; Wild Rice	Ground/Aerial	0.61	NS	2	7
Rye	Ground/Aerial	0.61	NS	1	NA
Sorghum	Ground/Aerial	0.61	NS	2	7
Trefoil (birdsfoot)	Ground/Aerial	0.61	NS	NS	14
Vetch	Ground/Aerial	0.61	NS	NS	14
Wheat (spring and winter)	Ground/Aerial	0.61	NS	2	7

5 Action Area

Action area means all areas affected directly, or indirectly, by the Federal action, and not just the immediate area involved in the action (50 C.F.R. §402.02). Given EPA's nationwide authorization of these pesticides and anticipated chemical transport following application, the action area includes the entire U.S. and its territories, including all waters in which EPA's action causes effects to listed species or designated critical habitat. The action area includes all ESA-listed species and designated critical habitat under NMFS jurisdiction.

6 Interrelated and Interdependent Actions

Interrelated actions are those that are part of a larger action and depend on that action for their justification. *Interdependent* actions are those that do not have independent utility apart from the action under consideration. There are no interrelated and interdependent actions associated with the proposed action.

Chapter 7, 8

Species and Critical Habitat Not Likely to be Adversely Affected, Species and Critical habitat Likely to be Adversely Affected

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7 SPECIES AND CRITICAL HABITAT NOT LIKELY TO BE ADVERSELY AFFECTED

The National Marine Fisheries Service (NMFS) uses two criteria to identify the species listed under the Endangered Species Act (ESA) or designated critical habitat that are Not Likely to be Adversely Affected (NLAA) by the proposed action, as well as the effects of activities that are interrelated to or interdependent with the Federal agency's proposed action. The first criterion is exposure, or some reasonable expectation of a co-occurrence, between one or more potential stressors associated with the proposed activities and ESA-listed species or designated critical habitat. If we conclude that an ESA-listed species or designated critical habitat is not likely to be exposed to the proposed activities, we must also conclude that the species or critical habitat is NLAA by those activities.

The second criterion is the probability of a response given exposure. ESA-listed species or designated critical habitat that is exposed to a potential stressor but is likely to be unaffected by the exposure is also NLAA by the proposed action.

An action warrants a "NLAA" finding when its effects are wholly *beneficial, insignificant* or *discountable*. *Beneficial* effects have an immediate positive effect without any adverse effects to the species or habitat. Beneficial effects are usually discussed when the project has a clear link to the ESA-listed species or its specific habitat needs and consultation is required because the species may be affected.

Insignificant effects relate to the size or severity of the impact and include those effects that are undetectable, not measurable, or so minor that they cannot be meaningfully evaluated. Insignificant is the appropriate effect conclusion when plausible effects are going to happen, but will not rise to the level of constituting an adverse effect. That means the ESA-listed species may be expected to be affected, but not harmed or harassed.

Discountable effects are those that are extremely unlikely to occur. For an effect to be discountable, there must be a plausible adverse effect (i.e., a credible effect that could result from the action and that would be an adverse effect if it did impact a listed species), but it is very unlikely to occur.

EPA has determined the following marine species effect determinations to be NLAA (***Table 1***,***Table 2***, and ***Table 3***). NMFS concurs the proposed action to register chlorpyrifos, diazinon, and malathion will have insignificant and discountable effects to these species. The habitats each occupy throughout their life history and their prey are expected to have extremely low to no overlap with use sites where the labels authorize these pesticides to be applied.

Cetaceans
Direct effects to listed cetaceans from the action are not expected due to dilution of the three a.i.s in the marine environments (resulting in a very low potential for exposure) and the cetaceans' very large size (very low potential for effects). Additionally, some of the listed cetaceans are found primarily in deep, ocean waters [*i.e*., Sei whale (*Balaenoptera borealis*), Bryde's whale (*Balaenoptera edemi*), blue whale (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), and sperm whale (*Physeter microcephalus(=icrocephalus*)], and/or are circumpolar [*i.e*., the bowhead whale (*Balaena mysticetus*)]. Species that are found primarily in deep waters or are circumpolar (*i.e.,* found at high latitudes around the earth's Polar Regions) are expected to range far from any potential application sites – further limiting the potential for exposure. In addition, because each of these pesticides are readily metabolized and do not accumulate in aquatic organisms (see EPA BE section 7.1.1), dietary exposure for these species is of very low concern (see EPA Appendix 3-1). Therefore, for direct effects, we consider the risk to be low (due to limited exposure and potential for effects) and the confidence in that conclusion to be high. The same conclusions and rationale apply to the designated critical habitats associated with these species.

For indirect effects (*i.e*., reductions in whales' prey), due to the effect of dilution in the types of marine environments in which the listed cetaceans are found and distance from potential use sites, risks from the potential loss of marine invertebrate and vertebrate prey are not expected. Therefore, for the listed cetaceans that rely wholly on marine prey [*i.e*., bowhead whale, Bryde's whale, Sei whale, blue whale, fin whale, North Atlantic right whale, North Pacific right whale, humpback whale, sperm whale, false killer whale (Main Hawaiian Islands Insular Distinct Population Segment (DPS)), we do not expect indirect effects from the potential loss of prey. For these species, we consider the risk for indirect effects to be low (due to limited exposure) and we have high confidence in this risk assessment. The same conclusions and rationale apply to the designated critical habitats associated with these species. Therefore, NMFS can concur with the Not Likely to Adversely Affect (NLAA) effects determinations EPA made for the bowhead whale, Bryde's whale, Sei whale, blue whale, fin whale, North Atlantic right whale, North Pacific right whale, humpback whale, sperm whale, false killer whale (Main Hawaiian Islands Insular DPS), and for the designated critical habitat associated with the North Atlantic Right Whale DPS and the North Pacific Right Whale DPS (***Table 1***). The proposed action to register chlorpyrifos, diazinon, and malathion will have insignificant and discountable effects to these species. The habitats each occupy throughout their life history and their prey are expected to have extremely low to no overlap with use sites where the labels authorize these pesticides to be applied.

Table 1. Cetaceans – Summary of the NLAA Determinations for Chlorpyrifos, Diazinon, and Malathion

Scientific Name	Common Name	Listing Status[1]	FWS/NMFS Species ID	Risk (Direct Effects)	Confidence (Direct Effects)	Risk (Indirect Effects)	Confidence (Indirect Effects)	Species Call?	Critical Habitat Call[2]?
Balaena mysticetus	Bowhead whale	E	3133	Low	High	Low	High	NLAA	NA
Balaenoptera borealis	Sei whale	E	1769	Low	High	Low	High	NLAA	NA
Balaenoptera edemi	Bryde's whale	C	178	Low	High	Low	High	NLAA	NA
Balaenoptera musculus	Blue whale	E	3199	Low	High	Low	High	NLAA	NA
Balaenoptera physalus	Fin whale	E	3096	Low	High	Low	High	NLAA	NA
Delphinapterus leucas	Beluga whale (Cook Inlet DPS)	E	10144	Low	High	Low	High	NLAA	NLAA
Eubalaena glacialis	North Atlantic Right Whale	E	2510	Low	High	Low	High	NLAA	NLAA
Eubalaena japonica	North Pacific Right Whale	E	10145	Low	High	Low	High	NLAA	NLAA
Megaptera novaeangliae	Humpback whale	E	5623	Low	High	Low	High	NLAA	NA
Physeter microcephalus(=icrocephalus)	Sperm whale	E	4719	Low	High	Low	High	NLAA	NA
Pseudorca crassidens	False killer whale (Main Hawaiian Islands Insular DPS)	E	10700	Low	High	Low	High	NLAA	NA

[1] ESA Status: E = Endangered, C = Candidate
[2] Critical Habitat: NA = Not Applicable, Critical Habitat has not been designated

Sharks

Direct effects to the listed and candidate sharks from chlorpyrifos, diazinon, or malathion are not expected due to dilution in the marine environments (very low potential for exposure). Additionally, the cusk, oceanic whitetip, and porbeagle sharks are only (or primarily) found in deep waters and, thus, are expected to range far from any potential application sites – further limiting the potential for exposure. In addition, each of these pesticides are readily metabolized and do not accumulate in aquatic organisms, dietary exposure for shark species is of very low concern. Therefore, for direct effects, we consider the risk to be low (due to limited exposure and potential for effects) and we have high confidence in this risk determination.

For indirect effects (*i.e*., reductions in sharks' prey), due to the effect of dilution in the types of marine environments in which the listed sharks are found, risks from the potential loss of marine invertebrate and vertebrate prey are not expected. Therefore, for the listed and candidate sharks, which rely wholly on marine prey, indirect effects from the potential loss of prey are not expected. For these species, we consider the risk for indirect effects to be low (due to limited exposure) and the confidence is considered high. Therefore, NMFS can concur with the Not Likely to Adversely Affect (NLAA) effects determination EPA made for the scalloped hammerhead shark (Eastern Pacific DPS; Central and Southwest Atlantic DPS; and Indo-West Pacific DPS), the cusk shark, the oceanic whitetip shark, and the porbeagle shark (***Table 2***). The proposed action to register chlorpyrifos, diazinon, and malathion will have insignificant and discountable effects to these species. The habitats each occupy throughout their life history and their prey are expected to have extremely low to no overlap with use sites where the labels authorize these pesticides to be applied.

Table 2. Sharks – Summary of the NLAA Determinations for Chlorpyrifos, Diazinon, and Malathion

Scientific Name	Common Name	Listing Status[3]	ID number	Risk (Direct Effects)	Confidence (Direct Effects)	Risk (Indirect Effects)	Confidence (Indirect Effects)	Species Call?	Critical Habitat Call[4]?
Sphyrna lewini	Scalloped hammerhead shark (Eastern Pacific DPS)	E	10733	Low	High	Low	High	NLAA	NA
Sphyrna lewini	Scalloped hammerhead shark (Central and Southwest Atlantic DPS)	E	10734	Low	High	Low	High	NLAA	NA
Sphyrna lewini	Scalloped hammerhead shark (Indo-West Pacific DPS)	T	10736	Low	High	Low	High	NLAA	NA
Brosme brosme	Cusk shark	C	NMFS137	Low	High	Low	High	NLAA	NA
Carcharhinus longimanus	Oceanic whitetip shark	C	NMFS175	Low	High	Low	High	NLAA	NA
Lamna nasus	Porbeagle shark	C	NMFS176	Low	High	Low	High	NLAA	NA

[3] ESA Status: E = Endangered, T = Threatened, C = Candidate
[4] Critical Habitat: NA = Not Applicable, Critical Habitat has not been designated

Pinnipeds

Two of the species included in EPA's assessment only occur in waters of the US and terrestrial areas that are in Alaska: the bearded seal and the spotted seal. EPA considered the USDA's census of agriculture data for Alaska (2012), and learned a limited amount of land was used for grains, fruits, and vegetables, with most use acres for forage crops (e.g., hay, alfalfa, and silage). Most of these crops are grown in the interior of the state (*e.g.*, near Fairbanks). Although, there are some potential use sites found in Southcentral Alaska (e.g., forage (hay, alfalfa)), they are limited and largely removed from coastal areas. Additionally, while chlorpyrifos and malathion are registered as a mosiquitocide, this use is intended to protect public health usually in urban areas, so use of chlorpyrifos and malathion in the areas where these species are located (ice shelfs, Federal wildlife refuges (Aleutian Islands)), is unlikely. We expect the direct and indirect risk to these species is low; and we have high confidence in this risk determination. The potential use sites are limited in nature in areas that may be near the bearded seal and the spotted seal. Therefore, NMFS can concur with EPA's NLAA determinations for these two species (***Table 3***). The proposed action to register chlorpyrifos, diazinon, and malathion will have insignificant and discountable effects to these species. The habitats each occupy throughout their life history and their prey are expected to have extremely low to no overlap with use sites where the labels authorize these pesticides to be applied.

Table 3. Pinnipeds – Summary of the fNLAA Determinations for Chlorpyrifos, Diazinon, and Malathion

Scientific Name	**Common Name**	**Listing Status**[5]	**FWS/NMFS Species ID (ENTITY_ID)**	**Risk (Direct Effects)**	**Confidence (Direct Effects)**	**Risk (Indirect Effects)**	**Confidence (Indirect Effects)**	**Species Call?**	**Critical Habitat Call**[6]**?**
Erignathus barbatus	Bearded Seal (Beringia)	T	10381	Low	High	Low	High	NLAA	NA
Phoca largha	Spotted seal (Southern DPS)	T	NMFS182	Low	High	Low	High	NLAA	NA

[5] ESA Status: T = Threatened
[6] Critical Habitat: NA = Not Applicable, Critical Habitat has not been designated

8 SPECIES AND CRITICAL HABITAT LIKELY TO BE ADVERSELY AFFECTED

This section identifies the ESA-listed species and designated critical habitats that EPA has determined in its BE's are likely to be adversely affected (LAA) by the action. The list of species which received LAA determinations are identical (see footnote in ***Table 4***) within the BE's for chlorpyrifos, diazinon, and malathion. Therefore, the species listed in ***Table 4*** will be carried forward in this Biological Opinion (Opinion) for further analysis of effects of the action and the potential for jeopardy to the species or destruction or adverse modification of critical habitat for all three compounds.

Table 4. Species and Designated Critical Habitat Likely to be Adversely Affected[1]

Species	ESA Status	Critical Habitat Designated?
Atlantic Salmon, Gulf of Maine	Endangered	Yes[2]
Chum Salmon, Columbia River	Threatened	Yes
Chum Salmon, Hood Canal summer-run	Threatened	Yes
Chinook Salmon, California Coastal	Threatened	Yes
Chinook Salmon, Central Valley spring-run	Threatened	Yes
Chinook Salmon, Lower Columbia River	Threatened	Yes
Chinook Salmon, Puget Sound	Threatened	Yes
Chinook Salmon, Sacramento River winter-run	Endangered	Yes
Chinook Salmon, Snake River fall-run	Threatened	Yes
Chinook Salmon, Snake River spring/summer run	Threatened	Yes
Chinook Salmon, Upper Columbia River spring-run	Endangered	Yes
Chinook Salmon, Upper Willamette River	Threatened	Yes
Coho Salmon, Central California Coast	Endangered	Yes
Coho Salmon, Lower Columbia River	Threatened	Yes
Coho Salmon, Oregon Coast	Threatened	Yes
Coho Salmon, South Oregon and North Calif. Coast	Threatened	Yes
Sockeye Salmon, Ozette Lake	Threatened	Yes
Sockeye Salmon, Snake River	Endangered	Yes

Steelhead, California Central Valley	Threatened	Yes
Steelhead, Central California coast	Threatened	Yes
Steelhead, Lower Columbia River	Threatened	Yes
Steelhead, Middle Columbia River	Threatened	Yes
Steelhead, Northern California	Threatened	Yes
Steelhead, Puget Sound	Threatened	Yes
Steelhead, Snake River Basin	Threatened	Yes
Steelhead, South Central California Coast	Threatened	Yes
Steelhead, Southern California	Endangered	Yes
Steelhead, Upper Columbia River	Endangered	Yes
Steelhead, Upper Willamette River	Threatened	Yes
Eulachon, Pacific smelt, Southern	Threatened	Yes
Green sturgeon, Southern	Threatened	Yes
Shortnose sturgeon	Endangered	No
Atlantic sturgeon, Carolina	Endangered	Yes
Atlantic sturgeon, Chesapeake Bay	Endangered	Yes
Atlantic sturgeon, Gulf of Maine	Threatened	Yes
Atlantic sturgeon, New York Bight	Endangered	Yes
Atlantic sturgeon, South Atlantic	Endangered	Yes
Gulf sturgeon	Threatened	Yes
Yelloweye rockfish	Threatened	Yes
Bocaccio	Endangered	Yes
Gulf grouper	Endangered	No
Nassau grouper	Threatened	No
Smalltooth sawfish	Endangered	Yes
Black abalone	Endangered	Yes
White abalone	Endangered	No
Staghorn coral	Threatened	Yes
Elkhorn coral	Threatened	Yes
Coral, Acropora globiceps	Threatened	No
Coral, Acropora jacquelineae[3]	Threatened	No

Coral, Acropora retusa	Threatened	No
Coral, Acropora speciose	Threatened	No
Coral, Euphyllia pardivisa	Threatened	No
Coral, Isopora crateriformis	Threatened	No
Coral Seriatopora aculeate	Threatened	No
Coral, Boulder star	Threatened	No
Coral, Lobed star	Threatened	No
Coral, Mountainous star	Threatened	No
Coral, Pillar	Threatened	No
Coral, Rough cactus	Threatened	No
Green sea turtle, Central North Pacific	Threatened	No
Green sea turtle, Central South Pacific	Endangered	No
Green sea turtle, Central West Pacific	Endangered	No
Green sea turtle, East Pacific	Threatened	No
Green sea turtle, North Atlantic	Threatened	Yes
Green sea turtle, South Atlantic	Threatened	No
Hawksbill sea turtle	Endangered	Yes
Kemp's ridley sea turtle	Endangered	No
Leatherback sea turtle	Endangered	Yes
Loggerhead sea turtle, North Pacific Ocean	Endangered	No
Loggerhead sea turtle, Northwest Atlantic Ocean	Threatened	Yes
Olive ridley sea turtle Mex. Pac. Coast breeding	Endangered	No
Olive ridley sea turtle, all other areas	Threatened	No
Killer whale, Southern Resident	Endangered	Yes
Steller sea lion, Western	Threatened	Yes
Guadalupe fur seal	Threatened	No
Hawaiian monk seal	Endangered	Yes
Johnson's seagrass	Threatened	Yes
Total species and designated critical habitats	**77 Species**	**50 Designated Critical Habitats**

[1]*Pavona diffluens received LAA calls in EPA's final BE for chlorpyrifos, diazinon, and malathion. However, recent reports indicate that this species has not been confirmed to occupy any U.S. jurisdiction (action area). Thus, this species will be included in the Opinion as having received a no-effect determination.*

[2]*For Atlantic salmon, NMFS jurisdiction is limited to the marine environment only. However, specific areas of designated critical habitat were not identified within the marine environment (71 FR 69054). Therefore, NMFS did not assess impacts to designated critical habitat of Atlantic salmon in this Opinion; these impacts are addressed by FWS.*

[3]*Acropora jaquuelineae received a no-effect determination in EPA's final BE for diazinon. This species will be included in the Opinion as may-affect/LAA because it has recently come to NMFS's attention that the coral occurs in American Samoa in waters where the action is expected to have effects on corals. American Samoa contains agricultural lands where diazinon may be applied and therefore we expect some level of exposure to occur. The may-affect/LAA decision is consistent with EPA's determinations for other corals with similar geographic ranges (e.g. Euphyllia paradivisa, Isopora cratiformis). See the diazinon BE Appendix 4-3(o) for more information regarding LAA determinations for coral species.*

Chapter 9a

Status of Species and Critical Habitat Likely to be Adversely Affected

Salmonids

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9 STATUS OF SPECIES AND CRITICAL HABITAT LIKELY TO BE ADVERSELY AFFECTED

9.1 Introduction

The purpose of this section is to characterize the condition and status of the 77 species[1] that are likely to be adversely affected by the action, and to describe the status, conservation role and function of their respective critical habitats.

The status of species includes the existing level of risk that the Endangered Species Act (ESA)-listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. The species status section helps to inform the description of the species' current "reproduction, numbers, or distribution," which is part of the jeopardy determination as described in 50 C.F.R. §402.02.

This section also examines the condition of critical habitat throughout the designated area (such as various watersheds and coastal and marine environments that make up the designated area), and discusses the condition and current function of designated critical habitat, including the essential physical and biological features that contribute to that conservation value of the critical habitat.

The National Marine Fisheries Service (NMFS) has determined that the following species and critical habitat designations may occur in the action area (***Table 1***). More detailed information on the status of these species and critical habitat are found in a number of published documents including recent recovery plans, status reviews, stock assessment reports, and technical memorandums. Many are available on the Internet at http://www.nmfs.noaa.gov/pr/species/.

Table 1. Listed Species and Critical Habitat (denoted by asterisk) in the Action Area.

Common Name (Distinct Population Segment (DPS) or Evolutionarily Significant Unit (ESU))	Scientific Name	Status
Atlantic salmon, Gulf of Maine ESU*	Salmo salar	ENDANGERED
Chum salmon , Columbia River ESU*	Oncorhynchus keta	THREATENED
Chum salmon, Hood Canal summer-run ESU*		THREATENED
Chinook salmon, California coastal ESU*	Oncorhynchus tshawytscha	THREATENED
Chinook salmon, Central Valley spring-run ESU*		THREATENED
Chinook salmon, Lower Columbia River ESU*		THREATENED
Chinook salmon, Puget Sound ESU*		THREATENED
Chinook salmon, Sacramento River winter-run ESU*		ENDANGERED
Chinook salmon, Snake River fall-run ESU*		THREATENED
Chinook salmon, Snake River spring/summer run ESU*		THREATENED
Chinook salmon, Upper Columbia River spring-run ESU*		ENDANGERED

[1] We use the word "species" as it has been defined in section 3 of the ESA, which include "species, subspecies, and any distinct population segment (DPS) of any species of vertebrate fish or wildlife which interbreeds when mature (16 U.S.C 1533)." Pacific salmon other than steelhead that have been listed as endangered or threatened were listed as "evolutionarily significant units" (ESU), which NMFS uses to identify distinct population segments of Pacific salmon. Any ESU or DPS is a "species" for the purposes of the ESA.

Common Name (Distinct Population Segment (DPS) or Evolutionarily Significant Unit (ESU))	Scientific Name	Status
Chinook salmon, Upper Willamette River ESU*		THREATENED
Coho salmon, Central California coast ESU*	Oncorhynchus kisutch	ENDANGERED
Coho salmon, Lower Columbia River ESU*		THREATENED
Coho salmon, Oregon coast ESU*		THREATENED
Coho salmon, S. Oregon and N. Calif coasts ESU*		THREATENED
Sockeye, Ozette Lake ESU*	Oncorhynchus nerka	THREATENED
Sockeye, Snake River ESU*		ENDANGERED
Steelhead, California Central Valley DPS*	Oncorhynchus mykiss	THREATENED
Steelhead, Central California coast DPS*		THREATENED
Steelhead, Lower Columbia River DPS*		THREATENED
Steelhead, Middle Columbia River DPS*		THREATENED
Steelhead, Northern California DPS*		THREATENED
Steelhead, Puget Sound DPS*		THREATENED
Steelhead, Snake River Basin DPS*		THREATENED
Steelhead, South-Central California coast DPS*		THREATENED
Steelhead, Southern California DPS*		ENDANGERED
Steelhead, Upper Columbia River DPS*		THREATENED
Steelhead, Upper Willamette River DPS*		THREATENED
Eulachon, Pacific smelt, Southern DPS*	Thaleichthys pacificus	THREATENED
Green sturgeon, Southern DPS*	Acipenser medirostris	THREATENED
Shortnose sturgeon	Acipenser brevirostrum	ENDANGERED
Atlantic sturgeon, Carolina DPS	Acipenser oxyrinchus desotoi	ENDANGERED
Atlantic sturgeon, Chesapeake Bay DPS		ENDANGERED
Atlantic sturgeon, Gulf of Maine DPS		THREATENED
Atlantic sturgeon, New York Bight DPS		ENDANGERED
Atlantic sturgeon, South Atlantic DPS		ENDANGERED
Gulf sturgeon*	Acipenser oxyrinchus oxyrinchus	THREATENED
Yelloweye rockfish*	Sebastes ruberrimus	THREATENED
Boccacio, Puget Sound/Georgia Basin*	Sebastes paucispinis	ENDANGERED
Gulf grouper	Mycteroperca jordani	ENDANGERED
Nassau grouper	Epinephelus striatus	THREATENED
Smalltooth sawfish, U.S. DPS*	Pristis pectinata	ENDANGERED
Black abalone*	Haliotis cracherodii	ENDANGERED
White abalone	Haliotis sorenseni	ENDANGERED
Staghorn coral*	Acropora cervicornis	THREATENED
Elkhorn coral*	Acropora palmata	THREATENED
Coral, no common name	Acropora globiceps	THREATENED
Coral, no common name	Acropora jacquelineae	THREATENED
Coral, no common name	Acropora retusa	THREATENED
Coral, no common name	Acropora speciosa	THREATENED
Coral, no common name	Euphyllia pardivisa	THREATENED
Coral, no common name	Isopora crateriformis	THREATENED
Coral, no common name	Seriatopora aculeata	THREATENED
Boulder star coral	Orbicella franksi	THREATENED

Common Name (Distinct Population Segment (DPS) or Evolutionarily Significant Unit (ESU))	Scientific Name	Status
Lobed star coral	Orbicella annularis	THREATENED
Mountainous star coral	Orbicella faveolata	THREATENED
Pillar coral	Dendrogyra cylindrus	THREATENED
Rough cactus coral	Mycetophyllia ferox	THREATENED
Green sea turtle, Central North Pacific DPS	Chelonia mydas	THREATENED
Green sea turtle, Central South Pacific DPS		ENDANGERED
Green sea turtle, Central West Pacific DPS		ENDANGERED
Green sea turtle, East Pacific DPS		THREATENED
Green sea turtle, North Atlantic DPS*		THREATENED
Green sea turtle, South Atlantic DPS		THREATENED
Hawksbill sea turtle*	Eretmochelys imbricata	ENDANGERED
Kemp’s ridley sea turtle	Lepidochelys kempii	ENDANGERED
Leatherback sea turtle*	Dermochelys coriacea	ENDANGERED
Loggerhead sea turtle, North Pacific Ocean DPS	Caretta caretta	ENDANGERED
Loggerhead sea turtle, Northwest Atlantic Ocean DPS*		THREATENED
Olive ridley sea turtle, Mexico's Pacific Coast breeding colonies	Lepidochelys olivacea	ENDANGERED
Olive ridley sea turtle, all other areas		THREATENED
Killer whale, Southern Resident DPS*	Orcinus orca	ENDANGERED
Steller sea lion, Western*	Eumetopias jubatus	ENDANGERED
Guadalupe fur seal	Arctocephalus townsendi	THREATENED
Hawaiian monk seal*	Monachus schauinslandi	ENDANGERED
Johnson’s seagrass*	Halophila johnsonii	THREATENED

The following narratives summarize the biology and ecology of threatened and endangered species that are likely to be adversely affected by the Environmental Protection Agency’s (EPA) proposed action. The summaries include a description of the timing and duration of each life stage (e.g. adult river entry, spawning, egg incubation, freshwater rearing, smolt outmigration, and ocean migration). We also highlight information related to the viability of populations and the physical or biological features essential for the conservation of the species (PBFs) of designated critical habitats. These summaries provide a foundation for NMFS’ evaluation of the effects of the proposed action on these listed species.

In assessing the status of the listed species NMFS made use of the viable salmonid population (VSP) concept and its four criteria. NMFS used these criteria to assess salmonids and, where appropriate, non-salmonid species. A VSP is an independent population (a population of which extinction probability is not substantially affected by exchanges of individuals with other populations) with a negligible risk of extinction, over a 100-year period, when threats from random catastrophic events, local environmental variation, demographic variation, and genetic diversity changes are taken into account (McElhany et al. 2000b). The four factors defining a viable population are a population’s: (1) spatial structure; (2) abundance; (3) annual growth rate, including trends and variability of annual growth rates; and (4) diversity (McElhany et al. 2000b).

A population’s tendency to increase in abundance and its variation in annual population growth defines a viable population (McElhany et al. 2000b; Morris and Doak 2002). A negative long-term trend in average annual population growth rate will eventually result in extinction. Further, a weak positive long-term growth rate will increase the risk of extinction as it maintains a small population at low abundances over a longer time frame. A large variation in the growth rates also increases the likelihood of extinction (Lande 1993; Morris and Doak 2002). Thus, in our status reviews of each listed species, we provide information on population abundance and annual growth rate of extant populations.

The action area for this consultation contains designated critical habitat. Critical habitat is defined as the specific areas within the geographical area occupied by the species, at the time it is listed, on which are found those physical or biological features that are essential to the conservation of the species, and which may require special management considerations or protection. Critical habitat can also include specific areas outside the geographical area occupied by the species at the time it is listed that are determined by the Secretary to be essential for the conservation of the species (ESA of 1973, as amended, section 3(5)(A)).

The primary purpose in evaluating the status of critical habitat is to identify for each Evolutionarily Significant Unit (ESU) or Distinct Population Segment (DPS) the function of the critical habitat to support the intended conservation role for each species. Such information is important for an adverse modification analysis as it establishes the context for evaluating whether the proposed action results in negative changes in the function and role of the critical habitat for species conservation. NMFS bases its critical habitat analysis on the areas of the critical habitat that are affected by the proposed action and the area's physical or biological features that are essential to the conservation of a given species, and not on how individuals of the species will respond to changes in habitat quantity and quality.

In evaluating the status of designated critical habitat, we consider the current quantity, quality, and distribution of the physical or biological features (PBFs[2]) that are essential for the conservation of the species. NMFS has identified PBFs of critical habitat for each life stage (*e.g.,* migration, spawning, rearing, and estuary) common for a number of species (see Appendix C). To fully understand the conservation role of these habitats, specific physical and biological habitat features (*e.g.,* water temperature, water quality, forage, natural cover, etc.) were identified for each life stage.

Besides potential toxicity, water free of contaminants is important as contaminants can disrupt normal behavior necessary for successful migration, spawning, and juvenile rearing. Sufficient forage is necessary for juveniles to maintain growth that reduces freshwater predation mortality, increases overwintering success, initiates smoltification, and increases ocean survival. Natural cover such as submerged and overhanging large wood and aquatic vegetation provides shelter from predators, shades freshwater to prevent increase in water temperature, and creates important side channels. A description of the past, ongoing, and continuing activities that threaten the functional condition of PBFs and their attributes are described in the *Environmental Baseline* section of this Biological Opinion (Opinion).

The information from the Status of the Species section may be used as a "risk modifier" in the Integration and Synthesis section (Chapters 19-24). Factors which have the potential to "modify"

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[2] Some of the critical habitat designations used the term "primary constituent elements" or PCEs, a regulatory that is no longer in effect. PCEs are generally the same as PBFs, and we will use the terms interchangeably based on the description in the critical habitat designation.

the risk of the action jeopardizing the species are those which are able to interact with the effects of the action. While many of the factors described in this section have the potential to modify the risk, and were thus considered, three of the factors within the status of the species were consistently found to have a high potential to modify the risk. Those three factors are: 1) trends in abundance, spatial distribution, and productivity; 2) listing status; and 3) achievement of recovery goals. We therefore developed three key questions to guide our synthesis of the information within the Status of the Species section:

1. Are abundance, spatial distribution, and productivity trends increasing, decreasing or stable?
2. Is the species listed as threatened or endangered?
3. Have recovery goals been met or are they on a sustained positive trajectory toward recovery?

Each status section within Chapter 9 concludes with a table providing a brief response to each of these questions.

Within the Integration and Synthesis section (Chapters 19-24) we characterize the overall magnitude of influence of the species status as either "low" or "high". This characterization includes directionality (i.e. positive influence which equates to less risk or negative influence which equates to more risk) as well as confidence. The magnitude, directionality, and confidence of the influence are determined primarily by answers provided to the three key questions outlined above. We acknowledge that the magnitude, and directionality of these three factors varies on a species-by-species basis (for example, the significance of the attainment of recovery goals are relative to the specifics of the recovery goals themselves). We further acknowledge that the quantitative data (e.g. estimates of population growth rates) are incomplete without considering the more qualitative data often provided in recovery plans, status reports and listing documents. Therefore, we characterized magnitude and directionality with the following guidelines: 1) If the listing status of the species is "endangered", the magnitude is high and the directionality is negative; 2) If the listing status is "threatened" and both of the other two factors indicates stability and/or recovery and/or uncertainty than the magnitude is low and the directionality is negative; 3) if the listing status is "threatened" and the other two factors indicate population decline and failure to meet recovery goals than the magnitude is high and the directionality is negative. It is conceivable directionality could also be positive. For example, if the listing status is "threatened" and the population's growth rate, abundance, and spatial distribution has been consistently increasing between status reports, the direction could be positive. However, none of the species evaluated in this Opinion exhibited this.

The overall confidence in the magnitude and directionality is then characterized as either "low" or "high". Confidence is determined by assessing the amount of evidence provided, as well as by further considering the species specific implications of the three factors.

9.2 Atlantic Salmon, Gulf of Maine DPS

Table 2. Atlantic salmon, Gulf of Maine DPS; overview table

Species	Common Name	Distinct Population Segment	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Salmo salar	Atlantic salmon	Gulf of Maine	Endangered	2006	E – 74 FR 29344	Draft Recovery Plan (2016)	74 FR 29300

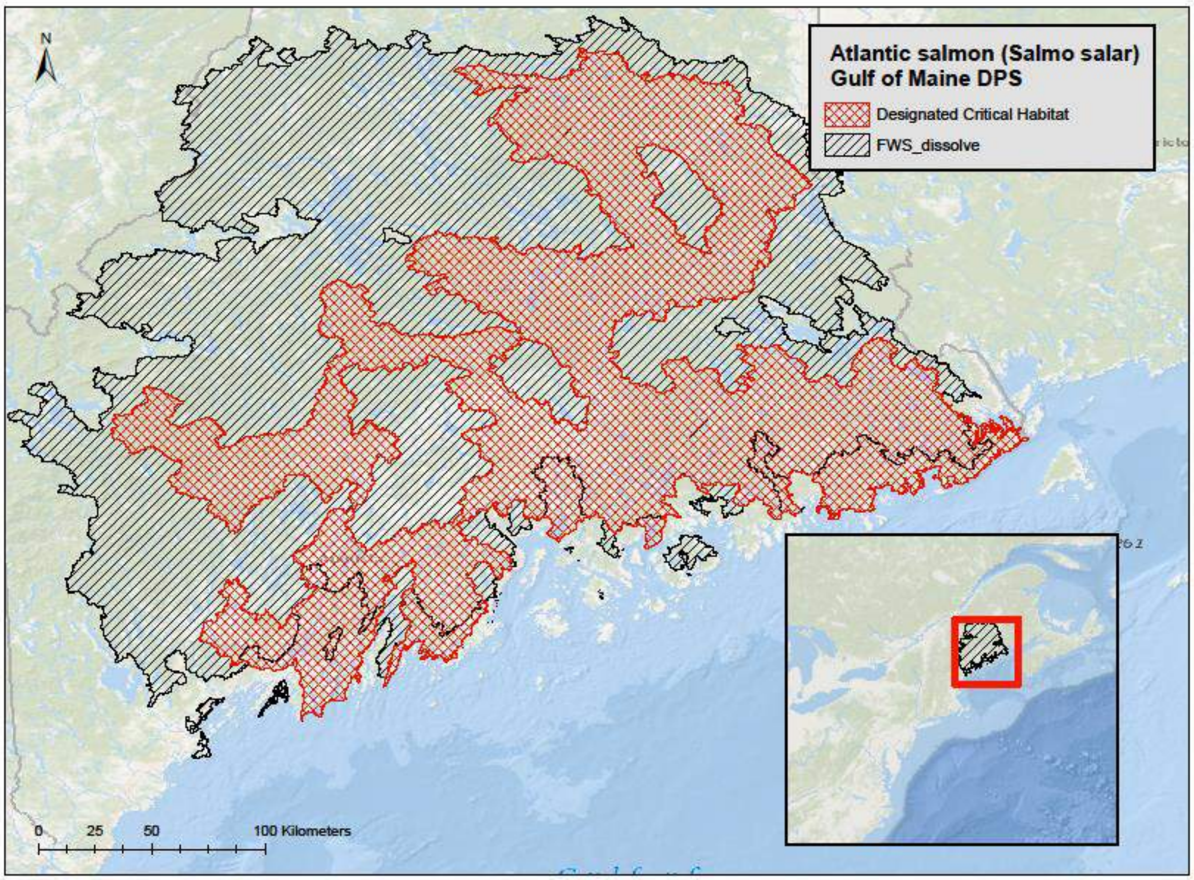

Figure 1. Atlantic salmon range and designated critical habitat

Species Description Atlantic salmon is an anadromous fish, occupying freshwater streams in North America. There are three Atlantic salmon distinct population segments in the United States: Long Island Sound, Central New England, and the Gulf of Maine (Fay et al. 2006). The Gulf of Maine DPS Atlantic salmon are found in watersheds throughout Maine (***Figure 1***). Adult Atlantic salmon are silver-blue with dark spots. The Gulf of Maine DPS was first listed as endangered by the U. S. Fish and Wildlife Service and NMFS on November 17, 2000 (65 FR 69459). The listing was refined by the Services on June 19, 2009 (74 FR 29344) to include all anadromous Atlantic salmon whose freshwater range occurs in the watersheds from the

Androscoggin River northward along the Maine coast to the Dennys River, and wherever these fish occur in the estuarine and marine environment.

Status Historically, Atlantic salmon occupied U.S. rivers throughout New England, with an estimated 300,000 to 500,000 adults returning annually (Fay et al. 2006). Of the three DPSs found in the U.S., native salmon in the Long Island Sound and Central New England DPSs were extirpated in the 1800s. Several rivers within these DPSs are presently stocked with Gulf of Maine DPS salmon. The Gulf of Maine DPS Atlantic salmon was listed as endangered in response to population decline caused by many factors, including overexploitation, degradation of water quality and damming of rivers, all of which remain persistent threats (Fay et al. 2006). Coastal development poses a threat as well, as artificial light can disrupt and delay fry dispersal (Riley et al. 2013). Climate change may cause changes in prey availability and thermal niches, further threatening Atlantic salmon populations (Mills et al. 2013). Even with current conservation efforts, returns of adult Atlantic salmon to the Gulf of Maine DPS rivers remain extremely low, with an estimated extinction risk of 19 to 75 % in the next one hundred years (Fay et al. 2006). Based on the information above, the species would likely have a low resilience to additional perturbations.

Life history Adult Atlantic salmon typically spawn in early November and juveniles spend about two years feeding in freshwater until they weigh approximately two ounces and are six inches in length. Smoltification (the physiological and behavioral changes required for the transition to salt water) usually occurs at age two for Gulf of Maine DPS Atlantic salmon. Immediately upon entering marine water, Gulf of Maine DPS Atlantic salmon migrate more than 4,000 km in the open ocean to reach feeding areas in the Davis Strait between Labrador and Greenland. The majority of Gulf of Maine DPS Atlantic salmon (about 90%) spend two winters at sea before reaching maturity and returning to their natal rivers, with the remainder spending one or three winters at sea. At maturity, Gulf of Maine DPS Atlantic salmon typically weigh between eight to fifteen pounds and average thirty inches in length.

Population Dynamics The following is a discussion of the species' population and its variance over time. This section is broken down into: abundance, population growth rate, genetic diversity, and spatial distribution.

Abundance The conservation hatchery program plays a significant role in the persistence of Gulf of Maine DPS Atlantic salmon. In 2015, four million juvenile salmon (eggs, fry, parr and smolts) and 4,271 adults were stocked in the Connecticut, Merrimack, Saco, Penobscot and five other coastal rivers in Maine (USASAC 2016). The total number of returns to U.S. rivers was 921, and the majority (80%) of the adult returns were of hatchery origin. The fact that so few of the returning adults are naturally-reared is concerning to managers; the reliance on hatcheries can pose risks such as artificial selection, inbreeding depression and outbreeding depression (Fay et al. 2006).

Adult returns of Gulf of Maine DPS Atlantic salmon captured in six Maine rivers from 1997 to 2004 ranged from 567 to 1,402. These counts include both wild and hatchery origin fish. Each year, the majority (92 to 98%) of adult returns were found in the Penobscot River; the Narraguagus River supported between 0.8 to 4.1% of adult returns during those years (Fay et al. 2006).

Productivity / Population Growth Rate There is no population growth rate available for Gulf of Maine DPS Atlantic salmon. However, the consensus is that the DPS exhibits a continuing declining trend (NOAA 2016).

Genetic Diversity The Gulf of Maine DPS Atlantic salmon is genetically distinct from other Atlantic salmon populations in Canada, and can be further delineated into stocks by river. The Downeast Coastal stocks include the Dennys, East Machias, Machias, Pleasant and Narraguagus rivers. The Penobscot Bay stock and the Merrymeeting Bay (Sheepscot). The hatchery supplementation programs for the Penobscot and Merrymeeting Bays stocks use river-specific broodstock (USASAC 2016).

Distribution Gulf of Maine DPS Atlantic salmon can be found in at least eight rivers in Maine: Dennys River, East Machias River, Machias River, Pleasant River, Narraguagus River, Ducktrap River, Sheepscot River, Cove Brook, Penobscot River, Androscoggin River and the Kennebec River.

Designated Critical Habitat On June 19, 2009, NMFS and the U.S. Fish and Wildlife Service designated critical habitat for Atlantic salmon (74 FR 29300). PBFs considered essential for the conservation of the Gulf of Maine DPS of Atlantic salmon are:

Spawning and Rearing

- Deep, oxygenated pools and cover (e.g., boulders, woody debris, vegetation, etc.), near freshwater spawning sites, necessary to support adult migrants during summer while they await spawning in the fall.
- Freshwater spawning sites that contain clean, permeable gravel and cobble substrate with oxygenated water and cool water temperatures to support spawning activity, egg incubation, and larval development.
- Freshwater spawning and rearing sites with clean, permeable gravel and cobble substrate with oxygenated water and cool water temperatures to support emergence, territorial development and feeding activities of Atlantic salmon fry.
- Freshwater rearing sites with space to accommodate growth and survival of Atlantic parr.
- Freshwater rearing sites with a combination of river, stream, and lake habitats that accommodate parr's ability to occupy many niches and maximize parr production.

Migration

- Freshwater and estuary migratory sites free from physical and biological barriers that delay or prevent access of adult seeking spawning grounds needed to support recovered populations.
- Freshwater and estuary migration sites with pool, lake, and instream habitat that provide cool, oxygenated water and cover items (e.g., boulders, woody debris, and vegetation) to serve as temporary holding and resting areas during upstream migration of adult Atlantic salmon.
- Freshwater and estuary migration sites with abundant, diverse native fish communities to serve as a protective buffer against predation.
- Freshwater and estuary migration sites free from physical and biological barriers that delay or prevent emigration of smolts to the marine environment.

- Freshwater and estuary migration sites with sufficiently cool water temperatures and water flows that coincide with diurnal cues to stimulate smolt migration.

The critical habitat listing document identified a number of activities and associated threats that may affect the PBFs and associated physical and biological features essential to the conservation of Atlantic salmon within the occupied range of the Gulf of Maine DPS. These activities, which include agriculture, forestry, changing land-use and development, hatcheries and stocking, roads and road crossings, mining, dams, dredging, and aquaculture have the potential to reduce the quality and quantity of the PBFs and their associated physical and biological features.

Recovery Goals See the 2016 Draft Recovery Plan for the Gulf of Maine DPS Atlantic Salmon, for complete down listing/delisting criteria for each of their respective recovery goals. The following items were the top recovery actions identified to support in the Draft Recovery Plan:

1. Enhance connectivity between the ocean and freshwater habitats important for salmon recovery
2. Maintain the genetic diversity of Atlantic salmon populations over time.
3. Increase adult spawners through the conservation hatchery program.
4. Increase adult spawners through the freshwater production of smolts.
5. Increase Atlantic salmon survival through increased ecosystem understanding and identification of spatial and temporal constraints to salmon marine productivity to inform and support management actions that improve survival.
6. Consult with all involved Tribes on a government-to-government basis.
7. Collaborate with partners and engage interested parties in recovery efforts for the Gulf of Maine DPS.

Table 3. Summary of status; Atlantic salmon, Gulf of Maine DPS

Criteria	Description
Abundance / productivity trends	Declining population trend, sustained by hatchery supplementation, low resilience to disturbances
Listing status	Endangered
Attainment of recovery goals	Criteria not yet met
Condition of PBFs	

9.3 Chum salmon, Columbia River ESU

Table 4. Chum salmon, Columbia River ESU; overview table

Species	Common Name	Distinct Population Segment	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus keta	Chum Salmon	Columbia River ESU	Threatened	2016	70 FR 37160	78 FR 41911	70 FR 52630

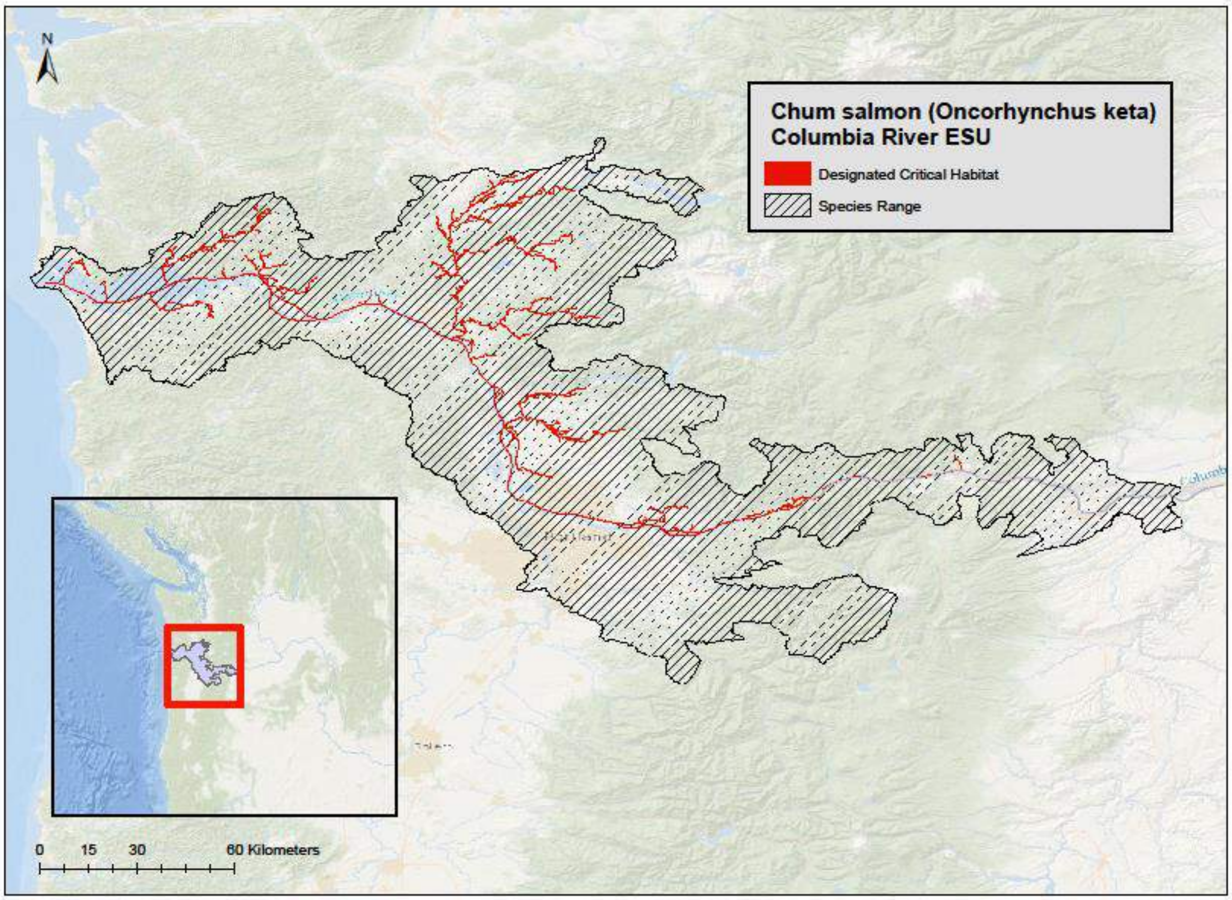

Figure 2. Chum salmon, Columbia River ESU range and designated critical habitat

Species Description Chum salmon are an anadromous (i.e., adults migrate from marine to freshwater streams and rivers to spawn) and semelparous (i.e., they spawn once and then die) fish species. Adult chum salmon are typically between eight and fifteen pounds, but they can get as large as 45 pounds and 3.6 feet long. Males have enormous canine-like fangs and a striking calico pattern body color (front two-thirds of the flank marked by a bold, jagged, reddish line and the posterior third by a jagged black line) during spawning. Females are less flamboyantly colored and lack the extreme dentition of the males. Ocean stage chum salmon are metallic greenish-blue along the back with black speckles. Chum salmon have the widest natural geographic and spawning distribution of the Pacific salmonids. Chum salmon have been documented to spawn from Korea and the Japanese island of Honshu, east around the rim of the North Pacific Ocean to Monterey Bay, California. Historically, chum salmon were distributed throughout the coastal regions of western Canada and the U.S. At present, major spawning populations occur as far south as Tillamook Bay on the northern Oregon coast. On March 25, 1999, NMFS listed the Hood Canal Summer-run ESU and the Columbia River ESU of chum salmon as threatened (64 FR 14508). NMFS reaffirmed the status of these two ESUs as threatened on June 28, 2005 (70 FR 37160).

Status The majority of the populations within the Columbia River chum salmon ESU are at high to very high risk, with very low abundances (NWFSC 2015b). These populations are at risk of extirpation due to demographic stochasticity and Allee effects. One population, Grays River, is at low risk, with spawner abundances in the thousands and demonstrating a recent positive trend. The Washougal River and Lower Gorge populations maintain moderate numbers of spawners and appear to be relatively stable. The life history of chum salmon is such that ocean conditions have a strong influence on the survival of emigrating juveniles. The potential prospect of poor ocean conditions for the near future may put further pressure on the Columbia River chum salmon ESU (NWFSC 2015b). Freshwater habitat conditions may be negatively influencing spawning and early rearing success in some basins, and contributing to the overall low productivity of the ESU. Columbia River chum salmon were historically abundant and subject to substantial harvest until the 1950s (Johnson et al. 1997). There is no directed harvest of this ESU and the incidental harvest rate has been below one % for the last five years (NWFSC 2015b). Land development, especially in the low gradient reaches that chum salmon prefer, will continue to be a threat to most chum salmon populations due to projected increases in the population of the greater Vancouver-Portland area and the Lower Columbia River overall (Metro 2015). The Columbia River chum salmon ESU remains at a moderate to high risk of extinction (NWFSC 2015b).

Life history Most chum salmon mature and return to their birth stream to spawn between three and five years of age, with 60 to 90 % of the fish maturing at four years of age. Age at maturity appears to follow a latitudinal trend (i.e., greater in the northern portion of the species' range). Chum salmon typically spawn in the lower reaches of rivers, with redds usually dug in the mainstem or in side channels of rivers from just above tidal influence to 100 km from the sea. Juveniles out-migrate to seawater almost immediately after emerging from the gravel covered redds ((Salo 1991). This ocean-type migratory behavior contrasts with the stream-type behavior of some other species in the genus *Oncorhynchus* (e.g., coastal cutthroat trout, steelhead, Coho salmon, and most types of Chinook and sockeye salmon), which usually migrate to sea at a larger size, after months or years of freshwater rearing. This means that survival and growth in juvenile chum salmon depend less on freshwater conditions (unlike stream-type salmonids which depend heavily on freshwater habitats) than on favorable estuarine conditions. Another behavioral difference between chum salmon and species that rear extensively in freshwater is that chum salmon form schools, presumably to reduce predation (Pitcher 1986), especially if their movements are synchronized to swamp predators (Miller and Brannon 1982).

Chum salmon spend two to five years in feeding areas in the northeast Pacific Ocean, which is a greater proportion of their life history compared to other Pacific salmonids. Chum salmon distribute throughout the North Pacific Ocean and Bering Sea, although North American chum salmon (as opposed to chum salmon originating in Asia), rarely occur west of 175 E longitude

(Johnson et al. 1997). North American chum salmon migrate north along the coast in a narrow band that broadens in southeastern Alaska, although some data suggest that Puget Sound chum, including Hood Canal summer-run chum, may not make extended coastal migrations into northern British Columbian and Alaskan waters, but instead may travel directly offshore into the north Pacific Ocean (Johnson et al. 1997).

Table 5. Temporal distribution of Chum salmon, Columbia River ESU

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Present</td></tr>
<tr><td>Spawning</td><td>Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Incubation (eggs)</td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td></td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Population Dynamics

Abundance / Productivity Chum populations in the Columbia River historically reached hundreds of thousands to a million adults each year (NMFS 2017b). In the past 50 years, the average has been a few thousand a year. The majority of populations in the Columbia River chum ESU remain at high to very high risk, with very low abundances (NWFSC 2015b). Ford (2011b) concluded that 14 out of 17 of chum populations in this ESU were either extirpated or nearly extirpated. The very low persistence probabilities or possible extirpations of most chum salmon populations are due to low abundance, productivity, spatial structure, and diversity. Only one population (Grays River) is at low risk, with spawner abundances in the thousands, and demonstrating a recent positive trend. Two other populations (Washougal River and Lower Gorge) maintain moderate numbers of spawners and appear to be relatively stable (NWFSC 2015b).

Genetic Diversity There are currently four hatchery programs in the Lower Columbia River releasing juvenile chum salmon: Grays River Hatchery, Big Creek Hatchery, Lewis River Hatchery, and Washougal Hatchery (NMFS 2017b). Total annual production from these hatcheries has not exceeded 500,000 fish. All of the hatchery programs in this ESU use integrated stocks developed to supplement natural production. Other populations in this ESU persist at very low abundances and the genetic diversity available would be very low (NWFSC 2015b). Although, hatchery production of Columbia River chum salmon has been limited and hatchery effects on diversity are thought to have been relatively small, diversity has been greatly reduced at the ESU level because of presumed extirpations and low abundance in the remaining populations (fewer than 100 spawners per year for most populations) (LCFRB 2010a; NMFS 2013a).

Distribution The Columbia River chum salmon ESU includes all natural-origin chum salmon in the Columbia River and its tributaries in Washington and Oregon. The ESU consists of three populations: Grays River, Hardy Creek and Hamilton Creek in Washington State. Chum salmon from four artificial propagation programs also contribute to this ESU.

Designated Critical Habitat NMFS designated critical habitat for the Columbia River chum salmon ESU in 2005 (70 FR 52630). Sixteen of the 19 subbasins reviewed in NMFS' assessment of critical habitat for the CR chum salmon ESU were rated as having a high conservation value. The remaining three subbasins were given a medium conservation value. Washington's federal lands were rated as having high conservation value to the species. PBFs considered essential for the conservation of the Columbia River ESU of Chum salmon are:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development;
- Freshwater rearing sites with:
  - Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility;
  - Water quality and forage supporting juvenile development;
  - Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
- Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival;
- Estuarine areas free of obstruction and excessive predation with:
  - Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh & saltwater;
  - Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels;
  - Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.
- Nearshore marine areas free of obstruction and excessive predation with:
  - Water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and
  - Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.
- Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

Limited information exists on the quality of essential habitat characteristics for CR chum salmon. However, migration PBF has been significantly impacted by dams obstructing adult migration and access to historic spawning locations. Water quality and cover for estuary and rearing PBFs have decreased in quality to the extent that the PBFs are not likely to maintain their intended function to conserve the species.

Recovery Goals The ESU recovery strategy for Columbia River chum salmon focuses on improving tributary and estuarine habitat conditions, reducing or mitigating hydropower impacts, and reestablishing chum salmon populations where they may have been extirpated (NMFS 2013a). The goal of the strategy is to increase the abundance, productivity, diversity, and spatial structure of chum salmon populations such that the Coast and Cascade chum salmon strata are restored to a high probability of persistence, and the persistence probability of the two Gorge populations improves. For details on Columbia River chum salmon ESU recovery goals, including complete down-listing/delisting criteria, see the NMFS 2013 recovery plan (NMFS 2013a).

Table 6. Summary of status; Chum salmon, Columbia River ESU

Criteria	Description
Abundance / productivity trends	Most populations have very low abundances and productivity, low genetic diversity, high risk of extinction
Listing status	threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Rearing PBFs (water quality and cover) are degraded; Migration PBFs significantly impacted by dams; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; All 19 watersheds of high or medium conservation value

9.4 Chum salmon, Hood Canal summer-run ESU

Table 7. Chum salmon, Hood Canal summer-run ESU; overview table

Species	Common Name	Distinct Population Segment	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus keta	Chum salmon	Hood Canal summer-run	Threatened	2011	70 FR 37160	2005	70 FR 52630

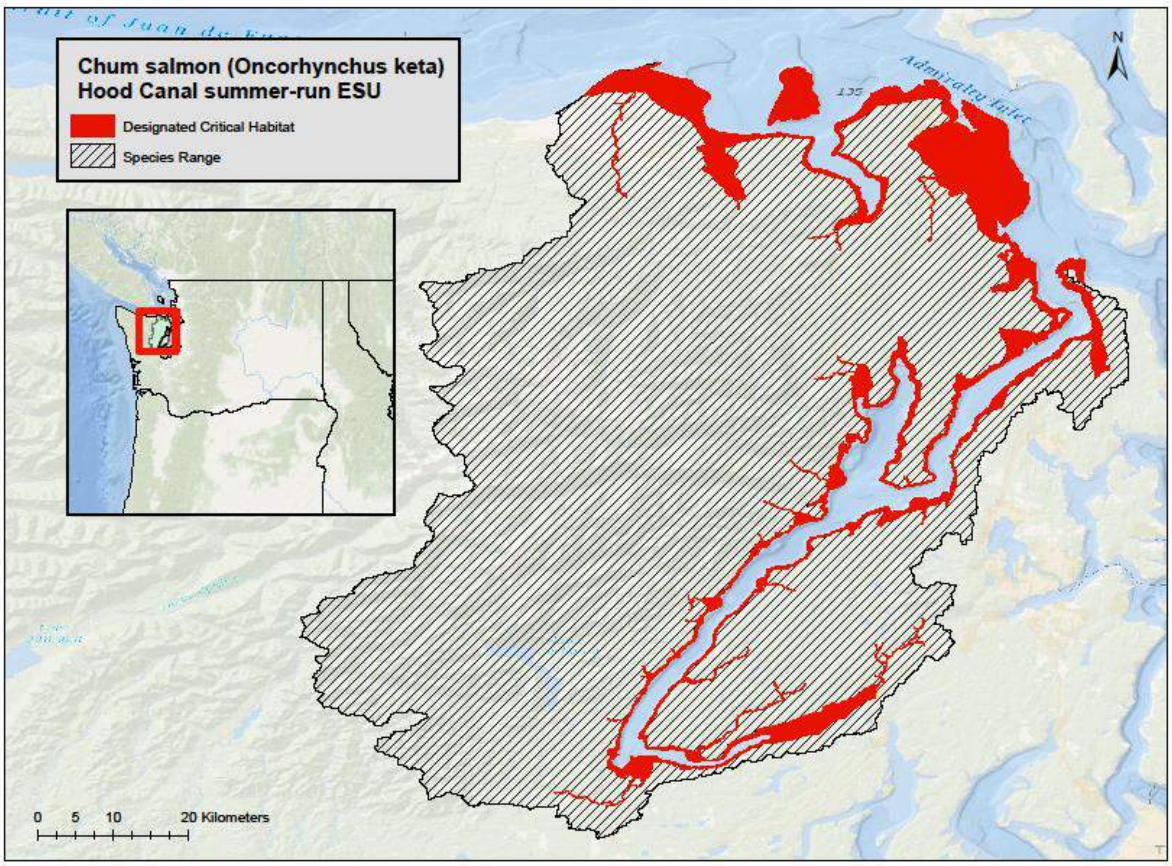

Figure 3. Chum salmon, Hood Canal summer-run ESU range and designated critical habitat

Species Description Chum salmon are an anadromous (i.e., adults migrate from marine to freshwater streams and rivers to spawn) and semelparous (i.e., they spawn once and then die) fish species. Adult chum salmon are typically between eight and fifteen pounds, but they can get as large as 45 pounds and 3.6 feet long. Males have enormous canine-like fangs and a striking calico pattern body color (front two-thirds of the flank marked by a bold, jagged, reddish line and the posterior third by a jagged black line) during spawning. Females are less flamboyantly colored and lack the extreme dentition of the males. Ocean stage chum salmon are metallic greenish-blue along the back with black speckles. Chum salmon have the widest natural geographic and spawning distribution of the Pacific salmonids. Chum salmon have been documented to spawn from Korea and the Japanese island of Honshu, east around the rim of the North Pacific Ocean to Monterey Bay, California. Historically, chum salmon were distributed throughout the coastal regions of western Canada and the U.S. At present, major spawning populations occur as far south as Tillamook Bay on the northern Oregon coast. On March 25, 1999, NMFS listed the Hood Canal Summer-run ESU and the Columbia River ESU of chum salmon as threatened (64 FR 14508). NMFS reaffirmed the status of these two ESUs as threatened on June 28, 2005 (70 FR 37160).

Status The two most recent status reviews (2011 and 2015) indicate some positive signs for the Hood Canal summer-run chum salmon ESU. Diversity has increased from the low levels seen in the 1990s due to both the reintroduction of spawning aggregates and the more uniform relative abundance between populations; considered a good sign for viability in terms of spatial structure and diversity (Ford 2011b). Spawning distribution within most streams was also extended further upstream with increased abundance. At present, spatial structure and diversity viability parameters for each population nearly meet the viability criteria (NWFSC 2015b). Spawning abundance has remained relatively high compared to the low levels observed in the early 1990's (Ford 2011b). Natural-origin spawner abundance has shown an increasing trend since 1999, and spawning abundance targets in both populations were met in some years (NWFSC 2015b). Despite substantive gains towards meeting viability criteria in the Hood Canal and Strait of Juan de Fuca summer chum salmon populations, the ESU still does not meet all of the recovery criteria for population viability at this time (NWFSC 2015b). Overall, the Hood Canal Summer-run chum salmon ESU remains at a moderate risk of extinction.

Life history Most chum salmon mature and return to their birth stream to spawn between three and five years of age, with 60 to 90 % of the fish maturing at four years of age. Age at maturity appears to follow a latitudinal trend (i.e., greater in the northern portion of the species' range). Chum salmon typically spawn in the lower reaches of rivers, with redds usually dug in the mainstem or in side channels of rivers from just above tidal influence to 100 km from the sea. Juveniles out-migrate to seawater almost immediately after emerging from the gravel covered redds ((Salo 1991). This ocean-type migratory behavior contrasts with the stream-type behavior of some other species in the genus *Oncorhynchus* (e.g., coastal cutthroat trout, steelhead, Coho salmon, and most types of Chinook and sockeye salmon), which usually migrate to sea at a larger size, after months or years of freshwater rearing. This means that survival and growth in juvenile chum salmon depend less on freshwater conditions (unlike stream-type salmonids which depend heavily on freshwater habitats) than on favorable estuarine conditions. Another behavioral difference between chum salmon and species that rear extensively in freshwater is that chum salmon form schools, presumably to reduce predation (Pitcher 1986), especially if their movements are synchronized to swamp predators (Miller and Brannon 1982).

Chum salmon spend two to five years in feeding areas in the northeast Pacific Ocean, which is a greater proportion of their life history compared to other Pacific salmonids. Chum salmon distribute throughout the North Pacific Ocean and Bering Sea, although North American chum salmon (as opposed to chum salmon originating in Asia), rarely occur west of 175 E longitude (Johnson et al. 1997). North American chum salmon migrate north along the coast in a narrow band that broadens in southeastern Alaska, although some data suggest that Puget Sound chum, including Hood Canal summer-run chum, may not make extended coastal migrations into northern British Columbian and Alaskan waters, but instead may travel directly offshore into the north Pacific Ocean (Johnson et al. 1997).

Table 8. Temporal distribution of Chum salmon, Hood Canal summer-run ESU

<table>
<tr><td>Life History phase</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td><td></td><td></td></tr>
<tr><td>Spawning</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Present</td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td></td><td colspan="5">Present</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Population Dynamics

Abundance / Productivity Of the sixteen populations that comprise the Hood Canal Summer-run chum ESU, seven are considered "functionally extinct" (Skokomish, Finch Creek, Anderson Creek, Dewatto, Tahuya, Big Beef Creek and Chimicum). The remaining nine populations are well distributed throughout the ESU range except for the eastern side of Hood Canal (Johnson et al. 1997). Two independent major population groups have been identified for this ESU: (1) spawning aggregations from rivers and creeks draining into the Strait of Juan de Fuca, and (2) spawning aggregations within Hood Canal proper (Sands 2009). NMFS examined average escapements (geometric means) for five-year intervals and estimated trends over the intervals for all natural spawners and for natural-origin only spawners. For both populations, abundance was relatively high in the 1970s, lowest for the period 1985-1999, and high again for the most recent 10 years (NWFSC 2015b). The overall trend in spawning abundance is generally stable for the Hood Canal population (all natural spawners and natural-origin only spawners) and for the Strait of Juan de Fuca population (all natural spawners). Only the Strait of Juan de Fuca population's natural-origin only spawners shows a significant positive trend. NMFS determined the only abundance trend that appears to be positive occurs during a short time span (1995-2009) is the Juan de Fuca population (NWFSC 2015b). Productivity rates, which were quite low during the five-year period from 2005-2009 (Ford 2011b), increased from 2011-2015 and were greater than replacement rates from 2014-2015 for both major population groups (NWFSC 2015b). However, productivity of individual spawning aggregates still shows only two of eight aggregates have viable performance.

Genetic Diversity There were likely at least two ecological diversity groups within the Strait of Juan de Fuca population and at least four ecological diversity groups within the Hood Canal population. With the possible exception of the Dungeness River aggregation within the Strait of Juan de Fuca population, Hood Canal ESU summer chum spawning groups exist today that represent each of the ecological diversity groups within the two populations (NMFS 2017a). NMFS measured spatial distribution of the Hood Canal chum salmon ESU using the Shannon diversity index (NWFSC 2015b). Higher diversity values indicate a more uniform distribution of the population among spawning sites, which provides greater robustness to the population. Diversity values were generally lower in the 1990s for both independent populations within the ESU, indicating that most of the abundance occurred at a few spawning sites. Although the overall linear trend in diversity appears to be negative, the last five-year interval shows the highest average value for both populations within the Hood Canal ESU. This results in part from the addition of one reintroduced spawning aggregation in the Strait of Juan de Fuca population and two reintroduced spawning aggregations in the Hood Canal population (NMFS 2017a).

Distribution The Hood Canal summer-run chum salmon ESU includes all naturally spawned populations of summer-run chum salmon in Hood Canal and its tributaries as well as populations in Olympic Peninsula rivers between Hood Canal and Dungeness Bay, Washington. This ESU also includes three artificial propagation programs: Hamma Hamma Fish Hatchery, Lilliwaup Creek Fish Hatchery, and the Jimmycomelately Creek Fish Hatchery (five other Hood Canal summer chum hatchery programs were terminated between 2005 and 2010 and are no longer part of the ESU).

Designated Critical Habitat NMFS designated critical habitat for Hood Canal Summer-run chum salmon in 2005 (70 FR 52630). There are 12 watersheds within the range of this ESU. Three watersheds received a medium rating and nine received a high rating of conservation value to the ESU (NMFS 2005a). Five nearshore marine areas also received a rating of high conservation value. Habitat areas for the Hood Canal Summer-run chum salmon include 88 mi (142 km) of stream and 402 mi (647 km) of nearshore marine areas. PBFs considered essential for the conservation of the Hood Canal ESU of Chum salmon are:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development;
- Freshwater rearing sites with:
  - Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility;
  - Water quality and forage supporting juvenile development;
  - Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
- Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival;
- Estuarine areas free of obstruction and excessive predation with:
  - Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh & saltwater;
  - Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels;
  - Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.
- Nearshore marine areas free of obstruction and excessive predation with:
  - Water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and
  - Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.
- Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

The spawning PBF is degraded by excessive fine sediment in the gravel, and the rearing PBF is degraded by loss of access to sloughs in the estuary and nearshore areas and excessive predation. Low river flows in several rivers also adversely affect most PBFs. In the estuarine areas, both migration and rearing PBFs of juveniles are impaired by loss of functional floodplain areas necessary for growth and development of juvenile chum salmon. These degraded conditions likely maintain low population abundances across the ESU.

Recovery Goals The recovery strategy for Hood Canal Summer-run chum salmon focuses on habitat protection and restoration throughout the geographic range of the ESU, including both freshwater habitat and nearshore marine areas within a one-mile radius of the watersheds' estuaries (NMFS 2007). The recovery plan includes an ongoing harvest management program to reduce exploitation rates, a hatchery supplementation program, and the reintroduction of naturally spawning summer chum aggregations to several streams where they were historically present. The Hood Canal plan gives first priority to protecting the functioning habitat and major production areas of the ESU's eight extant stocks, keeping in mind the biological and habitat needs of different life-history stages, and second priority to restoration of degraded areas, where recovery of natural processes appears to be feasible (HCCC 2005). For details on Hood Canal Summer-run chum salmon ESU recovery goals, including complete down-listing/delisting criteria, see the Hood Canal Coordinating Council 2005 recovery plan (HCCC 2005) and the NMFS 2007 supplement to this recovery plan (NMFS 2007).

Table 9. Summary of status; Chum salmon, Hood Canal summer-run ESU

Criteria	Description
Abundance / productivity trends	stable to increasing abundance trend, increasing population productivity
Listing status	threatened
Attainment of recovery goals	some criteria met
Condition of PBFs	Spawning and rearing PBFs are degraded; Migration and rearing PBFs are impaired by loss of floodplain habitat necessary for juvenile growth and development; Elevated temperatures and environmental mixtures anticipated in freshwater habitats ; All 12 watersheds of high or medium conservation value

9.5 Chinook salmon, California coastal ESU

Table 10. Chinook salmon, California coastal ESU; overview table

Species	Common Name	Distinct Population Segment	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus tshawytscha	Chinook salmon	California Coastal	Threatened	2016	70 FR 37160	2016	70 FR 52488

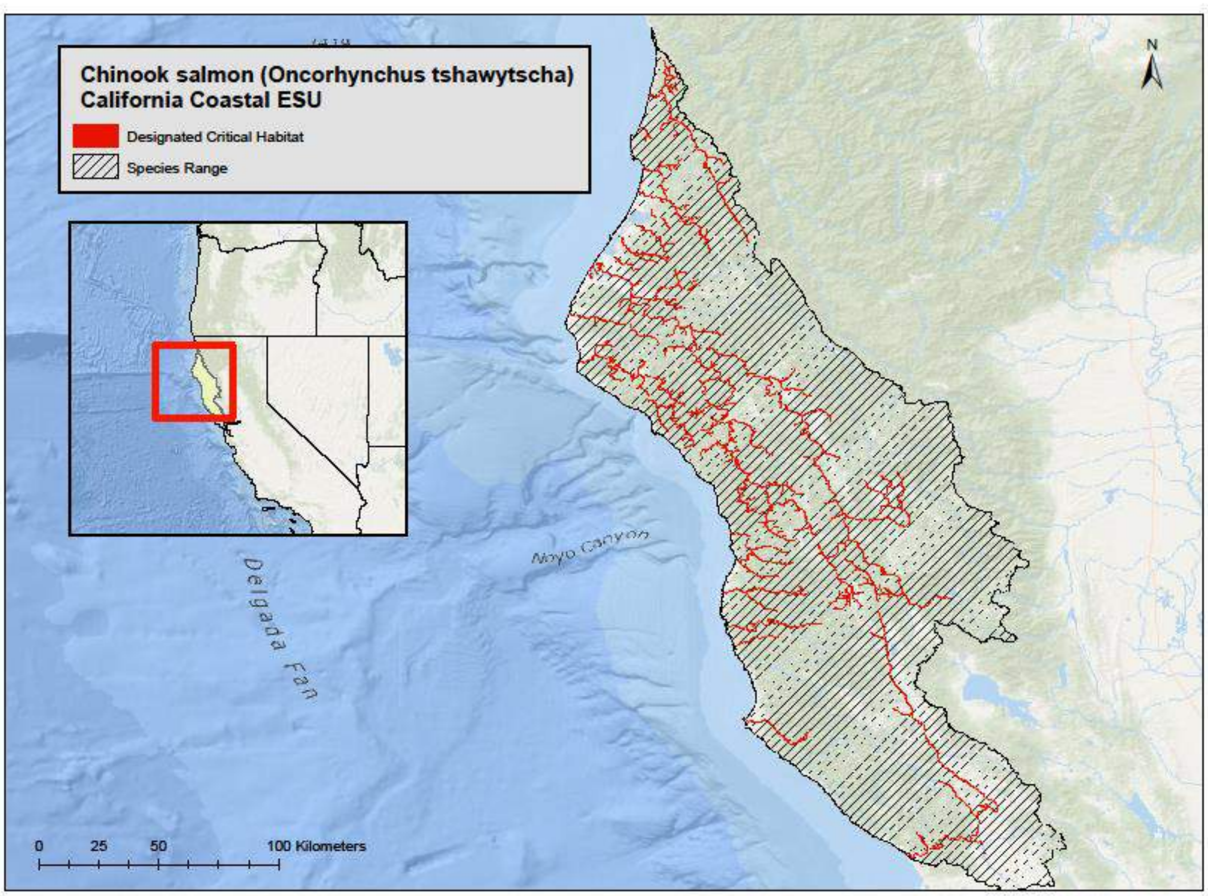

Figure 4. Chinook salmon, California coastal ESU range and designated critical habitat

Species Description Chinook salmon, also referred to as king salmon in California, are the largest of the Pacific salmon. Spawning adults are olive to dark maroon in color, without conspicuous streaking or blotches on the sides. Spawning males are darker than females, and have a hooked jaw and slightly humped back. They can be distinguished from other spawning salmon by the color pattern, particularly the spotting on the back and tail, and by the dark, solid black gums of the lower jaw (Moyle 2002a). On September 16, 1999, NMFS listed the California coastal ESU of Chinook salmon as a "threatened" species (FR 64 50394). On June 28, 2005, NMFS confirmed the listing of CC Chinook salmon as threatened under the ESA and also added seven artificially propagated populations from the following hatcheries or programs to the listing. The California Coastal (CC) Chinook salmon ESU includes all naturally spawned populations of Chinook salmon from rivers and streams south of the Klamath River (Humboldt County, CA.) to the Russian River (Sonoma County, CA) (70 FR 37160).

Status The ESU was historically comprised of 38 populations which included 32 fall-run populations and 6 spring-run populations across four Diversity Strata (Spence et al. 2008b). All six of the spring-run populations were classified as functionally independent, but are considered extinct (Williams et al. 2011). Good et al. (2005a) cited continued evidence of low population sizes relative to historical abundance, mixed trends in the few available time series of abundance indices available, and low abundance and extirpation of populations in the southern part of the ESU. In addition, the apparent loss of the spring-run life history type throughout the entire ESU as a significant diversity concern. The 2016 recovery plan determined that the four threats of greatest concern to the ESU are channel modification, roads and railroads, logging and wood harvesting, and both water diversion and impoundments and severe weather patterns.

Life history California coastal Chinook salmon are a fall-run, ocean-type fish. Although a spring-run (river-type) component existed historically, it is now considered extinct (Bjorkstedt et al. 2005). The different populations vary in run timing depending on latitude and hydrological differences between watersheds. Entry of California coastal Chinook salmon into the Russian River depends on increased flow from fall storms, usually in November to January. Juveniles of this ESU migrate downstream from April through June and may reside in the estuary for an extended period before entering the ocean.

The length of time required for embryo incubation and emergence from the gravel is dependent on water temperature. For maximum embryo survival, water temperatures reportedly must be between 41°F and 55.4°F and oxygen saturation levels must be close to maximum. Under those conditions, embryos hatch in 40 to 60 days and remain in the gravel as alevins (the life stage between hatching and egg sack absorption) for another 4 to 6 weeks before emerging as fry. Juveniles may reside in freshwater for 12 to 16 months, but some migrate to the ocean as young-of-the- year in the winter or spring months within eight months of hatching.

Juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Healey et al. 1991). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson et al. 1981; MacFarlane and Norton 2002; Sommer et al. 2001a). Upon reaching the ocean, juvenile Chinook salmon feed voraciously on larval and juvenile fishes, plankton, and terrestrial insects (Healey et al. 1991; MacFarlane and Norton 2002). Chinook salmon grow rapidly in the ocean environment, with growth rates dependent on water temperatures and food availability.

Table 11. Temporal distribution of Chinook salmon, California coastal ESU

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td>Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td></tr>
<tr><td>Spawning</td><td>Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Incubation (eggs)</td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td></td><td colspan="5">Present</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Population Dynamics

Abundance Comparison of historical and current abundance information indicates that independent populations of Chinook salmon are depressed in many basins (Bennet 2005; Good et al. 2005b; NMFS 2008); only the Russian River currently has a run of any significance (Bjorkstedt et al. 2005). The 2000 to 2007 median observed (at Mirabel Dam) Russian River Chinook salmon run size is 2,991 with a maximum of 6,103 (2003) and a minimum of 1,125 (2008) adults (Cook 2008; Sonoma County Water Agency (SCWA) 2008).

Productivity / Population Growth Rate The available data, a mixture of short-term (6-year or less) population estimates or expanded redd estimates and longer-term partial population estimates and spawner/red indexes, provide no indication that any of the independent populations (likely to persist in isolation) are approaching viability targets. Overall, there is a lack of compelling evidence to suggest that the status of these populations has improved or deteriorated appreciably since the previous status review (Williams *et al*. 2011).

Genetic Diversity At the ESU level, the loss of the spring-run life history type represents a significant loss of diversity within the ESU, as has been noted in previous status reviews (Good *et al*. 2005; Williams *et al*. 2011). Concern remains about the extremely low numbers of Chinook salmon in most populations of the North-Central Coast and Central Coast strata, which diminishes connectivity across the ESU. However, the fact that Chinook salmon have regularly been reported in the Ten Mile, Noyo, Big, Navarro, and Garcia rivers represents a significant improvement in our understanding of the status of these populations in watersheds where they were thought to have been extirpated. These observations suggest that spatial gaps between extant populations are not as extensive as previously believed.

Distribution The California Coastal Chinook ESU includes all naturally spawned populations of Chinook salmon from rivers and streams south of the Klamath River to the Russian River, California (64 FR 50394; September 16, 1999). Seven artificial propagation programs are considered to be part of the ESU (***Table 1***): The Humboldt Fish Action Council (Freshwater Creek), Yager Creek, Redwood Creek, Hollow Tree, Van Arsdale Fish Station, Mattole Salmon Group, and Mad River Hatchery fall-run Chinook hatchery programs. These artificially propagated stocks are no more divergent relative to the local natural population(s) than what would be expected between closely related natural populations within the ESU (NMFS, 2005b).

Designated Critical Habitat NMFS designated critical habitat for the California coastal Chinook salmon on September 2, 2005 (70 FR 52488). It includes multiple CALWATER hydrological units north from Redwood Creek and south to Russian River. The total area of critical habitat includes 1,500 miles of stream habitat and about 25 square miles of estuarine habitat, mostly within Humboldt Bay. PBFs considered essential for the conservation of the California coastal ESU of Chinook salmon are:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development.
- Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver

dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

- Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.
- Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.
- Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.
- Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

There are 45 occupied CALWATER Hydrologic Subarea (HSA) watersheds within the freshwater and estuarine range of this ESU. Eight watersheds received a low rating, 10 received a medium rating, and 27 received a high rating of conservation value to the ESU (70 FR 52488). Two estuarine habitat areas used for rearing and migration (Humboldt Bay and the Eel River Estuary) also received a high conservation value rating. Critical habitat in this ESU consists of limited quantity and quality summer and winter rearing habitat, as well as marginal spawning habitat. Compared to historical conditions, there are fewer pools, limited cover, and reduced habitat complexity. The current condition of PBFs of the California coastal Chinook salmon critical habitat indicates that PBFs are not currently functioning or are degraded; their conditions are likely to maintain a low population abundance across the ESU.

Recovery Goals Recovery goals, objectives and criteria for the Central Valley spring-run Chinook are fully outlined in the 2016 Recovery Plan. Recovery plan objectives are to: 1. Reduce the present or threatened destruction, modification, or curtailment of habitat or range; 2. Ameliorate utilization for commercial, recreational, scientific, or educational purposes; 3. Abate disease and predation; 4. Establish the adequacy of existing regulatory mechanisms for protecting CC Chinook salmon now and into the future (i.e., post-delisting); 5. Address other natural or manmade factors affecting the continued existence of CC Chinook salmon; and 6. Ensure the status of CC Chinook salmon is at a low risk of extinction based on abundance, growth rate, spatial structure and diversity.

Table 12. Summary of status; Chinook salmon, California coastal ESU

Criteria	Description
Abundance / productivity trends	At considerable risk from population fragmentation and reduced spatial diversity. Comparisons to historical abundance is depressed in many basin. Only one population has had consistent run exceeding 1,000 spawning fish.

Listing status	threatened
Attainment of recovery goals	some criteria met
Condition of PBFs	Spawning PBFs are degraded by timber harvest; Rearing and migration PBFs impacted by dams and invasive species; Estuarine PBFs degraded by water quality and saltwater mixing; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of 45 watersheds, 27 are of high and 10 are of medium conservation value.

9.6 Chinook salmon, Central Valley spring-run ESU

Table 13. Chinook salmon, Central Valley spring-run ESU; overview table

Species	Common Name	Distinct Population Segments (DPS)	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus tshawytscha	Chinook Salmon	Central Valley Spring-run	Threatened	2016	1999 64 FR 50394 2014 79 FR 20802	2014	2005 70 FR 52488

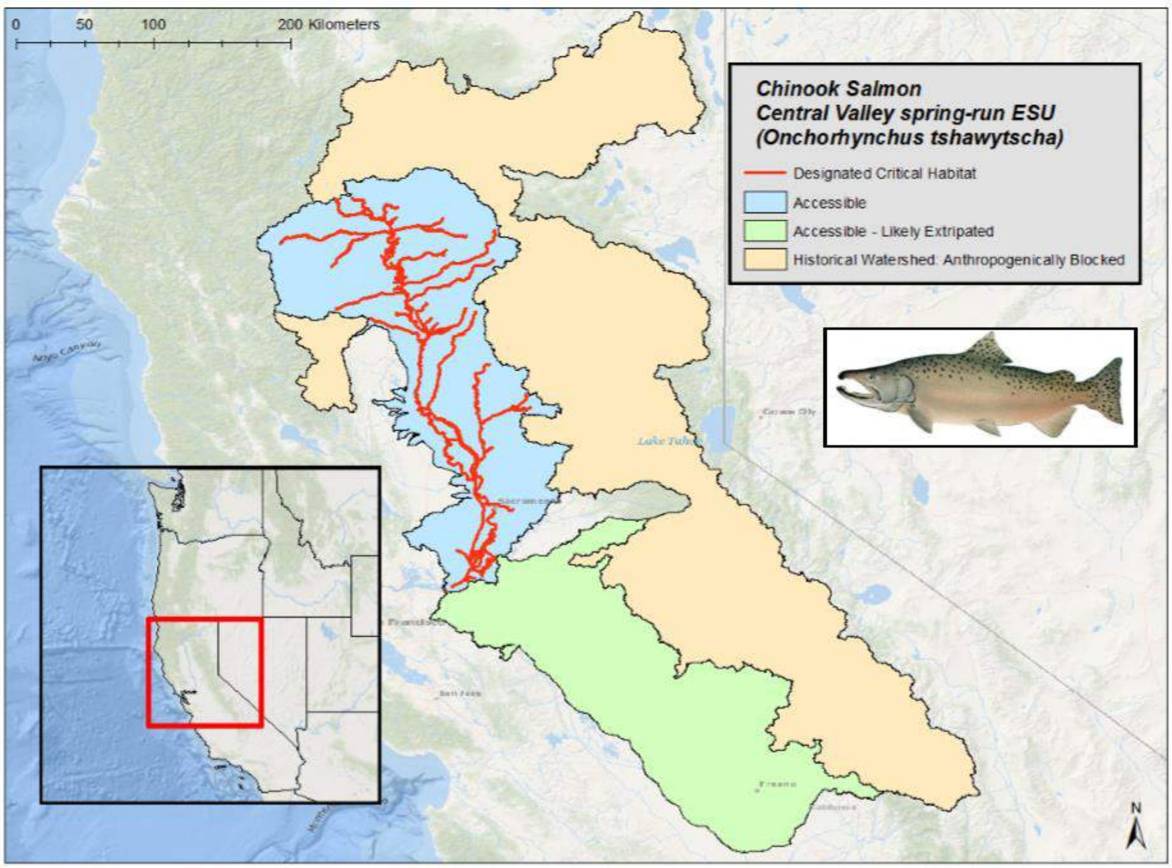

Figure 5. Chinook salmon, Central Valley spring-run ESU range and designated critical habitat

Species Description Chinook salmon, also referred to as king salmon in California, are the largest of the Pacific salmon. Spawning adults are olive to dark maroon in color, without conspicuous streaking or blotches on the sides. Spawning males are darker than females, and have a hooked jaw and slightly humped back. They can be distinguished from other spawning salmon by the color pattern, particularly the spotting on the back and tail, and by the dark, solid black gums of the lower jaw (Moyle 2002a). On September 16, 1999, NMFS listed the Central Valley ESU of spring-run Chinook salmon as a “threatened” species (FR 64 50394). Historically, spring-run Chinook salmon occurred in the headwaters of all major river systems in the Central Valley where natural barriers to migration were absent. The only known streams that currently support self-sustaining populations of non-hybridized spring-run Chinook salmon in the Central Valley are Mill, Deer and Butte creeks. Each of these populations is small and isolated (NMFS 2014b).

Status Although spring-run Chinook salmon were probably the most abundant salmonid in the Central Valley, this ESU has suffered the most severe declines of any of the four Chinook salmon runs in the Sacramento River Basin (Fisher 1994). The ESU is currently limited to independent populations in Mill, Deer, and Butte creeks, persistent and presumably dependent populations in the Feather and Yuba rivers and in Big Chico, Antelope, and Battle creeks, and a few ephemeral or dependent populations in the Northwestern California region (e.g., Beegum, Clear, and Thomes creeks). The Central Valley spring-run Chinook salmon ESU is currently faced with three primary threats: (1) loss of most historic spawning habitat; (2) degradation of the remaining habitat; and (3) genetic introgression with the Feather River fish hatchery spring-run Chinook salmon strays. The potential effects of climate change are likely to adversely affect spring-run Chinook salmon and their recovery (NMFS 2014b).

Life history Adult Central Valley spring-run Chinook salmon leave the ocean to begin their upstream migration in late January and early February, and enter the Sacramento River between March and September, primarily in May and June (Moyle 2002a; Yoshiyama et al. 1998). Spring-run Chinook salmon generally enter rivers as sexually immature fish and must hold in freshwater for up to several months before spawning. While maturing, adults hold in deep pools with cold water. Spawning normally occurs between mid- August and early October, peaking in September (Moyle 2002a).

The length of time required for embryo incubation and emergence from the gravel is dependent on water temperature. For maximum embryo survival, water temperatures reportedly must be between 41°F and 55.4°F and oxygen saturation levels must be close to maximum. Under those conditions, embryos hatch in 40 to 60 days and remain in the gravel as alevins (the life stage between hatching and egg sack absorption) for another 4 to 6 weeks before emerging as fry. Spring-run fry emerge from the gravel from November to March (Moyle 2002a). Juveniles may reside in freshwater for 12 to 16 months, but some migrate to the ocean as young-of-the- year in the winter or spring months within eight months of hatching.

Juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Healey et al. 1991). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson et al. 1981; MacFarlane and Norton 2002; Sommer et al. 2001a). Upon reaching the ocean, juvenile Chinook salmon feed voraciously on larval and juvenile fishes, plankton, and terrestrial insects (Healey et al. 1991; MacFarlane and Norton 2002). Chinook salmon grow rapidly in the ocean environment, with growth rates dependent on water temperatures and food availability.

Table 14. Temporal distribution of Chinook salmon, Central Valley spring-run ESU

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
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<tr><td>Spawning</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="5">Present</td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance The Central Valley as a whole is estimated to have supported spring-run Chinook salmon runs as large as 600,000 fish between the late 1880s and 1940s. The only known streams that currently support self-sustaining populations of nonhybridized spring-run Chinook salmon in the Central Valley are Mill, Deer and Butte creeks. Abundance and trend estimates for these streams as well as streams supporting dependent populations are provided in Table 15 (NMFS 2014b).

Table 15. Viability metrics for Central Valley spring-run ESU Chinook salmon populations.

Population	N	$\hat{S}$	10-year trend (95% CI)	Recent Decline (%)
Antelope Creek	8.0	2.7	-0.375 (-0.706, -0.045)	87.8
Battle Creek	1836	61	0.176 (0.033, 0.319)	9.0
Big Chico Creek	0.0	0.0	-0.358 (-0.880, 0.165)	60.7
Butte Creek	20169	6723	0.353 (-0.061, 0.768)	15.7
Clear Creek	822	27	0.010 (-0.311, 0.330)	63.3
Cottonwood Creek	4	1.3	-0.343 (-0.672, -0.013)	87.5
Deer Creek	2272	757.3	-0.089 (-0.337, 0.159)	83.8
Feather River Fish Hatchery	10808	3602.7	0.082 (-0.015, 0.179)	17.1
Mill Creek	2091.	697.0	-0.049 (-0.183, 0.086)	58.0
Sacramento River[a]	-	-	-	-
Yuba River	6515	2170.7	0.67 (-0.138, 0.272)	9.0

N: Total population size (N) is estimated as the sum of estimated run sizes over the most recent three years for Core 1 populations (bold) and Core 2 populations.
$\hat{S}$: The mean population size ($\hat{S}$) is the average of the estimated run sizes for the most recent 3 years (2012 to 2014).
Population growth/decline rate (10 year trend) is estimated from the slope of log-transformed estimated run size.
The catastrophic metric (recent decline) is the largest year-to-year decline in total population size (N) over the most recent 10 such ratios.
[a] Beginning in 2009, estimates of spawning escapement of Upper Sacramento River spring chinook were no longer monitored.

Productivity / Population Growth Rate Cohort replacement rates (CRR) are indications of whether a cohort is replacing itself in the next generation. The majority of Central Valley (CV) spring-run Chinook salmon are found to return as three-yearolds, therefore looking at returns every three years is used as an estimate of the CRR. In the past the CRR has fluctuated between just over 1.0 to just under 0.5, and in the recent years with high returns (2012 and 2013), CRR jumped to 3.84 and 8.68 respectively. CRR for 2014 was 1.85, and the CRR for 2015 with very low returns was a record low of 0.14. Low returns in 2015 were further decreased due to high temperatures and most of the CV spring-run Chinook salmon tributaries experienced some pre-spawn mortality. Butte Creek experienced the highest prespawn mortality in 2015, resulting in a carcass survey CRR of only 0.02.

Genetic Diversity Threats to the genetic integrity of spring-run Chinook salmon was identified as a serious concern to the species when it was listed in 1999 (FR 64 50394; Myers et al. 1998a). Three main factors compromised the genetic integrity of spring-run Chinook salmon: (1) the lack of reproductive isolation following dam construction throughout the Central Valley resulting in introgression with fall-run Chinook salmon in the wild; (2) within basin and inter-basin mixing between spring and fall broodstock for artificial propagation, resulting in introgression in hatcheries; and (3) releasing hatchery-produced juvenile Chinook salmon in the San Francisco estuary, which contributes to the straying of returning adults throughout the Central Valley (NMFS 2014b).

Distribution The Central Valley Technical Recovery Team delineated 18 or 19 historic independent populations of CV spring-run Chinook salmon, and a number of smaller dependent populations, that are distributed among four diversity groups (southern Cascades, northern Sierra, southern Sierra, and Coast Range) (Lindley et al. 2004). Of these independent populations, only three are extant (Mill, Deer, and Butte creeks) and they represent only the northern Sierra Nevada diversity group. Of the dependent populations, CV spring-run Chinook salmon are found in Battle, Clear, Cottonwood, Antelope, Big Chico, and Yuba creeks, as well as the Sacramento and Feather rivers and a number of tributaries of the San Joaquin River including Mokelumne, Stanislaus, and Tuolumne rivers. The 2005 listing determination concluded that the Feather River Fish Hatchery spring-run Chinook salmon production should be included in the Central Valley spring-run Chinook salmon ESU (79 FR 20802; NMFS 2016a).

Designated Critical Habitat NMFS published a final rule designating critical habitat for Central Valley spring-run Chinook on September 2, 2005 (70 FR 52488). The designated critical habitat includes 1,853 km (1,158 mi) of streams and 655 km2 (254 km2) of estuarine habitat. PBFs considered essential for the conservation of the Central Valley spring-run ESU of Chinook salmon are:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development.
- Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
- Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.
- Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; natural cover such as submerged and overhanging large wood,

aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.
- Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.
- Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

The current condition of PBFs of the CV Spring-run Chinook salmon critical habitat indicates that PBFs are not currently functioning or are degraded; their conditions are likely to maintain a low population abundance across the ESU. Spawning and rearing PBFs are degraded by high water temperature caused by the loss of access to historic spawning areas in the upper watersheds which maintained cool and clean water throughout the summer. The rearing PBF is degraded by floodplain habitat being disconnected from the mainstem of larger rivers throughout the Sacramento River watershed, thereby reducing effective foraging. Migration PBF is degraded by lack of natural cover along the migration corridors. Juvenile migration is obstructed by water diversions along Sacramento River and by two large state and federal water-export facilities in the Sacramento-San Joaquin Delta.

Recovery Goals Recovery goals, objectives and criteria for the Central Valley spring-run Chinook are fully outlined in the 2014 Recovery Plan (NMFS 2014b). The ESU delisting criteria for the spring-run Chinook are: 1) One population in the Northwestern California Diversity Group at low risk of extinction; 2) Two populations in the Basalt and Porous Lava Diversity Group at low risk of extinction; 3) Four populations in the Northern Sierra Diversity Group at low risk of extinction; 4) Two populations in the Southern Sierra Diversity Group at low risk of extinction; and 5) Maintain multiple populations at moderate risk of extinction.

Table 16. Summary of status; Chinook salmon, Central Valley spring-run ESU

Criteria	Description
Abundance / productivity trends	Stable to declining trends, low abundances, low genetic diversity, fragmented populations
Listing status	Threatened
Attainment of recovery goals	Criteria not yet met
Condition of PBFs	Spawning and rearing PBFs are degraded by elevated temperatures, lost access to historic spawning sites, and loss of floodplain habitat; Migration PBFs degraded by loss of cover and water diversions; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of 38 watersheds, 28 are of high and 3 are of medium conservation value

9.7 Chinook salmon, Lower Columbia River ESU

Table 17. Chinook salmon, Lower Columbia River ESU; overview table

Species	Common Name	Distinct Population Segment	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus tshawytscha	Chinook Salmon	Lower Columbia River ESU	Threatened	2016	70 FR 37160	2013	70 FR 52630

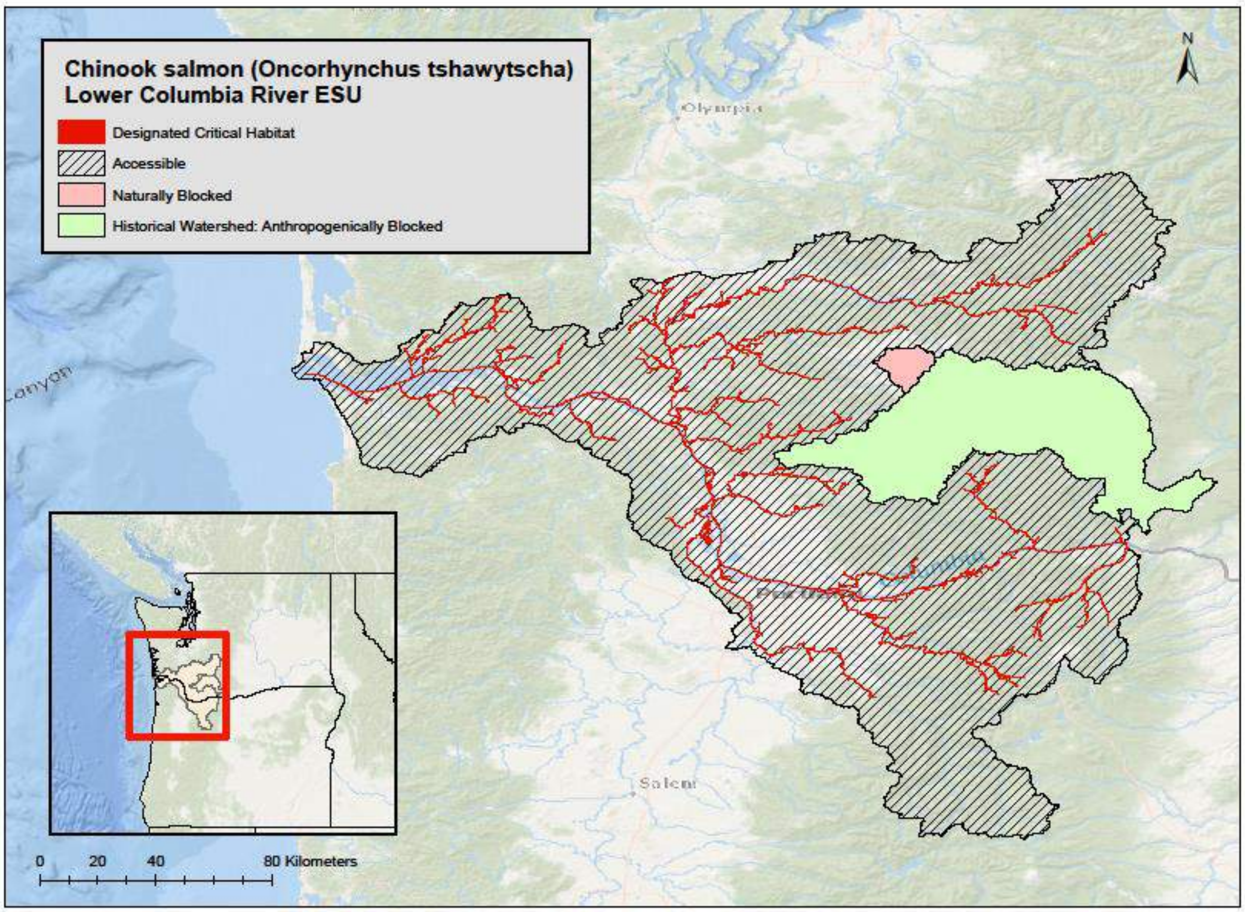

Figure 6. Chinook salmon, Lower Columbia River ESU range and designated critical habitat

Species Description Chinook salmon, also referred to as king salmon in California, are the largest of the Pacific salmon. Spawning adults are olive to dark maroon in color, without conspicuous streaking or blotches on the sides. Spawning males are darker than females, and have a hooked jaw and slightly humped back. They can be distinguished from other spawning salmon by the color pattern, particularly the spotting on the back and tail, and by the dark, solid black gums of the lower jaw (Moyle 2002a). On March 24, 1999, NMFS listed the Lower Columbia River ESU of Chinook salmon as a "threatened" species (64 FR 14308). The listing was revisited and confirmed as "threatened" in 2005 (70 FR 37160). The Lower Columbia River

Chinook salmon ESU includes all naturally-spawned populations of fall-run and spring-run Chinook salmon from the Columbia River and its tributaries from its mouth at the Pacific Ocean upstream to a transitional point between Oregon and Washington, east of the Hood River and the White Salmon River and any such fish originating from the Willamette River and its tributaries below Willamette Falls. Twenty artificial propagation programs are included in the ESU (70 FR 37160).

Status Populations of Lower Columbia River Chinook salmon have declined substantially from historical levels. Out of the 32 populations that make up this ESU, only the two late-fall runs (the North Fork Lewis and Sandy) are considered viable. Most populations (26 out of 32) have a very low probability of persistence over the next 100 years and some are extirpated or nearly so. Five of the six strata fall significantly short of the recovery plan criteria for viability. Low abundance, poor productivity, losses of spatial structure, and reduced diversity all contribute to the very low persistence probability for most Lower Columbia River Chinook salmon populations. Hatchery contribution to naturally-spawning fish remains high for a number of populations, and it is likely that many returning unmarked adults are the progeny of hatcheryorigin parents, especially where large hatchery programs operate. Continued land development and habitat degradation in combination with the potential effects of climate change will present a continuing strong negative influence into the foreseeable future.

Life history Lower Columbia River Chinook salmon display three run types including early fall-runs, late fall-runs, and spring-runs. Presently, the fall-run is the predominant life history type. Spring-run Chinook salmon were numerous historically. Fall-run Chinook salmon enter fresh water typically in August through October. Early fall-run spawn within a few weeks in large river mainstems. The late fall-run enters in immature conditions, has a delayed entry to spawning grounds, and resides in the river for a longer time between river entry and spawning. Spring-run Chinook salmon enter fresh water in March through June to spawn in upstream tributaries in August and September.

Offspring of fall-run spawning may migrate as fry to the ocean soon after yolk absorption (*i.e.*, ocean-type), at 30–45 mm in length (Healey 1991). In the Lower Columbia River system, however, the majority of fall-run Chinook salmon fry migrate either at 60-150 days post-hatching in the late summer or autumn of their first year. Offspring of fall-run spawning may also include a third group of yearling juveniles that remain in fresh water for their entire first year before emigrating. The spring-run Chinook salmon migrates to the sea as yearlings (stream-type) typically in spring. However, the natural timing of Lower Columbia River (LCR) spring-run Chinook salmon emigration is obscured by hatchery releases (Myers et al. 2006). Once at sea, the ocean-type LCR Chinook salmon tend to migrate along the coast, while stream-type LCR Chinook salmon appear to move far off the coast into the central North Pacific Ocean (Healey 1991; Myers et al. 2006). Adults return to tributaries in the lower Columbia River predominately as three- and four-year-olds for fall-run fish and four- and five-year-olds for spring-run fish.

Juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Healey et al. 1991). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson et al. 1981; MacFarlane and Norton 2002; Sommer et al. 2001a). Upon reaching the ocean, juvenile Chinook salmon feed voraciously on larval and juvenile fishes, plankton, and terrestrial insects (Healey et al. 1991; MacFarlane and Norton 2002). Chinook salmon grow rapidly in the ocean environment, with growth rates dependent on water temperatures and food availability.

Table 18. Temporal distribution of Chinook salmon, Lower Columbia River ESU

Life History phase	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Entering Fresh Water (adults/jacks)			Present	Present	Present	Present	Present	Present	Present	Present	Present	Present
Spawning	Present							Present	Present	Present	Present	Present
Incubation (eggs)	Present	Present	Present					Present	Present	Present	Present	Present
Emergence (alevin to fry phases)	Present	Present	Present	Present								
Rearing and migration (juveniles)	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present

Population Dynamics

Abundance Populations of Lower Columbia River Chinook salmon have declined substantially from historical levels. Many of the ESU's populations are believed to have very low abundance of natural-origin spawners (100 fish or fewer), which increases genetic and demographic risks. Other populations have higher total abundance, but several of these also have high proportions of hatchery-origin spawners (***Table 19***).

Table 19. Lower Columbia River Chinook salmon population structure, abundances, and hatchery contributions (Good et al. 2005; Myers et al. 2006).

Run	Population	Historical Abundance	Mean* Number of Spawners	Hatchery Abundance Contributions
F-R	Grays River (WA)	2,477	99	38%
	Elochoman River (WA)	Unknown	676	68%
	Mill, Abernathy, and German Creeks (WA)	Unknown	734	47%
	Youngs Bay (OR)	Unknown	Unknown	Unknown
	Big Creek (OR)	Unknown	Unknown	Unknown
	Clatskanie River (OR)	Unknown	50	Unknown
	Scappoose Creek (OR)	Unknown	Unknown	Unknown
F-R	Lower Cowlitz River (WA)	53,956	1,562	62%
	Upper Cowlitz River (WA)	Unknown	5,682	Unknown
	Coweeman River (WA)	4,971	274	0%
	Toutle River (WA)	25,392	Unknown	Unknown
	Salmon Creek and Lewis River (WA)	47,591	256	0%
	Washougal River (WA)	7,518	3,254	58%
	Kalama River (WA)	22,455	2,931	67%
	Clackamas River (OR)	Unknown	40	Unknown
	Sandy River (OR)	Unknown	183	Unknown
LF-R	Lewis R-North Fork (WA)	Unknown	7,841	13%
	Sandy River (OR)	Unknown	504	3%
S-R	Upper Cowlitz River (WA)	Unknown	Unknown	Unknown
	Tilton River (WA)	Unknown	Unknown	Unknown
	Cispus River (WA)	Unknown	1,787*	Unknown
	Toutle River (WA)	2,901	Unknown	Unknown
	Kalama River (WA)	4,178	98	Unknown

Run	Population	Historical Abundance	Mean* Number of Spawners	Hatchery Abundance Contributions
	Lewis River (WA)	Unknown	347	Unknown
	Sandy River (OR)	Unknown	3,085	3%
F-R	Upper Columbia Gorge (WA)	2,363	136	13%
	Big White Salmon R (WA)	Unknown	334	21%
	Lower Columbia Gorge (OR)	Unknown	Unknown	Unknown
	Hood River (OR)	Unknown	18	Unknown
S-R	Big White Salmon R (WA)	Unknown	334	21%
	Hood River (OR)	Unknown	18	Unknown

****Arithmetic mean***
Recent 5-year spawner abundance (up to 2001) and historic abundance over more than 20 years is given as a geometric mean, and include hatchery origin Chinook salmon.
F-R is fall run, LF-R is late fall run, and S-R is spring run Chinook salmon.

Productivity / Population Growth Rate Trend indicators for most populations are negative. The majority of populations for which data are available have a long-term trend of <1; indicating the population is in decline (Bennet 2005; Good et al. 2005b). Only the late-fall run population in Lewis River has an abundance and population trend that may be considered viable (McElhany et al. 2007a). The Sandy River is the only stream system supporting a natural production of spring-run Chinook salmon of any amount. However, the population is at risk from low abundance and negative to low population growth rates (McElhany et al. 2007a).

Genetic Diversity The genetic diversity of all populations (except the late fall-run Chinook salmon) has been eroded by large hatchery influences and periodically by low effective population sizes. The near loss of the spring-run life history type remains an important concern for maintaining diversity within the ESU.

Distribution The basin wide spatial structure has remained generally intact. However, the loss of about 35% of historic habitat has affected distribution within several Columbia River subbasins. Currently, only one population appears self-sustaining (Good et al. 2005b).

Designated Critical Habitat NMFS designated critical habitat for LCR Chinook salmon on September 2, 2005 (70 FR 52630). It includes all Columbia River estuarine areas and river reaches proceeding upstream to the confluence with the Hood Rivers as well as specific stream reaches in a number of tributary subbasins. PBFs considered essential for the conservation of Chinook salmon, Lower Columbia River ESU are:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development;
- Freshwater rearing sites with:
  - Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility;
  - Water quality and forage supporting juvenile development;
  - Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

- Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival;
- Estuarine areas free of obstruction and excessive predation with:
  - Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh & saltwater;
  - Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels;
  - Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.
- Nearshore marine areas free of obstruction and excessive predation with:
  - Water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and
  - Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.
- Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

Timber harvest, agriculture, and urbanization have degraded spawning and rearing PBFs by reducing floodplain connectivity and water quality, and by removing natural cover in several rivers. Hydropower development projects have reduced timing and magnitude of water flows, thereby altering the water quantity needed to form and maintain physical habitat conditions and support juvenile growth and mobility. Adult and juvenile migration PBFs are affected by several dams along the migration route.

Recovery Goals NMFS has developed the following delisting criteria for the Lower Columbia River Chinook salmon ESU. For a complete description of the ESU recovery goals, including complete down-listing/delisting criteria, see the 2013 recovery plan.

1. All strata that historically existed have a high probability of persistence or have a probability of persistence consistent with their historical condition. High probability of stratum persistence is defined as:
   a. At least two populations in the stratum have at least a 95 % probability of persistence over a 100-year time frame (i.e., two populations with a score of 3.0 or higher based on the Technical Recovery Team's (TRT) scoring system).
   b. Other populations in the stratum have persistence probabilities consistent with a high probability of stratum persistence (i.e., the average of all stratum population scores is 2.25 or higher, based on the TRT's scoring system). (See Section 2.6 for a brief discussion of the TRT's scoring system.)
   c. Populations targeted for a high probability of persistence are distributed in a way that minimizes risk from catastrophic events, maintains migratory connections among populations, and protects within-stratum diversity.

   A probability of persistence consistent with historical condition refers to the concept that strata that historically were small or had complex population structures may not have met Criteria A through C, above, but could still be considered sufficiently viable if they provide a contribution to overall ESU viability similar to their historical contribution.

2. The threats criteria described in Section 3.2.2 have been met.

Table 20. Summary of status; Chinook salmon, Lower Columbia River ESU

Criteria	Description
Abundance / productivity trends	Trends for most populations are declining. Only one population is self-sustaining. The near loss of the spring-run life history remains an important concern for maintaining genetic diversity.
Listing status	threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Spawning and rearing PBFs are degraded by timber harvest, agriculture, urbanization, loss of floodplain habitat, and reduced natural cover; Migration PBFs impacted by dams; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of occupied watersheds, 31 are of high and 13 are of medium conservation value.

9.8 Chinook salmon, Puget Sound ESU

Table 21. Chinook salmon, Puget Sound ESU; overview table

Species	Common Name	Distinct Population Segment	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus tshawytscha	Chinook salmon	Puget Sound ESU	Threatened	2011	70 FR 37160	2007	70 FR 52630

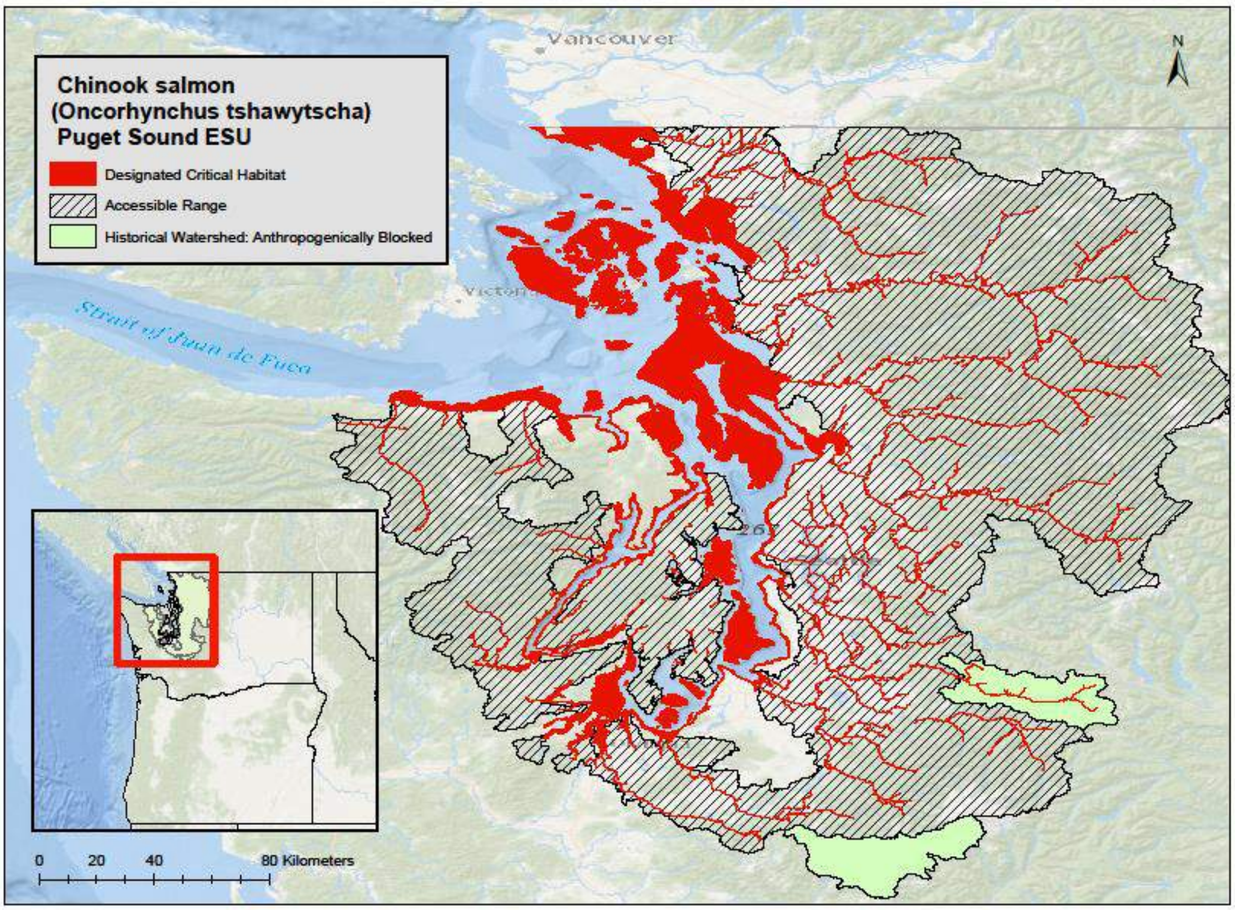

Figure 7. Chinook salmon, Puget Sound ESU range and designated critical habitat

Species Description Chinook salmon, also referred to as king salmon in California, are the largest of the Pacific salmon. Spawning adults are olive to dark maroon in color, without conspicuous streaking or blotches on the sides. Spawning males are darker than females, and have a hooked jaw and slightly humped back. They can be distinguished from other spawning salmon by the color pattern, particularly the spotting on the back and tail, and by the dark, solid black gums of the lower jaw (Moyle 2002a). On March 24, 1999, NMFS listed the Puget Sound ESU of Chinook salmon as a "threatened" species (64 FR 14308). The listing was revisited and confirmed as "threatened" in 2005 (70 FR 37160). The Puget Sound ESU includes naturally spawned Chinook salmon originating from rivers flowing into Puget Sound from the Elwha River (inclusive) eastward, including rivers in Hood Canal, South Sound, North Sound and the Strait of Georgia. Twenty-six artificial propagation programs are included as part of the ESU.

Status All Puget Sound Chinook salmon populations are well below escapement abundance levels identified as required for recovery to low extinction risk in the recovery plan. In addition, most populations are consistently below the productivity goals identified in the recovery plan as necessary for recovery. Although trends vary for individual populations across the ESU, most populations have declined in total natural origin recruit abundance since the last status review; and natural origin recruit escapement trends since 1995 are mostly stable. Several of the risk factors identified in the previous status review (Good et al. 2005) are still present, including high fractions of hatchery fish in many populations and widespread loss and degradation of habitat. Although this ESU's total abundance is a greatly reduced from historic levels, recent abundance levels do not indicate that the ESU is at immediate risk of extinction. This ESU remains relatively well distributed over 22 populations in 5 geographic areas across the Puget Sound. Although current trends are concerning, the available information indicates that this ESU remains at moderate risk of extinction.

Life history Puget Sound Chinook salmon populations exhibit both early-returning (August) and late-returning (mid-September and October) Chinook salmon spawners (Healey 1991). Juvenile Chinook salmon within the Puget Sound generally exhibit an "ocean-type" life history. However, substantial variation occurs with regard to juvenile residence time in freshwater and estuarine environments. Hayman (Hayman et al. 1996) described three juvenile life histories for Chinook salmon with varying freshwater and estuarine residency times in the Skagit River system in northern Puget Sound. In this system, 20% to 60% of sub-yearling migrants rear for several months in freshwater habitats while the remaining fry migrate to rear in the Skagit River estuary and delta (Beamer et al. 2005). Juveniles in tributaries to Lake Washington exhibit both a stream rearing and a lake rearing strategy. Lake rearing fry are found in highest densities in nearshore shallow (<1 m) habitat adjacent to the opening of tributaries or at the mouth of tributaries where they empty into the lake (Tabor et al. 2006). Puget Sound Chinook salmon also has several estuarine rearing juvenile life history types that are highly dependent on estuarine areas for rearing (Beamer et al. 2005). In the estuaries, fry use tidal marshes and connected tidal channels including dikes and ditches developed to protect and drain agricultural land. During their first ocean year, immature Chinook salmon use nearshore areas of Puget Sound during all seasons and can be found long distances from their natal river systems (Brennan et al. 2004).

Juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Healey et al. 1991). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson et al. 1981; MacFarlane and Norton 2002; Sommer et al. 2001a). Upon reaching the ocean, juvenile Chinook salmon feed voraciously on larval and juvenile fishes, plankton, and terrestrial insects (Healey et al. 1991; MacFarlane and Norton 2002). Chinook salmon grow rapidly in the ocean environment, with growth rates dependent on water temperatures and food availability.

Table 22. Temporal distribution of Chinook salmon, Puget Sound ESU

<table>
<tr><td>Life History phase</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td></td><td></td><td></td><td colspan="8">Present</td><td></td></tr>
<tr><td>Spawning</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="6">Present</td></tr>
<tr><td>Incubation (eggs)</td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td colspan="6">Present</td></tr>
<tr><td>Emergence (alevin to fry phase)</td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance Estimates of the historic abundance range from 1,700 to 51,000 potential Puget Sound Chinook salmon spawners per population. During the period from 1996 to 2001, the geometric mean of natural spawners in populations of Puget Sound Chinook salmon ranged from 222 to just over 9,489 fish. Thus, the historical estimates of spawner capacity are several orders of magnitude higher than spawner abundances currently observed throughout the ESU (Good et al. 2005b).

Table 23. Puget Sound Chinook salmon preliminary population structure, abundances, and hatchery contributions (Good et al. 2005).

Independent Populations	Historical Abundance	Mean Number of Spawners	Hatchery Abundance Contributions
Nooksack-North Fork	26,000	1,538	91%
Nooksack-South Fork	13,000	338	40%
Lower Skagit	22,000	2,527	0.2%
Upper Skagit	35,000	9,489	2%
Upper Cascade	1,700	274	0.3%
Lower Sauk	7,800	601	0%
Upper Sauk	4,200	324	0%
Suiattle	830	365	0%
Stillaguamish-North Fork	24,000	1,154	40%
Stillaguamish-South Fork	20,000	270	Unknown
Skykomish	51,000	4,262	40%
Snoqualmie	33,000	2,067	16%
Sammamish	Unknown	Unknown	Unknown
Cedar	Unknown	327	Unknown
Duwamish/Green			
Green	Unknown	8,884	83%
White	Unknown	844	Unknown
Puyallup	33,000	1,653	Unknown
Nisqually	18,000	1,195	Unknown
Skokomish	Unknown	1,392	Unknown
Mid Hood Canal Rivers			
Dosewallips	4,700	48	Unknown
Duckabush	Unknown	43	Unknown
Hamma Hamma	Unknown	196	Unknown
Mid Hood Canal	Unknown	311	Unknown
Dungeness	8,100	222	Unknown
Elwha	Unknown	688	Unknown

Productivity / Population Growth Rate While natural origin recruit escapements have remained fairly constant during the most recent review period (1985-2009), total natural origin recruit abundance and productivity have continued to decline. Median recruits per spawner for the last five-year period (brood years 2002-2006) is the lowest over any of the five year intervals. However, results vary across populations in the ESU with some populations showing stronger trends than others. Long-term trends in abundance and median population growth rates for naturally spawning populations indicate that approximately half of the populations are declining and the other half are increasing in abundance over the length of available time series. However, the median overall long-term trend in abundance is close to 1 for most populations that have a lambda exceeding 1, indicating that most of these populations are barely replacing themselves. Genetic Diversity / Spatial Distribution The Northwest Fisheries Science Center estimated the diversity index for five year time intervals over the 25 year time span of the available data. In general, a higher diversity value indicates a healthier distribution of salmon among the streams and rivers in the ESU. Current estimates of diversity show a decline over the past 25 years, indicating a decline of salmon in some areas and increases in others. Salmon returns to the Whidbey Region increased in abundance while returns to other regions declined. In aggregate, the diversity of the ESU as a whole has been declining over the last 25 years.

Designated Critical Habitat

Critical habitat was designated for this species on September 2, 2005 (70 FR 52630). It includes 1,683 km of stream channels, 41 square km of lakes, and 3,512 km of nearshore marine habitat. PBFs considered essential for the conservation of Chinook salmon, Puget Sound ESU are:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development;
- Freshwater rearing sites with:
  - Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility;
  - Water quality and forage supporting juvenile development;
  - Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
- Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival;
- Estuarine areas free of obstruction and excessive predation with:
  - Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh & saltwater;
  - Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels;
  - Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.
- Nearshore marine areas free of obstruction and excessive predation with:
  - Water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and
  - Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.

- Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

Forestry practices have heavily impacted migration, spawning, and rearing PBFs in the upper watersheds of most rivers systems within critical habitat designated for the Puget Sound Chinook salmon. Degraded PBFs include reduced conditions of substrate supporting spawning, incubation and larval development caused by siltation of gravel; and degraded rearing habitat by removal of cover and reduction in channel complexity. Urbanization and agriculture in the lower alluvial valleys of mid- to southern Puget Sound and the Strait of Juan de Fuca have reduced channel function and connectivity, reduced available floodplain habitat, and affected water quality. Thus, these areas have degraded spawning, rearing, and migration PBFs. Hydroelectric development and flood control also obstruct Puget Sound Chinook salmon migration in several basins. The most functional PBFs are found in northwest Puget Sound: the Skagit River basin, parts of the Stillaguamish River basin, and the Snohomish River basin where federal land overlap with critical habitat designated for the Puget Sound Chinook salmon. However, estuary PBFs are degraded in these areas by reduction in the water quality from contaminants, altered salinity conditions, lack of natural cover, and modification and lack of access to tidal marshes and their channels.

Recovery Goals The ESU-wide delisting and recovery criteria (PSTRT, 2002) provide flexibility in meeting the requirements of the Endangered Species Act, and preserve options for Puget Sound Chinook in the future. The recommendations by the TRT describe the biological characteristics that would constitute a viable ESU for Puget Sound Chinook. The ESU would have a high likelihood of persistence if:

1. All populations improve in status and at least some achieve a low risk status.
2. At least 2-4 viable Chinook populations are present in each of the 5 regions.
3. Each region has one or more viable populations from each major diversity group that was historically present within that region.
4. Freshwater tributary habitats in Puget Sound are providing sufficient function for ESU persistence. Ecological functioning occurs even in those habitats that do not currently support any of the 22 identified Chinook populations, since they affect nearshore processes and may provide future habitat options.
5. The production of Chinook salmon in Puget Sound tributaries is consistent with ESU recovery objectives, and contributes to the health of the overall ecosystem in the region.
6. None of the 22 remaining Chinook populations go extinct, and the direct and indirect effects of habitat, harvest and hatchery management actions are consistent with ESU recovery.

Table 24. Summary of status; Chinook salmon, Puget Sound ESU

Criteria	Description
Abundance / productivity trends	Abundance is several orders of magnitude below historic levels. Approximately half the populations are declining and half are increasing in abundance. Most of the populations that are increasing have lambda of close to 1 (barely replacing themselves).

Listing status	threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Spawning, rearing and migration PBFs are degraded by forestry, agriculture, urbanization, and loss of habitat; Estuarine PBFs degraded by water quality, altered salinity, and lack of natural cover; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of 61 watersheds, 40 are of high and 9 are of medium conservation value.

9.9 Chinook salmon, Sacramento River winter-run ESU

Table 25. Chinook salmon, Sacramento winter-run ESU; overview table

Species	Comm on Name	Distinct Population Segments (DPS)	ESA Status	Recent Review Year	Listing	Recover y Plan	Critical Habitat
Oncorhynchu s tshawytscha	Chinoo k Salmon	Sacramento River winter-run	Endangered	2011	1990 54 FR 32085 1994 59 FR 440	2014	1993 58 FR 33212

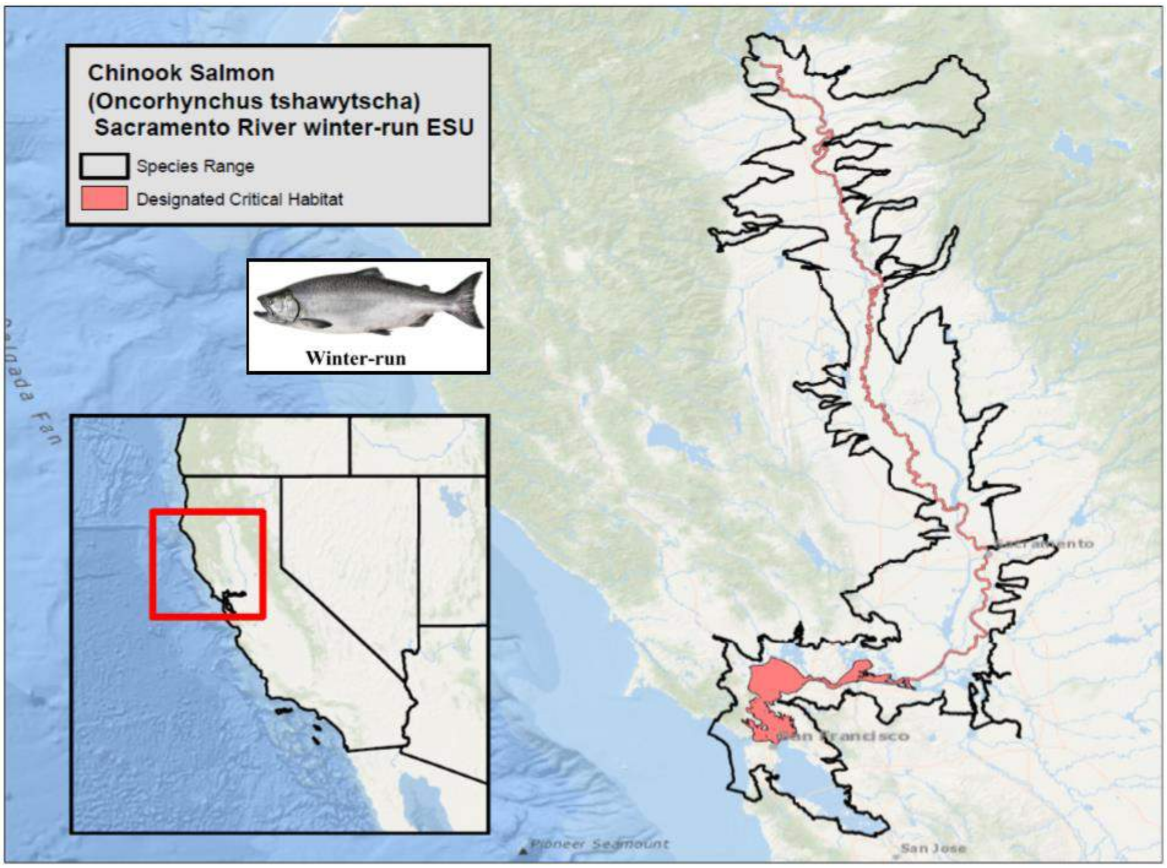

Figure 8. Chinook salmon, Sacramento winter-run ESU range and designated critical habitat

Species Description Chinook salmon, also referred to as king salmon in California, are the largest of the Pacific salmon. Spawning adults are olive to dark maroon in color, without conspicuous streaking or blotches on the sides. Spawning males are darker than females, and have a hooked jaw and slightly humped back. They can be distinguished from other spawning salmon by the color pattern, particularly the spotting on the back and tail, and by the dark, solid black gums of the lower jaw (Moyle 2002a). On January 4, 1994, NMFS listed the Sacramento

River winter-run ESU of Chinook salmon as Endangered (59 FR 440). The Sacramento River winter-run Chinook salmon ESU includes winter-run Chinook salmon spawning naturally in the Sacramento River and its tributaries, as well as winter-run Chinook salmon that are part of the conservation hatchery program at the Livingston Stone National Fish Hatchery (LSNFH). Winter-run Chinook salmon originally spawned in the upper Sacramento River system (Little Sacramento, Pit, McCloud and Fall rivers) and in Battle Creek (Yoshiyama et al. 1998; Yoshiyama et al. 2001). Currently, winter-run Chinook salmon spawning habitat is likely limited to the reach of the Sacramento River extending from Keswick Dam downstream to the Red Bluff Diversion Dam.

Status The Sacramento River winter-run Chinook salmon ESU is composed of just one small population that is currently under severe stress caused by one of California's worst droughts on record. Over the last 10 years of available data (2003-2013), the abundance of spawning winter-run Chinook adults ranged from a low of 738 in 2011 to a high of 17,197 in 2007, with an average of 6,298. The population subsists in large part due to agency-managed cold water releases from Shasta Reservoir during the summer and artificial propagation from Livingston Stone National Fish Hatchery's winter-run Chinook salmon conservation program. Winter-run Chinook salmon are dependent on sufficient cold water storage in Shasta Reservoir, and it has long been recognized that a prolonged drought could have devastating impacts, possibly leading to the species' extinction. The probability of extended droughts is increasing as the effects of climate change continue(NMFS 2014b). In addition to the drought, another important threat to winter-run Chinook salmon is a lack of suitable rearing habitat in the Sacramento River and Delta to allow for sufficient juvenile growth and survival(NMFS 2016e).

Life history Winter-run Chinook salmon are unique because they spawn during summer months when air temperatures usually approach their yearly maximum. As a result, winter-run Chinook salmon require stream reaches with cold water sources that will protect embryos and juveniles from the warm ambient conditions in summer. Adult winter-run Chinook salmon immigration and holding (upstream spawning migration) through the Delta and into the lower Sacramento River occurs from December through July, with a peak during the period extending from January through April (Fish and Service 1995). Winter-run Chinook salmon are sexually immature when upstream migration begins, and they must hold for several months in suitable habitat prior to spawning. Spawning occurs between late-April and mid-August, with a peak in June and July as reported by California Department of Fish and Wildlife (CDFW) annual escapement surveys (2000-2006).

Winter-run Chinook salmon embryo incubation in the Sacramento River can extend into October (Vogel et al. 1988). Winter-run Chinook salmon fry rearing in the upper Sacramento River exhibit peak abundance during September, with fry and juvenile emigration past Red Bluff Diversion Dam (RBDD) primarily occurring from July through November (Poytress and Carrillo 2010; Poytress and Carrillo 2011; Poytress and Carrillo 2012). Emigration of winter-run Chinook salmon juveniles past Knights Landing, located approximately 155.5 river miles downstream of the RBDD, reportedly occurs between November and March, peaking in December, with some emigration continuing through May in some years (Snider and Titus 2000).

Juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Healey et al. 1991). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson et al. 1982; MacFarlane and Norton 2002). Upon reaching the ocean, juvenile Chinook salmon feed voraciously on larval and juvenile fishes, plankton, and terrestrial insects (Healey et al. 1991; MacFarlane and Norton 2002). Chinook salmon grow rapidly in the ocean environment, with growth rates dependent on water temperatures and food availability.

Table 26. Temporal distribution of Chinook salmon, Sacramento winter-run ESU

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="6">Present</td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Spawning</td><td></td><td></td><td></td><td colspan="5">Present</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td></td><td></td><td></td><td colspan="6">Present</td><td></td><td></td><td></td></tr>
<tr><td>Emergence (alevin to fry phases</td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Present</td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td colspan="5">Present</td></tr>
</table>

Population Dynamics

Abundance Over the last 10 years of available data (2003-2013), the abundance of spawning winter-run Chinook adults ranged from a low of 738 in 2011 to a high of 17,197 in 2007, with an average of 6,298 (***Figure 9***).

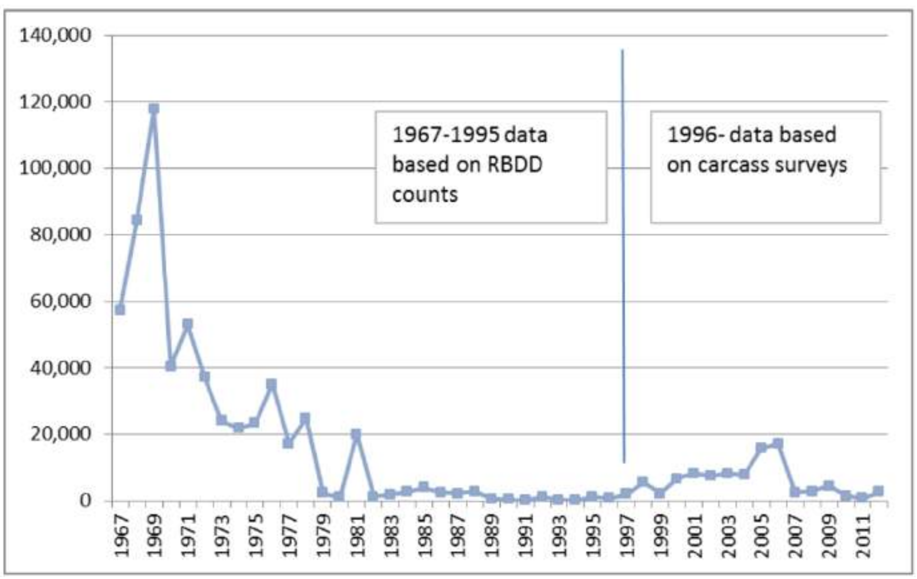

Figure 9. Estimated Sacramento River winter-run Chinook salmon run size (1967-2012)

Productivity / Population Growth Rate The population declined from an escapement of near 100,000 in the late 1960s to fewer than 200 in the early 1990s (Good et al. 2005a). More recent population estimates of 8,218 (2004), 15,730 (2005), and 17,153 (2006) show a three-year average of 13,700 returning winter-run Chinook salmon (CDFW Website 2007). However, the run size decreased to 2,542 in 2007 and 2,850 in 2008. Monitoring data indicated that approximately 5.6% of winter-run Chinook salmon eggs spawned in the Sacramento River in 2014 survived to the fry life stage (three to nearly 10 times lower than in previous years). The ongoing drought has made 2015 another challenging year for winter-run Chinook salmon (NMFS 2016e).

Genetic Diversity The rising proportion of hatchery fish among returning adults threatens to increase the risk of extinction. Lindley et al. (2007) recommend that in order to maintain a low risk of genetic introgression with hatchery fish, no more than five % of the naturally-spawning population should be composed of hatchery fish. Since 2001, hatchery origin winter-run Chinook salmon have made up more than five % of the run, and in 2005 the contribution of hatchery fish exceeded 18 % (Lindley et al. 2007).

Distribution The range of winter-run Chinook salmon has been greatly reduced by Keswick and Shasta dams on the Sacramento River and by hydroelectric development on Battle Creek. Currently, winter-run Chinook salmon spawning is limited to the main-stem Sacramento River between Keswick Dam (River Mile [RM] 302) and the RBDD (RM 243) where the naturally-spawning population is artificially maintained by cool water releases from the dams. Within the Sacramento River, the spatial distribution of spawners is largely governed by water year type and the ability of the Central Valley Project to manage water temperatures (NMFS 2014b).

Designated Critical Habitat NMFS designated critical habitat for the Sacramento winter-run Chinook on June 16, 1993 (58 FR 33212). It includes: the Sacramento River from Keswick Dam, Shasta County (river mile 302) to Chipps Island (river mile 0) at the westward margin of the Sacramento-San Joaquin Delta, and other specified estuarine waters**.** Physical and biological features that are essential for the conservation of Sacramento winter-run Chinook salmon, based on the best available information, include (1) access from the Pacific Ocean to appropriate spawning areas in the upper Sacramento River; (2) the availability of clean gravel for spawning substrate; (3) adequate river flows for successful spawning, incubation of eggs, fry development and emergence, and downstream transport of juveniles; (4) water temperatures between 42.5 and 57.5 °F (5.8 and 14.1 degrees Celsius (°C)) for successful spawning, egg incubation, and fry development; (5) habitat and adequate prey free of contaminants; (6) riparian habitat that provides for successful juvenile development and survival; and (7) access of juveniles downstream from the spawning grounds to San Francisco Bay and the Pacific Ocean (58 FR 33212).

The current condition of PBFs for the Sacramento River Winter-run Chinook salmon indicates that they are not currently functioning or are degraded. Their conditions are likely to maintain low population abundances across the ESU. Spawning and rearing PBFs are especially degraded by high water temperature caused by the loss of access to historic spawning areas in the upper watersheds where water maintain lower temperatures. The rearing PBF is further degraded by floodplain habitat disconnected from the mainstems of larger rivers throughout the Sacramento River watershed. The migration PBF is also degraded by the lack of natural cover along the migration corridors. Rearing and migration PBFs are further affected by pollutants entering the surface waters and riverine sediments as contaminated stormwater runoff, aerial drift and deposition, and via point source discharges. Juvenile migration is obstructed by water diversions along Sacramento River and by two large state and federal water-export facilities in the Sacramento-San Joaquin Delta.

Recovery Goals Recovery goals, objectives and criteria for the Sacramento River winter-run Chinook are fully outlined in the 2014 Recovery Plan (NMFS 2014b). In order to achieve the downlisting criteria, the species would need to be composed of two populations – one viable and one at moderate extinction risk. Having a second population would improve the species' viability, particularly through increased spatial structure and abundance, but further improvement would be needed to reach the goal of recovery. To delist winter-run Chinook salmon, three viable populations are needed. Thus, the downlisting criteria represent an initial key step along the path to recovering winter-run Chinook salmon.

Table 27. Summary of status; Chinook salmon, Sacramento winter-run ESU

Criteria	Description
Abundance / productivity trends	Only one small population, declining population trend hatchery-supported propagation, low genetic diversity
Listing status	Endangered
Attainment of recovery goals	Criteria not yet met
Condition of PBFs	Spawning and rearing PBFs are degraded by elevated temperatures and loss of habitat; Migration PBFs degraded by lack of natural cover and water diversions; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; The entire Sacramento river and delta are considered of high conservation value

9.10 Chinook salmon, Snake River fall-run

Table 28. Chinook salmon, Snake River fall-run ESU; overview table

Species	Common Name	Distinct Population Segments (DPS)	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus tshawytscha	Chinook Salmon	Snake River fall-run	Threatened	2011	2005 70 FR 37160 2014 79 FR 20802	Proposed 2015	1993 58 FR 68543

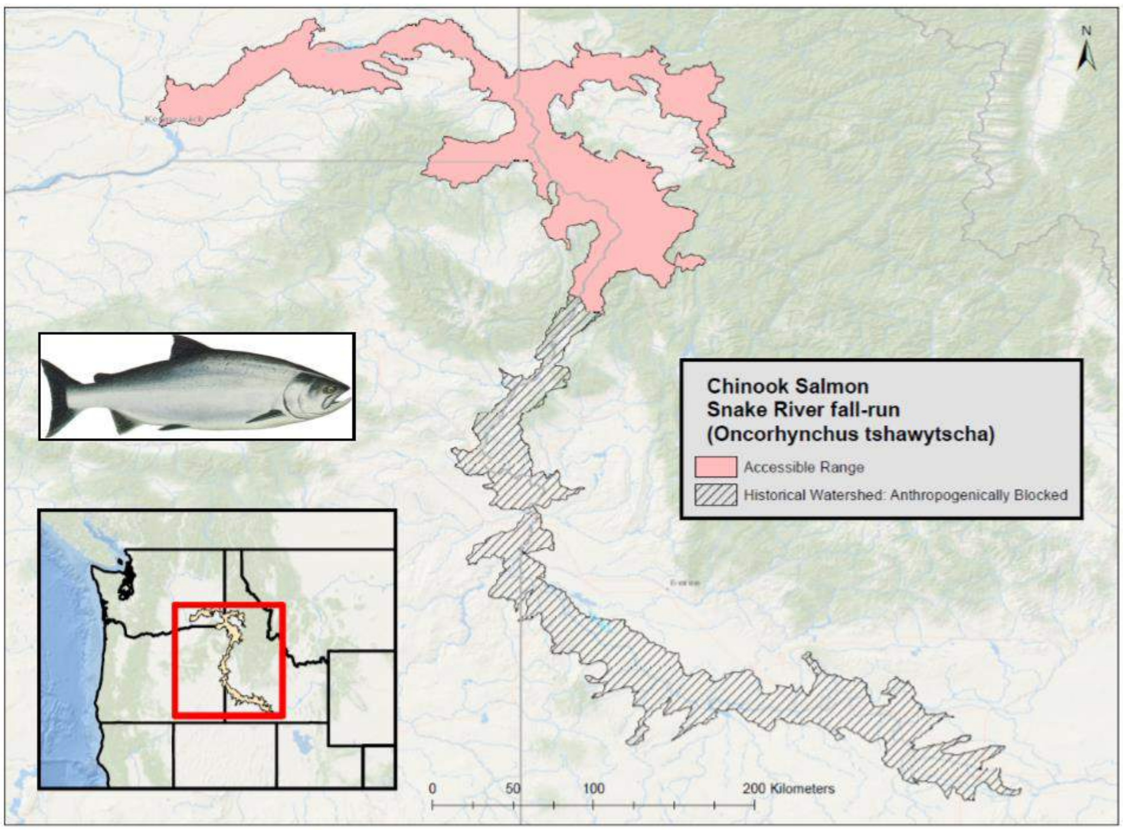

Figure 10. Chinook salmon, Snake River fall-run ESU range and designated critical habitat

Species Description Chinook salmon are the largest of the Pacific salmon. Spawning adults are olive to dark maroon in color, without conspicuous streaking or blotches on the sides. Spawning males are darker than females, and have a hooked jaw and slightly humped back. They can be distinguished from other spawning salmon by the color pattern, particularly the spotting on the back and tail, and by the dark, solid black gums of the lower jaw (Moyle 2002b). NMFS first listed Snake River fall Chinook salmon as a threatened species under the ESA on April 22, 1992 (57 FR 14658). NMFS reaffirmed the listing status in June 28, 2005 (70 FR 37160), and reaffirmed the status again in its 2014 (79 FR 20802). Snake River fall Chinook salmon historically spawned throughout the 600-mile reach of the mainstem Snake River from its mouth upstream to Shoshone Falls, a 212-foot high natural barrier near Twin Falls, Idaho (RM 614.7). The listed ESU currently includes all natural-origin fall-run Chinook salmon originating from the mainstem Snake River below Hells Canyon Dam (the lowest of three impassable dams that form the Hells Canyon Complex) and from the Tucannon River, Grande Ronde River, Imnaha River, Salmon River, and Clearwater River subbasins. The listed ESU also includes fall-run Chinook salmon from four artificial propagation programs (NMFS 2011; NMFS 2015).

Status As late as the late 1800s, approximately 408,500 to 536,180 fall Chinook salmon are believed to have returned annually to the Snake River. The run began to decline in the late 1800s and then continued to decline through the early and mid-1900s as a result of overfishing and other human activities, including the construction of major dams. Snake River fall Chinook salmon abundance has increased significantly since ESA listing in the 1990s. The overall current risk rating for the Lower Mainstem Snake River fall Chinook salmon population is viable (recovery plan). Nevertheless, while the number of natural-origin fall Chinook salmon has been high, substantial uncertainty remains about the status of the species' productivity and diversity. Threats posed by straying out-of-ESU hatchery fish have declined due to improved management. Still, large reaches of historical habitat remain blocked and inundated, and the mainstem Snake and Columbia River hydropower system, while less of a constraint than in the past, continues to cause juvenile and adult losses. The number of hatchery-origin fall Chinook salmon on the spawning grounds continues to threaten natural-origin fish productivity and genetic diversity. Further, the combined and relative effects of the different threats across the life cycle ─ including threats from climate change ─ remain poorly understood (NMFS 2011; NMFS 2015).

Life history Snake River fall-run Chinook return to the Columbia River in August and September, pass Bonneville Dam from mid-August to the end of September, and enter the Snake River between early September and mid-October (DART 2013). Once they reach the Snake River, fall Chinook salmon generally travel to one of five major spawning areas and spawn from late October through early December (Connor et al. 2014).

Upon emergence from the gravel, most young fall Chinook salmon move to shoreline riverine habitat (recovery plan). Some fall Chinook salmon smolts sustain active migration after passing Lower Granite Dam and enter the ocean as subyearlings, whereas some delay seaward migration and enter the ocean as yearlings (Connor et al. 2005; McMichael et al. 2008; NMFS 2015). Snake River fall Chinook salmon can be present in the estuary as juveniles in winter, as fry from March to May, and as fingerlings throughout the summer and fall (Fresh et al. 2005; Roegner et al. 2012; Teel et al. 2014).

Once in the Northern California Current, dispersal patterns differ for yearlings and subyearlings. Subyearlings migrate more slowly, are found closer to shore in shallower water, and do not disperse as far north as yearlings (Fisher et al. 2014; Sharma and Quinn 2012; Trudel et al. 2009; Tucker et al. 2011). Snake River basin fall Chinook salmon spend one to four years in the Pacific Ocean, depending on gender and age at the time of ocean entry (Connor et al. 2005).

Juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Healey et al. 1991). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items

(Kjelson et al. 1982; MacFarlane and Norton 2002). Upon reaching the ocean, juvenile Chinook salmon feed voraciously on larval and juvenile fishes, plankton, and terrestrial insects (Healey et al. 1991). Chinook salmon grow rapidly in the ocean environment, with growth rates dependent on water temperatures and food availability.

Table 29. Temporal distribution of Chinook salmon, Snake River fall-run ESU

Life History phase	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Entering Fresh Water (adults/jacks)								Present				
Spawning										Present		
Incubation (eggs)	Present									Present		
Emergence (alevin to fry phases	Present											Present
Rearing and migration (juveniles)	Present											

Population Dynamics

Abundance The naturally spawning fall Chinook salmon in the lower Snake River have included both returns originating from naturally spawning parents and from returning hatchery releases. The geometric mean natural-origin adult abundance for the most recent 10 years of annual spawner escapement estimates (2005-2014) is 6,418, with a standard error of 0.19 (NMFS 2015)

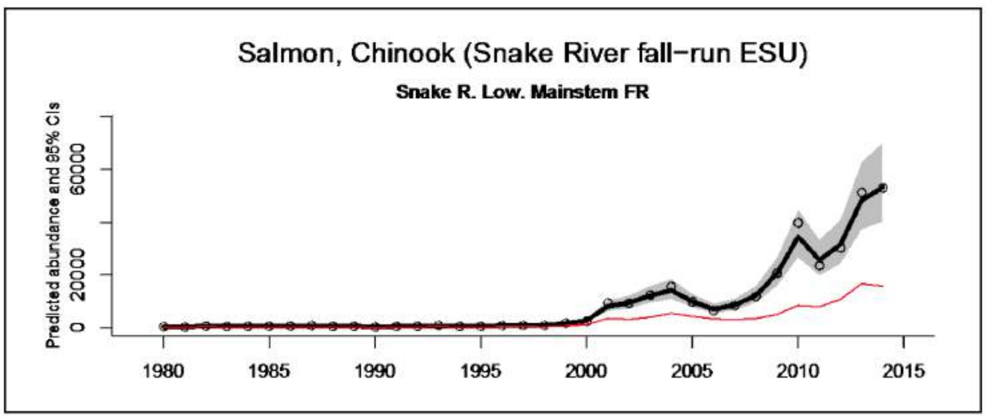

Figure 11. Smoothed trend in estimated total (thick black line) and natural (thin red line) population spawning abundance. Points show the annual spawning abundance estimates (from 2015 draft recovery plan).

Productivity / Population Growth Rate The current estimate of productivity for this population (1990-2009 brood years) is 1.53 with a standard error of 0.18. This estimate of productivity, however, may be problematic for two reasons: (1) the increasingly small number of years that actually contribute to the productivity estimate means that there is increasing statistical uncertainty surrounding that estimate, and (2) the years contributing to the estimate are now far in the past and may not accurately reflect the true productivity of the current population (NMFS 2015)

Genetic Diversity Genetic samples from the aggregate population in recent years indicate that composite genetic diversity is being maintained and that the Snake River Fall Chinook hatchery stock is similar to the natural component of the population, an indication that the actions taken to reduce the potential introgression of out-of-basin hatchery strays has been effective. Overall, the current genetic diversity of the population represents a change from historical conditions and, applying the Interior Columbia Technical Recovery Team (ICTRT) guidelines, the rating for this metric is moderate risk (NMFS 2015).

Distribution The extant Lower Snake River Fall Chinook salmon population consists of a spatially complex set of five historical major spawning areas (Cooney et al. 2007), each of which consists of a set of relatively discrete spawning patches of varying size. The primary Major spawning area (MaSA) in the extant Lower Mainstem Snake River population is the 96-km Upper Mainstem Snake River Reach, extending upriver from the confluence of the Salmon River to the Hells Canyon Dam site, where the canyon walls narrow and strongly confine the river bed. A second mainstem Snake River MaSA, the Lower Mainstem Snake River Reach, extends 69 km downstream from the Salmon River confluence to the upper end of the contemporary Lower Granite Dam pool. The lower mainstem reaches of two major tributaries to the mainstem Snake River, the Grande Ronde and the Clearwater Rivers, were also identified by the ICTRT as MaSAs. Both of these river systems currently support fall Chinook salmon spawning in the lower reaches. In addition, there is some historical evidence for production of late spawning Chinook salmon in spatially isolated reaches in upriver tributaries to each of these systems (NMFS 2015).

Designated Critical Habitat NMFS designated critical habitat for SR Fall-run Chinook salmon on December 28, 1993 (58 FR 68543). PBFs considered essential for the conservation of Chinook salmon, Snake River fall-run ESU are:

1. Juvenile rearing areas include adequate:
    - Spawning gravel
    - Water quality
    - Water quantity
    - Water temperature
    - Cover/shelter
    - Food
    - Riparian vegetation
    - Space

2. Juvenile and Adult migration corridors:
    - Substrate
    - Water quality
    - Water quantity
    - Water temperature
    - Water velocity
    - Cover/shelter
    - Food (juveniles only)
    - Riparian vegetation
    - Space
    - Safe passage conditions

The major degraded PBFs within critical habitat designated for SR Fall-run Chinook salmon include: (1) safe passage for juvenile migration which is reduced by the presence of the Snake and Columbia River hydropower system within the lower mainstem; (2) rearing habitat water quality altered by influx of contaminants and changing seasonal temperature regimes caused by water flow management; and (3) spawning/rearing habitat PBF attributes (spawning areas with gravel, water quality, cover/shelter, riparian vegetation, and space to support egg incubation and larval growth and development) that are reduced in quantity (80% loss) and quality due to the mainstem lower Snake River hydropower system.

Water quality impairments in the designated critical habitat are common within the range of this ESU. Pollutants such as petroleum products, pesticides, fertilizers, and sediment in the form of turbidity enter the surface waters and riverine sediments from the headwaters of the Snake, Salmon, and Clearwater Rivers to the Columbia River estuary; traveling along with contaminated stormwater runoff, aerial drift and deposition, and via point source discharges. Some contaminants such as mercury and pentachlorophenol enter the aquatic food web after reaching water and may be concentrated or even biomagnified in the salmon tissue. This species also requires migration corridors with adequate passage conditions (water quality and quantity available at specific times) to allow access to the various habitats required to complete their life cycle.

Recovery Goals Recovery goals, objectives and criteria for the Snake River fall-run Chinook are fully outlined in the 2015 Recovery Plan (NMFS 2015). ESA recovery goals should support conservation of natural fish and the ecosystems upon which they depend. Thus, the ESA recovery goal for Snake River fall Chinook salmon is that: the ecosystems upon which Snake River fall Chinook salmon depend are conserved such that the ESU is self-sustaining in the wild and no longer needs ESA protection.

Table 30. Summary of status; Chinook salmon, Snake River fall-run ESU

Criteria	Description
Abundance / productivity trends	Stable to increasing abundance trend, moderate extinction risk. Productivity of naturally spawned populations uncertain. Large proportion of hatchery-reared fish.
Listing status	Threatened
Attainment of recovery goals	Criteria not yet met
Condition of PBFs	Spawning, rearing and migration PBFs are degraded by loss of habitat, impaired stream flows, barriers to fish passage, and poor water quality; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; The entire river corridor is considered of high conservation value

9.11 Chinook salmon, Snake River spring/summer-run ESU

Table 31. Chinook salmon, Snake River spring/summer-run ESU; overview table

Species	Common Name	Distinct Population Segments (DPS)	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus tshawytscha	Chinook Salmon	Snake River Spring and Summer run	Threatened	2011	2005 70 FR 37160 2014 79 FR 20802	Proposed 2014	1999 64 FR 57399

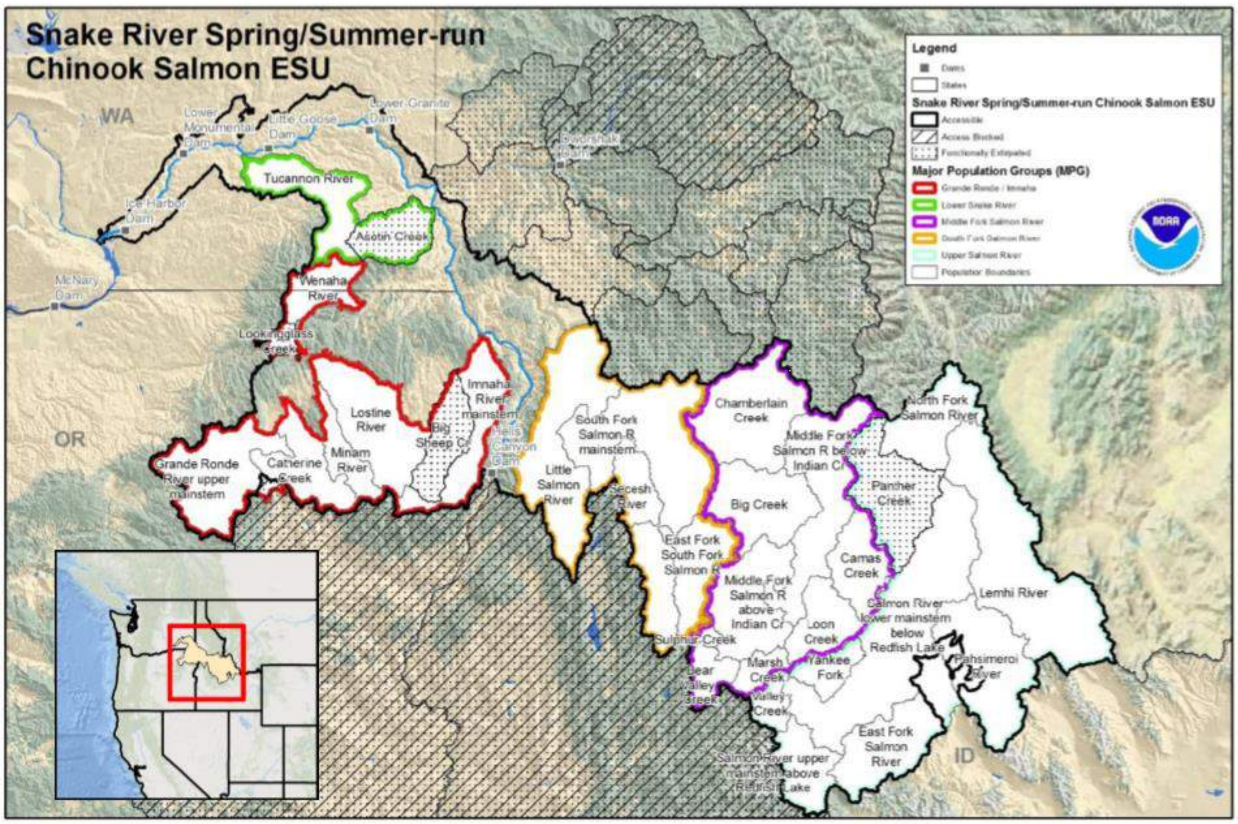

Figure 12. Chinook salmon, Snake River spring/summer-run ESU range and designated critical habitat

Species Description Chinook salmon are the largest of the Pacific salmon. Spawning adults are olive to dark maroon in color, without conspicuous streaking or blotches on the sides. Spawning males are darker than females, and have a hooked jaw and slightly humped back. They can be distinguished from other spawning salmon by the color pattern, particularly the spotting on the back and tail, and by the dark, solid black gums of the lower jaw (Moyle 2002b). Snake River spring/summer-run Chinook salmon, an ESU was listed as a threatened species under the ESA on April 22, 1992 (57 FR 14658). NMFS reaffirmed the listing on June 28, 2005 (70 FR 37160) and made minor technical corrections to the listing on April 14, 2014 (79 FR 20802). The Snake River spring/summer Chinook salmon ESU includes all naturally spawned populations of spring/summer Chinook salmon in the mainstem Snake River and the Tucannon River, Grand Ronde River, Imnaha River, and Salmon River subbasins as well as spring/summer Chinook salmon from 11 artificial propagation programs (NMFS 2016c).

Status The historical run of Chinook in the Snake River likely exceeded one million fish annually in the late 1800s, by the 1950s the run had declined to near 100,000 adults per year. The adult counts fluctuated throughout the 1980s but then declined further, reaching a low of 2,200 fish in 1995. Currently, the majority of extant spring/summer Chinook salmon populations in the Snake River spring/summer Chinook salmon ESU remain at high overall risk of extinction, with a low probability of persistence within 100 years. Factors cited in the 1991 status review as contributing to the species' decline since the late 1800s include overfishing, irrigation diversions, logging, mining, grazing, obstacles to migration, hydropower development, and questionable management practices and decisions (Matthews and Waples 1991). In addition, new threats ─ such as those posed by toxic contamination, increased predation by non-native species, and effects due to climate change ─ are emerging (NMFS 2016a).

Life history Adult spring-run Chinook salmon destined for the Snake River return to the Columbia River from the ocean in early spring and pass Bonneville Dam beginning in early March and ending May 31st. Snake River summer-run Chinook salmon return to the Columbia River from June through July. Adults from both runs hold in deep pools in the mainstem Columbia and Snake Rivers and the lower ends of the spawning tributaries until late summer, when they migrate into the higher elevation spawning reaches. Generally, Snake River spring-run Chinook salmon spawn in mid- through late August. Snake River summer-run Chinook salmon spawn approximately one month later than spring-run fish and tend to spawn lower in the tributary drainages, although their spawning areas often overlap with those of spring-run spawners

The eggs that Snake River spring and summer Chinook salmon deposit in late summer and early fall incubate over the following winter, and hatch in late winter and early spring. Juveniles rear through the summer, overwinter, and typically migrate to sea in the spring of their second year of life, although some juveniles may spend an additional year in fresh water. Depending on the tributary and the specific habitat conditions, juveniles may migrate extensively from natal reaches into alternative summer-rearing or overwintering areas. Most yearling fish are thought to spend relatively little time in the estuary compared to sub-yearling ocean-type fish however there is considerable variation in residence times in different habitats and in the timing of estuarine and ocean entry among individual fish (Holsman et al. 2012; McElhany et al. 2000a).

Snake River spring/summer-run Chinook salmon range over a large area in the northeast Pacific Ocean, including coastal areas off Washington, British Columbia, and southeast Alaska, the continental shelf off central British Columbia, and the Gulf of Alaska (NMFS 2016c). Most of the fish spend two or three years in the ocean before returning to tributary spawning grounds primarily as 4- and 5-year-old fish. A small fraction of the fish spend only one year in the ocean and return as 3-year-old "jacks," heavily predominated by males (Good et al. 2005a).

Juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Healey et al. 1991). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson et al. 1982; MacFarlane and Norton 2002). Upon reaching the ocean, juvenile Chinook salmon feed voraciously on larval and juvenile fishes, plankton, and terrestrial insects (Healey et al. 1991; MacFarlane and Norton 2002). Chinook salmon grow rapidly in the ocean environment, with growth rates dependent on water temperatures and food availability.

Table 32. Temporal distribution of Chinook salmon, Snake River spring/summer-run ESU

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td></td><td></td><td colspan="5">Present</td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>Incubation (eggs)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Present</td><td></td></tr>
<tr><td>Emergence (alevin to fry phases</td><td>Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance / Productivity

Lower Snake River Major Population Group (MPG): Abundance and productivity remain the major concern for the Tucannon River population. Natural spawning abundance (10-year geometric mean) has increased but remains well below the minimum abundance threshold for the single extant population in this MPG. Poor natural productivity continues to be a major concern.

Grande Ronde/Imnaha MPG: The Wenaha River, Lostine/Wallowa River and Minam River populations showed substantial increases in natural abundance relative to the previous ICTRT review, although each remains below their respective minimum abundance thresholds. The Catherine Creek and Upper Grande Ronde populations each remain in a critically depressed state. Geometric mean productivity estimates remain relatively low for all populations in the MPG.

South Fork Salmon River MPG: Natural spawning abundance (10-year geometric mean) estimates increased for the three populations with available data series. Productivity estimates for these populations are generally higher than estimates for populations in other MPGs within the ESU. Viability ratings based on the combined estimates of abundance and productivity remain at high risk, although the survival/capacity gaps relative to moderate and low risk viability curves are smaller than for other ESU populations.

Middle Fork Salmon River MPG: Natural-origin abundance and productivity remains extremely low for populations within this MPG. As in the previous ICTRT assessment, abundance and productivity estimates for Bear Valley Creek and Chamberlain Creek (limited data series) are the closest to meeting viability minimums among populations in the MPG.

Upper Salmon River MPG: Abundance and productivity estimates for most populations within this MPG remain at very low levels relative to viability objectives. The Upper Salmon Mainstem has the highest relative abundance and productivity combination of populations within the MPG.

Genetic Diversity / Spatial Structure

Lower Snake River MPG: The integrated spatial structure/diversity risk rating for the Lower Snake River MPG is moderate.

Grande Ronde/Imnaha MPG: The Upper Grande Ronde population is rated at high risk for spatial structure and diversity while the remaining populations are rated at moderate.

South Fork Salmon River MPG: Spatial structure/diversity risks are currently rated moderate for the South Fork Mainstem population (relatively high proportion of hatchery spawners) and low for the Secesh River and East Fork South Fork populations.

Middle Fork Salmon River MPG: Spatial structure/diversity risk ratings for Middle Fork Salmon River MPG populations are generally moderate. This primarily is driven by moderate ratings for genetic structure assigned by the ICTRT because of uncertainty arising from the lack of direct genetic samples from within the component populations.

Upper Salmon River MPG: Spatial structure/diversity risk ratings vary considerably across the Upper Salmon River MPG. Four of the eight populations are rated at low or moderate risk for overall spatial structure and diversity and could achieve viable status with improvements in average abundance/productivity. The high spatial structure/diversity risk rating for the Lemhi population is driven by a substantial loss of access to tributary spawning/rearing habitats and the associated reduction in life-history diversity. High risk ratings for Pahsimeroi River, East Fork Salmon River, and Yankee Fork Salmon River are driven by a combination of habitat loss and diversity concerns related to low natural abundance combined with chronically high proportions of hatchery spawners in natural areas.

Distribution The Snake River spring/summer Chinook salmon ESU includes all naturally spawned populations of spring/summer Chinook salmon in the mainstem Snake River and the Tucannon River, Grand Ronde River, Imnaha River, and Salmon River subbasins. The ESU is broken into five major population groups (MPG). Together, the MPGs contain 28 extant independent naturally spawning populations, three functionally extirpated populations, and one extirpated population. The Upper Salmon River MPG contains eight extant populations and one extirpated population. The Middle Fork Salmon River MPG contains nine extant populations. The South Fork Salmon River MPG contains four extant populations. The Grande Ronde/Imnaha Rivers MPG contains six extant populations, with two functionally extirpated populations. The Lower Snake River MPG contains one extant population and one functionally extirpated population. The South Fork and Middle Fork Salmon Rivers currently support most of the natural spring/summer Chinook salmon production in the Snake River drainage (NMFS 2016c).

Designated Critical Habitat Critical habitat for Snake River spring/summer Chinook salmon was designated on December 28, 1993 (58 FR 68543) and revised slightly on October 25, 1999 (64 FR 57399). PBFs considered essential for the conservation of Chinook salmon, Snake River spring/summer-run ESU are:

3. Juvenile rearing areas include adequate:
    - Spawning gravel
    - Water quality
    - Water quantity
    - Water temperature
    - Cover/shelter
    - Food
    - Riparian vegetation

- Space

4. Juvenile and Adult migration corridors:
   - Substrate
   - Water quality
   - Water quantity
   - Water temperature
   - Water velocity
   - Cover/shelter
   - Food (juveniles only)
   - Riparian vegetation
   - Space
   - Safe passage conditions

Spawning and juvenile rearing PBFs are regionally degraded by changes in flow quantity, water quality, and loss of cover. Juvenile and adult migrations are obstructed by reduced access that has resulted from altered flow regimes from hydroelectric dams. According to the ICBTRT, the Panther Creek population was extirpated because of legacy and modern mining-related pollutants creating a chemical barrier to fish passage (Chapman and Julius 2005).

Presence of cool water that is relatively free of contaminants is particularly important for the spring/summer run life history as adults hold over the summer and juveniles may rear for a whole year in the river. Water quality impairments are common in the range of the critical habitat designated for this ESU. Pollutants such as petroleum products, pesticides, fertilizers, and sediment in the form of turbidity enter the surface waters and riverine bottom substrate from the headwaters of the Snake, Salmon, and Clearwater Rivers to the Columbia River estuary as contaminated stormwater runoff, aerial drift and deposition, and via point source discharges. Some contaminants such as mercury and pentachlorophenol enter the aquatic food web after reaching water and may be concentrated or even biomagnified in the salmon tissue. This species also requires migration corridors with adequate passage conditions (water quality and quantity available at specific times) to allow access to the various habitats required to complete their life cycle.

Recovery Goals Recovery goals, scenarios and criteria for the Snake River spring and summer-run Chinook salmon are fully outlined in the 2016 proposed recovery plan (NMFS 2016c). The status levels targeted for populations within an ESU or DPS are referred to collectively as the "recovery scenario" for the ESU or DPS. NMFS has incorporated the viability criteria into viable recovery scenarios for each Snake River spring/summer Chinook salmon and steelhead MPG. The criteria should be met for an MPG to be considered Viable, or low (5% or less) risk of extinction, and thus contribute to the larger objective of ESU or DPS viability. These criteria are:

- At least one-half the populations historically present (minimum of two populations) should meet viability criteria (5% or less risk of extinction over 100 years).

- At least one population should be highly viable (less than 1% risk of extinction).

- Viable populations within an MPG should include some populations classified as "Very Large'" or "Large," and "Intermediate" reflecting proportions historically present.

- All major life history strategies historically present should be represented among the populations that meet viability criteria.
- Remaining populations within an MPG should be maintained (25% or less risk of extinction) with sufficient abundance, productivity, spatial structure, and diversity to provide for ecological functions and to preserve options for ESU or DPS recovery.
- For MPGs with only one population, this population must be highly viable (less than 1% risk of extinction).

Table 33. Summary of status; Chinook salmon, Snake River spring/summer-run ESU

Criteria	Description
Abundance / productivity trends	Low abundances, high risk of extinction. Poor natural productivity with unknown rates. Several Salmon River populations have higher abundances, but still well below recovery criteria. Moderate genetic diversity.
Listing status	Threatened
Attainment of recovery goals	Criteria not yet met
Condition of PBFs	Spawning, rearing and migration PBFs are degraded by loss of habitat, altered stream flows, barriers to fish passage, dams, loss of cover, and poor water quality; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; The entire river corridor is considered of high conservation value

9.12 Chinook salmon, Upper Columbia River spring-run ESU

Table 34. Chinook salmon, Upper Columbia River spring-run ESU; overview table

Species	Common Name	Distinct Population Segment	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus tshawytscha	Chinook salmon	Upper Columbia River spring-run ESU	Endangered	2016	70 FR 37160	2007	70 FR 52630

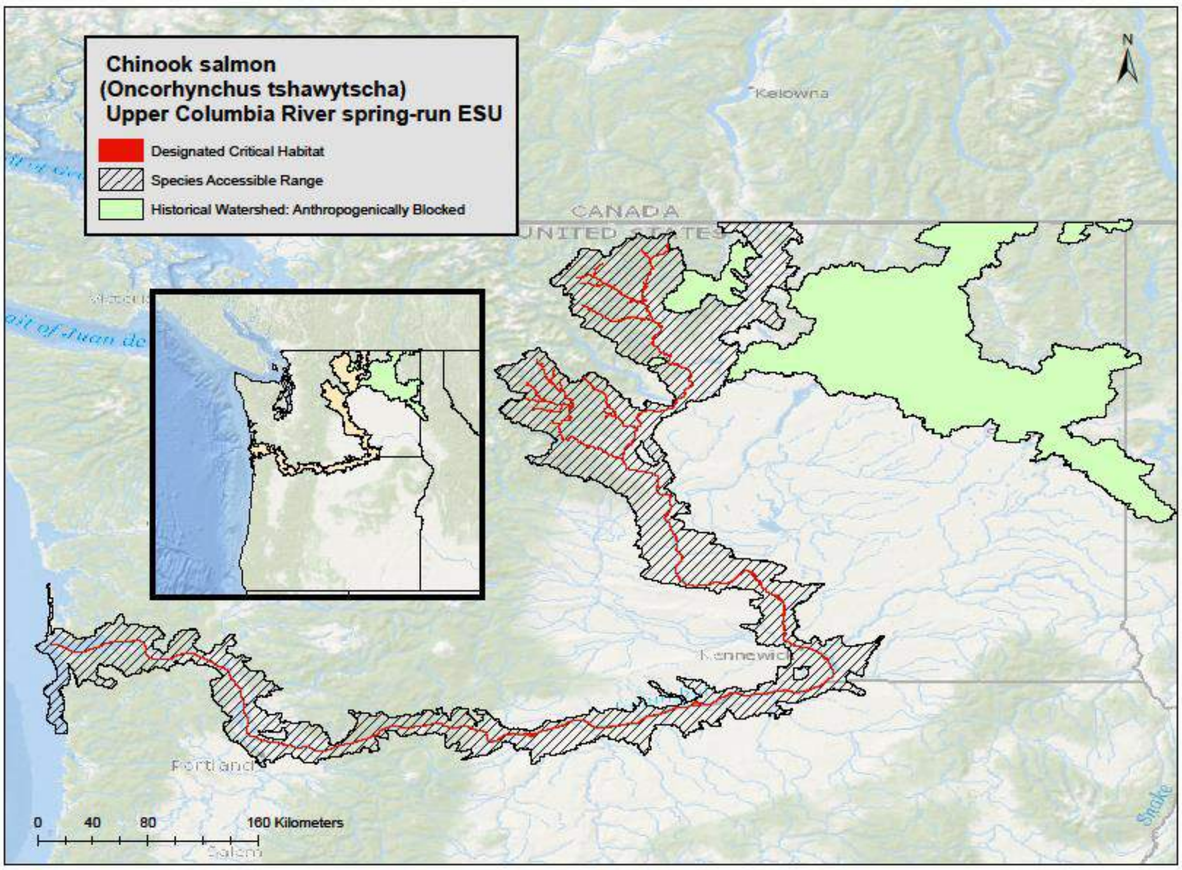

Figure 13. Chinook salmon, Upper Columbia River spring-run ESU range and designated critical habitat

Species Description Chinook salmon are the largest of the Pacific salmon. Spawning adults are olive to dark maroon in color, without conspicuous streaking or blotches on the sides. Spawning males are darker than females, and have a hooked jaw and slightly humped back. They can be distinguished from other spawning salmon by the color pattern, particularly the spotting on the back and tail, and by the dark, solid black gums of the lower jaw (Moyle 2002b). Upper Columbia River spring-run Chinook salmon, an ESU was listed as an endangered species under the ESA on March 24, 1999 (64 FR 14308). NMFS reaffirmed the listing on June 28, 2005 (70 FR 37160). The Snake River spring/summer Chinook salmon ESU includes all naturally spawned populations of spring/summer Chinook salmon in the mainstem Snake River and the Tucannon River, Grand Ronde River, Imnaha River, and Salmon River subbasins as well as spring/summer Chinook salmon from 11 artificial propagation programs (NMFS 2016c). This ESU includes naturally spawned spring-run Chinook salmon originating from Columbia River tributaries upstream of the Rock Island Dam and downstream of Chief Joseph Dam (excluding the Okanogan River subbasin). Also, spring-run Chinook salmon from six artificial propagation programs.

Status The Upper Columbia spring Chinook ESU includes three extant populations (Wenatchee, Entiat, and Methow), as well as one extinct population in the Okanogan subbasin (ICBTRT 2003). All three populations continued to be rated at low risk for spatial structure but at high risk for diversity criteria. Large-scale supplementation efforts in the Methow and Wenatchee Rivers are ongoing, intended to counter short-term demographic risks given current average survival levels and the associated year-to-year variability. Under the current recovery plan, habitat protection and restoration actions are being implemented that are directed at key limiting factors. Although the status of the ESU is improved relative to measures available at the time of listing, all three populations remain at high risk (NWFSC 2015).

Life history Adult Spring Chinook in the Upper Columbia Basin begin returning from the ocean in the early spring, with the run into the Columbia River peaking in mid-May. Spring Chinook enter the Upper Columbia tributaries from April through July. After migration, they hold in freshwater tributaries until spawning occurs in the late summer, peaking in mid to late August. Juvenile spring Chinook spend a year in freshwater before migrating to salt water in the spring of their second year of life. Most Upper Columbia spring Chinook return as adults after two or three years in the ocean. Some precocious males, or jacks, return after one winter at sea. A few other males mature sexually in freshwater without migrating to the sea. However, four and five year old fish that have spent two and three years at sea, respectively, dominate the run. Fecundity ranges from 4,200 to 5,900 eggs, depending on the age and size of the female.

Juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Healey et al. 1991). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson et al. 1982; MacFarlane and Norton 2002). Upon reaching the ocean, juvenile Chinook salmon feed voraciously on larval and juvenile fishes, plankton, and terrestrial insects (Healey et al. 1991; MacFarlane and Norton 2002). Chinook salmon grow rapidly in the ocean environment, with growth rates dependent on water temperatures and food availability.

Table 35. Temporal distribution of Chinook salmon, Upper Columbia River spring-run ESU

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td></td><td></td><td colspan="7">Present</td><td></td><td></td><td></td></tr>
<tr><td>Spawning</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td><td></td><td></td><td></td></tr>
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<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance For all populations, average abundance over the recent 10-year period is below the average abundance thresholds that the ICTRT identifies as a minimum for low risk (ICTRT 2008a; ICTRT 2008b; ICTRT 2008c). The geometric mean spawning escapements from 1997 to 2001 were 273 for the Wenatchee population, 65 for the Entiat population, and 282 for the Methow population. These numbers represent only 8% to 15% of the minimum abundance thresholds. The five-year geometric mean remained low as of 2003.

Productivity / Population Growth Rate Based on 1980-2004 returns, the lambda for this ESU is estimated at 0.93 (meaning the population is not replacing itself) (Fisher and Hinrichsen 2006). The long-term trend for abundance and lambda for individual populations indicate a decline for all three populations (Good et al. 2005b). Short-term lambda values indicate an increasing trend for the Methow population, but not for the Wenatchee and Entiat populations (ICTRT 2008a; ICTRT 2008b; ICTRT 2008c).

Genetic Diversity The ICTRT characterizes the diversity risk to all Upper Columbia River (UCR) Spring-run Chinook populations as "high". The high risk is a result of reduced genetic diversity from homogenization of populations that occurred under the Grand Coulee Fish Maintenance Project in 1939-1943.

Distribution Spring Chinook currently spawn and rear in the upper main Wenatchee River upstream from the mouth of the Chiwawa River, overlapping with summer Chinook in that area (Peven 1994). The primary spawning areas of spring Chinook in the Wenatchee subbasin include Nason Creek and the Chiwawa, Little Wenatchee, and White rivers. Hamstreet and Carie (2003) described the current spawning distribution for spring Chinook in the Entiat subbasin as the Entiat River (river mile 16.2 to 28.9) and the Mad River (river mile 32 1.5-5.0). Spring Chinook of the Methow population currently spawn in the mainstem Methow River and the Twisp, Chewuch, and 5 Lost drainages (Scribner et al. 1993; Humling and Snow 2004). A few also spawn in Gold, Wolf, 6 and Early Winters creeks.

Designated Critical Habitat NMFS designated critical habitat for Upper Columbia River Spring-run Chinook salmon on September 2, 2005 (70 FR 52630). It includes all Columbia River estuarine areas and river reaches proceeding upstream to Chief Joseph Dam and several tributary subbasins. PBFs considered essential for the conservation of Chinook salmon, Upper Columbia River spring-run ESU are:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development;
- Freshwater rearing sites with:
    - Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility;
    - Water quality and forage supporting juvenile development;
    - Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
- Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival;
- Estuarine areas free of obstruction and excessive predation with:

- Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh & saltwater;
    - Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels;
    - Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.
- Nearshore marine areas free of obstruction and excessive predation with:
    - Water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and
    - Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.
- Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

Spawning and rearing PBFs are somewhat degraded in tributary systems by urbanization in lower reaches, grazing in the middle reaches, and irrigation and diversion in the major upper drainages. These activities have resulted in excess erosion of fine sediment and silt that smother spawning gravel; reduction in flow quantity necessary for successful incubation, formation of physical rearing conditions, and juvenile mobility. Moreover siltation further affects critical habitat by reducing water quality through contaminated agricultural runoff; and removing natural cover. Adult and juvenile migration PBFs are heavily degraded by Columbia River Federal dam projects and a number of mid-Columbia River Public Utility District dam projects also obstruct the migration corridor.

Recovery Goals Recovery goals, objectives and detailed criteria for the Central Valley spring-run Chinook are fully outlined in the 2016 Recovery Plan. The general recovery objectives are:

- Increase the abundance of naturally produced spring Chinook spawners within each population in the Upper Columbia ESU to levels considered viable.
- Productivity 21 Increase the productivity (spawner:spawner ratios and smolts/redds) of naturally produced spring Chinook within each population to levels that result in low risk of extinction.
- Restore the distribution of naturally produced spring Chinook to previously occupied areas (where practical) and allow natural patterns of genetic and phenotypic diversity to be expressed.

Table 36. Summary of status; Chinook salmon, Upper Columbia River spring-run ESU

Criteria	**Description**
Abundance / productivity trends	All populations have low abundance and the long-term trend in growth rate of the ESU is declining (the population is not replacing itself).
Listing status	Endangered
Attainment of recovery goals	Criteria not yet met
Condition of PBFs	Spawning and rearing PBFs are degraded by urbanization and irrigation water diversions; Migration PBFs degraded by

	numerous dams; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of occupied watersheds, 26 are of high and 5 are of medium conservation value

9.13 Chinook salmon, Upper Willamette River ESU

Table 37. Chinook salmon, Upper Willamette River ESU; overview table

Species	Common Name	Distinct Population Segment	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus tshawytscha	Chinook salmon	Upper Willamette River ESU	Threatened	2016	70 FR 37160	2011	70 FR 52630

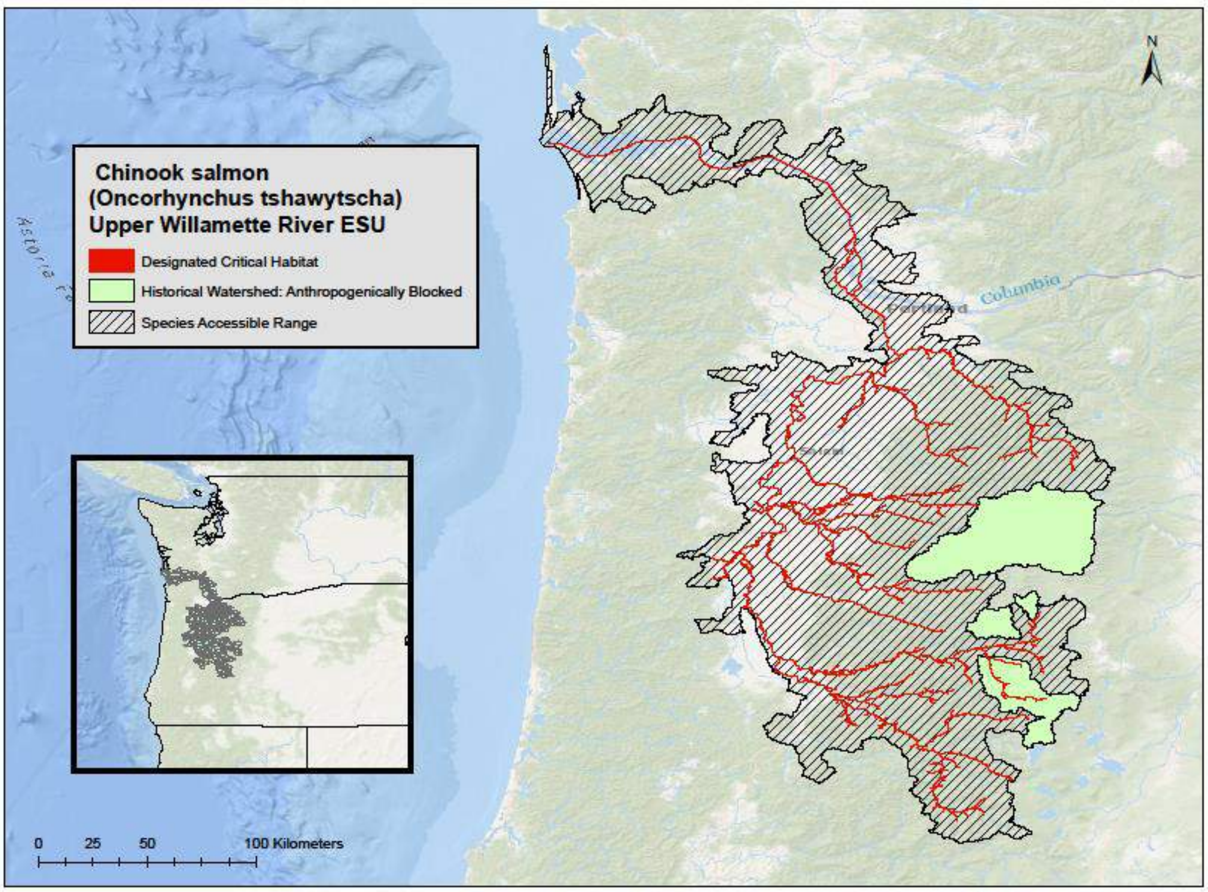

Figure 14. Chinook salmon, Upper Willamette River ESU range and designated critical habitat

Species Description Chinook salmon are the largest of the Pacific salmon. Spawning adults are olive to dark maroon in color, without conspicuous streaking or blotches on the sides. Spawning males are darker than females, and have a hooked jaw and slightly humped back. They can be distinguished from other spawning salmon by the color pattern, particularly the spotting on the back and tail, and by the dark, solid black gums of the lower jaw (Moyle 2002b). Upper Willamette River Chinook salmon, an ESU was listed as an endangered species under the ESA on March 24, 1999 (64 FR 14308). NMFS reaffirmed the listing on June 28, 2005 (70 FR 37160). This ESU includes naturally spawned spring-run Chinook salmon originating from the

Clackamas River and from the Willamette River and its tributaries above Willamette Falls. Also, spring-run Chinook salmon from six artificial propagation programs.

Status The Upper Willamette River Chinook ESU is considered to be extremely depressed, likely numbering less than 10,000 fish compared to a historical abundance estimate of 300,000 (Myers et al. 2003). There are seven demographically independent populations of spring-run Chinook salmon in the Upper Willamette River (UWR) Chinook salmon ESU: Clackamas, Molalla, North Santiam, South Santiam, Calapooia, McKenzie, and the Middle Fork Willamette (Myers et al. 2006). Currently, significant natural production occurs in only the Clackamas and McKenzie populations (McElhany et al. 2007). Juvenile spring Chinook produced by hatchery programs are released throughout many of the subbasins and adult Chinook returns to the ESU are typically 80-90% hatchery origin fish. Access to historical spawning and rearing areas is restricted by large dams in the four historically most productive tributaries, and in the absence of effective passage programs will continue to be confined to more lowland reaches where land development, water temperatures, and water quality may be limiting. Pre-spawning mortality levels are generally high in the lower tributary reaches where water temperatures and fish densities are generally the highest.

Life history Upper Willamette River Chinook salmon exhibit an earlier time of entry into the Columbia River than other spring-run Chinook salmon ESUs (Myers et al. 1998b). Adults appear in the lower Willamette River in February, but the majority of the run ascends Willamette Falls in April and May, with a peak in mid- to late May. However, present-day salmon ascend the Willamette Falls via a fish ladder. Consequently, the migration of spring Chinook salmon over Willamette Falls extends into July and August (overlapping with the beginning of the introduced fall-run of Chinook salmon).

The adults hold in deep pools over summer and spawn in late fall or early winter when winter storms augments river flows. Fry may emerge from February to March and sometimes as late as June (Myers et al. 2006). Juvenile migration varies with three distinct juvenile emigration "runs": fry migration in late winter and early spring; sub-yearling (0 yr +) migration in fall to early winter; and yearlings (1 yr +) migrating in late winter to spring. Sub-yearlings and yearlings rear in the mainstem Willamette River where they also use floodplain wetlands in the lower Willamette River during the winter-spring floodplain inundation period.

Juvenile Chinook salmon forage in shallow areas with protective cover, such as tidally influenced sandy beaches and vegetated zones (Healey et al. 1991). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson et al. 1982; MacFarlane and Norton 2002). Upon reaching the ocean, juvenile Chinook salmon feed voraciously on larval and juvenile fishes, plankton, and terrestrial insects (Healey et al. 1991; MacFarlane and Norton 2002). Chinook salmon grow rapidly in the ocean environment, with growth rates dependent on water temperatures and food availability.

Table 38. Temporal distribution of Chinook salmon, Upper Willamette River ESU

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
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<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance The UWR Chinook ESU is considered to be extremely depressed, likely numbering less than 10,000 fish compared to a historical abundance estimate of 300,000 (Myers et al. 2003). Currently, significant natural production occurs in only the Clackamas and McKenzie populations (McElhany et al. 2007).

Table 39. Upper Willamette River Chinook salmon independent populations core (C) and genetic legacy (G) populations and hatchery contributions (Good et al. 2005).

Functionally Independent Populations	Historical Abundance	Most Recent Spawner Abundance	Hatchery Abundance Contributions
Clackamas River (C)	Unknown	2,910	64%
Molalla River	Unknown	52 redds	>93%
North Santiam River (C)	Unknown	~ 7.1 rpm	>95%
South Santiam River	Unknown	982 redds	>84%
Calapooia River	Unknown	16 redds	100%
McKenzie River (C,G)	Unknown	~2,470	26%
Middle Fork Willamette River (C)	Unknown	235 redds	>39%
Total	>70,000	~9,700	Mostly hatchery

Productivity / Population Growth Rate The spring Chinook salmon in the McKenzie River is the only remaining self-sustaining naturally reproducing independent population. The other natural-origin populations in this ESU have very low current abundances, and long- and short-term population trends are negative.

Genetic Diversity Access of fall-run Chinook salmon to the upper Willamette River and the mixing of hatchery stocks within the ESU have threatened the genetic integrity and diversity of the species. Much of the genetic diversity that existed between populations has been homogenized (Myers et al. 2006).

Distribution Radio-tagging results from 2014 suggest that few fish strayed into west-side tributaries (no detections) and relatively fewer fish were unaccounted for between Willamette Falls and the tributaries, 12.9% of clipped fish and 5.3% of unclipped fish (Jepson et al. 2015). In contrast to most of the other populations in this ESU, McKenzie River Chinook salmon have access to much of their historical spawning habitat, although access to historically high quality habitat above Cougar Dam (South Fork McKenzie River) is still limited by poor downstream juvenile passage. Similarly, natural-origin returns to the Clackamas River have remained flat, despite adults having access to much of their historical spawning habitat. Although returning adults have access to most of the Calapooia and Molalla basin, habitat conditions are such that the productivity of these systems is very low. Natural-origin spawners in the Middle Fork Willamette River in the last 10 years consisted solely of adults returning to Fall Creek. While these fish contribute to the Demographically Independent Populations (DIP) and ESU, at best the contribution will be minor. Finally, improvements were noted in the North and South Santiam DIPs. The increase in abundance in both DIPs was in contrast to the other DIPs and the counts at Willamette Falls. While spring-run Chinook salmon in the South Santiam DIP have access to some of their historical spawning habitat, natural origin spawners in the North Santiam are still confined to below Detroit Dam and subject to relatively high prespawning mortality rates (NWFSC 2015).

Designated Critical Habitat NMFS designated critical habitat for this species on September 2, 2005 (70 FR 52630). Designated critical habitat includes all Columbia River estuarine areas and river reaches proceeding upstream to the confluence with the Willamette River as well as specific stream reaches in a number of subbasins. PBFs considered essential for the conservation of Chinook salmon, Upper Willamette River ESU are:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development;
- Freshwater rearing sites with:
  - Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility;
  - Water quality and forage supporting juvenile development;
  - Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
- Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival;
- Estuarine areas free of obstruction and excessive predation with:
  - Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh & saltwater;
  - Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels;
  - Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.
- Nearshore marine areas free of obstruction and excessive predation with:
  - Water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and
  - Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.
- Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation

The current condition of PBFs of the UWR Chinook salmon critical habitat indicates that migration and rearing PBFs are not currently functioning or are degraded. These conditions impact their ability to serve their intended role for species conservation. The migration PBF is degraded by dams altering migration timing and water management altering the water quantity necessary for mobility and survival. Migration, rearing, and estuary PBFs are also degraded by loss of riparian vegetation and instream cover. Pollutants such as petroleum products, fertilizers, pesticides, and fine sediment enter the stream through runoff, point source discharge, drift during application, and non-point discharge where agricultural and urban development occurs. Degraded water quality in the lower Willamette River where important floodplain rearing habitat is present affects the ability of this habitat to sustain its role to conserve the species.

Recovery Goals Recovery goals, objectives and detailed criteria for the Upper Willamette River Chinook are fully outlined in the 2011 Recovery Plan. The 2011 recovery plan outlines five potential scenario options for meeting the viability criteria for recovery. Of the five scenarios, scenario 1 reportedly represented the most balanced approach given limitations in some populations. The approach in this Plan to achieve ESU delisting of UWR Chinook salmon is to recover the McKenzie (core and genetic legacy population) and the Clackamas populations to an extinction risk status of very low risk (beyond minimal viability thresholds), to recover the North Santiam and Middle Fork Willamette populations (core populations) to an extinction risk status of low risk, to recover the South Santiam population to moderate risk, and improve the status of the remaining populations from very high risk to high risk.

Table 40. Summary of status; Chinook salmon, Upper Willamette River ESU

Criteria	**Description**
Abundance / productivity trends	Only one of seven remaining naturally reproducing independent populations. Unknown historical abundance. Declining trends with a high hatchery-produced fraction.
Listing status	Threatened
Attainment of recovery goals	Criteria not yet met
Condition of PBFs	Migration, rearing, and estuary PBFs are degraded by dams, water management, loss of riparian vegetation, and quality of floodplain habitat; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of 59 assessed watersheds, 22 are of high and 18 are of medium conservation value

9.14 Coho salmon, Central California Coast ESU

Table 41. Coho salmon, central California coast ESU; overview table

Species	Common Name	ESU	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus kisutch	**Coho salmon**	**Central California Coast**	**Endangered**	2016	70 FR 37160	2012	64 FR 24049

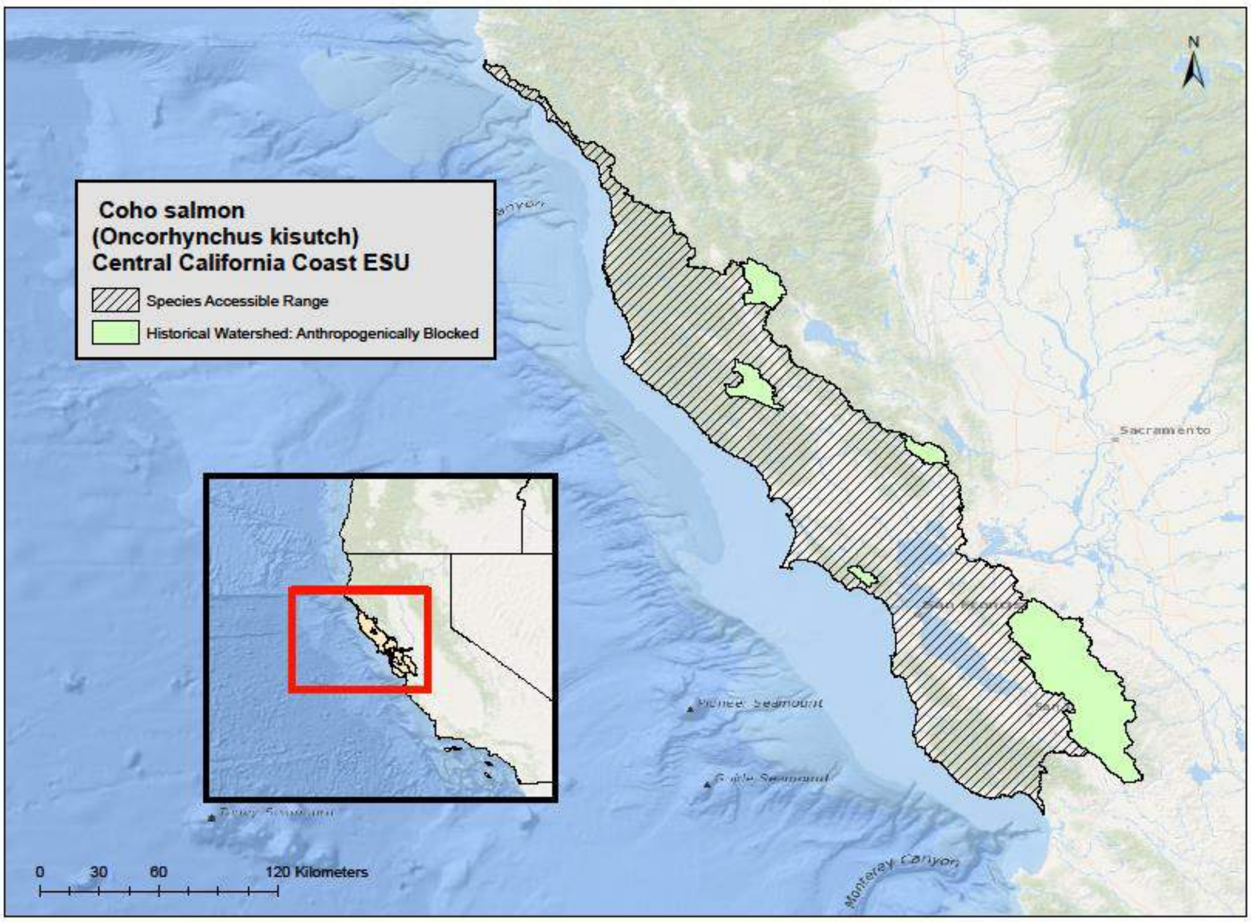

Figure 15. Coho salmon, central California coast ESU range

Species Description Coho salmon are an anadromous species (i.e., adults migrate from marine to freshwater streams and rivers to spawn). Adult coho salmon are typically about two feet long and eight pounds. Coho have backs that are metallic blue or green, silver sides, and light bellies; spawners are dark with reddish sides; and when coho salmon are in the ocean, they have small black spots on the back and upper portion of the tail. Central California coast coho salmon, an ESU was listed as threatened under the ESA on October 31, 1996 (64 FR 56138). NMFS re-classified the ESU as endangered on June 28, 2005 (70 FR 37160). This ESU includes naturally spawned coho salmon originating from rivers south of Punta Gorda, California to and including

Aptos Creek, as well as such coho salmon originating from tributaries to San Francisco Bay. Also, coho salmon from three artificial propagation programs.

Status The low survival of juveniles in freshwater, in combination with poor ocean conditions, has led to the precipitous declines of Central California Coast (CCC) coho salmon populations. Most independent CCC coho salmon populations remain at critically low levels, with those in the southern Santa Cruz Mountains strata likely extirpated. Data suggests some populations show a slight positive trend in annual escapement, but the improvement is not statistically significant. Overall, all CCC coho salmon populations remain, at best, a slight fraction of their recovery target levels, and, aside from the Santa Cruz Mountains strata, the continued extirpation of dependent populations continues to threaten the ESU's future survival and recovery. The evaluation of current habitat conditions and ongoing and future threats led to the conclusion that summer and winter rearing survival are very low due to impaired instream habitats. These impairments were due to a lack of complexity formed by instream wood, high sediment loads, lack of refugia habitats during winter, low summer flows and high instream temperatures. Additionally, populations throughout the ESU, but particularly at the southern end of the range, are likely to be significantly impacted by climate change in the future (NMFS 2012).

Life history Central California Coast coho salmon typically enter freshwater from November through January, and spawn into February or early March (Moyle 2002a). The upstream migration towards spawning areas coincides with large increases in stream flow (Hassler 1987). Coho salmon often are not able to enter freshwater until heavy rains have caused breaching of sand bars that form at the mouths of many coastal California streams. Spawning occurs in streams with direct flow to the ocean, or in large river tributaries (Moyle 2002b). Female coho salmon choose a site to spawn at the head of a riffle, just downstream of a pool where water flow changes from slow to turbulent, and where medium to small size gravel is abundant (Moyle 2002b).

Eggs incubate in redds from November through April, and hatch into "alevins" after a period of 35-50 days (Shapovalov and Taft 1954b). The period of incubation is inversely related to water temperature. Alevins remain in the gravel for two to ten weeks then emerge into the water column as young juveniles, known as "fry". Juveniles, or fry, form schools in shallow water along the undercut banks of the stream to avoid predation. The juveniles feed heavily during this time, and as they grow they set up individual territories. Juveniles are voracious feeders, ingesting any organism that moves or drifts over their holding area. The juvenile's diet is mainly aquatic insect larvae and terrestrial insects, but small fish are taken when available (Moyle 2002a).

After one year in freshwater juvenile coho salmon undergo physiological transformation into "smolts" for outmigration to the ocean. Smolts may spend time residing in the estuarine habitat prior to ocean entry, to allow for the transition to the saline environment. After entering the ocean, the immature salmon initially remain in the nearshore waters close to their natal stream. They gradually move northward, generally staying over the continental shelf (Brown et al. 1994). After approximately two years at sea, adult coho salmon move slowly homeward. Adults begin their freshwater migration upstream after heavy fall or winter rains breach the sandbars at the mouths of coastal streams (Sandercock 1991) and/or flows are sufficient to reach upstream spawning areas.

Table 42. Temporal distribution of Coho salmon, central California coast ESU

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Spawning</td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Incubation (eggs)</td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Present</td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Present</td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance Limited information exists on abundance of coho salmon within the CCC coho salmon ESU. About 200,000 to 500,000 coho salmon were produced statewide in the 1940s (Good et al. 2005b). This escapement declined to about 99,000 by the 1960s with approximately 56,000 (56%) originating from streams within the CCC coho salmon ESU. The estimated number of coho salmon produced within the ESU in 2011 was between 2,000 and 3,000 wild adults (Gallagher et al. 2010).

Productivity / Population Growth Rate Within the Lost Coast – Navarro Point stratum, current population sizes range from 4% to 12% of proposed recovery targets, with two populations (Albion River and Big River, respectively) at or below their high-risk depensation thresholds. Most independent populations show positive but non-significant population trends. Dependent populations within the stratum have declined significantly since 2011. Similar results were obtained immediately south within the Navarro Point – Gualala Point stratum, where two of the three largest independent populations, the Navarro and Garcia rivers, have averaged 257 and 46 adult returns, respectively, during the past six years (both populations are at or below their high-risk depensation threshold). Data from the three dependent populations within the stratum (Brush, Greenwood and Elk creeks) suggest little to no adult coho salmon escapement since 2011. In the Russian River and Lagunitas Creek watersheds, which are the two largest within the Central Coast strata, recent coho salmon population trends suggest limited improvement, although both populations remain well below recovery targets. Likewise, most dependent populations within the strata remain at very low levels, although excess broodstock adults from the Russian River and Olema Creek were recently stocked into Salmon Creek and the subsequent capture of juvenile fish indicates successful reproduction occurred. Finally, recent sampling within Pescadero Creek and San Lorenzo River, the only two independent populations within the Santa Cruz Mountains strata, suggest coho salmon have likely been extirpated within both basins. A bright spot appears to be the recent improvement in abundance and spatial distribution noted within the strata's dependent populations; Scott Creek experienced the largest coho salmon run in a decade during 2014/15, and researchers recently detected juvenile coho salmon within four dependent watersheds where they were previously thought to be extirpated (San Vincente, Waddell, Soquel and Laguna creeks

Genetic Diversity Hatchery raised smolt have been released infrequently but occasionally in large numbers in rivers throughout the ESU (Bjorkstedt et al. 2005). Releases have included transfer of stocks within California and between California and other Pacific states as well as smolt raised from eggs collected from native stocks. However, genetic studies show little homogenization of populations, *i.e.,* transfer of stocks between basins have had little effect on the geographic genetic structure of CCC coho salmon (Sonoma County Water Agency (SCWA) 2002). The CCC coho salmon likely has considerable diversity in local adaptations given that the

ESU spans a large latitudinal diversity in geology and ecoregions, and include both coastal and inland river basins.

Distribution The TRT identified 11 "functionally independent", one "potentially independent" and 64 "dependent" populations in the CCC coho salmon ESU (Bjorkstedt *et al.,* 2005 with modifications described in Spence *et al.* 2008). The 75 populations were grouped into five Diversity Strata. ESU spatial structure has been substantially modified due to lack of viable source populations and loss of dependent populations. One of the two historically independent populations in the Santa Cruz mountains (*i.e.,* South of the Golden Gate Bridge) is extirpated (Good et al. 2005b; Spence et al. 2008a). Coho salmon are considered effectively extirpated from the San Francisco Bay (NMFS 2001; Spence et al. 2008a). The Russian River is of particular importance for preventing the extinction and contributing to the recovery of CCC coho salmon (NOAA 2013). The Russian River population, once the largest and most dominant source population in the ESU, is now at high risk of extinction because of low abundance and failed productivity (Spence et al. 2008a). The Lost Coast to Navarro Point to the north contains the majority of coho salmon remaining in the ESU.

Designated Critical Habitat Critical habitat for the CCC coho salmon ESU was designated on May 5, 1999 (64 FR 24049). It encompasses accessible reaches of all rivers (including estuarine areas and tributaries) between Punta Gorda and the San Lorenzo River (inclusive) in California. Critical habitat for this species also includes two streams entering San Francisco Bay: Arroyo Corte Madera Del Presidio and Corte Madera Creek. PBFs considered essential for the conservation of Coho salmon, central California coast ESU are:

- Within the range of both ESUs, the species' life cycle can be separated into 5 essential habitat types:
    1. Juvenile summer and winter rearing areas;
    2. juvenile migration corridors;
    3. areas for growth and development to adulthood;
    4. adult migration corridors; and
    5. spawning areas.

- Essential features of coho critical habitat include adequate
    1. substrate,
    2. water quality,
    3. water quantity,
    4. water temperature,
    5. water velocity,
    6. cover/shelter,
    7. food,
    8. riparian vegetation,
    9. space, and
    10. safe passage conditions.

NMFS (2008) evaluated the condition of each habitat attribute in terms of its current condition relative to its role and function in the conservation of the species. The assessment of habitat for this species showed a distinct trend of increasing degradation in quality and quantity of all PBFs as the habitat progresses south through the species range, with the area from the Lost Coast to the

Navarro Point supporting most of the more favorable habitats and the Santa Cruz Mountains supporting the least. However, all populations are generally degraded regarding spawning and incubation substrate, and juvenile rearing habitat. Elevated water temperatures occur in many streams across the entire ESU.

Recovery Goals See the 2012 Recovery Plan for complete down listing/delisting criteria for each of the following recovery goals (NMFS 2012):

1. Prevent extinction by protecting existing populations and their habitats;
2. Maintain current distribution of coho salmon and restore their distribution to previously occupied areas essential to their recovery;
3. Increase abundance of coho salmon to viable population levels, including the expression of all life history forms and strategies;
4. Conserve existing genetic diversity and provide opportunities for interchange of genetic material between and within meta populations;
5. Maintain and restore suitable freshwater and estuarine habitat conditions and characteristics for all life history stages so viable populations can be sustained naturally;
6. Ensure all factors that led to the listing of the species have been ameliorated; and
7. Develop and maintain a program of monitoring, research, and evaluation that advances understanding of the complex array of factors associated with coho salmon survival and recovery and which allows for adaptively managing our approach to recovery over time.

Table 43. Summary of status; Coho salmon, central California coast ESU

Criteria	Description
Abundance / productivity trends	Stable population trend, low abundances, fragmented populations, supported by hatchery propagation.
Listing status	Endangered
Attainment of recovery goals	Criteria not yet met
Condition of PBFs	Degradation in quality and quantity of PBFs, especially in southern end of range; Rearing PBFs degraded by loss of suitable incubation substrate and loss of habitat; Elevated temperatures anticipated in freshwater habitats; Environmental mixtures anticipated in freshwater habitats may impact PBFs

9.15 Coho salmon, Lower Columbia River ESU

Table 44. Coho salmon, lower Columbia River ESU; overview table

Species	Common Name	ESU	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus kisutch	**Coho salmon**	**Lower Columbia River**	**Threatened**	2016	70 FR 37160	2013	81 FR 9251

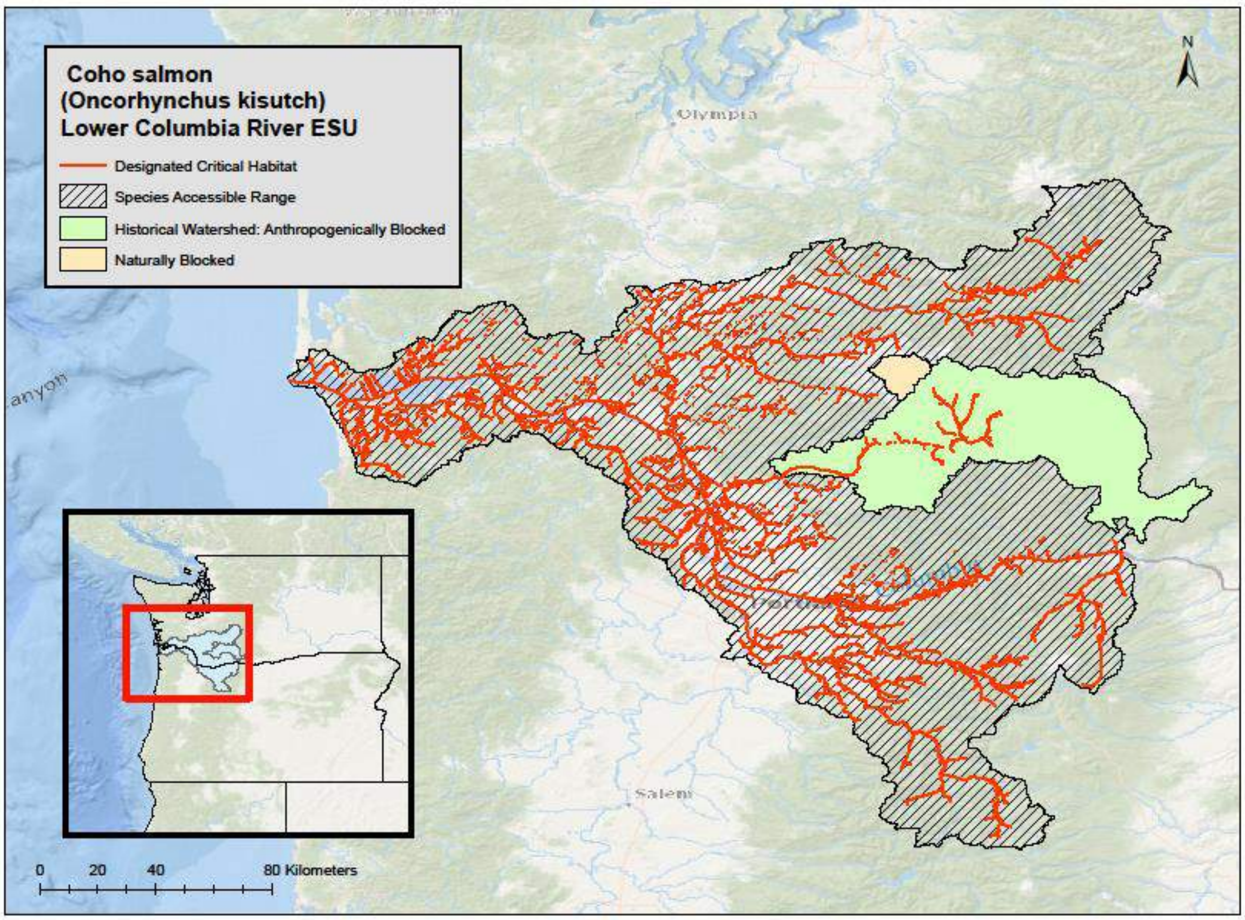

Figure 16. Coho salmon, lower Columbia River ESU range and designated critical habitat

Species Description Coho salmon are an anadromous species (i.e., adults migrate from marine to freshwater streams and rivers to spawn). Adult coho salmon are typically about two feet long and eight pounds. Coho have backs that are metallic blue or green, silver sides, and light bellies; spawners are dark with reddish sides; and when coho salmon are in the ocean, they have small black spots on the back and upper portion of the tail. Lower Columbia River coho salmon, an ESU was listed as threatened under the ESA on June 28, 2005 (70 FR 37160). This ESU includes naturally spawned coho salmon originating from the Columbia River and its tributaries downstream from the Big White Salmon and Hood Rivers (inclusive) and any such fish originating from the Willamette River and its tributaries below Willamette Falls. Also, coho salmon from 21 artificial propagation programs.

Status Recovery efforts have likely improved the status of a number of coho salmon demographically independent populations (DIPs), abundances are still at low levels and the majority of the DIPs remain at moderate or high risk. For the lower Columbia River region, land development and increasing human population pressures will likely continue to degrade habitat, especially in lowland areas. Although populations in this ESU have generally improved, especially in the 2013/14 and 2014/15 return years, recent poor ocean conditions suggest that population declines might occur in the upcoming return years. Regardless, this ESU is still considered to be at moderate risk (NWFSC 2015a).

Life history Lower Columbia River coho salmon are typically categorized into early- and late-returning stocks. Early-returning (Type S) adult coho salmon enter the Columbia River in mid-August and begin entering tributaries in early September, with peak spawning from mid-October to early November. Late-returning (Type N) coho salmon pass through the lower Columbia from late September through December and enter tributaries from October through January. Most spawning occurs from November to January, but some occurs as late as March (LCFRB 2010b).

Coho salmon typically spawn in small to medium, low- to-moderate elevation streams from valley bottoms to stream headwaters. Coho salmon construct redds in gravel and small cobble substrate in pool tailouts, riffles, and glides, with sufficient flow depth for spawning activity (NMFS 2013b). Eggs incubate over late fall and winter for about 45 to 140 days, depending on water temperature, with longer incubation in colder water. Fry may thus emerge from early spring to early summer (ODFW 2010). Juveniles typically rear in freshwater for more than a year. After emergence, coho salmon fry move to shallow, low-velocity rearing areas, primarily along the stream edges and inside channels. Juvenile coho salmon favor pool habitat and often congregate in quiet backwaters, side channels, and small creeks with riparian cover and woody debris. Side-channel rearing areas are particularly critical for overwinter survival, which is a key regulator of freshwater productivity (LCFRB 2010b).

Most juvenile coho salmon migrate seaward as smolts in April to June, typically during their second year. Salmon that have stream-type life histories, such as coho, typically do not linger for extended periods in the Columbia River estuary, but the estuary is a critical habitat used for feeding during the physiological adjustment to salt water. Juvenile coho salmon are present in the Columbia River estuary from March to August. Columbia River coho salmon typically range throughout the nearshore ocean over the continental shelf off of the Oregon and Washington coasts. Early-returning (Type S) coho salmon are typically found in ocean waters south of the Columbia River mouth. Late-returning (Type N) coho salmon are typically found in ocean waters north of the Columbia River mouth. Most coho salmon sexually mature at age three, except for a small percentage of males (called "jacks") who return to natal waters at age two, after only 5 to 7 months in the ocean (LCFRB 2010b).

Table 45. Temporal distribution of Coho salmon, lower Columbia River ESU

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Present</td></tr>
<tr><td>Spawning</td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td></tr>
<tr><td>Incubation (eggs)</td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td></td><td colspan="5">Present</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance Although poor data quality prevents precise quantification, most populations are believed to have very low abundance of natural-origin spawners (50 fish or fewer, compared to historical abundances of thousands or tens of thousands).

Productivity / Population Growth Rate Both the long- and short-term trend, and lambda for the natural origin (late-run) portion of the Clackamas River coho salmon are negative but with large confidence intervals (Good et al. 2005b). The short-term trend for the Sandy River population is close to 1, indicating a relatively stable population during the years 1990 to 2002 (Good et al. 2005b). The long-term trend (1977 to 2002) for this same population shows that the population has been decreasing (trend=0.54); there is a 43% probability that the median population growth rate (lambda) was less than one. More recent spawning surveys indicate short-term increases in natural production in the Clatskanie, Scappoose, and Mill/Abernathy/Germany populations (Ford 2011a; ODFW 2010).

Genetic Diversity The spatial structure of some populations is constrained by migration barriers (such as tributary dams) and development in lowland areas. Low abundance, past stock transfers, other legacy hatchery effects, and ongoing hatchery straying may have reduced genetic diversity within and among coho salmon populations (LCFRB 2010a, ODFW 2010). It is likely that hatchery effects have also decreased population productivity.

Distribution The Lower Columbia River coho salmon ESU historically consisted of a total of 24 independent populations (see Table 6-2). Because NMFS had not yet listed the ESU in 2003 when the WLC TRT designated core and genetic legacy populations for other ESUs, there are no such designations for Lower Columbia River coho salmon. However, the Clackamas and Sandy subbasins contain the only populations in the ESU that have clear records of continuous natural spawning (McElhany et al. 2007b).

Designated Critical Habitat Critical habitat for the lower Columbia River coho salmon ESU was designated on February 24, 2016 (81 FR 9252). PBFs considered essential for the conservation of Coho salmon, lower Columbia River ESU are:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development.
- Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
- Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large

rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.

- Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.
- Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.
- Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

Reduced complexity, connectivity, quantity, and quality of habitat used for spawning, rearing, foraging, and migrating continues to be a concern for all four lower Columbia River listed species. Loss of habitat from conversion to agricultural or urbanized uses continues to be a particular concern throughout the lower Columbia River region, especially the loss of habitat complexity in the lower tributary/mainstem Columbia River interface, and concomitant changes in water temperature (LCFRB 2010b; NMFS 2013b; ODFW 2010). Toxic contamination through the production, use, and disposal of numerous chemicals from multiple sources including industrial, agricultural, medical and pharmaceutical, and common household uses that enter the Columbia River in wastewater treatment plant effluent, stormwater runoff, and nonpoint source pollution is a growing concern (Morace 2012).

Recovery Goals NMFS has developed the following delisting criteria for the Lower Columbia River coho salmon ESU:

1. All strata that historically existed have a high probability of persistence or have a probability of persistence consistent with their historical condition. High probability of stratum persistence is defined as:
    a. At least two populations in the stratum have at least a 95% probability of persistence over a 100-year time frame (i.e., two populations with a score of 3.0 or higher based on the TRT’s scoring system).
    b. Other populations in the stratum have persistence probabilities consistent with a high probability of stratum persistence (i.e., the average of all stratum population scores is 2.25 or higher, based on the TRT’s scoring system). (See Section 2.6 for a brief discussion of the TRT’s scoring system.)
    c. Populations targeted for a high probability of persistence are distributed in a way that minimizes risk from catastrophic events, maintains migratory connections among populations, and protects within-stratum diversity.

    A probability of persistence consistent with historical condition refers to the concept that strata that historically were small or had complex population structures may not have met Criteria A through C, above, but could still be considered sufficiently viable if they provide a contribution to overall ESU viability similar to their historical contribution.

2. The threats criteria described in Section 3.2.2 of the 2013 recovery plan have been met.

Table 46. Summary of status; Coho salmon, lower Columbia River ESU

Criteria	Description
Abundance / productivity trends	90% reduction in abundance of all independent populations. Two of 25 populations have significant natural production. Long and short term lambda projections remain negative. Diversity of populations remain in the high risk category.
Listing status	Threatened
Attainment of recovery goals	Criteria not yet met
Condition of PBFs	Spawning and rearing PBFs are degraded by timber harvest, agriculture, urbanization, loss of floodplain habitat, and reduced natural cover; Migration PBFs impacted by dams; Elevated temperatures and environmental mixtures anticipated in freshwater habitats

9.16 Coho salmon, Oregon Coast ESU

Table 47. Coho salmon, Oregon coast ESU; overview table

Species	Common Name	ESU	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus kisutch	Coho salmon	Oregon Coast	Threatened	2016	76 FR 35755	2016	73 FR 7816

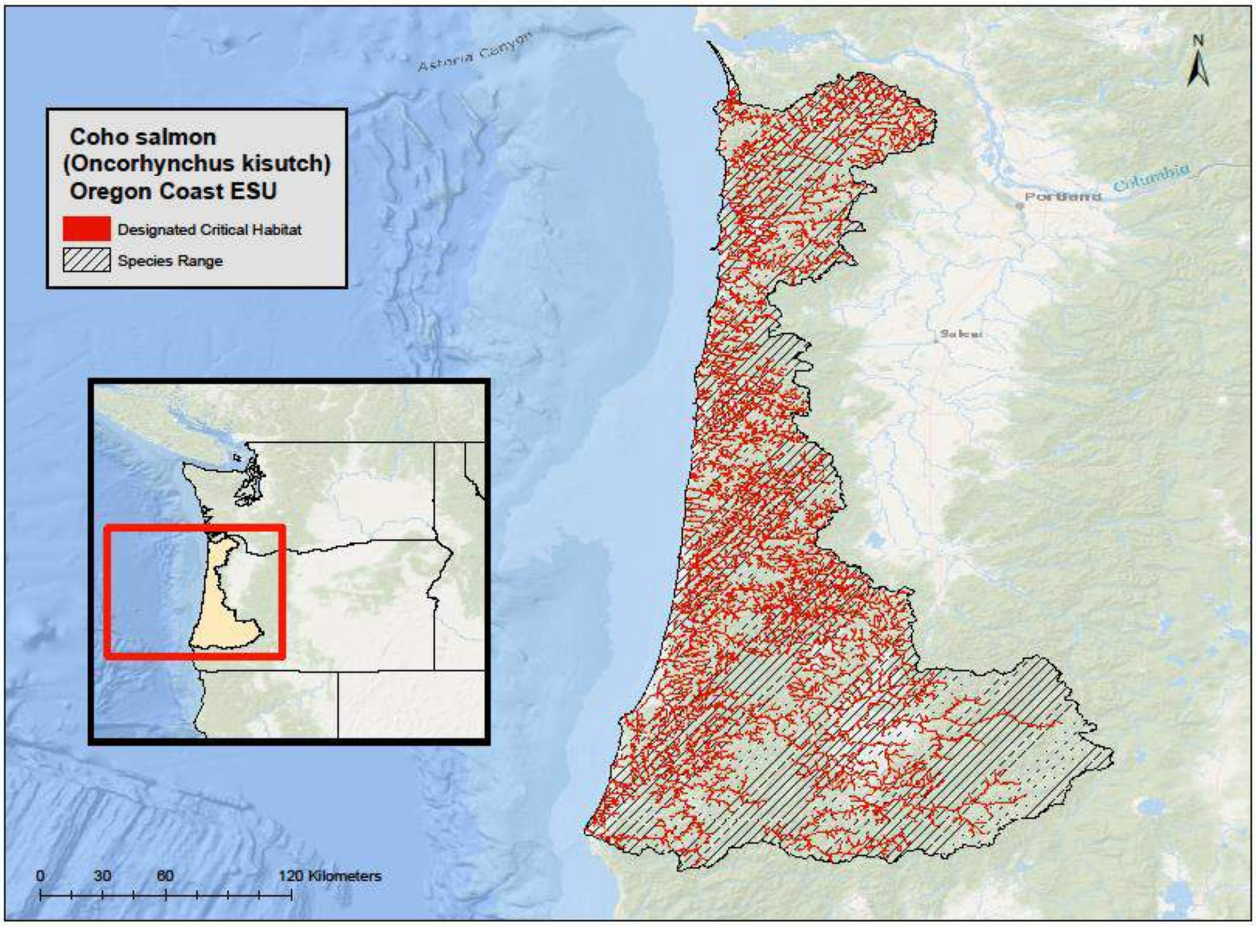

Figure 17. Coho salmon, Oregon coast ESU range and designated critical habitat

Species Description Coho salmon are an anadromous species (i.e., adults migrate from marine to freshwater streams and rivers to spawn). Adult coho salmon are typically about two feet long and eight pounds. Coho have backs that are metallic blue or green, silver sides, and light bellies; spawners are dark with reddish sides; and when coho salmon are in the ocean, they have small black spots on the back and upper portion of the tail. Oregon coast coho salmon, an ESU was listed as threatened under the ESA on August 10, 1998 (63 FR 42587). The listing was revisited and confirmed as threatened on June 20, 2011 (76 FR 35755). This ESU includes naturally spawned coho salmon originating from coastal rivers south of the Columbia River and north of

Cape Blanco, and also coho salmon from one artificial propagation program: Cow Creek Hatchery Program.

Status Findings by the NWFSC (2015a) and ODFW (2016) show many positive improvements to Oregon Coast coho salmon in recent years, including positive long-term abundance trends and escapement. Results from the NWFSC recent review show that while Oregon Coast coho salmon spawner abundance varies by time and population, the total abundance of spawners within the ESU has been generally increasing since 1999, with total abundance exceeding 280,000 spawners in three of the last five years. Overall, the NWFSC (2015a) found that increases in Oregon Coast coho salmon ESU scores for persistence and sustainability clearly indicate that the biological status of the ESU is improving, due in large part to management decisions (reduced harvest and hatchery releases). It determined, however, that Oregon Coast coho salmon abundance remains strongly correlated with marine survival rates.

Life history The anadromous life cycle of coho salmon begins in their home stream where they emerge from eggs as ‘alevins’ (a larval life stage dependent on food stored in a yolk sac). These very small fish require cool, slow moving freshwater streams with quiet areas such as backwater pools, beaver ponds, and side channels (Reeves et al. 1989) to survive and grow through summer and winter seasons. Current production of coho salmon smolts in the Oregon Coast coho salmon ESU is particularly limited by the availability of complex stream habitat that provides the shelter for overwintering juveniles during periods when flows are high, water temperatures are low, and food availability is limited (ODFW 2007).

The Oregon Coast coho salmon follow a yearling-type life history strategy, with most juvenile coho salmon migrating to the ocean as smolts in the spring, typically from as late as March into June . Coho salmon smolts outmigrating from freshwater reaches may feed and grow in lower mainstem and estuarine habitats for a period of days or weeks before entering the nearshore ocean environment. The areas can serve as acclimation areas, allowing coho salmon juveniles to adapt to saltwater. Research shows that substantial numbers of coho fry may also emigrate downstream from natal streams into tidally influenced lower river wetlands and estuarine habitat (Bass 2010; Chapman 1962; Koski 2009).

Oregon Coast coho salmon tend to make relatively short ocean migrations. Coho from this ESU are present in the ocean from northern California to southern British Columbia, and even fish from a given population can be widely dispersed in the coastal ocean, but the bulk of the ocean harvest of coho salmon from this ESU are found off the Oregon coast. The majority of coho salmon adults return to spawn as 3–year-old fish, having spent about 18 months in freshwater and 18 months in salt water (Sandercock 1991). The primary exceptions to this pattern are ‘‘jacks,’’ sexually mature males that return to freshwater to spawn after only 5 to 7 months in the ocean.

Table 48. Temporal distribution of Coho salmon, Oregon coast ESU

<table>
<tr><td>Life History phase</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td>Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td></tr>
<tr><td>Spawning</td><td>Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td></tr>
<tr><td>Incubation (eggs)</td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Present</td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance Results from the NWFSC recent review show that while Oregon Coast (OC) coho salmon spawner abundance varies by time and population, the total abundance of spawners within the ESU has been generally increasing since 1999, with total abundance exceeding 280,000 spawners in three of the last five years (NWFSC 2015a).

Productivity / Population Growth Rate Most independent populations in the ESU showed an overall increasing trend in abundance with synchronously high abundances in 2002-2003, 2009-2011, and 2014, and low abundances in 2007, 2009, and 2015. This synchrony suggests the overriding importance of marine survival to recruitment and escapement of Oregon Coast coho salmon (NWFSC 2015a).

Genetic Diversity While the 2008 biological review team status review concluded that there was low certainty that ESU-level genetic diversity was sufficient for long-term sustainability in the ESU (Wainwright et al. 2008), the recent NWFSC review suggests this is an unlikely outcome. The observed upward trends in abundance and productivity and downward trends in hatchery influence make decreases in genetic or life history diversity or loss of dependent populations in recent years unlikely (NWFSC 2015a).

Distribution The geographic setting for the Oregon Coast coho salmon ESU includes the Pacific Ocean and the freshwater habitat (rivers, streams, and lakes) along the Oregon Coast from the Necanicum River near Seaside on the north to the Sixes River near Port Orford on the south. The Oregon/Northern California Coasts Technical Recovery Team identified 56 historical populations that function collectively to form the Oregon Coast coho salmon ESU. The team classified 21 of the populations as independent because they occur in basins with sufficient historical habitat to have persisted through several hundred years of normal variations in marine and freshwater conditions (NMFS 2016d).

Designated Critical Habitat NMFS designated critical habitat for Oregon Coast coho salmon on February 11, 2008 (73 FR 7816). PBFs considered essential for the conservation of Coho salmon, Oregon coast ESU are:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development.
- Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
- Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.
- Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

- Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.
- Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

The spawning PBF has been impacted in many watersheds from the inclusion of fine sediment into spawning gravel from timber harvest and forestry related activities, agriculture, and grazing. These activities have also diminished the channels' rearing and overwintering capacity by reducing the amount of large woody debris in stream channels, removing riparian vegetation, disconnecting floodplains from stream channels, and changing the quantity and dynamics of stream flows. The rearing PBF has been degraded by elevated water temperatures in 29 of the 80 HUC 5 watersheds; rearing PBF within the Nehalem, North Umpqua, and the inland watersheds of the Umpqua subbasins have elevated stream temperatures. Water quality is impacted by contaminants from agriculture and urban areas in low lying areas in the Umpqua subbasins, and in coastal watersheds within the Siletz/Yaquina, Siltcoos, and Coos subbasins. Reductions in water quality have been observed in 12 watersheds due to contaminants and excessive nutrition. The migration PBF has been impacted throughout the ESU by culverts and road crossings that restrict passage. As described above the PBFs vary widely throughout the critical habitat area designated for OC coho salmon, with many watersheds heavily impacted with low quality PBFs while habitat in other coho salmon bearing watersheds having sufficient quality for supporting the conservation purpose of designated critical habitat.

Recovery Goals See the 2016 Recovery Plan for detailed descriptions of the recovery goals and delisting criteria (NMFS 2016d). In the simplest terms, NMFS will remove the Oregon Coast coho salmon from federal protection under the ESA when we determine that:

- The species has achieved a biological status consistent with recovery—the best available information indicates it has sufficient abundance, population growth rate, population spatial structure, and diversity to indicate it has met the biological recovery goals.
- Factors that led to ESA listing have been reduced or eliminated to the point where federal protection under the ESA is no longer needed, and there is reasonable certainty that the relevant regulatory mechanisms are adequate to protect Oregon Coast coho salmon sustainability.

Table 49. Summary of status; Coho salmon, Oregon coast ESU

Criteria	**Description**
Abundance / productivity trends	Drastic reductions in ESU abundance compared to historical estimates. Highly variable abundances with periods of severe declines followed by a year of increases. Long term trends remain negative due to low abundances in the 1990s.
Listing status	Threatened
Attainment of recovery goals	Criteria not yet met

Condition of PBFs	Rearing PBFs are degraded by elevated water temperature; All PBFs degraded by reduced water quality from contaminants and excess nutrients; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of 80 assessed watersheds, 45 are of high and 27 are of medium conservation value

9.17 Coho salmon, Southern Oregon/Northern California Coast ESU

Table 50. Coho salmon, Southern Oregon/Northern California ESU ; overview table

Species	Common Name	ESU	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus kisutch	Coho salmon	Southern Oregon / Northern California	Threatened	2016	70 FR 37160	2014	64 FR 24049

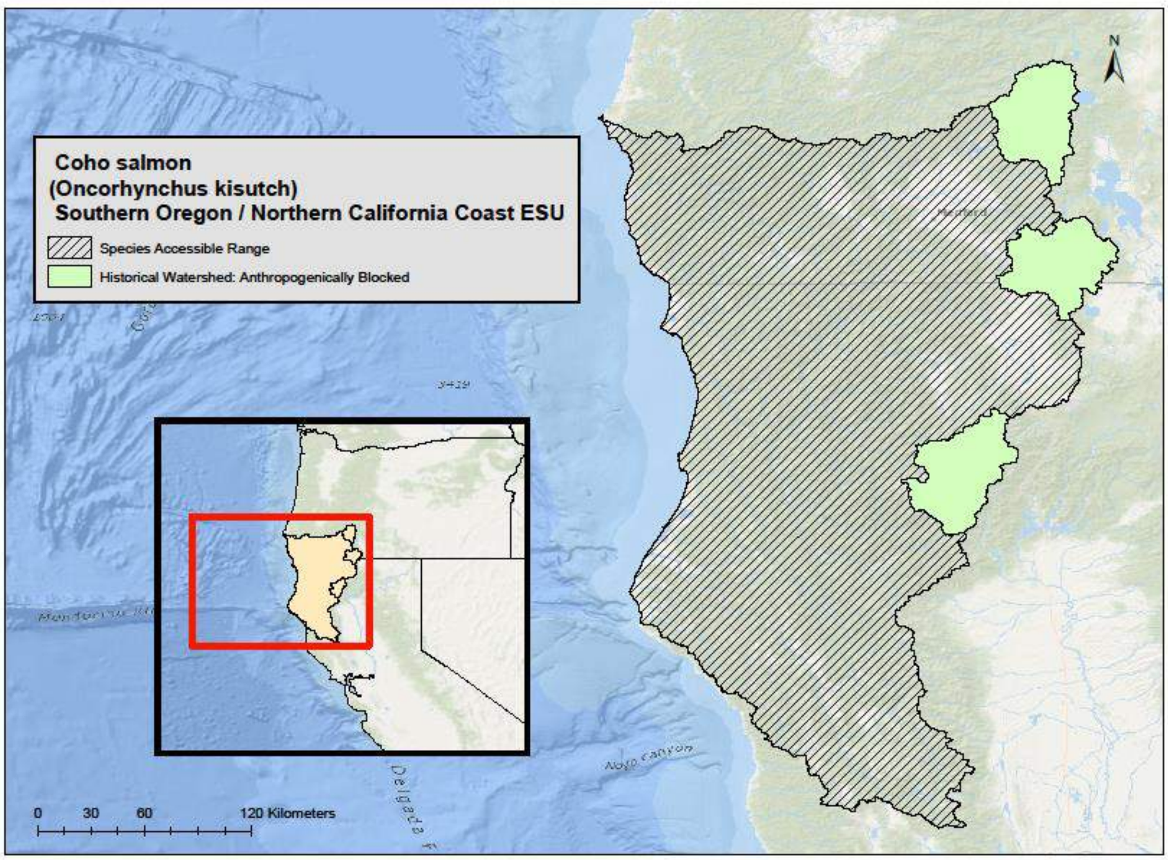

Figure 18. Coho salmon, Southern Oregon/Northern California ESU range and designated critical habitat

Species Description Coho salmon are an anadromous species (i.e., adults migrate from marine to freshwater streams and rivers to spawn). Adult coho salmon are typically about two feet long and eight pounds. Coho have backs that are metallic blue or green, silver sides, and light bellies; spawners are dark with reddish sides; and when coho salmon are in the ocean, they have small black spots on the back and upper portion of the tail. Southern Oregon / Northern California Coast (SONCC) coho salmon, an ESU was listed as threatened under the ESA on May 6, 1997 (62 FR 24588). The listing was revisited and confirmed as threatened on June 28, 2005 (70 FR 37160). This ESU includes naturally spawned coho salmon originating from coastal streams and rivers between Cape Blanco, Oregon, and Punta Gorda, California. Also, coho salmon from three artificial propagation programs.

Status Though population-level estimates of abundance for most independent populations are lacking, the best available data indicate that none of the seven diversity strata appears to support a single viable population as defined by the SONCC coho salmon technical recovery team's viability criteria (low extinction risk; Williams et al. (2008)). Further, 24 out of 31 independent populations are at high risk of extinction and 6 are at moderate risk of extinction. Based on the above discussion of the population viability parameters, and qualitative viability criteria presented in Williams et al. (2008), NMFS concludes that the SONCC coho salmon ESU is currently not viable and is at high risk of extinction. The primary causes of the decline are likely long-standing human-caused conditions (e.g., harvest and habitat degradation), which exacerbated the impacts of adverse environmental conditions (e.g., drought and poor ocean conditions) (60 FR 38011; July 25, 1995).

Life history Coho salmon is an anadromous fish species that generally exhibits a relatively simple 3-year life cycle. Adults typically begin their freshwater spawning migration in the late summer and fall, spawn by mid-winter, and then die. The run and spawning times vary between and within populations. Depending on river temperatures, eggs incubate in ‘‘redds’’ (gravel nests excavated by spawning females) for 1.5 to 4 months before hatching as ‘‘alevins’’ (a larval life stage dependent on food stored in a yolk sac). Once most of the yolk sac is absorbed, the 30 to 35 millimeter fish (then termed “fry”) begin emerging from the gravel in search of shallow stream margins for foraging and safety (Council 2004). Coho salmon fry typically transition to the juvenile stage by about mid-June when they are about 50 to 60 mm, and both stages are collectively referred to as “young of the year.” Juveniles develop vertical dark bands or “parr marks”, and begin partitioning available instream habitat through aggressive agonistic interactions with other juvenile fish (Quinn 2005). Juveniles rear in fresh water for up to 15 months, then migrate to the ocean as ‘‘smolts’’ in the spring. Coho salmon typically spend 2 growing seasons in the ocean before returning to their natal stream to spawn as 3 year-olds. Some precocious males, called ‘‘jacks,’’ return to spawn after only 6 months at sea (NMFS 2014a).

Table 51. Temporal distribution of Coho salmon, Southern Oregon/Northern California ESU

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Present</td></tr>
<tr><td>Spawning</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td></tr>
<tr><td>Incubation (eggs)</td><td>Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Present</td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance Population-level estimates of abundance for most independent populations are lacking. The best available data indicate that none of the seven diversity strata appears to support a single viable population (one at low risk of extinction) as defined by in the viability criteria. In fact, most of the 30 independent populations in the ESU are at high risk of extinction for abundance because they are below or likely below their depensation threshold (NMFS 2014a).

Productivity / Population Growth Rate Available data show that the 95% confidence intervals for the slope of the regression line include zero for many populations, indicating that whether the slope is negative or positive cannot be determined. However, there is 95% confidence that the slope of the regression line is negative, indicating a decreasing trend, for Mill Creek in the Smith

River and Freshwater Creek in Humboldt Bay Tributaries. In contrast, there is 95% confidence that the slope of the regression line is positive, indicating an increasing trend, at Gold Ray Dam in the Upper Rogue River(NMFS 2014a).

Genetic Diversity The primary factors affecting the genetic and life-history diversity of SONCC coho salmon appear to be low population abundance and the influence of hatcheries and out-of-basin introductions. The ESU's current genetic variability and variation in life-history likely contribute significantly to long-term risk of extinction. Given the recent trends in abundance across the ESU, the genetic and life-history diversity of populations is likely very low and is inadequate to contribute to a viable ESU (NMFS 2014a).

Distribution The SONCC Coho Salmon ESU includes all naturally spawned populations of coho salmon in coastal streams between Cape Blanco, Oregon and Punta Gorda, California, as well as coho salmon produced by three artificial propagation programs: Cole Rivers Hatchery, Trinity River Hatchery, and Iron Gate Hatchery. The ESU if comprised of 40 populations within seven diversity strata. Recent information for SONCC coho salmon indicates that their distribution within the ESU has been reduced and fragmented, as evidenced by an increasing number of previously occupied streams from which they are now absent. However, extant populations can still be found in all major river basins within the ESU (70 FR 37160; June 28, 2005).

Designated Critical Habitat NMFS designated critical habitat for the SONCC coho salmon on May 5, 1999 (64 FR 24049). PBFs considered essential for the conservation of Coho salmon, Southern Oregon/Northern California ESU are:

- Within the range of both ESUs, the species' life cycle can be separated into 5 essential habitat types:
    1. Juvenile summer and winter rearing areas;
    2. juvenile migration corridors;
    3. areas for growth and development to adulthood;
    4. adult migration corridors; and
    5. spawning areas.

- Essential features of coho critical habitat include adequate
    1. substrate,
    2. water quality,
    3. water quantity,
    4. water temperature,
    5. water velocity,
    6. cover/shelter,
    7. food,
    8. riparian vegetation,
    9. space, and
    10. safe passage conditions.

Critical habitat designated for the SONCC coho salmon is generally of good quality in northern coastal streams. Spawning PBF has been degraded throughout the ESU by logging activities that has increased fines in spawning gravel. Rearing PBF has been considerably degraded in many inland watersheds from the loss of riparian vegetation resulting in unsuitably high water temperatures. Rearing and juvenile migration PBFs have been reduced from the disconnection of floodplains and off-channel habitat in low gradient reaches of streams, consequently reducing winter rearing capacity.

Recovery Goals See the 2014 recovery plan for complete down listing/delisting criteria for this ESU (***Table 52***; (NMFS 2014a)).

Table 52. Biological recovery objectives and criteria for SONCC coho salmon. All Biological criteria must be met in a recovered ESU. Taken from (NMFS 2014a).

VSP Parameter	Population Role	Biological Recovery Objective	Biological Recovery Criteria[1]
Abundance	Core	Achieve a low risk of extinction[2]	The geometric mean of wild adults over 12 years meets or exceeds the "low risk threshold" of spawners for each core population[2,3,4]
	Non-Core 1	Achieve a moderate or low risk of extinction[2]	The annual number of wild adults is greater than or equal to four spawners per IP-km for each non-core population[2]
Productivity	Core and Non-Core 1	Population growth rate is not negative	Slope of regression of the geometric mean of wild adults over the time series ≥ zero[4]
Spatial Structure	Core and Non-Core 1	Ensure populations are widely distributed	Annual within-population juvenile distribution ≥ 80%[4] of habitat[5,6] (outside of a temperature mask[7])
	Non-Core 2 and Dependent	Achieve inter- and intra-stratum connectivity	≥ 80% of accessible habitat[4] is occupied in years[8] following spawning of cohorts that experienced high marine survival[9]
Diversity	Core and Non-Core 1	Achieve low or moderate hatchery impacts on wild fish	Proportion of hatchery-origin adults (pHOS) < 0.05
	Core and Non-Core 1	Achieve life-history diversity	Variation is present in migration timing, age structure, size and behavior. The variation in these parameters[10] is retained.

[1] All applicable criteria must be met for each population in order for the ESU to be viable.
[2] See Table 4-2 for specific spawner abundance requirements needed to meet this objective.
[3] In the Shasta River, Upper Trinity River, and Upper Rogue River populations, IP above some anthropogenic dams was excluded from the spawner target, so the low-risk threshold for these populations is based on the IP downstream of those dams.
[4] Assess for at least 12 years, striving for a coefficient of variation (CV) of 15% or less at the population level (Crawford and Rumsey 2011).
[5] Based on available rearing habitat within the watershed (Wainwright et al. 2008). For purposes of these biological recovery criteria, "available" means accessible. 80% of habitat occupied relates to a truth value of +1.0,(true: juveniles occupy a high proportion of the available rearing habitat within the watershed (p. 56, Wainwright et al. 2008).
[6] The average for each of the three year classes over the 12 year period used for delisting evaluation must each meet this criterion. Strive to detect a 15% change in distribution with 80% certainty (Crawford and Rumsey 2011).
[7] Williams et al. (2008) identified a threshold air temperature, above which juvenile coho salmon generally do not occur, and identified areas with air temperatures over this threshold. These areas are considered to be within the temperature mask.
[8] If young-of-year are sampled, sampling would occur the spring following spawning of the cohorts experiencing high marine survival. If 1+ juveniles are sampled, sampling would occur approximately 1.5 years after spawning of the cohorts experiencing high marine survival, but before outmigration to the estuary and ocean.
[9] High marine survival is defined as 10.2% for wild fish and 8% for hatchery fish; Sharr et al. 2000. If marine survival is not high, then this criterion does not apply.
[10] This variation is documented in the population profiles in Chapters 7 to 46 of this plan.

Table 53. Summary of status; Coho salmon, Southern Oregon/Northern California ESU

Criteria	Description
Abundance / productivity trends	Data on population abundance and trends are limited for this ESU. Trend data are variable throughout the ESU.
Listing status	Threatened

Attainment of recovery goals	Criteria not yet met
Condition of PBFs	Spawning PBFs are degraded by logging; Rearing and migration PBFs degraded by loss of riparian vegetation and loss of floodplain habitat; Elevated temperatures and environmental mixtures anticipated in freshwater habitats

9.18 Sockeye salmon, Ozette Lake ESU

Table 54. Sockeye salmon, Ozette Lake ESU; overview table

Species	Common Name	ESU	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus nerka	Sockeye salmon	Ozette Lake	Threatened	2016	70 FR 37160	2009	70 FR 52630

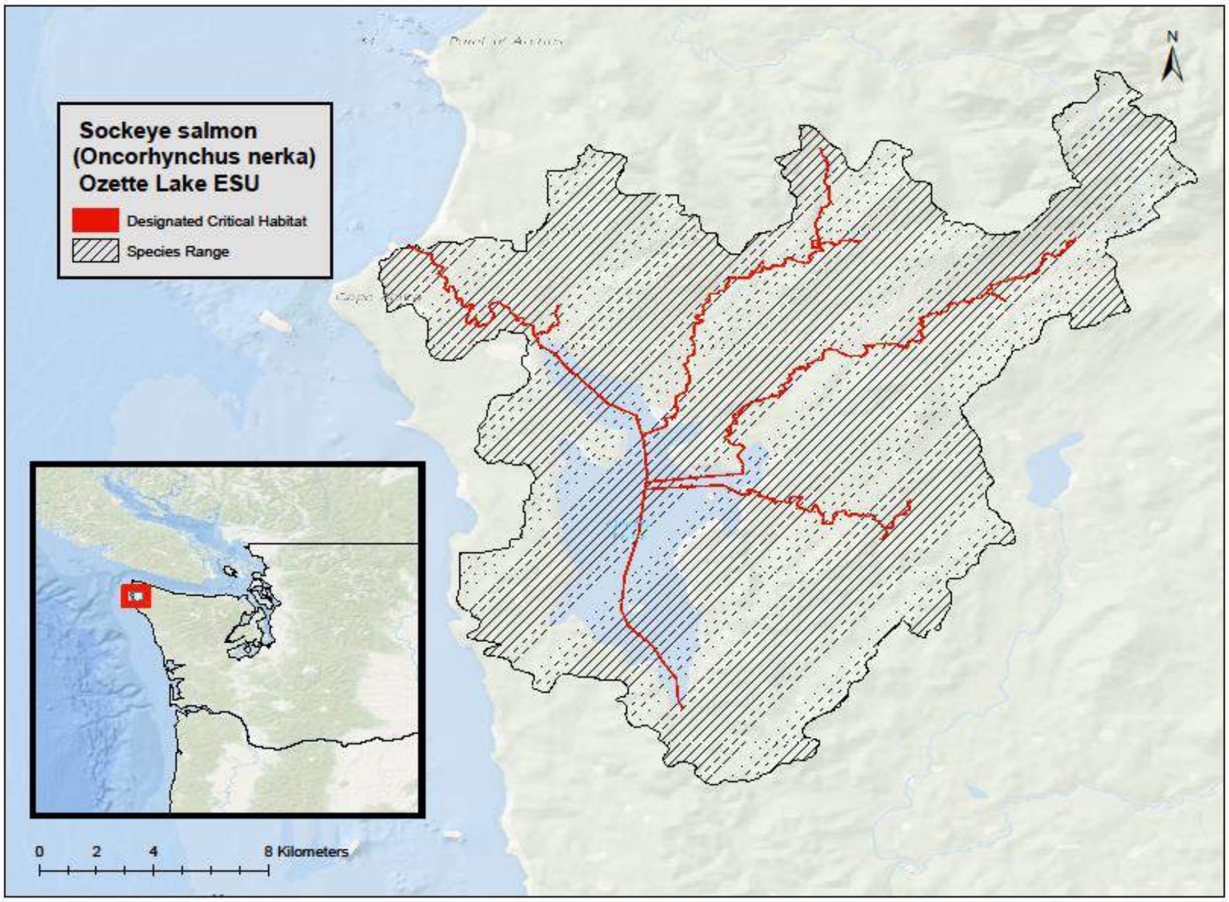

Figure 19. Sockeye salmon, Ozette Lake ESU range and designated critical habitat

Species Description The sockeye salmon is an anadromous species (i.e., adults migrate from marine to freshwater streams and rivers to spawn), although some sockeye spend their entire lives (about five years) in freshwater. Adult sockeye salmon are about three feet long and eight pounds. Sockeyes are bluish black with silver sides when they are in the ocean, and they turn bright red with a green head when they are spawning. On March 25, 1999, NMFS listed the Ozette Lake sockeye salmon ESU as threatened (64 FR 14528) and reaffirmed the ESU's status as threatened on June 28, 2005 (70 FR 37160). This ESU includes naturally spawned sockeye salmon originating from the Ozette River and Ozette Lake and its tributaries. Also, sockeye salmon from two artificial propagation programs.

Status NMFS listed the Ozette Lake sockeye salmon ESU because of habitat loss and degradation from the combined effects of logging, road building, predation, invasive plant species, and overharvest. Ozette Lake sockeye salmon have not been commercially harvested since 1982 and only minimally harvested by the Makah Tribe since 1982 (0 to 84 fish per year); there is no known marine fishing of this ESU. Overall abundance is substantially below historical levels, and whether the decrease in abundance is a result of fewer spawning aggregations, lower abundances in each aggregation, or a combination of both factors is unknown. Regardless, this ESU's viability has not improved, and the ESU would likely have a low resilience to additional perturbations. However, recovery potential for the Ozette Lake sockeye salmon ESU is good, particularly because of protections afforded it based on the lake's location within a national park (NMFS 2009; NMFS 2016a).

Life history Most sockeye salmon exhibit a lake-type life history (i.e., they spawn and rear in or near lakes), though some exhibit a river-type life history. Spawning generally occurs in late summer and fall, but timing can vary greatly among populations. In lakes, sockeye salmon commonly spawn along "beaches" where underground seepage provides fresh oxygenated water. Females spawn in three to five redds (nests) over a couple of days. Incubation period is a function of water temperature and generally lasts 100-200 days (Burgner 1991). Sockeye salmon spawn once, generally in late summer and fall, and then die (semelparity).

Sockeye salmon fry primarily rear in lakes; river-emerged and stream-emerged fry migrate into lakes to rear. In the early fry stage from spring to early summer, juveniles forage exclusively in the warmer littoral (i.e., shoreline) zone where they depend mostly on fly larvae and pupae, copepods, and water fleas. Sub-yearling sockeye salmon move from the littoral habitat to a pelagic (i.e., open water) existence where they feed on larger zooplankton; however, flies may still make up a substantial portion of their diet. From one to three years after emergence, juvenile sockeye salmon generally rear in lakes, though some river-spawned sockeye may migrate to sea in their first year. Juvenile sockeye salmon feeding behaviors change as they transition through life stages after emergence to the time of smoltification. Distribution in lakes and prey preference is a dynamic process that changes daily and yearly depending on many factors including water temperature, prey abundance, presence of predators and competitors, and size of the juvenile. Peak emigration to the ocean occurs in mid-April to early May in southern sockeye populations (lower than 52ºN latitude) and as late as early July in northern populations (62ºN latitude) (Burgner 1991). Adult sockeye salmon return to their natal lakes to spawn after spending one to four years at sea. The diet of adult salmon consists of amphipods, copepods, squid and other fish.

Table 55. Temporal distribution of Sockeye salmon, Ozette Lake ESU

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td>Present</td><td></td><td></td><td colspan="9">Present</td></tr>
<tr><td>Spawning</td><td>Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Present</td></tr>
<tr><td>Incubation (eggs)</td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td></td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance The historical abundance of Ozette Lake sockeye salmon is poorly documented, but may have been as high as 50,000 individuals (Blum 1988). Kemmerich (Kemmerich 1945), reported a decline in the run size since the 1920s weir counts and Makah Fisheries Management (Makah Fisheries Management 2000) concluded a substantial decline in the Tribal catch of Ozette Lake sockeye salmon occurred at the beginning of the 1950s. Whether decrease in abundance compared to historic estimates is a result of fewer spawning aggregations, lower abundances at each aggregation, or both, is unknown (Good et al. 2005b).

The most recent (1996-2006) escapement estimates (run size minus broodstock take) range from a low of 1,404 in 1997 to a high of 6,461 in 2004, with a median of approximately 3,800 sockeye per year (geometric mean: 3,353) (Rawson et al. 2009). No statistical estimation of trends is reported. However, comparing four year averages (to include four brood years in the average since the species primarily spawn as four-year olds) shows an increase during the period 2000 to 2006: For return years 1996 to 1999 the run size averaged 2,460 sockeye salmon, for the years 2000 to 2003 the run size averaged just over 4,420 fish, and for the years 2004 to 2006, the three-year average abundance estimate was 4,167 sockeye (Data from appendix A in (Rawson et al. 2009)). It is estimated that between 35,500 and 121,000 spawners could be normally carried after full recovery (Hard et al. 1992).

Productivity / Population Growth Rate The Ozette Lake sockeye salmon ESU is composed of one historical population (Currens et al. 2009) with multiple spawning aggregations and two populations from the Umbrella Creek and Big River sockeye hatchery programs. Historically, at least four lake beaches were used for spawning; today only two beach spawning locations, Allen's and Olsen's Beaches, are used. Additionally, spawning occurs in the two tributaries of the hatchery programs (NWFSC 2015). The historical abundance of Ozette Lake sockeye salmon is poorly documented, but it may have been as high as 50,000 individuals (Blum 1988). Declines began to be reported in the 1920s. For the period from 1977 to 2011 the estimated annual number of natural spawners ranged from 699 to 5,313, well below the 31,250 – 121,000 viable population range proposed in the Lake Ozette sockeye recovery plan (Haggerty et al. 2009). The limited available data indicate that abundance of Lake Ozette sockeye did not change substantially from the 2011 status review (Ford 2011) to the 2015 review (NWFSC 2015). Productivity has fluctuated up and down over the last few decades, but overall appears to have remained stable (NWFSC 2015). The proportion of beach spawners originating from the hatchery is unknown, but straying is likely low.

Genetic Diversity For the Ozette Lake sockeye salmon ESU, the proportion of beach spawners is likely low; therefore, hatchery-originated fish are not likely to affect greatly the genetics of the naturally-spawned population. However, Ozette Lake sockeye have a relatively low genetic diversity compared to other sockeye salmon populations examined in Washington State (Crewson et al. 2001). Genetic differences do occur among age cohorts. However, because different age groups do not reproduce together, the population may be more vulnerable to significant reductions in population structure due to catastrophic events or unfavorable conditions affecting a single year class. Finally, actions identified in the Ozette Lake Sockeye Salmon Hatchery and Genetics Management Plan are being implemented, but the tributary hatchery reintroduction program will not reduce genetic diversity in the natural beach spawning aggregation because there is very little straying of hatchery-origin fish to beach spawning areas (NOAA 2016a).

Distribution The Ozette Lake sockeye salmon ESU includes all naturally spawned aggregations of sockeye salmon in Lake Ozette and streams and tributaries flowing into Lake Ozette, Washington. The ESU also includes fish originating from two artificial propagation programs: the Umbrella Creek and Big River sockeye hatchery programs.

Designated Critical Habitat NMFS designated critical habitat for Ozette Lake sockeye salmon on September 2, 2005 (70 FR 52630). It encompasses areas within the Hoh/Quillayute subbasin, Ozette Lake, and the Ozette Lake watershed. PBFs considered essential for the conservation of Sockeye salmon, Ozette Lake ESU are:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development;
- Freshwater rearing sites with:
  - Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility;
  - Water quality and forage supporting juvenile development;
  - Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
- Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival;
- Estuarine areas free of obstruction and excessive predation with:
  - Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh & saltwater;
  - Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels;
  - Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.
- Nearshore marine areas free of obstruction and excessive predation with:
  - Water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and
  - Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.
- Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

Spawning habitat has been affected by loss of tributary spawning areas and exposure of much of the available beach spawning habitat due to low water levels in summer. Further, native and non-native vegetation as well as sediment have reduced the quantity and suitability of beaches for spawning. The rearing PBF is degraded by excessive predation and competition with introduced non-native species, and by loss of tributary rearing habitat. Migration habitat may be adversely affected by high water temperatures and low water flows in summer which causes a thermal block to migration (La Riviere 1991).

Recovery Goals Recovery goals, objectives and criteria for Ozette Lake sockeye salmon are fully outlined in the 2009 recovery plan (NMFS 2009c).

Table 56. Summary of proposed Lake Ozette sockeye viability criteria for naturally self-sustaining adults. Taken from (NMFS 2009c)

VSP Parameter	Proposed Criteria
Abundance Planning Range	31,250 – 121,000 spawners, over a number of years
Productivity	Population growth rate stable or increasing
Spatial Structure	Multiple spatially distinct and persistent spawning aggregations across the historical range of the population
Diversity	One or more persistent spawning aggregations from each major genetic and life history group historically present within the population

Table 57. Summary of status; Sockeye salmon, Ozette Lake ESU

Criteria	Description
Abundance / productivity trends	Stable productivity rates, but abundance only 1% of historical levels. Low genetic diversity and low resilliance to future perturbations.
Listing status	threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Rearing PBFs are degraded by excessive predation, invasive species, and loss of habitat; Spawning and migration PBFs are degraded by low water levels, loss of suitable spawning habitat, and low summer water flows; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; The entire watershed is of high conservation value

9.19 Sockeye salmon, Snake River ESU

Table 58. Sockeye salmon, Snake River ESU; overview table

Species	Common Name	ESU	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus nerka	Sockeye salmon	Snake River	Endangered	2016	70 FR 37160	2015	58 FR 68543

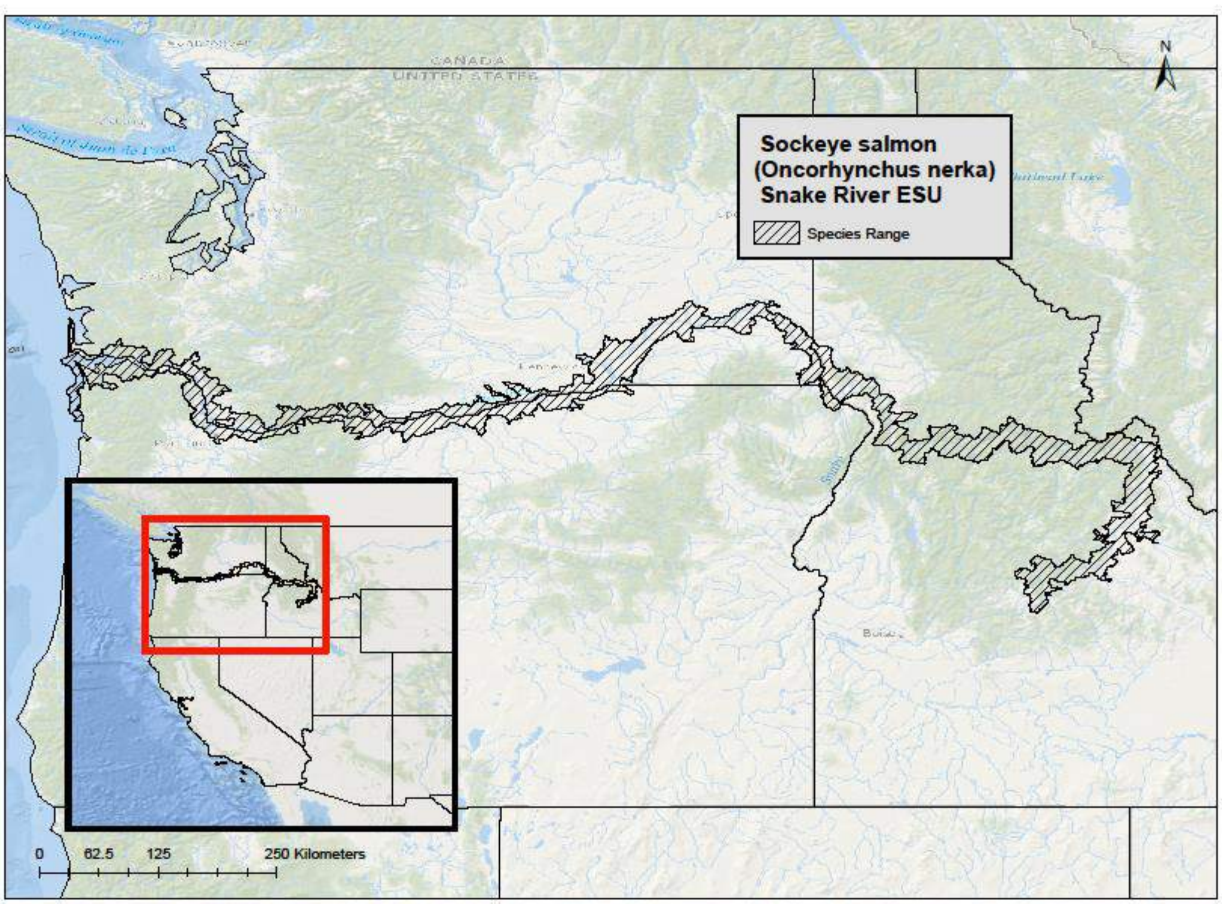

Figure 20. Sockeye salmon, Snake River ESU range and designated critical habitat

Species Description The sockeye salmon is an anadromous species (i.e., adults migrate from marine to freshwater streams and rivers to spawn), although some sockeye spend their entire lives (about five years) in freshwater. Adult sockeye salmon are about three feet long and eight pounds. Sockeyes are bluish black with silver sides when they are in the ocean, and they turn bright red with a green head when they are spawning. On November 20, 1991 NMFS listed the Ozette Lake sockeye salmon ESU as endangered (70 FR 37160) and reaffirmed the ESU's status as endangered on June 28, 2005 (70 FR 37160). This ESU includes naturally spawned anadromous and residual sockeye salmon originating from the Snake River basin, and also sockeye salmon from one artificial propagation program: Redfish Lake Captive Broodstock Program.

Status The Snake River sockeye salmon ESU includes only one population comprised of all anadromous and residual sockeye salmon from the Snake River Basin, Idaho, as well as artificially propagated sockeye salmon from the Redfish Lake captive propagation program. Historical evidence indicates that the Snake River sockeye once had a range of life history patterns, with spawning populations present in several of the small lakes in the Sawtooth Basin (NMFS 2015). NMFS listed the Snake River sockeye salmon ESU because of habitat loss and degradation from the combined effects of damming and hydropower development, overexploitation, fisheries management practices, and poor ocean conditions. Recent effects of climate change, such as reduced stream flows and increased water temperatures, are limiting Snake River ESU productivity (NMFS 2016b). Adults produced through the captive propagation program currently support the entire ESU. This ESU is still at extremely high risk across all four basic risk measures (abundance, productivity, spatial structure, and diversity) and would likely have a very low resilience to additional perturbations. Habitat improvement projects have slightly decreased the risk to the species, but habitat concerns and water temperature issues remain (NMFS 2016b). Overall, although the status of the Snake River sockeye salmon ESU appears to be improving, there is no indication that the biological risk category has changed (NWFSC 2015).

Life history Most sockeye salmon exhibit a lake-type life history (i.e., they spawn and rear in or near lakes), though some exhibit a river-type life history. Spawning generally occurs in late summer and fall, but timing can vary greatly among populations. In lakes, sockeye salmon commonly spawn along “beaches” where underground seepage provides fresh oxygenated water. Females spawn in three to five redds (nests) over a couple of days. Incubation period is a function of water temperature and generally lasts 100-200 days (Burgner 1991). Sockeye salmon spawn once, generally in late summer and fall, and then die (semelparity).

Sockeye salmon fry primarily rear in lakes; river-emerged and stream-emerged fry migrate into lakes to rear. In the early fry stage from spring to early summer, juveniles forage exclusively in the warmer littoral (i.e., shoreline) zone where they depend mostly on fly larvae and pupae, copepods, and water fleas. Sub-yearling sockeye salmon move from the littoral habitat to a pelagic (i.e., open water) existence where they feed on larger zooplankton; however, flies may still make up a substantial portion of their diet. From one to three years after emergence, juvenile sockeye salmon generally rear in lakes, though some river-spawned sockeye may migrate to sea in their first year. Juvenile sockeye salmon feeding behaviors change as they transition through life stages after emergence to the time of smoltification. Distribution in lakes and prey preference is a dynamic process that changes daily and yearly depending on many factors including water temperature, prey abundance, presence of predators and competitors, and size of the juvenile. Peak emigration to the ocean occurs in mid-April to early May in southern sockeye populations (lower than 52ºN latitude) and as late as early July in northern populations (62ºN latitude) (Burgner 1991). Adult sockeye salmon return to their natal lakes to spawn after spending one to four years at sea. The diet of adult salmon consists of amphipods, copepods, squid and other fish.

Table 59. Temporal distribution of Sockeye salmon, Snake River ESU

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="12">Present</td></tr>
<tr><td>Spawning</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td><td></td></tr>
<tr><td>Incubation (eggs)</td><td>Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Present</td></tr>
<tr><td>Emergence (alevin to fry phases</td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Present</td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance / Productivity For the Snake River ESU, the only extant population at the time of listing occurred in Redfish Lake. Adult returns to Redfish Lake during the period 1954 through 1966 ranged from 11 to 4,361 fish (Bjornn et al. 1968). In 1985, 1986, and 1987, 11, 29, and 16 sockeye, respectively, were counted at the Redfish Lake weir. Since 1987, only 18 natural-origin sockeye salmon have returned to the Stanley Basin. The first adult returns from the captive brood stock program returned to the Stanley Basin in 1999. From 1999 through 2005, 345 captive brood adults that had migrated to the ocean returned to the Stanley Basin, and returns increased to over 600 in 2008 and more than 700 returning adults in 2009. Annual adult releases during 2011-2014 averaged over 1,200; almost double the average for the prior five-year period (NWFSC 2015). The large increases in returning adults in recent years reflect improved downstream and ocean survival as well as increases in juvenile production since the early 1990s. The captive brood program has been successful in providing substantial numbers of hatchery-produced sockeye for use in supplementation efforts. While increased abundance of hatchery-reared Snake River sockeye salmon has reduced the risk of loss, levels of naturally-produced sockeye salmon returns have remained extremely low (Ford 2011; NWFSC 2015). Substantial increases in survival rates across life history stages must occur to re-establish sustainable natural production (Hebdon et al. 2004; Keefer et al. 2008).

Genetic Diversity For the Snake River ESU, the Sawtooth Hatchery is focusing on genetic conservation (NMFS 2016b). An overrepresentation of genes from the anadromous population in Redfish Lake exists, but inbreeding is low, which is a sign of a successful captive broodstock program (Kalinowski et al. 2012).

Distribution The Snake River sockeye salmon ESU includes only one population comprised of all anadromous and residual sockeye salmon from the Snake River Basin, Idaho, as well as artificially propagated sockeye salmon from the Redfish Lake captive propagation program.

Designated Critical Habitat NMFS designated critical habitat for Snake River sockeye salmon on December 28, 1993 (58 FR 68543). The critical habitat encompasses the waters, waterway bottoms, and adjacent riparian zones of specified lakes and river reaches in the Columbia River that are or were accessible to salmon of this ESU (except reaches above impassable natural falls, and Dworshak and Hells Canyon Dams). Specific PBFs were not designated in the critical habitat final rule; instead, four “essential habitat” categories were described: 1) spawning and juvenile rearing areas, 2) juvenile migration corridors, 3) areas for growth and development to adulthood, and 4) adult migration corridors.

Recovery Goals See the 2015 recovery plan for the Snake River sockeye salmon ESU for complete down-listing/delisting criteria for recovery goals for the species (NMFS 2009; NMFS

2015). Broadly, recovery plan goals emphasize restoring historical lake populations and improving water quality and quantity in lakes and migration corridors.

Table 60. Summary of status; Sockeye salmon, Snake River ESU

Criteria	Description
Abundance / productivity trends	Only one population remaining in Redfish Lake and it is supported by hatchery propagation. Increasing abundance, but well below those needed for sustainable natural production. Low resilience to future perturbations.
Listing status	Endangered
Attainment of recovery goals	Criteria not yet met
Condition of PBFs	Rearing and migration PBFs are degraded by impaired water quality from adjacent land uses; Migration PBFs are degraded by multiple dams; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; All occupied and used areas of the watershed are of high conservation value

9.20 Steelhead, California Central Valley DPS

Table 61. Steelhead, California Central Valley DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus mykiss	**Steelhead Trout**	**California Central Valley**	**Threatened**	2016	71 FR 834	2014	70 FR 52488

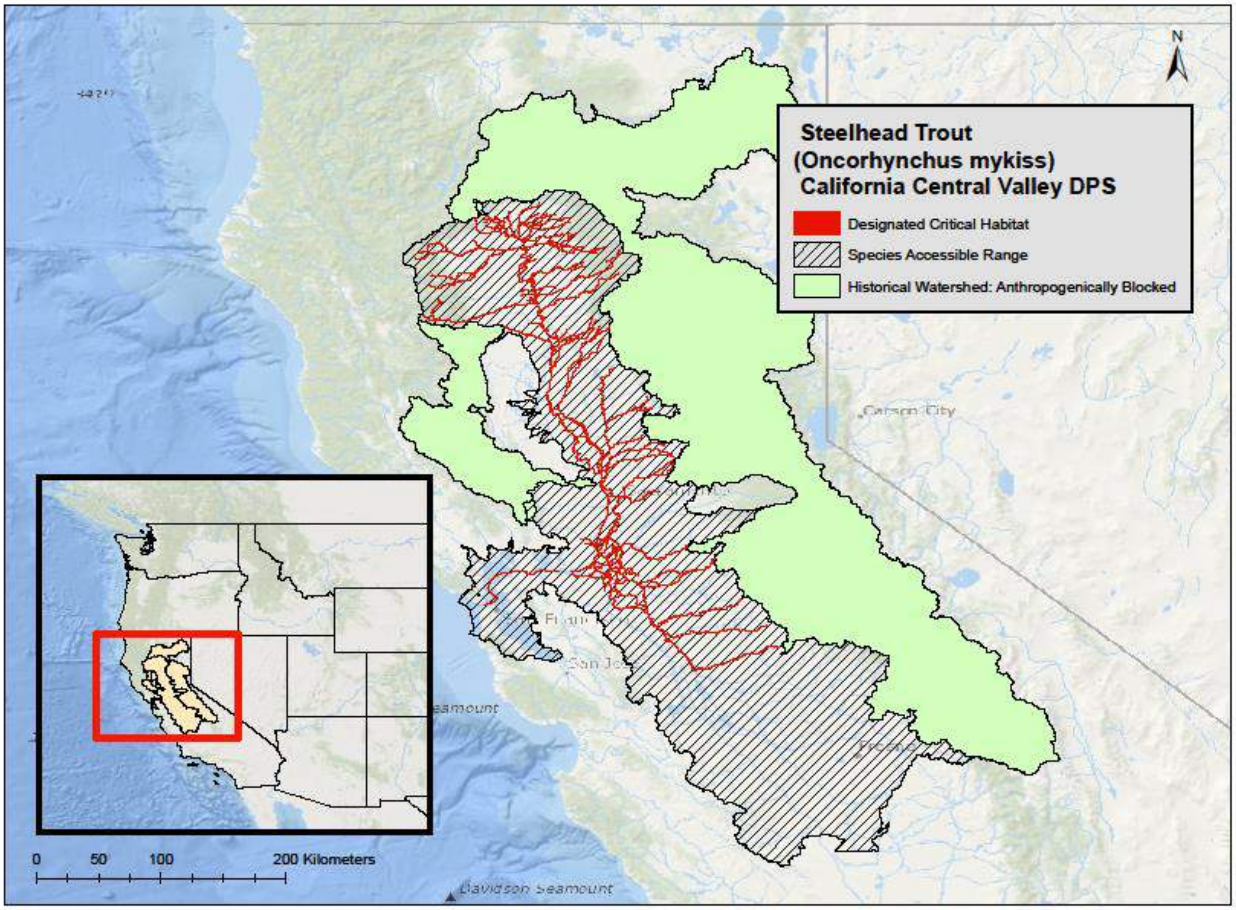

Figure 21. Steelhead, California Central Valley DPS range and designated critical habitat

Species Description Steelhead are dark-olive in color, shading to silvery-white on the underside with a speckled body and a pink-red stripe along their sides. Those migrating to the ocean develop a slimmer profile, becoming silvery in color, and typically growing larger than rainbow trout that remain in fresh water. Steelhead trout grow to 55 pounds (25 kg) in weight and 45 inches (120 cm) in length, though average size is much smaller. On March 19, 1998 NMFS listed the California Central Valley (CCV) DPS of steelhead as threatened (63 FR 13347) and reaffirmed the DPS's status as threatened on January 5, 2006 (71 FR 834). This DPS includes naturally spawned anadromous O. mykiss (steelhead) originating below natural and manmade impassable barriers from the Sacramento and San Joaquin Rivers and their tributaries; excludes such fish originating from San Francisco and San Pablo Bays and their tributaries. This DPS includes steelhead from two artificial propagation programs.

Status Many watersheds in the Central Valley are experiencing decreased abundance of CCV steelhead. Dam removal and habitat restoration efforts in Clear Creek appear to be benefiting CCV steelhead as recent increases in non-clipped (wild) abundance have been observed. Despite the positive trend in Clear Creek, all other concerns raised in the previous status review remain, including low adult abundances, loss and degradation of a large percentage of the historic spawning and rearing habitat, and domination of smolt production by hatchery fish. Many other planned restoration and reintroduction efforts have yet to be implemented or completed, or are focused on Chinook salmon, and have yet to yield demonstrable improvements in habitat, let alone documented increases in naturally produced steelhead. There are indications that natural production of steelhead continues to decline and is now at a very low levels. Their continued low numbers in most hatcheries, domination by hatchery fish, and relatively sparse monitoring makes the continued existence of naturally reproduced steelhead a concern. CCV steelhead is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

Life history Central Valley steelhead spawn downstream of dams on every major tributary within the Sacramento and San Joaquin River systems. The female steelhead selects a site with good intergravel flow, digs a redd with her tail, usually in the coarse gravel of the tail of a pool or in a riffle, and deposits eggs while an attendant male fertilizes them. The preferred water temperature range for steelhead spawning is reported to be 30°F to 52°F (CDFW 2000). Following deposition of fertilized eggs in the redd, they are covered with loose gravel. The eggs hatch in three to four weeks at 50°F to 59°F, and fry emerge from the gravel four to six weeks later (Shapovalov and Taft 1954). Regardless of life history strategy, for the first year or two of life steelhead are found in cool, clear, fastflowing permanent streams and rivers where riffles predominate over pools, there is ample cover from riparian vegetation or undercut banks, and invertebrate life is diverse and abundant (Moyle 2002). The smallest fish are most often found in riffles, intermediate size fish in runs, and larger fish in pools.

Steelhead typically migrate to marine waters after spending two years in fresh water. They reside in marine waters for typically two or three years prior to returning to their natal stream to spawn as four- or five-yearolds. Unlike Pacific salmon, steelhead are capable of spawning more than once before they die. However, it is rare for steelhead to spawn more than twice before dying, and most that do so are females (Moyle 2002). Currently, Central Valley steelhead are considered “ocean-maturing” (also known as winter) steelhead, although summer steelhead may have been present prior to construction of large dams (Moyle 2002). Ocean maturing steelhead enter fresh water with well-developed gonads and spawn shortly after river entry. Central Valley steelhead enter fresh water from August through April. They hold until flows are high enough in tributaries to enter for spawning (Moyle 2002). Steelhead adults typically spawn from December through April, with peaks from January through March in small streams and tributaries where cool, well oxygenated water is available year-round (Hallock *et al.* 1961; McEwan 2001).

Table 62. Temporal distribution of Steelhead, California Central Valley DPS

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="5">Present</td><td></td><td colspan="6">Present</td></tr>
<tr><td>Spawning</td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Present</td></tr>
<tr><td>Incubation (eggs)</td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Present</td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance Historic CCV steelhead run size may have approached one to two million adults annually (McEwan 2001). By the early 1960s, the steelhead run size had declined to about 40,000 adults (McEwan 2001). Over the past 30 years, the naturally spawned steelhead populations in the upper Sacramento River have declined substantially. Hallock *et al.* (1961) estimated an average of 20,540 adult steelhead in the Sacramento River, upstream of the Feather River, through the 1960s. Steelhead were counted at the Red Bluff Diversion Dam (RBDD) up until 1993. Counts at the dam declined from an average of 11,187 for the period of 1967 to 1977, to an average of approximately 2,000 through the early 1990s. An estimated total annual run size for the entire Sacramento-San Joaquin system was no more than 10,000 adults during the early 1990s (McEwan and Jackson 1996; McEwan 2001). Based on catch ratios at Chipps Island in the Delta and using some generous assumptions regarding survival, the average number of CCV steelhead females spawning naturally in the entire Central Valley during the years 1980 to 2000 was estimated at about 3,600 (Good et al. 2005b)

Productivity / Population Growth Rate CCV steelhead lack annual monitoring data for calculating trends and lambda. However, the RBDD counts and redd counts up to 1993 and later sporadic data show that the DPS has had a significant long-term downward trend in abundance (NMFS 2009a).

Genetic Diversity / Distribution The CCV steelhead distribution ranged over a wide variety of environmental conditions and likely contained biologically significant amounts of spatially structured genetic diversity (Lindley et al. 2006). Thus, the loss of populations and reduction in abundances have reduced the large diversity that existed within the DPS. The genetic diversity of the majority of CCV steelhead spawning runs is also compromised by hatchery-origin fish.

Designated Critical Habitat NMFS designated critical habitat for CCV steelhead on September 2, 2005 (70 FR 52488). PBFs considered essential for the conservation of Steelhead, California Central Valley DPS are:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development.
- Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
- Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic

vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.
- Estuarine areas free of obstruction with water

Recovery Goals See the 2014 recovery plan for the California Central Valley steelhead DPS for complete down-listing/delisting criteria for recovery goals for the species. The delisting criteria for this DPS are:

- One population in the Northwestern California Diversity Group at low risk of extinction
- Two populations in the Basalt and Porous Lava Flow Diversity Group at low risk of extinction
- Four populations in the Northern Sierra Diversity Group at low risk of extinction
- Two populations in the Southern Sierra Diversity Group at low risk of extinction
- Maintain multiple populations at moderate risk of extinction

The current condition of CCV steelhead critical habitat is degraded, and does not provide the conservation value necessary for species recovery. In addition, the Sacramento-San Joaquin River Delta, as part of CCV steelhead designated critical habitat, provides very little function necessary for juvenile CCV steelhead rearing and physiological transition to salt water.

The spawning PBF is subject to variations in flows and temperatures, particularly over the summer months. Some complex, productive habitats with floodplains remain in the system and flood bypasses (*i.e.*, Yolo and Sutter bypasses). However, the rearing PBF is degraded by the channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento-San Joaquin system and which typically have low habitat complexity, low abundance of food organisms, and offer little protection from either fish or avian predators. Stream channels commonly have elevated temperatures.

The current conditions of migration corridors are substantially degraded. Both migration and rearing PBFs are affected by dense urbanization and agriculture along the mainstems and in the Delta which contribute to reduced water quality by introducing several contaminants. In the Sacramento River, the migration corridor for both juveniles and adults is obstructed by the RBDD gates which are down from May 15 through September 15. The migration PBF is also obstructed by complex channel configuration making it more difficult for CCV steelhead to migrate successfully to the western Delta and the ocean. In addition, the state and federal government pumps and associated fish facilities change flows in the Delta which impede and obstruct for a functioning migration corridor that enhance migration. The estuarine PBF, which is present in the Delta, is affected by contaminants from agricultural and urban runoff and release of wastewater treatment plants effluent.

Table 63. Summary of status; Steelhead, California Central Valley DPS

Criteria	Description
Abundance / productivity trends	Long-term trend of declining abundances and reduced genetic diversity. Populations supplemented by hatchery propagation.
Listing status	Threatened
Attainment of recovery goals	Criteria not yet met

Condition of PBFs	Spawning PBFs are degraded by altered water flows and temperature; Rearing and migration PBFs are degraded by altered riverine habitat, dense urbanization and agriculture, poor water quality, and water diversions; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of 67 occupied watersheds, 37 are of high and 18 are of medium conservation value

9.21 Steelhead, Central California Coast DPS

Table 64. Steelhead, Central California Coast DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus mykiss	Steelhead Trout	Central California Coast	Threatened	2011	71 FR 834	2016	70 FR 52488

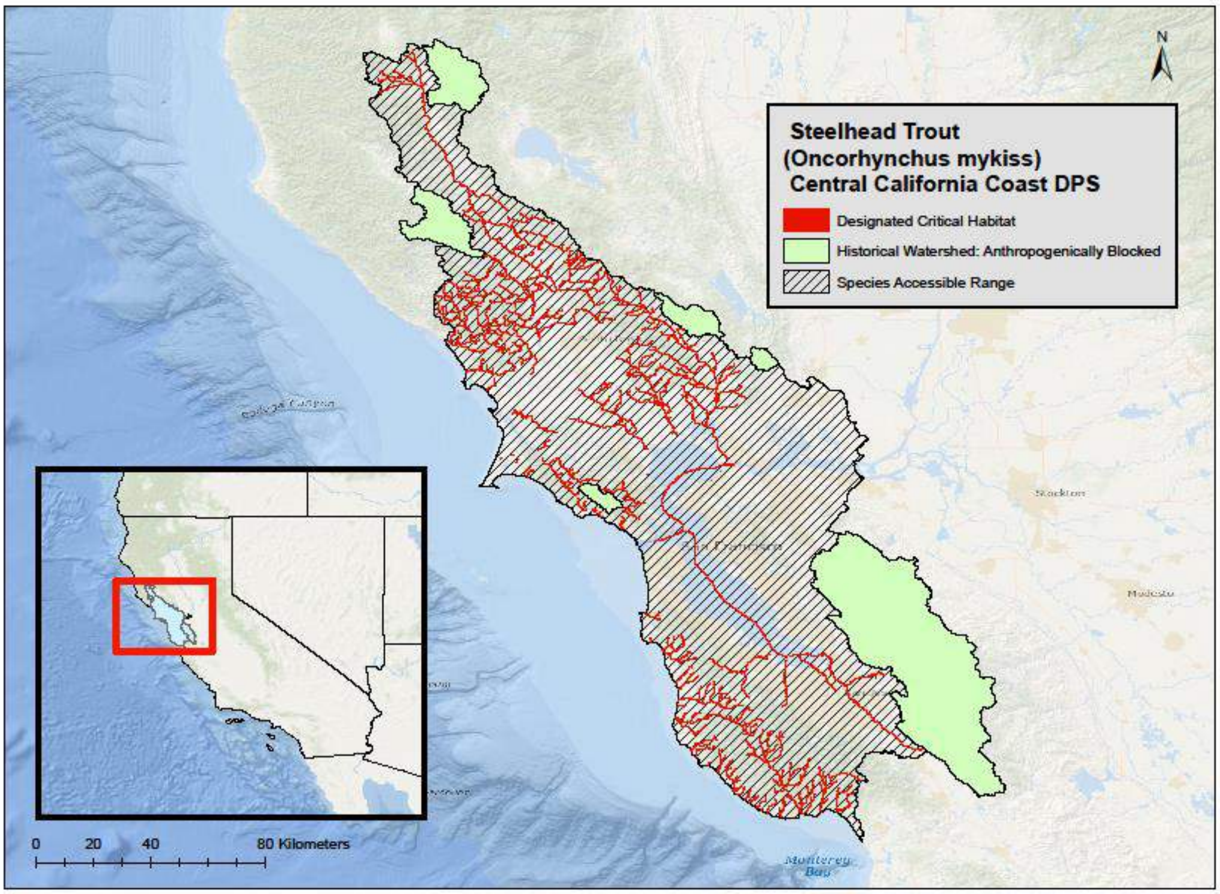

Figure 22. Steelhead, Central California Coast DPS range and designated critical habitat

Species Description Steelhead are dark-olive in color, shading to silvery-white on the underside with a speckled body and a pink-red stripe along their sides . Those migrating to the ocean develop a slimmer profile, becoming silvery in color, and typically growing larger than rainbow trout that remain in fresh water. Steelhead trout grow to 55 pounds (25 kg) in weight and 45 inches (120 cm) in length, though average size is much smaller. On August 18, 1997 NMFS listed the Central California Coast (CCC) DPS of steelhead as threatened (62 FR 43937) and reaffirmed the DPS's status as threatened on January 5, 2006 (71 FR 834). This DPS includes all naturally spawned populations of steelhead (and their progeny) in streams from the Russian

River to Aptos Creek, Santa Cruz County, California (inclusive). It also includes the drainages of San Francisco and San Pablo Bays.

Status The CCC steelhead consisted of nine historic functionally independent populations and 23 potentially independent populations (Bjorkstedt et al. 2005). Of the historic functionally independent populations, at least two are extirpated while most of the remaining are nearly extirpated. Current runs in the basins that originally contained the two largest steelhead populations for CCC steelhead, the San Lorenzo and the Russian Rivers, both have been estimated at less than 15% of their abundances just 30 years earlier (Good et al. 2005b). The Russian River is of particular importance for preventing the extinction and contributing to the recovery of CCC steelhead (NOAA 2013). Steelhead access to significant portions of the upper Russian River has also been blocked (Busby et al. 1996; NMFS 2008).

Life history The DPS is entirely composed of winter-run fish, as are those DPSs to the south. Adults return to the Russian River and migrate upstream from December – April, and smolts emigrate between March – May) (Hayes et al. 2004; Shapovalov and Taft 1954a). Most spawning takes place from January through April. While age at smoltification typically ranges for one to four years, recent studies indicate that growth rates in Soquel Creek likely prevent juveniles from undergoing smoltification until age two (Sogard et al. 2009). Survival in fresh water reaches tends to be higher in summer and lower from winter through spring for year classes 0 and 1 (Sogard et al. 2009). Larger individuals also survive more readily than do smaller fish within year classes (Sogard et al. 2009). Greater movement of juveniles in fresh water has been observed in winter and spring versus summer and fall time periods. Smaller individuals are more likely to be observed to exceed 0.3 mm per day, and are highest in winter through spring, potentially due to higher water flow rates and greater food availability (Boughton et al. 2007; Sogard et al. 2009).

Table 65. Temporal distribution of Steelhead, Central California Coast DPS

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Present</td></tr>
<tr><td>Spawning</td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td colspan="5">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance Historically, the entire CCC steelhead DPS may have consisted of an average runs size of 94,000 adults in the early 1960s (Good et al. 2005b). Information on current CCC steelhead populations consists of anecdotal, sporadic surveys that are limited to only smaller portions of watersheds. Presence-absence data indicated that most (82%) sampled streams (a subset of all historical steelhead streams) had extant populations of juvenile *O. mykiss* (Adams 2000; Good et al. 2005b).

Productivity / Population Growth Rate Though the information for individual populations is limited, available information strongly suggests that no population is viable. Long-term population sustainability is extremely low for the southern populations in the Santa Cruz mountains and in the San Francisco Bay (NMFS 2008). Declines in juvenile southern populations are consistent with the more general estimates of declining abundance in the region

(Good et al. 2005b). The interior Russian River winter-run steelhead has the largest runs with an estimate of an average of over 1,000 spawners; it may be able to be sustained over the long-term but hatchery management has eroded the population's genetic diversity (Bjorkstedt et al. 2005; NMFS 2008). Data on abundance trends do not exist for the DPS as a whole or for individual watersheds. Thus, it is not possible to calculate long-term trends or lambda.

Genetic Diversity / Distribution This DPS includes all naturally spawned populations of steelhead (and their progeny) in streams from the Russian River to Aptos Creek, Santa Cruz County, California (inclusive). It also includes the drainages of San Francisco and San Pablo Bays.

Designated Critical Habitat Critical habitat was designated for this species on September 2, 2005 (70 FR 52630). It includes the Russian River watershed, coastal watersheds in Marin County, streams within the San Francisco Bay, and coastal watersheds in the Santa Cruz Mountains down to Apos Creek. PBFs considered essential for the conservation of Steelhead, Central California Coast DPS are:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development.
- Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
- Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.
- Estuarine areas free of obstruction with water

Streams throughout the critical habitat have reduced quality of spawning PBFs; sediment fines in spawning gravel have reduced the ability of the substrate attribute to provide well oxygenated and clean water to eggs and alevins. High proportions of fines in bottom substrate also reduce forage by limiting the production of aquatic stream insects adapted to running water. Elevated water temperatures and impaired water quality have further reduced the quality, quantity and function of the rearing PBF within most streams. These impacts have diminished the ability of designated critical habitat to conserve the CCC steelhead.

Recovery Goals See the 2016 recovery plan for the Central California Coast steelhead DPS for complete down-listing/delisting criteria for recovery goals for the species. Recovery plan objectives are to:

- Reduce the present or threatened destruction, modification, or curtailment of habitat or range;
- Ameliorate utilization for commercial, recreational, scientific, or educational purposes;
- Abate disease and predation;
- Establish the adequacy of existing regulatory mechanisms for protecting CCC steelhead now and into the future (i.e., post-delisting);

- Address other natural or manmade factors affecting the continued existence of CCC steelhead;
- Ensure CCC steelhead status is at a low risk of extinction based on abundance, growth rate, spatial structure and diversity.

Table 66. Summary of status; Steelhead, Central California Coast DPS

Criteria	Description
Abundance / productivity trends	5-year population trend uncertain. Population abundance supplemented by hatchery propagation. Populations are likely not viable, and have lost spatial structure.
Listing status	threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Spawning and rearing PBFs are degraded by sedimentation and elevated temperature; All PBFs are degraded by loss of habitat, low summer flows, erosion, and contaminants; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of 47 occupied watersheds, 19 are of high and 15 are of medium conservation value

9.22 Steelhead, Lower Columbia River DPS

Table 67. Steelhead, Lower Columbia River DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus mykiss	Steelhead Trout	Lower Columbia River	Threatened	2016	71 FR 834	2013	70 FR 52630

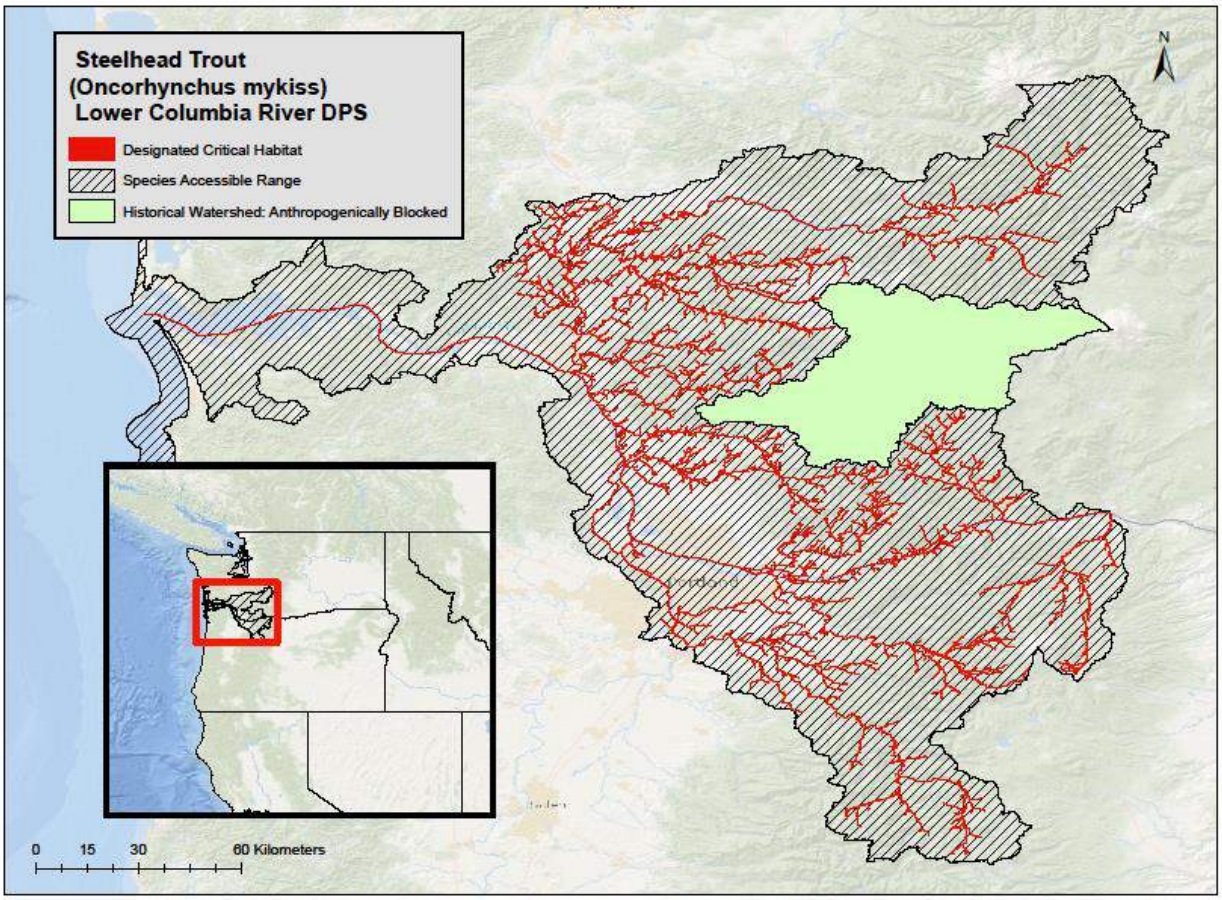

Figure 23. Steelhead, Lower Columbia River DPS range and designated critical habitat

Species Description Steelhead are dark-olive in color, shading to silvery-white on the underside with a speckled body and a pink-red stripe along their sides . Those migrating to the ocean develop a slimmer profile, becoming silvery in color, and typically growing larger than rainbow trout that remain in fresh water. Steelhead trout grow to 55 pounds (25 kg) in weight and 45 inches (120 cm) in length, though average size is much smaller. On March 19, 1998 NMFS listed the Lower Columbia River (LCR) DPS of steelhead as threatened (63 FR 13347) and reaffirmed the DPS's status as threatened on January 5, 2006 (71 FR 834). This DPS includes naturally spawned anadromous O. mykiss (steelhead) originating below natural and manmade impassable barriers from rivers between the Cowlitz and Wind Rivers (inclusive) and the Willamette and

Hood Rivers (inclusive); excludes such fish originating from the upper Willamette River basin above Willamette Falls. This DPS includes steelhead from seven artificial propagation programs.

Status The LCR steelhead had 17 historically independent winter steelhead populations and 6 independent summer steelhead populations (McElhany et al. 2003; Myers et al. 2006). All historic LCR steelhead populations are considered extant. However, spatial structure within the historically independent populations, especially on the Washington side, has been substantially reduced by the loss of access to the upper portions of some basins due to tributary hydropower development. The majority of winter-run steelhead populations in this DPS continue to persist at low abundances (NWFSC 2015). Hatchery interactions remain a concern in select basins, but the overall situation is somewhat improved compared to prior reviews. Summer-run steelhead DIPs were similarly stable, but at low abundance levels. Habitat degradation continues to be a concern for most populations. Even with modest improvements in the status of several winter-run populations, none of the populations appear to be at fully viable status, and similarly none of the MPGs meet the criteria for viability. The DPS therefore continues to be at moderate risk (NWFSC 2015).

Life history The LCR steelhead DPS includes both summer- and winter-run stocks. Summer-run steelhead return sexually immature to the Columbia River from May to November, and spend several months in fresh water prior to spawning. Winter-run steelhead enter fresh water from November to April, are close to sexual maturation during freshwater entry, and spawn shortly after arrival in their natal streams. Where both races spawn in the same stream, summer-run steelhead tend to spawn at higher elevations than the winter-run.

The majority of juvenile LCR steelhead remain for two years in freshwater environments before ocean entry in spring. Both winter- and summer-run adults normally return after two years in the marine environment.

Table 68. Temporal distribution of Steelhead, Lower Columbia River DPS

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="12">Present</td></tr>
<tr><td>Spawning</td><td></td><td></td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td></td><td></td><td colspan="5">Present</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Emergence (alevin to fry phases</td><td></td><td></td><td></td><td></td><td colspan="4">Present</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance All LCR steelhead populations declined from 1980 to 2000, with sharp declines beginning in 1995. Historical counts in some of the larger tributaries (Cowlitz, Kalama, and Sandy Rivers) suggest the population probably exceeded 20,000 fish. During the 1990s, fish abundance dropped to 1,000 to 2,000 fish. Recent abundance estimates of natural-origin spawners range from completely extirpated for some populations above impassable barriers to over 700 fishes for the Kalama and Sandy winter-run populations. A number of the populations have a substantial fraction of hatchery-origin spawners in spawning areas. Many of the long-and short-term trends in abundance of individual populations are negative.

Productivity / Population Growth Rate There is a difference in population stability between winter- and summer-run LCR steelhead. The winter-run steelhead in the Cascade region has the highest likelihood of being sustained as it includes a few populations with moderate abundance and positive short-term population growth rates (Good et al. 2005b; McElhany et al. 2007a). The Gorge summer-run steelhead is at the highest risk over the long-term as the Hood River population is at high risk of being lost (McElhany et al. 2007a)

Genetic Diversity / Distribution This DPS includes naturally spawned anadromous O. mykiss (steelhead) originating below natural and manmade impassable barriers from rivers between the Cowlitz and Wind Rivers (inclusive) and the Willamette and Hood Rivers (inclusive); excludes such fish originating from the upper Willamette River basin above Willamette Falls. This DPS includes steelhead from seven artificial propagation programs. The WLC TRT identified 23 historical independent populations of Lower Columbia River steelhead: 17 winter-run populations and six summer-run populations, within the Cascade and Gorge ecozones.

Designated Critical Habitat Critical habitat was designated for the LCR steelhead on September 2, 2005 (70 FR 52488). PBFs considered essential for the conservation of Steelhead, Lower Columbia River DPS are:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development.
- Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
- Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.
- Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.
- Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels
- Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

Critical habitat is affected by reduced quality of rearing and juvenile migration PBFs within the lower portion and alluvial valleys of many watersheds; contaminants from agriculture affect both water quality and food production in these reaches of tributaries and in the mainstem Columbia River. Several dams affect adult migration PBF by obstructing the migration corridor. Watersheds which consist of a large proportion of federal lands such as is the case with the Sandy River watershed, have relatively healthy riparian corridors that support attributes of the rearing PBF such as cover, forage, and suitable water quality.

Recovery Goals NMFS therefore has developed the following delisting criteria for the Lower Columbia River steelhead DPS. (NMFS has amended the WLC TRT's criteria to incorporate the concept that each stratum should have a probability of persistence consistent with its historical condition, thus allowing for resolution of questions regarding the Gorge strata):

1. All strata that historically existed have a high probability of persistence or have a probability of persistence consistent with their historical condition. High probability of stratum persistence is defined as:
    a. At least two populations in the stratum have at least a 95% probability of persistence over a 100-year time frame (i.e., two populations with a score of 3.0 or higher based on the TRT's scoring system).
    b. Other populations in the stratum have persistence probabilities consistent with a high probability of stratum persistence (i.e., the average of all stratum population scores is 2.25 or higher, based on the TRT's scoring system). (See Section 2.6 for a brief discussion of the TRT's scoring system.)
    c. Populations targeted for a high probability of persistence are distributed in a way that minimizes risk from catastrophic events, maintains migratory connections among populations, and protects within-stratum diversity.

    A probability of persistence consistent with historical condition refers to the concept that strata that historically were small or had complex population structures may not have met Criteria A through C, above, but could still be considered sufficiently viable if they provide a contribution to overall ESU viability similar to their historical contribution.

2. The threats criteria described in Section 3.2.2 of the recovery plan have been met.

Table 69. Summary of status; Steelhead, Lower Columbia River DPS

Criteria	Description
Abundance / productivity trends	5-year population trend stable. Populations have low genetic diversity and impacted by a loss of available habitat.
Listing status	threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Rearing PBFs are degraded by agricultural runoff and lack of available prey; Spawning, rearing and migration PBFs are degraded by timber harvests, dams, and loss of floodplain habitat; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of 41 occupied watersheds, 28 are of high and 11 are of medium conservation value

9.23 Steelhead, Middle Columbia River DPS

Table 70. Steelhead, Middle Columbia River DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus mykiss	Steelhead Trout	Middle Columbia River	Threatened	2016	71 FR 834	2009	70 FR 52630

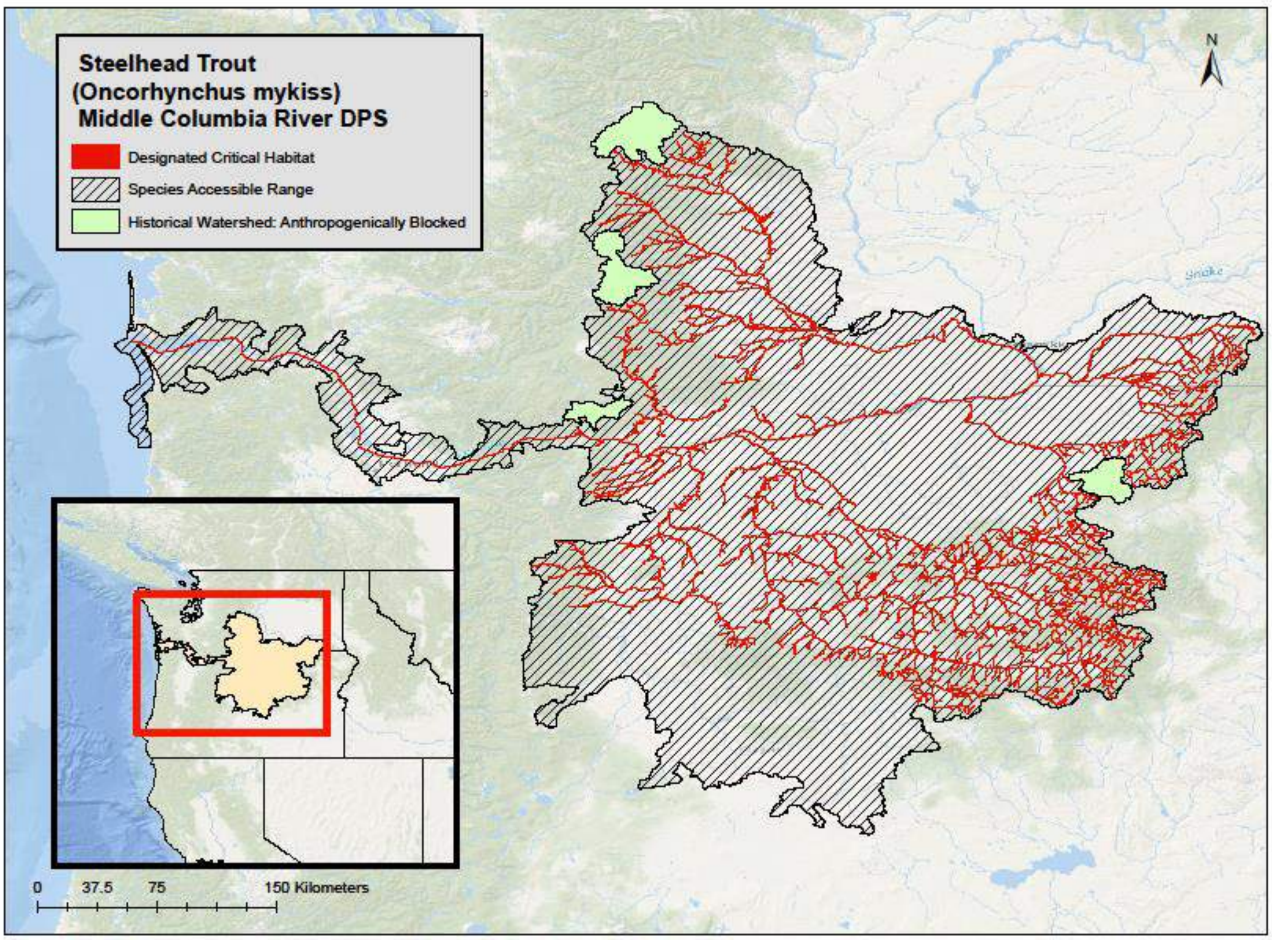

Figure 24. Steelhead, Middle Columbia River DPS range and designated critical habitat

Species Description Steelhead are dark-olive in color, shading to silvery-white on the underside with a speckled body and a pink-red stripe along their sides . Those migrating to the ocean develop a slimmer profile, becoming silvery in color, and typically growing larger than rainbow trout that remain in fresh water. Steelhead trout grow to 55 pounds (25 kg) in weight and 45 inches (120 cm) in length, though average size is much smaller. On March 25, 1999 NMFS listed the Middle Columbia River (MCR) DPS of steelhead as threatened (64 FR 14517) and reaffirmed the DPS's status as threatened on January 5, 2006 (71 FR 834). This DPS includes naturally spawned anadromous O. mykiss (steelhead) originating below natural and manmade impassable barriers from the Columbia River and its tributaries upstream of the Wind and Hood Rivers (exclusive) to and including the Yakima River; excludes such fish originating from the Snake River basin. This DPS includes steelhead from seven artificial propagation programs.

Status The ICTRT identified 16 extant populations in four major population groups (Cascades Eastern Slopes Tributaries, John Day River, Walla Walla and Umatilla Rivers, and Yakima River) and one unaffiliated independent population (Rock Creek) (ICTRT 2003). There are two extinct populations in the Cascades Eastern Slope major population group: the White Salmon River and the Deschutes Crooked River above the Pelton/Round Butte Dam complex. Present population structure is delineated largely on geographical proximity, topography, distance, ecological similarities or differences. Using criteria for abundance and productivity, the ICTRT modeled a gaps analysis for each of the four MPGs in this DPS under three different ocean conditions and a base hydro condition (most recent 20-year survival rate). The results showed that none of the MPGs would be able to achieve a five % or less risk of extinction over 100 years without recovery actions. It is important to consider that significant gaps in factors affecting spatial structure and diversity also contribute to the risk of extinction for these fish.

Life history MCR steelhead populations are mostly of the summer-run type. Adult steelhead enter fresh water from June through August. The only exceptions are populations of inland winter-run steelhead which occur in the Klickitat River and Fifteenmile Creek (Busby et al. 1996).

The majority of juveniles smolt and outmigrate as two-year olds. Most of the rivers in this region produce about equal or higher numbers of adults having spent one year in the ocean as adults having spent two years. However, summer-run steelhead in Klickitat River have a life cycle more like LCR steelhead whereby the majority of returning adults have spent two years in the ocean (Busby et al. 1996). Adults may hold in the river up to a year before spawning.

Table 71. Temporal distribution of Steelhead, Middle Columbia River DPS

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="12">Present</td></tr>
<tr><td>Spawning</td><td colspan="7">Present</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td colspan="7">Present</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td></td><td></td><td colspan="5">Present</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance Historic run estimates for the Yakima River imply that annual species abundance may have exceeded 300,000 returning adults (Busby et al. 1996). The five-year average (geometric mean) return of natural MCR steelhead for 1997 to 2001 was up from previous years' basin estimates. Returns to the Yakima River, the Deschutes River, and sections of the John Day River system were substantially higher compared to 1992 to 1997 (Good et al. 2005b). The five-year average for these basins is 298 and 1,492 fish, respectively (Good et al. 2005b).

Productivity / Population Growth Rate Good *et al.* (2005b) calculated that the median estimate of long-term trend over 12 indicator data sets was –2.1% per year (–6.9 to 2.9), with 11 of the 12 being negative. Long-term annual population growth rates (λ) were also negative

(Good et al. 2005b). The median long-term λ was 0.98, assuming that hatchery spawners do not contribute to production, and 0.97 assuming that both hatchery- and natural-origin spawners contribute equally.

Distribution The MCR steelhead DPS includes all naturally spawned steelhead populations below natural and manmade impassable barriers in streams from above the Wind River, Washington, and the Hood River, Oregon (exclusive), upstream to, and including, the Yakima River, Washington, excluding *O. mykiss* from the Snake River Basin. Steelhead from the Snake River basin (described later in this section) are excluded from this DPS. Seven artificial propagation programs are part of this DPS. They include: the Touchet River Endemic, Yakima River Kelt Reconditioning Program (in Satus Creek, Toppenish Creek, Naches River, and Upper Yakima River), Umatilla River, and the Deschutes River steelhead hatchery programs. These artificially propagated populations are considered no more divergent relative to the local natural populations than would be expected between closely related natural populations within the DPS. According to the ICBTRT (ICTRT 2003), this DPS is composed of 16 populations in four major population groups (Cascade Eastern Slopes Tributaries, John Day River, Walla Walla and Umatilla Rivers, and Yakima River), and one unaffiliated population (Rock Creek).

Designated Critical Habitat Critical habitat was designated for this species on September 2, 2005 (70 FR 52630). PBFs considered essential for the conservation of Steelhead, Middle Columbia River DPS are:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development;
- Freshwater rearing sites with:
  - Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility;
  - Water quality and forage supporting juvenile development;
  - Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
- Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival;
- Estuarine areas free of obstruction and excessive predation with:
  - Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh & saltwater;
  - Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels;
  - Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.
- Nearshore marine areas free of obstruction and excessive predation with:
  - Water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and
  - Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.

- Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

The current condition of critical habitat designated for the MCR steelhead is moderately degraded. Critical habitat is affected by reduced quality of juvenile rearing and migration PBFs within many watersheds; contaminants from agriculture affect both water quality and food production in several watersheds and in the mainstem Columbia River. Loss of riparian vegetation to grazing has resulted in high water temperatures in the John Day basin. Reduced quality of the rearing PBFs has diminished its contribution to the conservation value necessary for the recovery of the species. Several dams affect adult migration PBF by obstructing the migration corridor.

Recovery Goals See the 2016 recovery plan for the Middle Columbia River steelhead DPS for complete down-listing/delisting criteria for recovery goals for the species (NMFS 2009b).

Table 72. Summary of status; Steelhead, Middle Columbia River DPS

Criteria	Description
Abundance / productivity trends	5-year population trend stable to improving, but abundances still low compared to historical numbers.
Listing status	threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Rearing PBFs are degraded by water quality, reduced invertebrate prey, and loss of riparian vegetation; Migration PBFs are degraded by several dams; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of 106 assessed watersheds, 73 are of high and 24 are of medium conservation value

9.24 Steelhead, Northern California DPS

Table 73. Steelhead, Northern California DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus mykiss	Steelhead Trout	Northern California	Threatened	2016	71 FR 834	2016	70 FR 52488

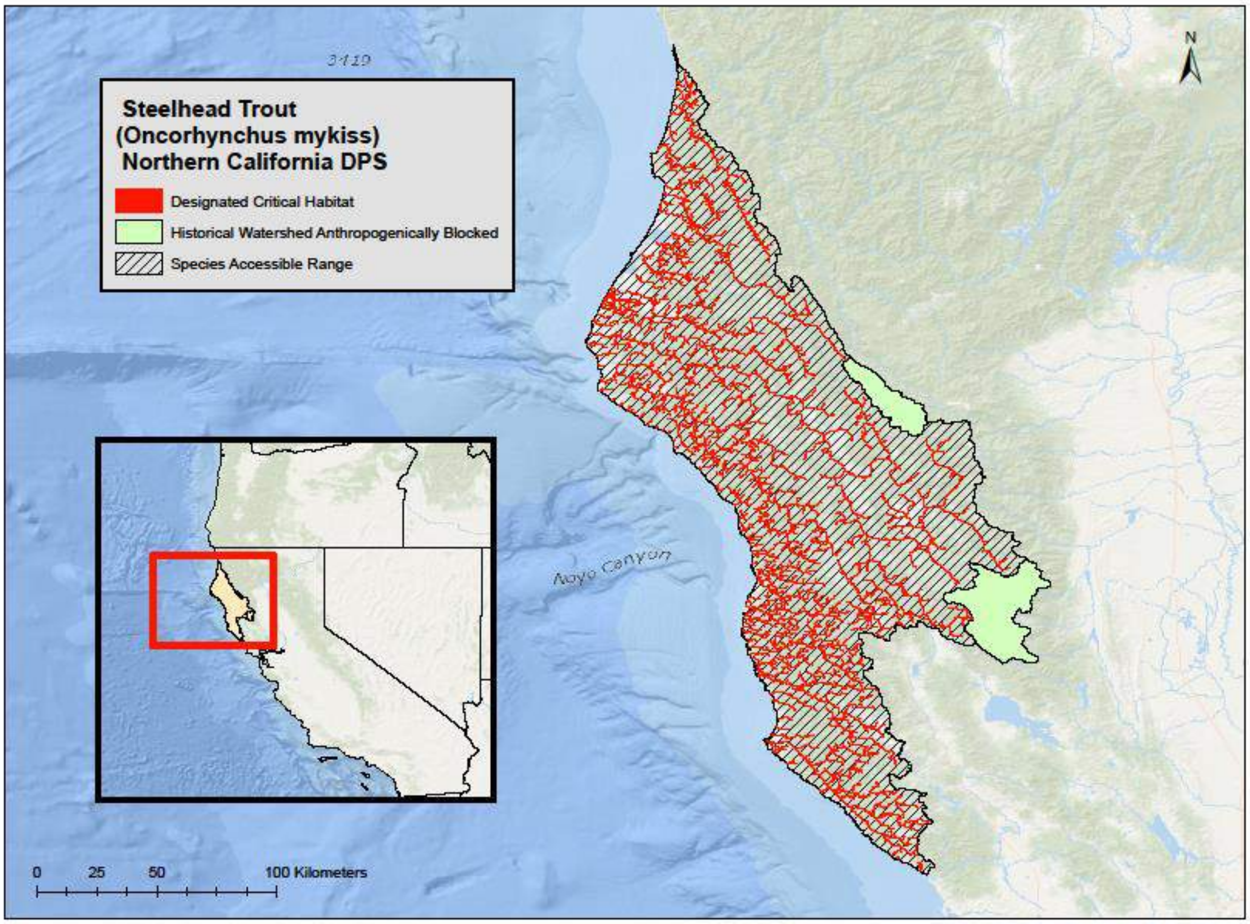

Figure 25. Steelhead, Northern California DPS range and designated critical habitat

Species Description Steelhead are dark-olive in color, shading to silvery-white on the underside with a speckled body and a pink-red stripe along their sides . Those migrating to the ocean develop a slimmer profile, becoming silvery in color, and typically growing larger than rainbow trout that remain in fresh water. Steelhead trout grow to 55 pounds (25 kg) in weight and 45 inches (120 cm) in length, though average size is much smaller. On June 7, 2000 NMFS listed the Northern California (NC) DPS of steelhead as threatened (65 FR 36074) and reaffirmed the DPS's status as threatened on January 5, 2006 (71 FR 834). This DPS includes naturally spawned anadromous O. mykiss (steelhead) originating below natural and manmade impassable barriers in California coastal river basins from Redwood Creek to and including the Gualala River.

Status The available data for winter-run populations— predominately in the North Coastal, North-Central Coastal, and Central Coastal strata— indicate that all populations are well below viability targets, most being between 5% and 13% of these goals. For the two Mendocino Coast populations with the longest time series, Pudding Creek and Noyo River, the 13-year trends have been negative and neutral, respectively (Spence 2016). However, the short-term (6-year) trend has been generally positive for all independent populations in the North-Central Coastal and Central Coastal strata, including the Noyo River and Pudding Creek (Spence 2016). Data from Van Arsdale Station likewise suggests that, although the long-term trend has been negative, run sizes of natural-origin steelhead have stabilized or are increasing (Spence 2016). Thus, we have no strong evidence to indicate conditions for winter-run populations in the DPS have worsened appreciably since the last status review (Williams et al. 2011). Summer-run populations continue to be of significant concern because of how few populations currently exist. The Middle Fork Eel River population has remained remarkably stable for nearly five decades and is closer to its viability target than any other population in the DPS (Spence 2016). Although the time series is short, the Van Duzen River appears to be supporting a population numbering in the low hundreds. However, the Redwood Creek and Mattole River populations appear small, and little is known about other populations including the Mad River and other tributaries of the Eel River (i.e., Larabee Creek, North Fork Eel, and South Fork Eel). Most populations for which there are population estimates available remain well below viability targets; however, the short-term increases observed for many populations, despite the occurrence of a prolonged drought in northern California, suggests this DPS is not at immediate risk of extinction.

Life history This DPS includes both winter- and summer –run steelhead. In the Mad and Eel Rivers, immature steelhead may return to fresh water as "half-pounders" after spending only two to four months in the ocean. Generally, a half-pounder will overwinter in fresh water and return to the ocean in the following spring.

Juvenile out-migration appears more closely associated with size than age but generally, throughout their range in California, juveniles spend two years in fresh water (Busby et al 1996). Smolts range from 14-21 cm in length. Juvenile steelhead may migrate to rear in lagoons throughout the year with a peak in the late spring/early summer and in the late fall/early winter period (Shapovalov and Taft 1954a; Zedonis 1992).

Steelhead spend anywhere from one to five years in salt water, however, two to three years are most common (Busby et al. 1996). Ocean distribution is not well known but coded wire tag recoveries indicate that most NC steelhead migrate north and south along the continental shelf (Barnhart 1986).

Table 74. Temporal distribution of Steelhead, Northern California DPS

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Spawning</td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Present</td></tr>
<tr><td>Incubation (eggs)</td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Emergence (alevin to fry phases</td><td></td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance Northern California steelhead historic functionally independent populations and their abundances and hatchery contributions are provided in Table 75.

Table 75. Northern California DPS steelhead historic and recent spawner abundance

Population	Historical Abundance	Recent Spawner Abundance	Hatchery Abundance Contributions
Mad River (S)	6,000	162-384	2%
MF Eel River (S)	Unknown	384-1,246	0%
NF Eel River (S)	Unknown	Extirpated	N/A
Mattole River (S)	Unknown	9-30*	Unknown
Redwood Creek (S)	Unknown	6*	Unknown
Van Duzen (W)	10,000	Unknown	Unknown
Mad River (W)	6,000	Unknown	Unknown
SF Eel River (W)	34,000	2743-20,657	Unknown
Mattole River (W)	12,000	Unknown	Unknown
Redwood Creek (W)	10,000	Unknown	Unknown
Humboldt Bay (W)	3,000	Unknown	Unknown
Freshwater Creek (W)		25-32	
Ten Mile River (W)	9,000	Unknown	Unknown
Noyo River (W)	8,000	186-364*	Unknown
Big River (W)	12,000	Unknown	Unknown
Navarro River (W)	16,000	Unknown	Unknown
Garcia River (W)	4,000	Unknown	Unknown
Gualala River (W)	16,000	Unknown	Unknown
Total	198,000	Unknown	

**From Spence et al. (2008). Redwood Creek abundance is mean count over four generations. Mattole River abundances from surveys conducted between 1996 and 2005. Noyo River abundances from surveys conducted since 2000.*
Summer –run steelhead is noted with a (S) and winter-run steelhead with a (W)

Productivity / Population Growth Rate Good *et al.* (2005b) estimated lambda at 0.98 with a 95% confidence interval of 0.93 and 1.04. The result is an overall downward trend in both the long- and short- term. Juvenile data were also recently examined. Both upward and downward trends were apparent (Good et al. 2005b).

Reduction of summer-run steelhead populations has significantly reduced current DPS diversity compared to historic conditions. Of the 10 summer-run steelhead populations, only four are extant. Of these, only the Middle Fork Eel River population is at moderate risk of extinction, the remaining three are at high risk (Spence et al. 2008a). Hatchery influence has likely been limited.

Genetic Diversity / Distribution: Artificial propagation was identified as negatively affecting wild stocks of salmonids through interactions with non-native fish, introductions of disease, genetic changes, competition for space and food resources, straying and mating with native populations, loss of local genetic adaptations, mortality associated with capture for broodstock and palliating the destruction of habitat and concealing problems facing wild stocks.

Designated Critical Habitat NMFS designated critical habitat for NC steelhead on September 2, 2005 (70 FR 52488). PBFs considered essential for the conservation of Steelhead, Northern California DPS are:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development.
- Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
- Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.
- Estuarine areas free of obstruction with water

The current condition of critical habitat designated for the NC steelhead is moderately degraded. Nevertheless, it does provide some conservation value necessary for species recovery. Within portions of its range, especially the interior Eel River, rearing PBF quality is affected by elevated temperatures by removal of riparian vegetation. Spawning PBF attributes such as the quality of substrate supporting spawning, incubation, and larval development have been generally degraded throughout designated critical habitat by silt and sediment fines in the spawning gravel. Bridges and culverts further restrict access to tributaries in many watersheds, especially in watersheds with forest road construction, thereby reducing the function of adult migration PBF.

Recovery Goals See the 2016 recovery plan for the Northern California steelhead DPS for complete down-listing/delisting criteria for recovery goals for the species (NMFS 2016b).

Table 76. Summary of status; Steelhead, Northern California DPS

Criteria	Description
Abundance / productivity trends	5-year population trend stable to improving, but abundances still low compared to historical numbers.
Listing status	threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Rearing PBFs are degraded by loss of riparian vegetation and elevated temperature; Spawning PBFs are degraded by lack of

	quality substrate and sedimentation; Migration PBFs are degraded by bridges, culverts, and forest road construction; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of 50 assessed watersheds, 27 are of high and 14 are of medium conservation value

9.25 Steelhead, Puget Sound DPS

Table 77. Steelhead, Puget Sound DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus mykiss	Steelhead Trout	Puget Sound	Threatened	2011	72 FR 26722	None	81 FR 9251

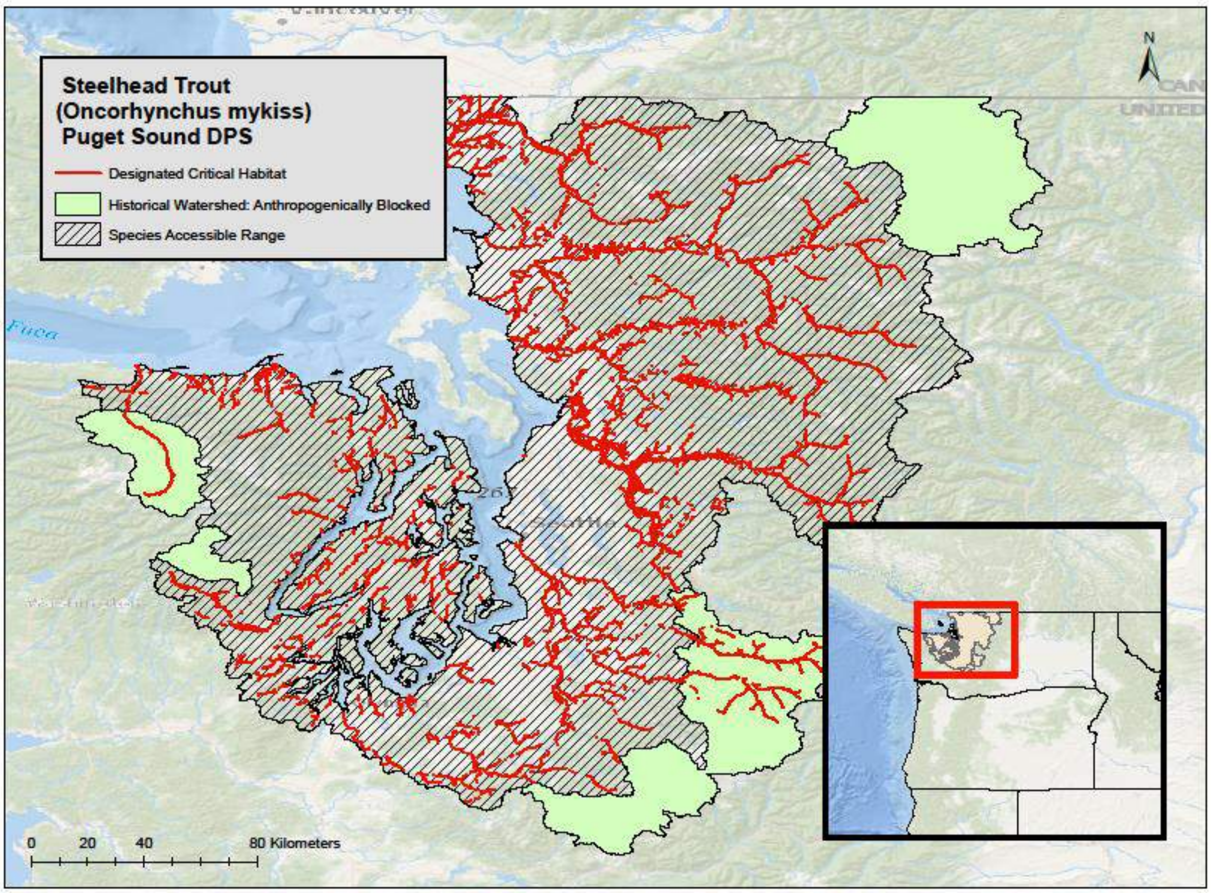

Figure 26. Steelhead, Puget Sound DPS range and designated critical habitat

Species Description Steelhead are dark-olive in color, shading to silvery-white on the underside with a speckled body and a pink-red stripe along their sides . Those migrating to the ocean develop a slimmer profile, becoming silvery in color, and typically growing larger than rainbow trout that remain in fresh water. Steelhead trout grow to 55 pounds (25 kg) in weight and 45 inches (120 cm) in length, though average size is much smaller. On May 11, 2007 NMFS listed the Puget Sound (PS) DPS of steelhead as threatened (72 FR 26722). This DPS includes naturally spawned anadromous O. mykiss (steelhead) originating below natural and manmade impassable barriers from rivers flowing into Puget Sound from the Elwha River (inclusive) eastward, including rivers in Hood Canal, South Sound, North Sound and the Strait of Georgia. Also, steelhead from six artificial propagation programs.

Status For all but a few putative demographically independent populations of steelhead in Puget Sound, estimates of mean population growth rates obtained from observed spawner or redd counts are declining—typically 3 to 10% annually. Extinction risk within 100 years for most populations in the DPS is estimated to be moderate to high, especially for draft populations in the putative South Sound and Olympic major population groups. Collectively, these analyses indicate that steelhead in the Puget Sound DPS remain at risk of extinction throughout all or a significant portion of their range in the foreseeable future, but are not currently in danger of imminent extinction. 5-Year Review: Puget Sound NOAA Fisheries 23 Our Biological Review Team identified degradation and fragmentation of freshwater habitat, with consequent effects on connectivity, as the primary limiting factors and threats facing the PS steelhead DPS. In the three years since listing, the status of threats has not changed appreciably. The status of the listed PS steelhead DPS has not changed substantially since the 2007 listing. Most populations within the DPS are showing continued downward trends in estimated abundance, a few sharply so. The limited available information indicates that this DPS remains at a moderate risk of extinction.

Life history The Puget Sound steelhead DPS contains both winter-run and summer-run steelhead. Adult winter-run steelhead generally return to Puget Sound tributaries from December to April (NMFS 2005b). Spawning occurs from January to mid-June, with peak spawning occurring from mid-April through May. Prior to spawning, maturing adults hold in pools or in side channels to avoid high winter flows. Less information exists for summer-run steelhead as their smaller run size and higher altitude headwater holding areas have not been conducive for monitoring. Based on information from four streams, adult run time occur from mid-April to October with a higher concentration from July through September (NMFS 2005b).

The majority of juveniles reside in the river system for two years with a minority migrating to the ocean as one or three-year olds. Smoltification and seaward migration occur from April to mid-May. The ocean growth period for Puget Sound steelhead ranges from one to three years in the ocean (Busby et al. 1996). Juveniles or adults may spend considerable time in the protected marine environment of the fjord-like Puget Sound during migration to the high seas.

Table 78. Temporal distribution of Steelhead, Puget Sound DPS

Life History phase	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Entering Fresh Water (adults/jacks)	Present											
Spawning		Present										
Incubation (eggs)		Present										
Emergence (alevin to fry phases)				Present								
Rearing and migration (juveniles)	Present											

Population Dynamics

Abundance In the 1996 and 2005 status reviews, the Skagit and Snohomish Rivers (North Puget Sound) winter-run steelhead were found to produce the largest escapements ((Busby et al. 1996), (NMFS 2005b)). The two rivers still produce the largest wild escapement with a recent (2005 to 2008) four-year geometric mean of 5,468 for the Skagit River and an average 2,944 steelhead in Snohomish River for the two years 2005 and 2006 (Washington Department of Fish and Wildlife (WDFW) 2009). Lake Washington has the lowest abundances of winter-run steelhead with an escapement of less than 50 fish in each year from 2000 through 2004 (Washington Department of Fish and Wildlife (WDFW) 2008). The stock is now virtually extirpated with only eight and four returning fish in 2007 and 2008, respectively (Washington Department of Fish and Wildlife (WDFW) 2009). No abundance estimates exist for most of the summer-run populations; all appear to be small, most averaging less than 200 spawners annually.

Productivity / Population Growth Rate Long-term trends (1980 to 2004) for the Puget Sound steelhead natural escapement have declined significantly for most populations, especially in southern Puget Sound, and in some populations in northern Puget Sound (Stillaguamish winter-run), Canal (Skokomish winter-run), and along the Strait of Juan de Fuca (Dungeness winter-run) (NMFS 2005b). Positive trends were observed in the Samish winter-run (northern Puget Sound) and the Hamma Hamma winter-run (Hood Canal) populations. The increasing trend on the Hamma Hamma River may be due to a captive rearing program rather than to natural escapement (NMFS 2005b).

The negative trends in escapement of naturally produced fish resulted from peaks in natural escapement in the early 1980s. Still, the period 1995 through 2004 (short-term) showed strong negative trends for several populations. This is especially evident in southern Puget Sound (Green, Lake Washington, Nisqually, and Puyallup winter-run), Hood Canal (Skokomish winter-run), and the Strait of Juan de Fuca (Dungeness winter-run) (NMFS 2005b). As with the long-term trends, positive trends were evident in short-term natural escapement for the Samish and Hamma Hamma winter-run populations, and also in the Snohomish winter-run populations.

Median population growth rates (λ) using 4-year running sums is less than 1, indicating declining population growth, for nearly all populations in the DPS (NMFS 2005b). However, some of the populations with declining recent population growth show only slight declines, (*e.g.*, Samish and Skagit winter-run in northern Puget Sound, and Quilcene and Tahuya winter-run in Hood Canal).

Genetic Diversity Only two hatchery stocks genetically represent native local populations (Hamma Hamma and Green River natural winter-run). The remaining programs, which account for the vast preponderance of production, are either out-of-DPS derived stocks or were within-DPS stocks that have diverged substantially from local populations. The WDFW estimated that 31 of the 53 stocks were of native origin and predominantly natural production (Washington Department of Fish and Wildlife (WDFW) 1993).

Distribution NMFS listed Puget Sound steelhead as threatened on May 11, 2007 (72 FR 26722). Fifty-three populations of steelhead have been identified in this DPS, of which 37 are winter-run. Summer-run populations are distributed throughout the DPS but are concentrated in northern Puget Sound and Hood Canal; only the Elwha River and Canyon Creek support summer-run steelhead in the rest of the DPS. The Elwha River run, however, is descended from introduced Skamania Hatchery summer-run steelhead. Historical summer-run steelhead in the Green River and Elwha River were likely extirpated in the early 1900s.

Designated Critical Habitat NMFS designated critical habitat for Puget Sound steelhead on February 2, 2016 (81 FR 9251). PBFs considered essential for the conservation of Steelhead, Puget Sound DPS are:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development.

- Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
- Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.
- Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.
- Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.
- Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

Recovery Goals A recovery plan has not yet been developed for the Puget Sound DPS of steelhead.

Table 79. Summary of status; Steelhead, Puget Sound DPS

Criteria	**Description**
Abundance / productivity trends	5-year population trend stable, but populations have reduced genetic diversity.
Listing status	Threatened
Attainment of recovery goals	Criteria not yet met
Condition of PBFs	Rearing, migration and spawning PBFs are degraded by forestry, agriculture, urbanization, loss of floodplain habitat, and poor water quality; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Most watersheds are of high or medium conservation value

9.26 Steelhead, Snake River Basin

Table 80. Steelhead, Snake River Basin DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus mykiss	Steelhead Trout	Snake River Basin	Threatened	2016	71 FR 834	In Process	70 FR 52630

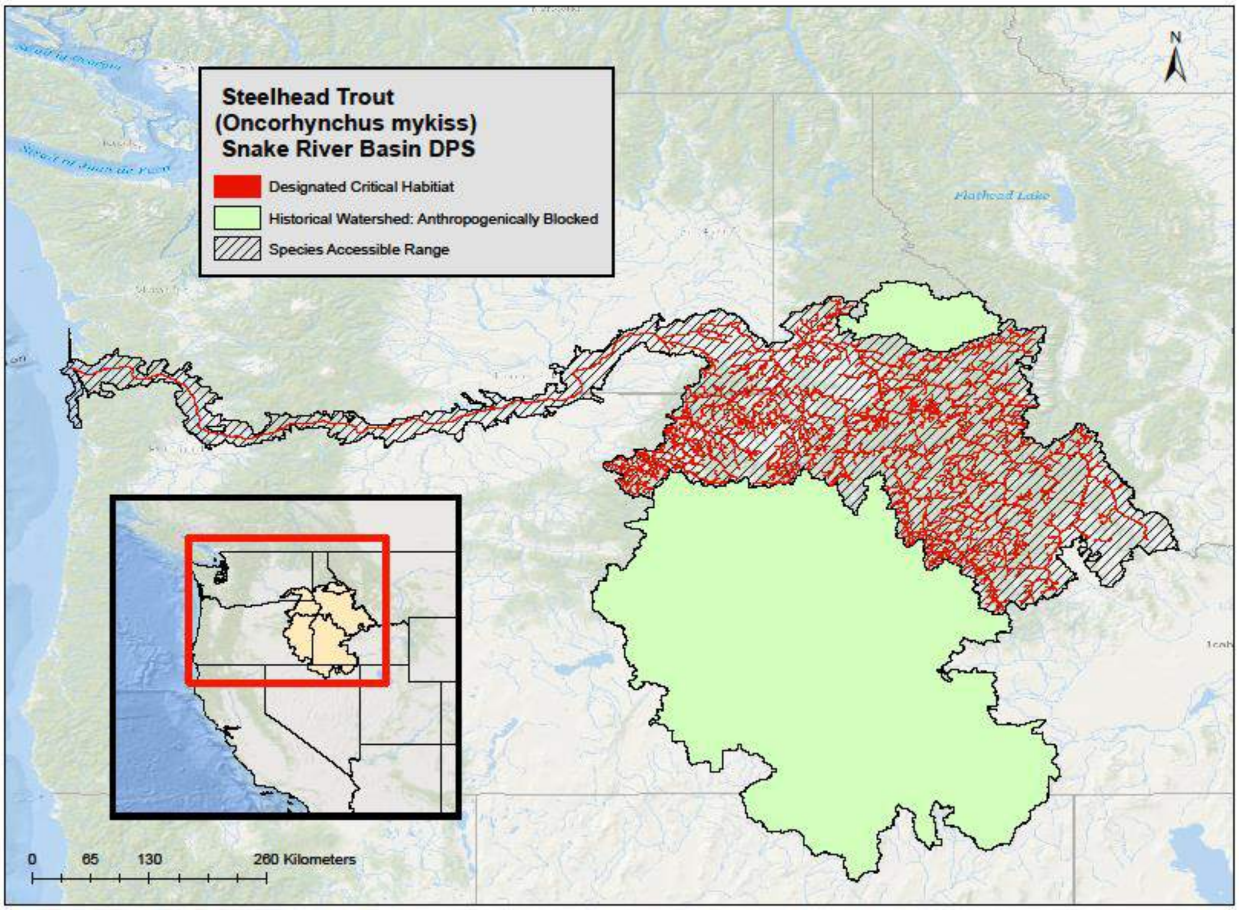

Figure 27. Steelhead, Snake River Basin DPS range and designated critical habitat

Species Description Steelhead are dark-olive in color, shading to silvery-white on the underside with a speckled body and a pink-red stripe along their sides . Those migrating to the ocean develop a slimmer profile, becoming silvery in color, and typically growing larger than rainbow trout that remain in fresh water. Steelhead trout grow to 55 pounds (25 kg) in weight and 45 inches (120 cm) in length, though average size is much smaller. On August 18, 1997 NMFS listed the Snake River Basin DPS of steelhead as threatened (62 FR 43937) and reaffirmed the DPS's status as threatened on January 5, 2006 (71 FR 834). This DPS includes naturally spawned anadromous O. mykiss (steelhead) originating below natural and manmade impassable barriers from the Snake River basin, and also steelhead from six artificial propagation programs.

Status Four out of the five MPGs are not meeting the specific objectives in the draft recovery plan being written by NMFS based on the updated status information available for this review, and the status of many individual populations remains uncertain (NWFSC 2015). The Grande Ronde MPG is tentatively rated as viable; more specific data on spawning abundance and the relative contribution of hatchery spawners for the Lower Grande Ronde and Wallowa populations would improve future assessments. A great deal of uncertainty still remains regarding the relative proportion of hatchery fish in natural spawning areas near major hatchery release sites within individual populations.

Life history SR basin steelhead are generally classified as summer-run fish. They enter the Columbia River from late June to October. After remaining in the river through the winter, SR basin steelhead spawn the following spring (March to May). Managers recognize two life history patterns within this DPS primarily based on ocean age and adult size upon return: A-run or B-run. A-run steelhead are typically smaller, have a shorter freshwater and ocean residence (generally one year in the ocean), and begin their up-river migration earlier in the year. B-run steelhead are larger, spend more time in fresh water and the ocean (generally two years in ocean), and appear to start their upstream migration later in the year. SR basin steelhead usually smolt after two or three years.

Table 81. Temporal distribution of Steelhead, Snake River Basin DPS

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td></td><td></td><td></td><td></td><td colspan="6">Present</td><td></td><td></td></tr>
<tr><td>Spawning</td><td></td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td></td><td></td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td></td><td></td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance / Productivity There is uncertainty for wild populations given limited data for adult spawners in individual populations. Regarding population growth rate, there are mixed long- and short-term trends in abundance and productivity. Overall, the abundances remain well below interim recovery criteria.

Genetic Diversity Genetic diversity is affected by the displacement of natural fish by hatchery fish (declining proportion of natural-origin spawners)

Distribution The ICTRT (ICTRT 2003) identified 23 populations. SR basin steelhead remain spatially well distributed in each of the six major geographic areas in the Snake River basin (Good et al. 2005b). The SR basin steelhead B- run populations remain particularly depressed.

Designated Critical Habitat Critical habitat was designated for this species on September 2, 2005 (70 FR 52630). PBFs considered essential for the conservation of Steelhead, Snake River Basin DPS are:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development;

- Freshwater rearing sites with:
  - Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility;
  - Water quality and forage supporting juvenile development;
  - Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
- Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival;
- Estuarine areas free of obstruction and excessive predation with:
  - Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh & saltwater;
  - Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels;
  - Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.
- Nearshore marine areas free of obstruction and excessive predation with:
  - Water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and
  - Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.
- Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

The current condition of critical habitat designated for SR basin steelhead is moderately degraded. Critical habitat is affected by reduced quality of juvenile rearing and migration PBFs within many watersheds; contaminants from agriculture affect both water quality and food production in several watersheds and in the mainstem Columbia River. Loss of riparian vegetation to grazing has resulted in high water temperatures in the John Day basin. These factors have substantially reduced the rearing PBFs contribution to the conservation value necessary for species recovery. Several dams affect adult migration PBF by obstructing the migration corridor.

Recovery Goals The Snake River Basin steelhead recovery plan is currently in the process of being developed.

Table 82. Summary of status; Steelhead, Snake River Basin DPS

Criteria	**Description**
Abundance / productivity trends	5-year population trend stable to improving, but still in moderate danger of extinction. Overall abundances are still below thresholds necessary for recovery.
Listing status	threatened
Attainment of recovery goals	criteria not yet met

Condition of PBFs	Rearing PBFs are degraded by agricultural runoff, reduced invertebrate prey, loss of riparian vegetation, and elevated temperature; Migration PBFs are degraded by several dams; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of assessed watersheds, 229 are of high and 41 are of medium conservation value

9.27 Steelhead, South-Central California Coast DPS

Table 83. Steelhead, South-Central California Coast DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus mykiss	Steelhead Trout	South-Central California Coast	Threatened	2016	71 FR 834	2013	70 FR 52488

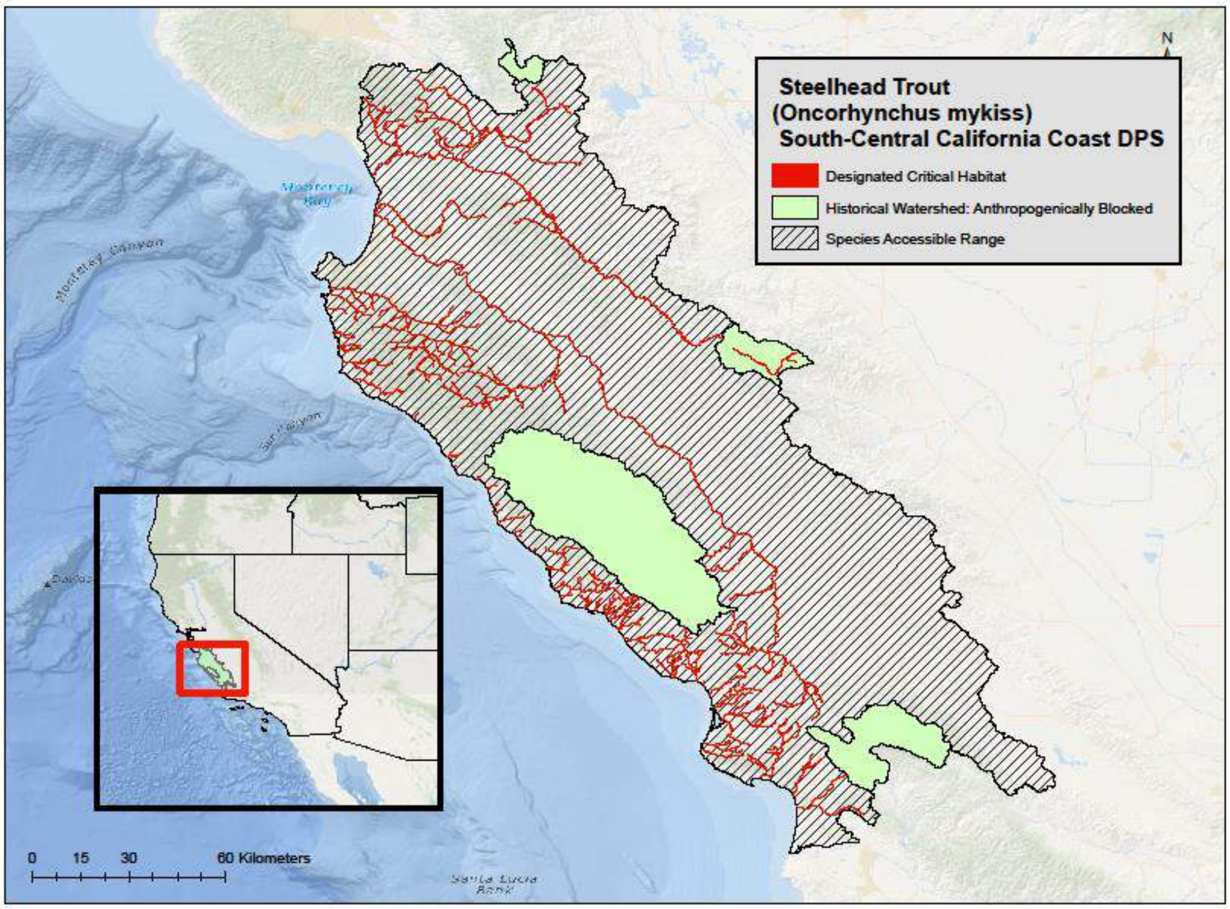

Figure 28. Steelhead, South-Central California Coast DPS range and designated critical habitat

Species Description Steelhead are dark-olive in color, shading to silvery-white on the underside with a speckled body and a pink-red stripe along their sides . Those migrating to the ocean develop a slimmer profile, becoming silvery in color, and typically growing larger than rainbow trout that remain in fresh water. Steelhead trout grow to 55 pounds (25 kg) in weight and 45 inches (120 cm) in length, though average size is much smaller. On August 18, 1997 NMFS listed the South-Central California Coast (SCCC) DPS of steelhead as threatened (62 FR 43937) and reaffirmed the DPS's status as threatened on January 5, 2006 (71 FR 5248). This DPS includes naturally spawned anadromous O. mykiss (steelhead) originating below natural and manmade impassable barriers from the Pajaro River to (but not including) the Santa Maria River.

Status Following the dramatic rise in South-Central California's human population after World War II and the associated land and water development within coastal drainages (particularly major dams and water diversions), steelhead abundance rapidly declined, leading to the extirpation of populations in many watersheds and leaving only sporadic and remnant populations in the remaining, more highly modified watersheds such as the Salinas River and Arroyo Grande Creek watersheds (Boughton et al. 2005, Good et al. 2005, Helmbrecht and Boughton 2005, Busby et al. 1996). As conditions in South-Central California coastal rivers and stream continued to deteriorate, put-and-take trout stocking became more focused on suitable manmade reservoirs. Since the listing of the SCCC DPS as threatened in 1997, the California Department of Fish and Wildlife has ceased stocking hatchery reared fish in the anadromous waters of South-Central California (California Department of Fish and Wildlife and U.S. Fish and Wildlife Service 2010). A substantial portion of the upper watersheds, which contain the majority of historical spawning and rearing habitats for anadromous O. mykiss, remain intact (though inaccessible to anadromous fish) and protected from intensive development as a result of their inclusion in the Los Padres National Forest (Blakley and Barnette 1985, Brown 1945).

Life history Only winter steelhead are found in this DPS. Migration and spawn timing are similar to adjacent steelhead populations. There is limited life history information for steelhead in this DPS.

Table 84. Temporal distribution of Steelhead, South-Central California Coast DPS

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Spawning</td><td></td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td></td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td></td><td></td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance / Productivity The data summarized in this status review indicate small (generally <10 fish) but surprisingly persistent annual runs of anadromous O. mykiss are currently being monitored across a limited but diverse set of basins within the range of this DPS, but interrupted in years when the mouth of the coastal estuaries fail to open to the ocean due to low flows (Williams et al. 2016, Williams et al. 2011).

Genetic Diversity / **Distribution** South-Central California Coast (SCCC) steelhead include all naturally spawned steelhead populations below natural and manmade impassable barriers in streams from the Pajaro River (inclusive) to, but not including the Santa Maria River, California. No artificially propagated steelhead populations that reside within the historical geographic range of this DPS are included in this designation. The two largest basins overlapping within the range of this DPS include the inland basins of the Pajaro River and the Salinas River.

Designated Critical Habitat Critical habitat was designated for this species on September 2, 2005 (70 FR 52488). PBFs considered essential for the conservation of Steelhead, South-Central California Coast DPS are:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development.
- Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
- Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.
- Estuarine areas free of obstruction with water

Migration and rearing PBFs are degraded throughout critical habitat by elevated stream temperatures and contaminants from urban and agricultural areas. Estuarine PBF is impacted by most estuaries being breached, removal of structures, and contaminants.

Recovery Goals See the 2013 recovery plan for the South-Central California Coast steelhead DPS for complete down-listing/delisting criteria for recovery goals for the species.

Table 85. Summary of status; Steelhead, South-Central California Coast DPS

Criteria	**Description**
Abundance / productivity trends	5-year popluation trend declining, depressed abundances.
Listing status	threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Rearing and migration PBFs are degraded by elevated temperatures and contaminants from urban and agricultural runoff; Estuarine PBFs are degraded by altered habitat and contaminated runoff; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of 29 occupied watersheds, 12 are of high and 11 are of medium conservation value

9.28 Steelhead, Southern California DPS

Table 86. Steelhead, Southern California DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus mykiss	Steelhead Trout	Southern California Coast	Endangered	2016	71 FR 834	2012	70 FR 52488

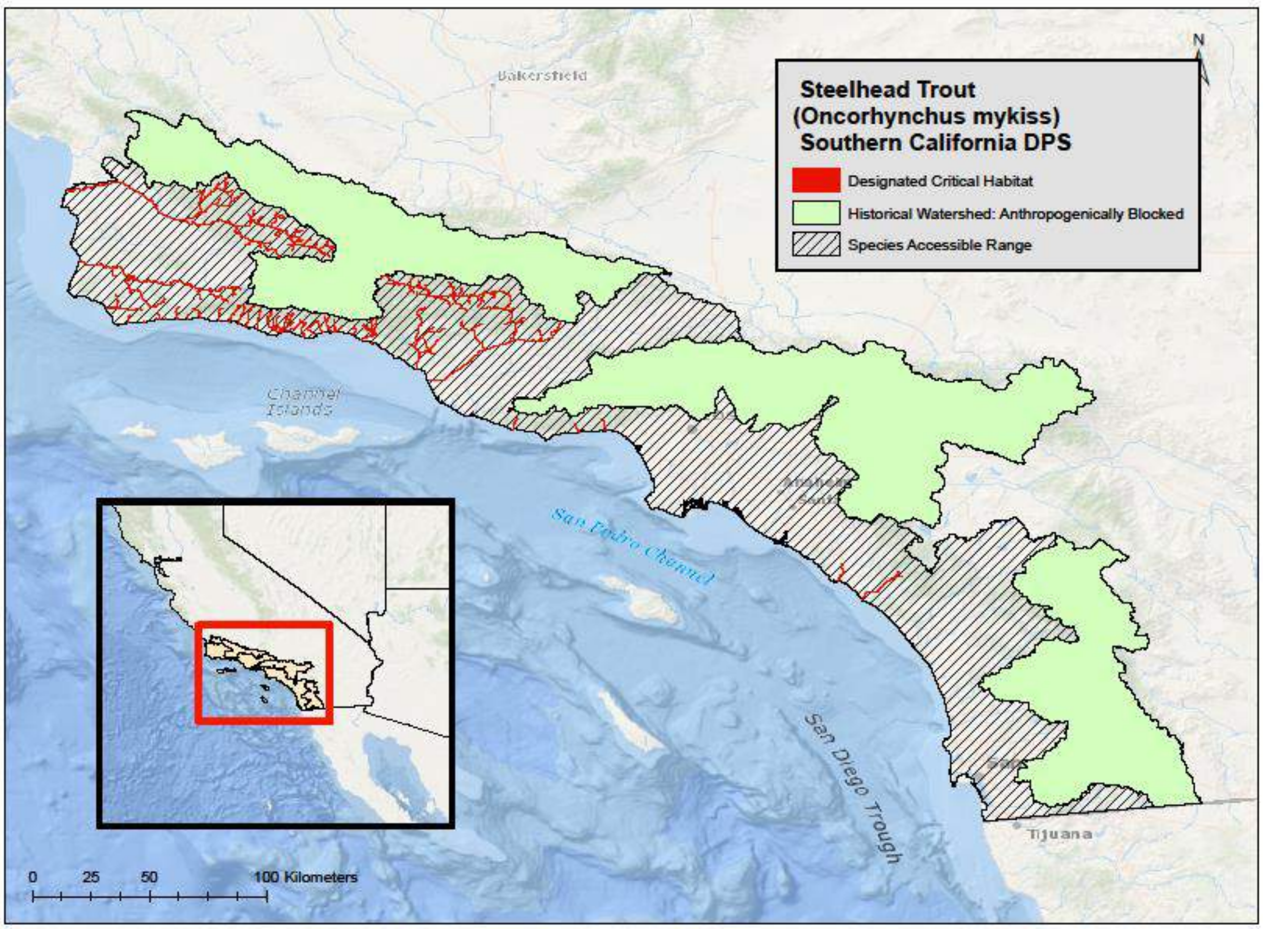

Figure 29. Steelhead, Southern California DPS range and designated critical habitat

Species Description Steelhead are dark-olive in color, shading to silvery-white on the underside with a speckled body and a pink-red stripe along their sides . Those migrating to the ocean develop a slimmer profile, becoming silvery in color, and typically growing larger than rainbow trout that remain in fresh water. Steelhead trout grow to 55 pounds (25 kg) in weight and 45 inches (120 cm) in length, though average size is much smaller. On August 18, 1997 NMFS listed the Southern California (SC) DPS of steelhead as endangered (62 FR 43937) and reaffirmed the DPS's status as endangered on January 5, 2006 (71 FR 5248). This DPS includes naturally spawned anadromous O. mykiss (steelhead) originating below natural and manmade impassable barriers from the Santa Maria River to the U.S.-Mexico Border.

Status There is little new evidence to indicate that the status of the Southern California Coast Steelhead DPS has changed appreciably in either direction since the last status review (Williams et al. 2011). The extended drought and the recent genetic data documenting the high level of introgression and extirpation of native O. mykiss stocks in the southern portion of the DPS has elevated the threats level to the already endangered populations; the drought, and the lack of 55 comprehensive monitoring, has also limited the ability to fully assess the status of individual populations and the DPS as whole. The systemic anthropogenic threats identified at the time of the initial listing have remained essentially unchanged over the past 5 years, though there has been significant progress in removing fish passage barriers in a number of the smaller and mid-sized watersheds. Threats to the Southern California Steelhead DPS posed by environmental variability resulting from projected climate change are likely to exacerbate the factors affecting the continued existence of the DPS.

Life history There is limited life history information for SC steelhead. In general, migration and life history patterns of SC steelhead populations are dependent on rainfall and stream flow (Moore 1980). Steelhead within this DPS can withstand higher temperatures compared to populations to the north. The relatively warm and productive waters of the Ventura River have resulted in more rapid growth of juvenile steelhead compared to the more northerly populations (Moore 1980).

Table 87. Temporal distribution of Steelhead, Southern California DPS

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td></td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Spawning</td><td></td><td></td><td></td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td></td><td></td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance / Productivity Limited information exists on SC steelhead runs. Based on combined estimates for the Santa Ynez, Ventura, and Santa Clara rivers, and Malibu Creek, an estimated 32,000 to 46,000 adult steelhead occupied this DPS historically. In contrast, less than 500 adults are estimated to occupy the same four waterways presently. The last estimated run size for steelhead in the Ventura River, which has its headwaters in Los Padres National Forest, is 200 adults (Busby et al. 1996).

Genetic Diversity / Distribution Limited information is available regarding the structural and genetic diversity of the Southern California steelhead.

Designated Critical Habitat Critical habitat was designated for this species on September 2, 2005 (70 FR 52630). PBFs considered essential for the conservation of Steelhead, Southern California DPS are:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development.

- Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
- Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.
- Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.
- Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.
- Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

All PBFs have been affected by degraded water quality by pollutants from densely populated areas and agriculture within the DPS. Elevated water temperatures impact rearing and juvenile migration PBFs in all river basins and estuaries. Rearing and spawning PBFs have also been affected throughout the DPS by management or reduction in water quantity. The spawning PBF has also been affected by the combination of erosive geology and land management activities that have resulted in an excessive amount of fines in the spawning gravel of most rivers.

Recovery Goals See the 2012 recovery plan for the California Central Valley steelhead DPS for complete down-listing/delisting criteria for recovery goals for the species.

Table 88. Summary of status; Steelhead, Southern California DPS

Criteria	**Description**
Abundance / productivity trends	5-year population trend uncertain. Population abundance supplemented by hatchery propagation. Populations are at the extreme southern end of the species' range. Large annual variations in abundances, and fragmented distributions.
Listing status	endangered
Attainment of recovery goals	criteria not yet met
Condition of PBFs	All PBFs are degraded by pollutants in urban and agricultural runoff, elevated temperatures, erosion, and low water flows; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of 29 freshwater and

	estuarine watersheds, 21 are of high and 5 are of medium conservation value

9.29 Steelhead, Upper Columbia River DPS

Table 89. Steelhead, Upper Columbia River DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus mykiss	Steelhead Trout	Upper Columbia River	Endangered	2016	74 FR 42605	2007	70 FR 52630

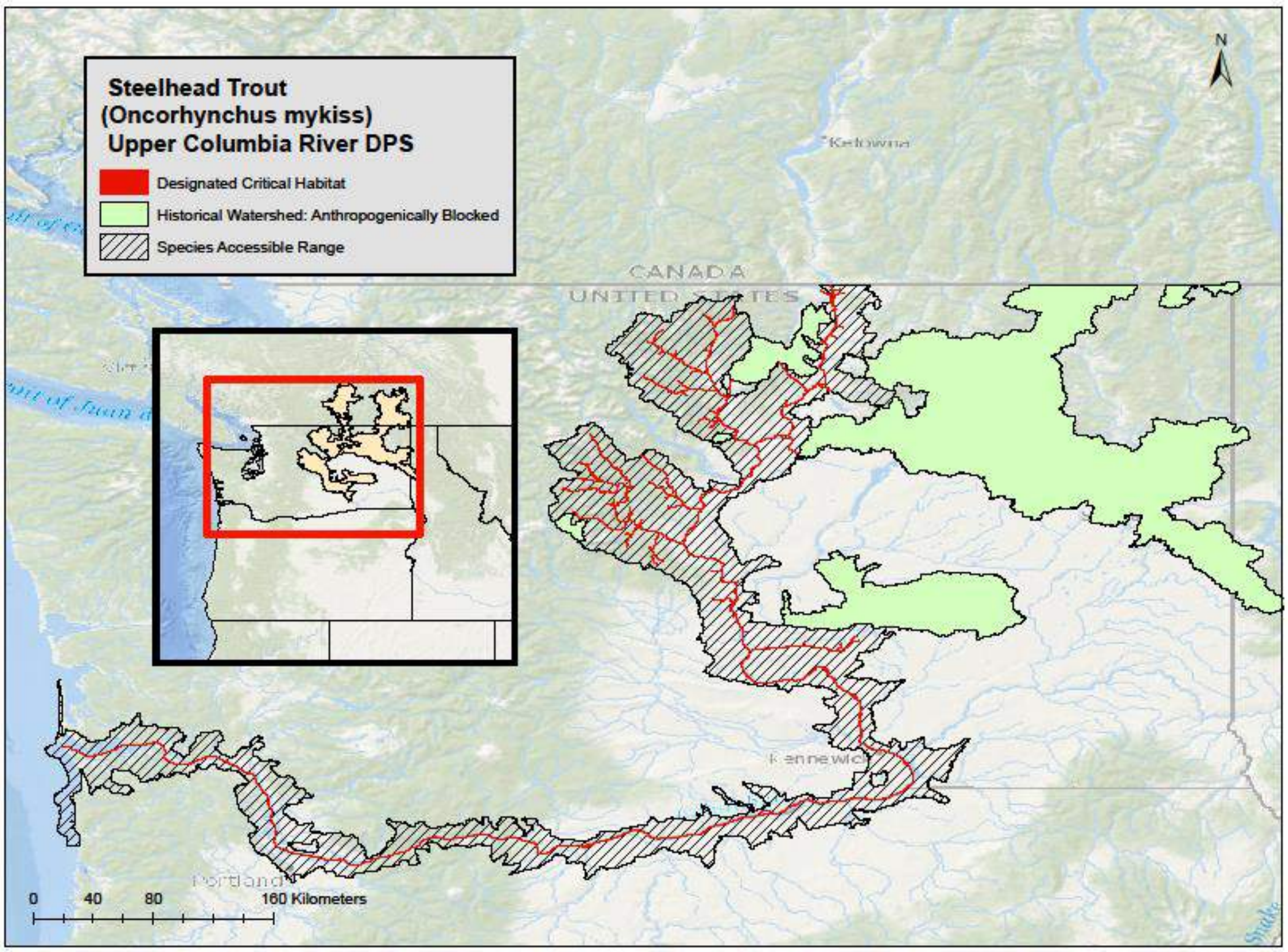

Figure 30. Steelhead, Upper Columbia River DPS range and designated critical habitat

Species Description Steelhead are dark-olive in color, shading to silvery-white on the underside with a speckled body and a pink-red stripe along their sides . Those migrating to the ocean develop a slimmer profile, becoming silvery in color, and typically growing larger than rainbow trout that remain in fresh water. Steelhead trout grow to 55 pounds (25 kg) in weight and 45 inches (120 cm) in length, though average size is much smaller. On August 18, 1997 NMFS listed the Upper Columbia River (UCR) DPS of steelhead as endangered (62 FR 43937) and reaffirmed the DPS's status as endangered on January 5, 2006 (71 FR 834). This DPS includes naturally spawned anadromous O. mykiss (steelhead) originating below natural and manmade impassable barriers from the Columbia River and its tributaries upstream of the Yakima River to the U.S.-Canada border. Also, steelhead from six artificial propagation programs.

Status Current estimates of natural origin spawner abundance increased relative to the levels observed in the prior review for all three extant populations, and productivities were higher for the Wenatchee and Entiat and unchanged for the Methow (NWFSC 2015). However abundance and productivity remained well below the viable thresholds called for in the Upper Columbia Recovery Plan for all three populations. Short-term patterns in those indicators appear to be largely driven by year-to year fluctuations in survival rates in areas outside of these watersheds. All three populations continued to be rated at low risk for spatial structure but at high risk for diversity criteria. Although the status of the ESU is improved relative to measures available at the time of listing, all three populations remain at high risk (NWFSC 2015).

Life history All UCR steelhead are summer-run steelhead. Adults return in the late summer and early fall, with most migrating relatively quickly to their natal tributaries. A portion of the returning adult steelhead overwinters in mainstem reservoirs, passing over upper-mid-Columbia dams in April and May of the following year. Spawning occurs in the late spring of the year following river entry. Juvenile steelhead spend one to seven years rearing in fresh water before migrating to sea. Smolt outmigrations are predominantly year class two and three (juveniles), although some of the oldest smolts are reported from this DPS at seven years. Most adult steelhead return to fresh water after one or two years at sea.

Table 90. Temporal distribution of Steelhead, Upper Columbia River DPS

<table>
<tr><td>Life History phase</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="12">Present</td></tr>
<tr><td>Spawning</td><td></td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td></td><td></td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Emergence (alevin to fry phases</td><td></td><td></td><td></td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance Returns of both hatchery and naturally produced steelhead to the upper Columbia River have increased in recent years. The average 1997 to 2001 return counted through the Priest Rapids fish ladder was approximately 12,900 fish. The average for the previous five years (1992 to 1996) was 7,800 fish. Abundance estimates of returning naturally produced UCR steelhead were based on extrapolations from mainstem dam counts and associated sampling information (Good et al. 2005b). The natural component of the annual steelhead run over Priest Rapids Dam increased from an average of 1,040 (1992-1996), representing about 10% of the total adult count, to 2,200 (1997-2001), representing about 17% of the adult count during this period of time (ICTRT 2003).

Recent population abundances for the Wenatchee and Entiat aggregate population and the Methow population remain well below the minimum abundance thresholds developed for these populations (ICTRT 2003). A five-year geometric mean (1997 to 2001) of approximately 900 naturally produced steelhead returned to the Wenatchee and Entiat rivers (combined). The abundance is well below the minimum abundance thresholds but it represents an improvement over the past (an increasing trend of 3.4% per year).

Productivity / Population Growth Rate Regarding the population growth rate of natural production, on average, over the last 20 full brood year returns (1980/81 through 1999/2000 brood years), including adult returns through 2004-2005, UCR steelhead populations have not replaced themselves. Overall adult returns are dominated by hatchery fish, and detailed information is lacking on the productivity of the natural population.

Genetic Diversity All UCR steelhead populations have reduced genetic diversity from homogenization of populations that occurred during the Grand Coulee Fish Maintenance project from 1939-1943, from 1960, and 1981 (Chapman et al. 1994).

Distribution The UCR steelhead consisted of four historical independent populations: the Wenatchee, Entiat, Methow, and Okanogan. All populations are extant. The UCR steelhead must navigate over several dams to access spawning areas. The construction of Grand Coulee Dam in 1939 blocked access to over 50% of the river miles formerly available to UCR steelhead (ICTRT 2003).

Designated Critical Habitat Critical habitat was designated for this species on September 2, 2005 (70 FR 52630). PBFs considered essential for the conservation of Steelhead, Upper Columbia River DPS are:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development;
- Freshwater rearing sites with:
    - Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility;
    - Water quality and forage supporting juvenile development;
    - Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
- Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival;
- Estuarine areas free of obstruction and excessive predation with:
    - Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh & saltwater;
    - Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels;
    - Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.
- Nearshore marine areas free of obstruction and excessive predation with:
    - Water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and

    - Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.
- Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

The current condition of critical habitat designated for the UCR steelhead is moderately degraded. Habitat quality in tributary streams varies from excellent in wilderness and roadless areas to poor in areas subject to heavy agricultural and urban development. Critical habitat is affected by reduced quality of juvenile rearing and migration PBFs within many watersheds; contaminants from agriculture affect both water quality and food production in several watersheds and in the mainstem Columbia River. Several dams affect adult migration PBF by obstructing the migration corridor.

Recovery Goals See the 2007 recovery plan for the Upper Columbia River steelhead DPS for complete down-listing/delisting criteria for recovery goals for the species.

Table 91. Summary of status; Steelhead, Upper Columbia River DPS

Criteria	Description
Abundance / productivity trends	5-year population trend improving, but low genetic diversity. Abundances still below those necessary for recovery.
Listing status	threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Rearing PBFs are degraded by agricultural runoff and lack of available prey; Migration PBFs are degraded by several dams; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of 41 occupied watersheds, 31 are of high and 7 are of medium conservation value

9.30 Steelhead, Upper Willamette River DPS

Table 92. Steelhead, Upper Willamette River DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Oncorhynchus mykiss	Steelhead Trout	California Central Valley	Threatened	2016	71 FR 834	2011	70 FR 52630

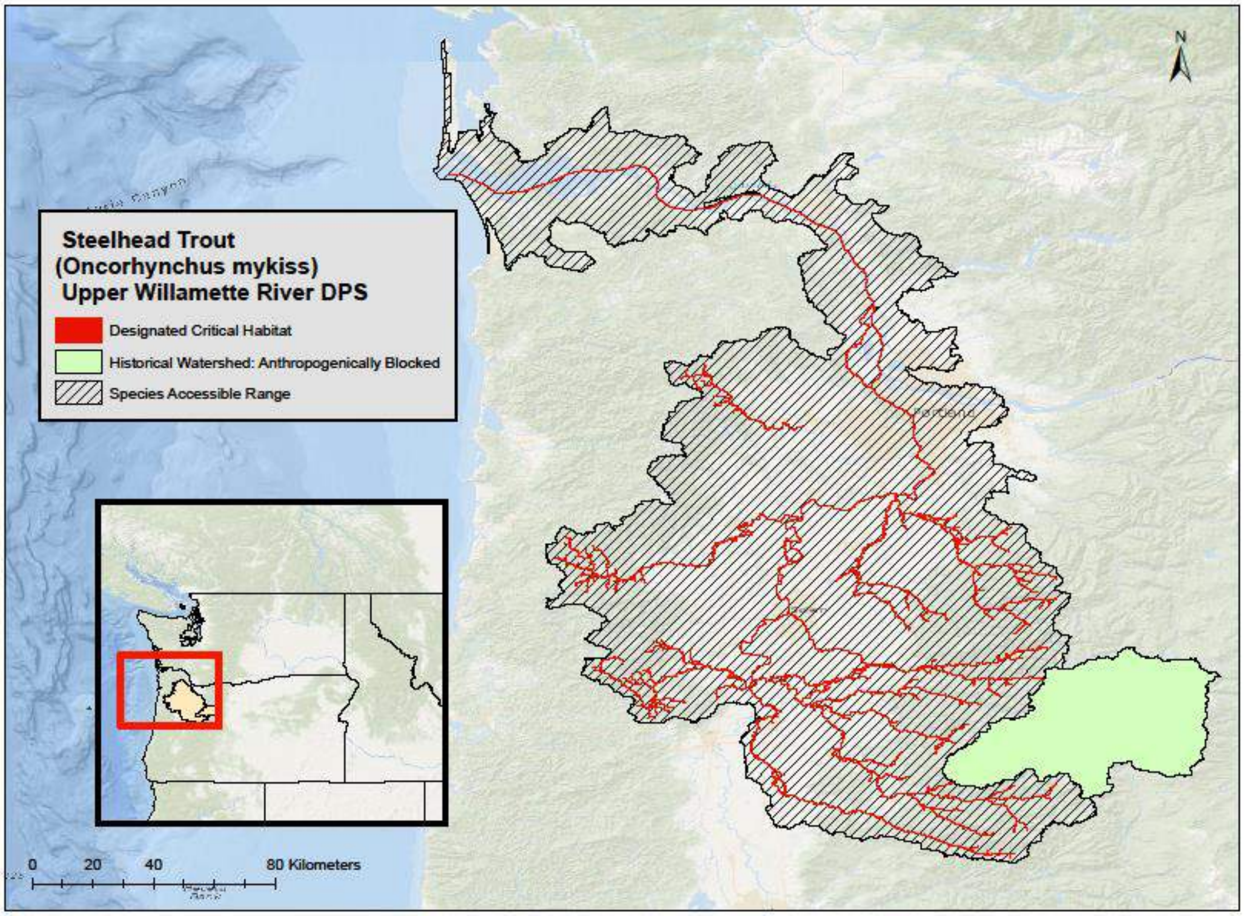

Figure 31. Steelhead, Upper Willamette River DPS range and designated critical habitat

Species Description Steelhead are dark-olive in color, shading to silvery-white on the underside with a speckled body and a pink-red stripe along their sides . Those migrating to the ocean develop a slimmer profile, becoming silvery in color, and typically growing larger than rainbow trout that remain in fresh water. Steelhead trout grow to 55 pounds (25 kg) in weight and 45 inches (120 cm) in length, though average size is much smaller. On March 25, 1999 NMFS listed the Upper Willamette River (UWR) DPS of steelhead as threatened (64 FR 14517) and reaffirmed the DPS's status as threatened on January 5, 2006 (71 FR 834). This DPS includes naturally spawned anadromous winter-run O. mykiss (steelhead) originating below natural and manmade impassable barriers from the Willamette River and its tributaries upstream of Willamette Falls to and including the Calapooia River.

Status Four basins on the east side of the Willamette River historically supported independent populations for the UWR steelhead, all of which remain extant. Data reported in McElhaney et al. (2007) indicate that currently the two largest populations within the DPS are the Santiam River populations. Mean spawner abundance in both the North and South Santiam River is about 2,100 native winter-run steelhead. However, about 30% of all habitat has been lost due to human activities (McElhany et al. 2007a). The North Santiam population has been substantially affected by the loss of access to the upper North Santiam basin. The South Santiam subbasin has lost habitat behind non-passable dams in the Quartzville Creek watershed. Notwithstanding the lost spawning habitat, the DPS continues to be spatially well distributed, occupying each of the four major subbasins.

Overall, the declines in abundance noted during the previous review (Ford et al. 2011) continued through the period 2010-2015. There is considerable uncertainty in many of the abundance estimates, except for perhaps the tributary dam counts. Radio-tagging studies suggest that a considerable proportion of winter-run steelhead ascending Willamette Falls do not enter the demographically independent populations (DIPs) that constitute this DPS; these fish may be nonnative early winter-run steelhead that appear to have colonized the western tributaries, misidentified summer-run steelhead, or late winter-run steelhead that have colonized tributaries not historically part of the DPS.

Life history Native steelhead in the Upper Willamette are a late-migrating winter group that enters fresh water in January and February (Howell et al. 1985). UWR steelhead do not ascend to their spawning areas until late March or April, which is late compared to other West Coast winter steelhead. Spawning occurs from April to June 1. The unusual run timing may be an adaptation for ascending the Willamette Falls, which may have facilitated reproductive isolation of the stock. The smolt migration past Willamette Falls also begins in early April and proceeds into early June, peaking in early- to mid-May (Howell et al. 1985). Smolts generally migrate through the Columbia via Multnomah Channel rather than the mouth of the Willamette River. As with other coastal steelhead, the majority of juveniles smolt and outmigrate after two years; adults return to their natal rivers to spawn after spending two years in the ocean. Repeat spawners are predominantly female and generally account for less than 10% of the total run size (Busby et al. 1996).

Table 93. Temporal distribution of Steelhead, Upper Willamette River DPS

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="6">Present</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Spawning</td><td></td><td></td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Population Dynamics

Abundance UWR steelhead are moderately depressed from historical levels (McElhany et al. 2007a). Average number of late-fall steelhead passing Willamette Falls decreased during the 1990s to less than 5,000 fish. The number again increased to over 10,000 fish in 2001 and 2002.

The geometric and arithmetic mean number of late-run steelhead passing Willamette Falls for the period 1998 to 2001 were 5,819 and 6,795, respectively.

Productivity / Population Growth Rate Population information for individual basins exist as redds per (river) mile. These redd counts show a declining long-term trend for all populations (Good et al. 2005b). One population, the Calapooia, had a positive short-term trend during the years from 1990 to 2001. McElhany *et al.* (2007a) however, found that the populations had a low risk of extinction. Two of the populations were considered at moderate risk from failed abundances and recruitment levels and two (North and South Santiam Rivers) were considered at low risk given current abundances and recruitment (McElhany et al. 2007a).

Genetic Diversity The release of non-native summer-run steelhead continues to be a concern. Genetic analysis suggests that there is some level introgression among native late-winter-run steelhead and summer-run steelhead (Van Doornik et al. 2015).

Distribution The UWR steelhead DPS includes all naturally spawned winter-run steelhead populations in the Willamette River and its tributaries upstream from Willamette Falls to the Calapooia River (inclusive). The North Santiam and South Santiam rivers are thought to have been major production areas (USFWS 1948) and these populations were designated as "core" and "genetic legacy" (McElhany et al. 2003). The four "east-side" subbasin populations are part of one stratum, the Cascade Tributaries Stratum, for UWR winter steelhead. There are no hatchery programs supporting this DPS (NMFS 2006). The hatchery summer-run steelhead that are produced and released in the subbasins are from an out-of-basin stock and not considered part of the DPS. Accessibility to historical spawning habitat is still limited, especially in the North Santiam River. Much of the accessible habitat in the Molalla, Calapooia, and lower reaches of North and South Santiam rivers is degraded and under continued development pressure. Although habitat restoration efforts are underway, the time scale for restoring functional habitat is considerable (NWFSC 2015).

Designated Critical Habitat NMFS designated critical habitat for this species on September 2, 2005 (70 FR 52488). PBFs considered essential for the conservation of Steelhead, Upper Willamette River DPS are:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development;
- Freshwater rearing sites with:
  - Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility;
  - Water quality and forage supporting juvenile development;
  - Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
- Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival;
- Estuarine areas free of obstruction and excessive predation with:

    - Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh & saltwater;
    - Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels;
    - Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.
- Nearshore marine areas free of obstruction and excessive predation with:
    - Water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and
    - Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.
- Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

The current condition of critical habitat designated for the UWR steelhead is degraded, and provides a reduced the conservation value necessary for species recovery. Critical habitat is affected by reduced quality of juvenile rearing and migration PBFs within many watersheds; contaminants from agriculture affect both water quality and food production in several watersheds and in the mainstem Columbia River. Several dams affect adult migration PBF by obstructing the migration corridor.

Recovery Goals See the 2011 recovery plan for the Upper Willamette River steelhead DPS for complete down-listing/delisting criteria for recovery goals for the species.

Table 94. Summary of status; Steelhead, Upper Willamette River DPS

Criteria	Description
Abundance / productivity trends	5-year population trend declining, large fluctuations in abundances.
Listing status	threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Rearing PBFs are degraded by agricultural runoff and lack of available prey; Migration PBFs are degraded by dams and elevated temperatures; Elevated temperatures and environmental mixtures anticipated in freshwater habitats; Of assessed watersheds, 14 are of high and 6 are of medium conservation value

CHAPTER 9B

STATUS OF SPECIES AND CRITICAL HABITAT LIKELY TO BE ADVERSELY AFFECTED

MARINE FISHES, STURGEON, SAWFISH, ABALONE, CORAL

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9 STATUS OF SPECIES AND CRITICAL HABITAT LIKELY TO BE ADVERSELY AFFECTED

9.31 Introduction

The purpose of this section is to characterize the condition and status of the 77 species[1] that are likely to be adversely affected by the action, and to describe the status, conservation role and function of their respective critical habitats.

The status of species includes the existing level of risk that the ESA-listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. The species status section helps to inform the description of the species' current "reproduction, numbers, or distribution," which is part of the jeopardy determination as described in 50 C.F.R. §402.02.

This section also examines the condition of critical habitat throughout the designated area (such as various watersheds and coastal and marine environments that make up the designated area), and discusses the condition and current function of designated critical habitat, including the essential physical and biological features that contribute to that conservation value of the critical habitat.

The National Marine Fisheries Service (NMFS) has determined that the following species and critical habitat designations may occur in the action area (***Table 1***). More detailed information on the status of these species and critical habitat are found in a number of published documents including recent recovery plans, status reviews, stock assessment reports, and technical memorandums. Many are available on the Internet at http://www.nmfs.noaa.gov/pr/species/.

Table 1. Listed Species and Critical Habitat (denoted by asterisk) in the Action Area.

Common Name (Distinct Population Segment (DPS) or Evolutionarily Significant Unit (ESU))	Scientific Name	Status
Atlantic salmon, Gulf of Maine ESU*	Salmo salar	ENDANGERED
Chum salmon , Columbia River ESU*	Oncorhynchus keta	THREATENED
Chum salmon, Hood Canal summer-run ESU*		THREATENED
Chinook salmon, California coastal ESU*	Oncorhynchus tshawytscha	THREATENED
Chinook salmon, Central Valley spring-run ESU*		THREATENED
Chinook salmon, Lower Columbia River ESU*		THREATENED
Chinook salmon, Puget Sound ESU*		THREATENED
Chinook salmon, Sacramento River winter-run ESU*		ENDANGERED
Chinook salmon, Snake River fall-run ESU*		THREATENED
Chinook salmon, Snake River spring/summer run ESU*		THREATENED

[1] We use the word "species" as it has been defined in section 3 of the ESA, which include "species, subspecies, and any distinct population segment (DPS) of any species of vertebrate fish or wildlife which interbreeds when mature (16 U.S.C 1533)." Pacific salmon other than steelhead that have been listed as endangered or threatened were listed as "evolutionarily significant units" (ESU), which NMFS uses to identify distinct population segments of Pacific salmon. Any ESU or DPS is a "species" for the purposes of the ESA.

Common Name (Distinct Population Segment (DPS) or Evolutionarily Significant Unit (ESU))	Scientific Name	Status
Chinook salmon, Upper Columbia River spring-run ESU*		ENDANGERED
Chinook salmon, Upper Willamette River ESU*		THREATENED
Coho salmon, Central California coast ESU*	Oncorhynchus kisutch	ENDANGERED
Coho salmon, Lower Columbia River ESU*		THREATENED
Coho salmon, Oregon coast ESU*		THREATENED
Coho salmon, S. Oregon and N. Calif coasts ESU*		THREATENED
Sockeye, Ozette Lake ESU*	Oncorhynchus nerka	THREATENED
Sockeye, Snake River ESU*		ENDANGERED
Steelhead, California Central Valley DPS*	Oncorhynchus mykiss	THREATENED
Steelhead, Central California coast DPS*		THREATENED
Steelhead, Lower Columbia River DPS*		THREATENED
Steelhead, Middle Columbia River DPS*		THREATENED
Steelhead, Northern California DPS*		THREATENED
Steelhead, Puget Sound DPS*		THREATENED
Steelhead, Snake River Basin DPS*		THREATENED
Steelhead, South-Central California coast DPS*		THREATENED
Steelhead, Southern California DPS*		ENDANGERED
Steelhead, Upper Columbia River DPS*		THREATENED
Steelhead, Upper Willamette River DPS*		THREATENED
Eulachon, Pacific smelt, Southern DPS*	Thaleichthys pacificus	THREATENED
Green sturgeon, Southern DPS*	Acipenser medirostris	THREATENED
Shortnose sturgeon	Acipenser brevirostrum	ENDANGERED
Atlantic sturgeon, Carolina DPS	Acipenser oxyrinchus desotoi	ENDANGERED
Atlantic sturgeon, Chesapeake Bay DPS		ENDANGERED
Atlantic sturgeon, Gulf of Maine DPS		THREATENED
Atlantic sturgeon, New York Bight DPS		ENDANGERED
Atlantic sturgeon, South Atlantic DPS		ENDANGERED
Gulf sturgeon*	Acipenser oxyrinchus oxyrinchus	THREATENED
Yelloweye rockfish*	Sebastes ruberrimus	THREATENED
Boccacio, Puget Sound/Georgia Basin*	Sebastes paucispinis	ENDANGERED
Gulf grouper	Mycteroperca jordani	ENDANGERED
Nassau grouper	Epinephelus striatus	THREATENED
Smalltooth sawfish, U.S. DPS*	Pristis pectinata	ENDANGERED
Black abalone*	Haliotis cracherodii	ENDANGERED
White abalone	Haliotis sorenseni	ENDANGERED
Staghorn coral*	Acropora cervicornis	THREATENED
Elkhorn coral*	Acropora palmata	THREATENED
Coral, no common name	Acropora globiceps	THREATENED
Coral, no common name	Acropora jacquelineae	THREATENED
Coral, no common name	Acropora retusa	THREATENED
Coral, no common name	Acropora speciosa	THREATENED
Coral, no common name	Euphyllia pardivisa	THREATENED
Coral, no common name	Isopora crateriformis	THREATENED
Coral, no common name	Seriatopora aculeata	THREATENED

Common Name (Distinct Population Segment (DPS) or Evolutionarily Significant Unit (ESU))	Scientific Name	Status
Boulder star coral	Orbicella franksi	THREATENED
Lobed star coral	Orbicella annularis	THREATENED
Mountainous star coral	Orbicella faveolata	THREATENED
Pillar coral	Dendrogyra cylindrus	THREATENED
Rough cactus coral	Mycetophyllia ferox	THREATENED
Green sea turtle, Central North Pacific DPS	Chelonia mydas	THREATENED
Green sea turtle, Central South Pacific DPS		ENDANGERED
Green sea turtle, Central West Pacific DPS		ENDANGERED
Green sea turtle, East Pacific DPS		THREATENED
Green sea turtle, North Atlantic DPS*		THREATENED
Green sea turtle, South Atlantic DPS		THREATENED
Hawksbill sea turtle*	Eretmochelys imbricata	ENDANGERED
Kemp's ridley sea turtle	Lepidochelys kempii	ENDANGERED
Leatherback sea turtle*	Dermochelys coriacea	ENDANGERED
Loggerhead sea turtle, North Pacific Ocean DPS	Caretta caretta	ENDANGERED
Loggerhead sea turtle, Northwest Atlantic Ocean DPS*		THREATENED
Olive ridley sea turtle, Mexico's Pacific Coast breeding colonies	Lepidochelys olivacea	ENDANGERED
Olive ridley sea turtle, all other areas		THREATENED
Killer whale, Southern Resident DPS*	Orcinus orca	ENDANGERED
Steller sea lion, Western*	Eumetopias jubatus	ENDANGERED
Guadalupe fur seal	Arctocephalus townsendi	THREATENED
Hawaiian monk seal*	Monachus schauinslandi	ENDANGERED
Johnson's seagrass*	Halophila johnsonii	THREATENED

The following narratives summarize the biology and ecology of threatened and endangered species that are likely to be adversely affected by EPA's proposed action. The summaries include a description of the timing and duration of each life stage (e.g. adult river entry, spawning, egg incubation, freshwater rearing, smolt outmigration, and ocean migration).We also highlight information related to the viability of populations and the physical or biological features essential for the conservation of the species (PBFs) of designated critical habitats. These summaries provide a foundation for NMFS' evaluation of the effects of the proposed action on these listed species.

In assessing the status of the listed species NMFS made use of the viable salmonid population (VSP) concept and its four criteria. NMFS used these criteria to assess salmonids and, where appropriate, non-salmonid species. A VSP is an independent population (a population of which extinction probability is not substantially affected by exchanges of individuals with other populations) with a negligible risk of extinction, over a 100-year period, when threats from random catastrophic events, local environmental variation, demographic variation, and genetic diversity changes are taken into account (McElhany et al. 2000). The four factors defining a viable population are a population's: (1) spatial structure; (2) abundance; (3) annual growth rate, including trends and variability of annual growth rates; and (4) diversity (McElhany et al. 2000).

A population's tendency to increase in abundance and its variation in annual population growth defines a viable population (McElhany et al. 2000; Morris and Doak 2002). A negative long-term trend in average annual population growth rate will eventually result in extinction. Further, a weak positive long-term growth rate will increase the risk of extinction as it maintains a small population at low abundances over a longer time frame. A large variation in the growth rates also increases the likelihood of extinction (Lande 1993; Morris and Doak 2002). Thus, in our status reviews of each listed species, we provide information on population abundance and annual growth rate of extant populations.

The action area for this consultation contains designated critical habitat. Critical habitat is defined as the specific areas within the geographical area occupied by the species, at the time it is listed, on which are found those physical or biological features that are essential to the conservation of the species, and which may require special management considerations or protection. Critical habitat can also include specific areas outside the geographical area occupied by the species at the time it is listed that are determined by the Secretary to be essential for the conservation of the species (Endangered Species Act (ESA) of 1973, as amended, section 3(5)(A)).

The primary purpose in evaluating the status of critical habitat is to identify for each ESU or DPS the function of the critical habitat to support the intended conservation role for each species. Such information is important for an adverse modification analysis as it establishes the context for evaluating whether the proposed action results in negative changes in the function and role of the critical habitat for species conservation. NMFS bases its critical habitat analysis on the areas of the critical habitat that are affected by the proposed action and the area's physical or biological features that are essential to the conservation of a given species, and not on how individuals of the species will respond to changes in habitat quantity and quality.

In evaluating the status of designated critical habitat, we consider the current quantity, quality, and distribution of the physical or biological features (PBFs[2]) that are essential for the conservation of the species. NMFS has identified PBFs of critical habitat for each life stage (*e.g.,* migration, spawning, rearing, and estuary) common for a number of species (see Appendix C). To fully understand the conservation role of these habitats, specific physical and biological habitat features (*e.g.,* water temperature, water quality, forage, natural cover, etc.) were identified for each life stage.

Besides potential toxicity, water free of contaminants is important as contaminants can disrupt normal behavior necessary for successful migration, spawning, and juvenile rearing. Sufficient forage is necessary for juveniles to maintain growth that reduces freshwater predation mortality, increases overwintering success, initiates smoltification, and increases ocean survival. Natural cover such as submerged and overhanging large wood and aquatic vegetation provides shelter from predators, shades freshwater to prevent increase in water temperature, and creates important side channels. A description of the past, ongoing, and continuing activities that threaten the functional condition of PBFs and their attributes are described in the environmental baseline section of this Opinion.

The information from the status of the species section may be used as a "risk modifier" in the Integration and Synthesis section (Chapters 19-24). Factors which have the potential to "modify"

[2] Some of the critical habitat designations used the term "primary constituent elements" or PCEs, a regulatory that is no longer in effect. PCEs are generally the same as PBFs, and we will use the terms interchangeably based on the description in the critical habitat designation.

the risk of the action jeopardizing the species are those which are able to interact with the effects of the action. While many of the factors described in this section have the potential to modify the risk, and were thus considered, three of the factors within the status of the species were consistently found to have a high potential to modify the risk. Those three factors are: 1) trends in abundance, spatial distribution, and productivity; 2) listing status; and 3) achievement of recovery goals. We therefore developed three key questions to guide our synthesis of the information within the status of the species section:

1. Are abundance, spatial distribution, and productivity trends increasing, decreasing or stable?
2. Is the species listed as threatened or endangered?
3. Have recovery goals been met or are they on a sustained positive trajectory toward recovery?

Each status section within Chapter 9 concludes with a table providing a brief response to each of these questions.

Within the Integration and Synthesis section (Chapters 19-24) we characterize the overall magnitude of influence of the species status as either “low” or “high”. This characterization includes directionality (i.e. positive influence which equates to less risk or negative influence which equates to more risk) as well as confidence. The magnitude, directionality, and confidence of the influence are determined primarily by answers provided to the three key questions outlined above. We acknowledge that the magnitude, and directionality of these three factors varies on a species-by-species basis (for example, the significance of the attainment of recovery goals are relative to the specifics of the recovery goals themselves). We further acknowledge that the quantitative data (e.g. estimates of population growth rates) are incomplete without considering the more qualitative data often provided in recovery plans, status reports and listing documents. Therefore, we characterized magnitude and directionality with the following guidelines: 1) If the listing status of the species is “endangered”, the magnitude is high and the directionality is negative; 2) If the listing status is “threatened” and both of the other two factors indicates stability and/or recovery and/or uncertainty than the magnitude is low and the directionality is negative; 3) if the listing status is “threatened” and the other two factors indicate population decline and failure to meet recovery goals than the magnitude is high and the directionality is negative. It is conceivable directionality could also be positive. For example, if the listing status is “threatened” and the population’s growth rate, abundance, and spatial distribution has been consistently increasing between status reports, the direction could be positive. However, none of the species evaluated in this Opinion exhibited this.

The overall confidence in the magnitude and directionality is then characterized as either “low” or “high”. Confidence is determined by assessing the amount of evidence provided, as well as by further considering the species specific implications of the three factors.

9.32 Eulachon, Southern DPS

Table 2. Eulachon. Southern DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Thaleichthys pacificus	Eulachon	Southern	Threatened	2016	T – 75 FR 13012	Draft Recovery Plan (2016)	76 FR 515

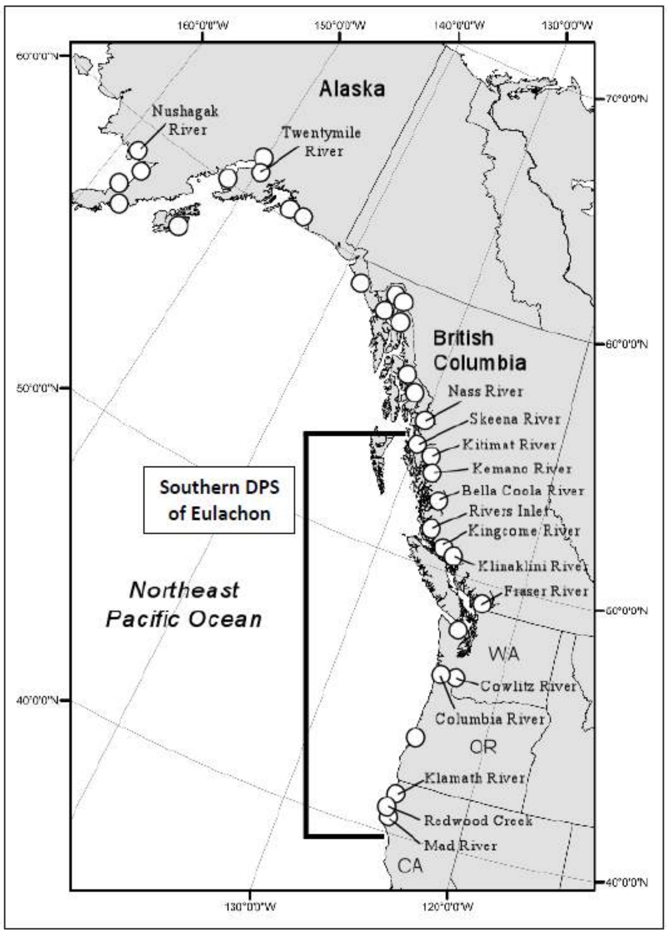

Figure 1. Eulachon. Southern DPS range. From the NMFS 2016 Five-Year Review (NMFS 2016).

Species Description The eulachon is a small, cold-water species of anadromous fish, occupying the eastern Pacific Ocean in nearshore waters to depths of about 1,000 feet (300 meters) from California to the Bering Sea. Eulachon will return to their natal river spawn. Southern DPS eulachon are those that spawn in rivers south of the Nass River in British Columbia to the Mad River in California (NMFS 2016a).

Status Eulachon formerly experienced widespread, abundant runs and have been a staple of Native American diets for centuries along the northwest coast. However, such runs that were formerly present in several California rivers as late as the 1960s and 1970s (i.e., Klamath River, Mad River and Redwood Creek) no longer occur (Larson and Belchik 2000). This decline likely began in the 1970s and continued until, in 1988 and 1989, the last reported sizeable run occurred in the Klamath River and no fish were found in 1996, although a moderate run was noted in 1999 (Larson and Belchik 2000; Moyle 2002b). Eulachon have not been identified in the Mad River and Redwood Creek since the mid-1990s (Moyle 2002b). The species is considered to be at moderate risk of extinction throughout its range because of a variety of factors, including predation, commercial and recreational fishing pressure (directed and bycatch), and loss of habitat. Warmer water temperatures associated with climate change could alter the timing of spawning, and the availability of prey for larval and juvenile eulachon (NMFS 2016a). Further population decline is anticipated to continue as a result of climate change and bycatch in commercial fisheries. However, because of their fecundity, eulachon are assumed to have the ability to recover quickly if given the opportunity (Bailey and Houde 1989).

Life history Although primarily marine, eulachon return to freshwater to spawn. For the Southern DPS eulachon, most spawning occurs in the Columbia River and its tributaries. Spawning usually occurs between ages two and five. Spawning is strongly influenced by water temperatures, and the timing of migration typically occurs between December and June, when water temperatures are between 0°C and 10°C (Gustafson 2016). In the Columbia River and further south, spawning occurs from late January to March (Hay and McCarter 2000). Further north, the peak of eulachon runs in Washington State is from February through March (Hay and McCarter 2000). Females lay between 7,000 and 60,000 eggs over sand, course gravel or detritial substrate. Eggs attach to gravel or sand and incubate for 30 to 40 days after which larvae drift to estuaries and coastal marine waters. In their first year of life, juveniles are found along the continental shelf (Gustafson 2016; Wydoski and Whitney 1979). Adult eulachon are found in coastal and offshore marine habitats. With the exception of some individuals in Alaska, eulachon generally die after spawning (Gustafson 2016). The maximum known lifespan is nine years of age, but 20 to 30 % of individuals live to four years and most individuals survive to three years of age, although spawning has been noted as early as two years of age. Larval and post larval eulachon prey upon phytoplankton, copepods, copepod eggs, mysids, barnacle larvae, worm larvae, and other eulachon larvae until they reach adult size (WDFW and ODFW 2001). The primary prey of adult eulachon are copepods and euphausiids, malacostracans and cumaceans.

Population Dynamics

Abundance There is no current population abundance estimate for the Southern DPS eulachon. There is a lack of long-term information on Southern DPS eulachon abundance, although the available fisheries landings data indicate a steep decline in the early to mid-1990s (Gustafson 2016). Data from fisheries surveys show that abundance can vary from year to year.

Productivity / Population Growth Rate There is no population growth rate available for Southern DPS eulachon, although some indices show an increasing temporal trend. (Gustafson 2016).

Genetic Diversity Southern DPS eulachon are genetically distinct from eulachon in the northern parts of its range (i.e., Alaska). Recent genetic analysis indicates that the Southern DPS exhibits a regional population structure, with a three-population southern Columbia-Fraser group, coming from the Cowlitz, Columbia, and Fraser rivers (Candy et al. 2015; Gustafson 2016).

Distribution Adult and juvenile Southern DPS eulachon can be found in the Pacific Ocean, along the continental shelf, in waters from 50 to 200 meters deep (Gustafson 2016). Adults are most frequently found in the Columbia River and its tributaries (e.g., Cowlitz River, Sandy River), and sometimes in the Klamath River, California.

Designated Critical Habitat On October 20, 2011, NMFS designated critical habitat for Southern DPS eulachon (76 FR 65324). Sixteen areas were designated in the states of Washington, Oregon, and California. These areas include: the Mad River, CA, Redwood Creek, CA, Klamath River, CA, Umpqua River/Winchester Bay, OR, Tenmile Creek, OR, Sandy River, OR, Lower Columbia River, OR and WA, Grays River, WA, Skamokawa Creek, WA, Elochoman River, WA, Cowlitz River, WA, Toutle River, WA, Kalama River, WA, Lewis River, WA, Quinault River, WA, and the Elwha River, WA. The designated areas are a combination of freshwater creeks and rivers and their associated estuaries, comprising approximately 539 km (335 mi) of habitat. The physical or biological features essential to the conservation of the DPS include:

- Freshwater spawning and incubation sites with water flow, quality and temperature conditions and substrate supporting spawning and incubation, and with migratory access for adults and juveniles.
- Freshwater and estuarine migration corridors associated with spawning and incubation sites that are free of obstruction and with water flow, quality and temperature conditions supporting larval and adult mobility, and with abundant prey items supporting larval feeding after the yolk sac is depleted.
- Nearshore and offshore marine foraging habitat with water quality and available prey, supporting juveniles and adult survival.

Recovery Goals See the 2016 Draft Recovery Plan for the Southern DPS eulachon, for complete down listing/delisting criteria for each of their respective recovery goals (NMFS 2016b). The following items were the top recovery actions identified to support in the Draft Recovery Plan:

1. Implement outreach and education strategies.
2. Conduct strategic research on eulachon.
3. Develop biological viability targets.
4. Conduct strategic research on eulachon habitats.
5. Conduct research on threats, including in marine and freshwater habitat, bycatch, predation, dams and water diversions, water quality, and others.
6. Assess regulatory measures, inadequacy of existing regulatory mechanisms.
7. Develop a research, monitoring, evaluation, and adaptive management plan.

Table 3. Summary of status; Eulachon. Southern DPS

Criteria	Description
Abundance / productivity trends	Although eulachon abundance in monitored populations has generally improved, especially in the 2013–2015 return years, recent poor ocean conditions and the likelihood that these conditions will persist into the near future suggest that population declines may be widespread in the upcoming return years. Therefore, it is too early to tell whether recent

	improvements in the southern DPS of eulachon will persist or whether a return to the severely depressed abundance years of the mid-late 1990s and late 2000s will reoccur.
Listing status	threatened
Attainment of recovery goals	Recovery plan not yet developed
Condition of PBFs	Spawning, incubation, and rearing PBFs are degraded; Dams block flow and access to historical spawning grounds and are cause for degraded spawning substrates below; Elevated temperatures prevalent in freshwater habitats; Environmental mixtures anticipated in freshwater habitats may affect prey.

9.33 Green Sturgeon, Southern DPS

Table 4. Green Sturgeon, Southern DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Acipenser medirostris	Green Sturgeon	Southern	Threatened	2015	2006 71 FR 17757	2010 Outline	2009 74 FR 52300

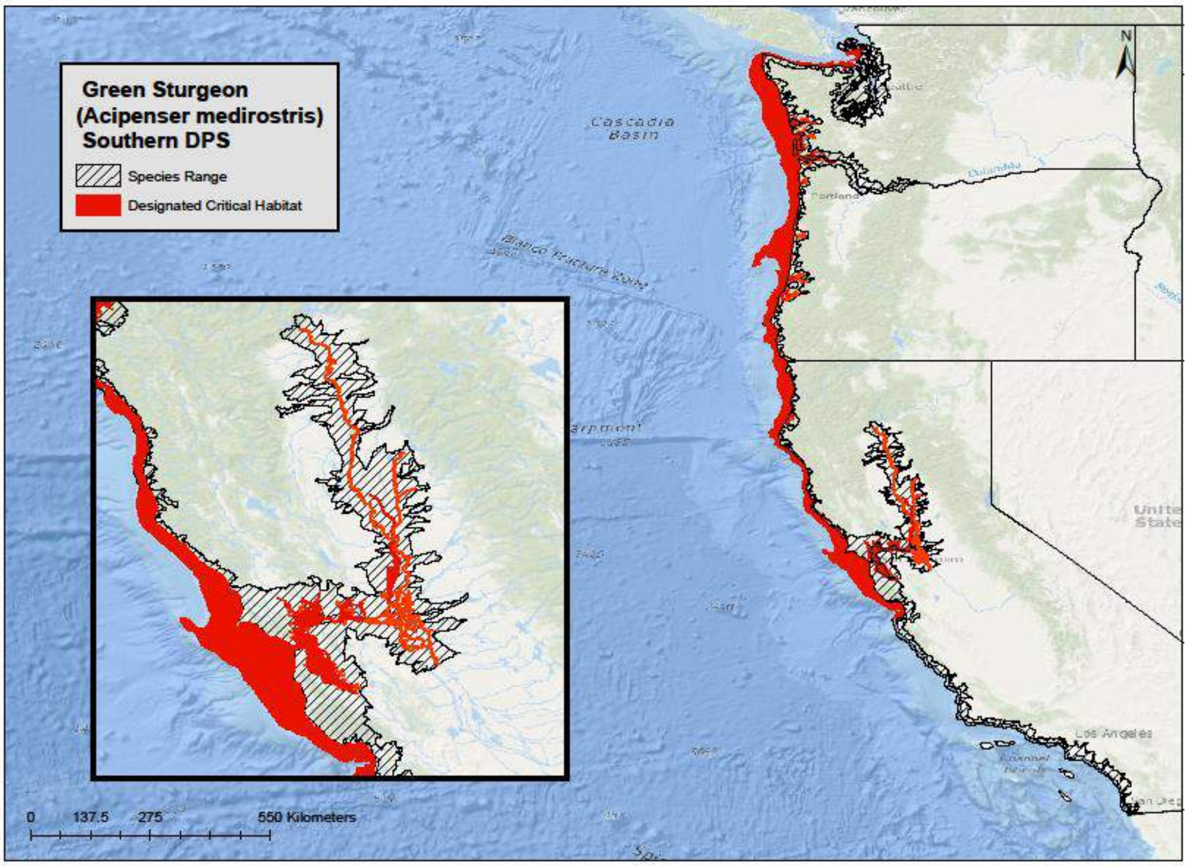

Figure 2. Green Sturgeon, Southern DPS range (within the contiguous US) and designated critical habitat

Species Description The North American green sturgeon, *Acipenser medirostris*, is an anadromous fish that occurs in the nearshore Eastern Pacific Ocean from Alaska to Mexico (Moyle 2002a). Green sturgeon are long-lived, late-maturing, iteroparous, anadromous species that spawn infrequently in natal streams, and spend substantial portions of their lives in marine waters. Although they are members of the class of bony fishes, the skeleton of sturgeons is composed mostly of cartilage. Sturgeon have five rows of characteristic bony plates on their body (called scutes). Green sturgeon have an olive green to dark green back, a yellowish green-white belly, and a white stripe beneath the lateral scutes (Adams et al. 2002) (*Error! Reference source not found.*). NMFS has identified two DPS of green sturgeon; northern and southern (Israel et al. 2009). In 2006, NMFS determined that the southern DPS green sturgeon warranted listing as a threatened species under the ESA (71 FR 17757). Green sturgeon have been observed in large concentrations in the summer and autumn within coastal bays and estuaries along the west coast of the US, including the Columbia River estuary, Willapa Bay, Grays Harbor, San Francisco bay and Monterey bay.

Status Attempts to evaluate the status of southern DPS green sturgeon have been met with limited success due to the lack of reliable long term data, however based on available scientific data (Adams et al. 2007) and ongoing conservation efforts, NMFS concluded in the final rule designating this species that southern DPS green sturgeon were likely to become endangered in the foreseeable future throughout all of its range. The final rule listing Southern DPS green sturgeon indicates that the principle factor for the decline in the DPS is the reduction of spawning to a limited area in the Sacramento River (71 FR 17757). In general, the primary threats to southern DPS green sturgeon are the reduction of potential spawning habitat (most notably by impoundments), water temperature and flow, and commercial and recreational bycatch. Climate change has the potential to impact Southern DPS green sturgeon in the future, but it is unclear how changing oceanic, nearshore and river conditions will affect the Southern DPS overall (NMFS 2015).

Life history Green sturgeon reach sexual maturity at approximately fifteen years of age (Van Eenennaam et al. 2006), and may spawn every three to five years throughout their long lives (Tracy 1990). Southern DPS green sturgeon spawn in cool (14-17ºC), deep, turbulent areas with clean, hard substrates. Six discrete spawning sites have been identified in the upper Sacramento River between Gianella Bridge (RK 320.6) and the Keswick dam (RK 486) (Poytress et al. 2013). Spawning has also been confirmed in the Feather River near the Thermalito Afterbay Outlet (RK 95) (Seesholtz et al. 2015). Adult diet includes shrimp, mollusks, amphipods, and even small fish (Houston 1988; Moyle et al. 1992). Juveniles in the Sacramento River delta feed on opossum shrimp, *Neomysis mercedis*, and *Corophium* amphipods (Radtke 1966).

In preparation for spawning, adult Southern DPS green sturgeon enter San Francisco Bay between mid-February and early-May, and migrate rapidly (on the order of a few weeks) up the Sacramento River (Heublein et al. 2009). Spawning occurs from April through early July, with peaks of activity that depend on a variety of factors including water temperature and water flow rates (Poytress et al. 2009; Poytress et al. 2010). Post-spawn fish typically congregate and hold for several months in a few deep pools in the upper mainstem Sacramento River near spawning sites and migrate back downstream when river flows increase in fall. They re-enter the ocean during the winter months (November through January) and begin their marine migration north along the coast (California Fish Tracking Consortium database).

Green sturgeon larvae are different from all other sturgeon because of the absence of a distinct swim-up or post-hatching stage. Larvae grow fast; young fish grow to 74 mm 45 days after hatching (Deng 2000). Larvae and juveniles migrate downstream toward the Sacramento-San Joaquin Delta/Estuary, where they rear for one to four years before migrating out to the Pacific Ocean as subadults (Nakamoto et al. 1995). Once at sea, subadults and adults occupy coastal waters to a depth of 110 m from Baja California, Mexico to the Bering Sea, Alaska (Hightower 2007). Seasonal migrations are known to occur. Fish congregate in coastal bays and estuaries of Washington, Oregon, and California during summer and fall. In winter and spring, similar aggregations can be found from Vancouver Island to Hecate Strait, British Columbia, Canada (Lindley et al. 2008)

Population Dynamics

Abundance Population dynamics of southern DPS green sturgeon focus on abundance; intrinsic growth rates; genetic diversity, drift, and natural selection. Preliminary results from 2010-14 surveys indicated the presence of the following number of adult Southern DPS green sturgeon in the Sacramento River (with 95% confidence interval): 2010: 164 ± 47; 2011: 220 ± 42; 2012: 329 ± 57; 2013: 338 ± 61; 2014: 526 ± 64. Based on these numbers and estimates of mean spawning periodicity, the total number of adults in the Southern DPS population is estimated to be 1,348 ± 524 (Mora 2015; NMFS 2015).

Productivity / Population Growth Rate Attempts to evaluate the status of southern DPS green sturgeon have been met with limited success due to the lack of reliable long term data. No estimate of λ is available for southern DPS green sturgeon.

Genetic Diversity The available genetic data do not change the status of the species or the imminence or magnitude of any threat; data only confirm the DPS structure and add detail to the DPS composition in different estuaries during the sampling periods (NMFS 2015). Green sturgeon stocks from the DPSs have been found to be genetically differentiated (Israel et al. 2009; Israel et al. 2004).

Distribution In general, subadult (from the age of ocean entry to age of first spawning) and adult North American green sturgeon spend most of their lives in oceanic environments where they occupy nearshore coastal waters from the Bering Sea, Alaska (Colway and Stevenson 2007) to Baja California, Mexico (Rosales-Casian and Almeda-Jauregui 2009). Within this range, green sturgeon have been observed in large concentrations in the summer and autumn within coastal bays and estuaries along the west coast of the US, including the Columbia River estuary, Willapa Bay, Grays Harbor, San Francisco bay and Monterey bay (Huff et al. 2012; Lindley et al. 2011; Lindley et al. 2008; Moser and Lindley 2007).

Adult Southern DPS green sturgeon enter San Francisco bay in late winter though early spring and pass though in a matter of days (Heublein et al. 2009). Spawning occurs from April through early July, with peaks of activity influenced by factors including water flow and temperature (Heublein et al. 2009; Poytress et al. 2011). Six discrete spawning sites have been identified in the upper Sacramento River between Gianella Bridge (RK 320.6) and the Keswick dam (RK 486) (Poytress et al. 2013). Spawning has also been confirmed in the Feather River near the Thermalito Afterbay Outlet (RK 95) (Seesholtz et al. 2015).

Designated Critical Habitat Critical habitat was designated for Southern DPS green sturgeon on October 9, 2009, and includes marine, coastal bay, estuarine, and freshwater areas (74 FR 52300). PBFs considered essential for the conservation of Green Sturgeon, Southern DPS are:

Freshwater areas

- *Food resources.* Abundant prey items for larval, juvenile, subadult, and adult life stages.
- Substrate type or size (i.e., structural features of substrates)
- Water flow. A flow regime (i.e., the magnitude, frequency, duration, seasonality, and rate-of-change of fresh water discharge over time) necessary for normal behavior, growth, and survival of all life stages.

- Water quality. Water quality, including temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages.
- Migratory corridor. A migratory pathway necessary for the safe and timely passage of Southern DPS fish within riverine habitats and between riverine and estuarine habitats (e.g., an unobstructed river or dammed river that still allows for safe and timely passage).
- Water depth. Deep (≥5 m) holding pools for both upstream and downstream holding of adult or subadult fish, with adequate water quality and flow to maintain the physiological needs of the holding adult or subadult fish.
- Sediment quality. Sediment quality (i.e., chemical characteristics) necessary for normal behavior, growth, and viability of all life stages.

Estuarine areas

- Food resources. Abundant prey items within estuarine habitats and substrates for juvenile, subadult, and adult life stages.
- Water flow. Within bays and estuaries adjacent to the Sacramento River (*i.e.,* the Sacramento-San Joaquin Delta and the Suisun, San Pablo, and San Francisco bays), sufficient flow into the bay and estuary to allow adults to successfully orient to the incoming flow and migrate upstream to spawning grounds.
- *Water quality.* Water quality, including temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages.
- Migratory corridor. A migratory pathway necessary for the safe and timely passage of Southern DPS fish within estuarine habitats and between estuarine and riverine or marine habitats.
- Water depth. A diversity of depths necessary for shelter, foraging, and migration of juvenile, subadult, and adult life stages.
- Sediment quality. Sediment quality (i.e., chemical characteristics) necessary for normal behavior, growth, and viability of all life stages. This includes sediments free of elevated levels of contaminants

Coastal Marine Areas

- Migratory corridor. A migratory pathway necessary for the safe and timely passage of Southern DPS fish within marine and between estuarine and marine habitats.
- Water quality. Coastal marine waters with adequate dissolved oxygen levels and acceptably low levels of contaminants (e.g., pesticides, PAHs, heavy metals that may disrupt the normal behavior, growth, and viability of subadult and adult green sturgeon).
- Food resources. Abundant prey items for subadults and adults, which may include benthic invertebrates and fish.

Recovery Goals The final recovery plan for Southern DPS green sturgeon has not been released. The recovery outline (NMFS 2010a) indicates that the recovery potential for sDPS green sturgeon is considered moderate to high; however, certain life history characteristics (e.g., long-lived, delayed maturity) indicate recovery could take many decades, even under the best circumstances. According to the recovery outline key recovery needs and implementation measures identified include additional spawning and egg/larval habitat as well as additional research and monitoring (NMFS 2010a).

Table 5. Summary of status; Green Sturgeon, Southern DPS

Criteria	Description
Abundance / productivity trends	Small population size, little population data, few remaining spawning sites
Listing status	Threatened
Attainment of recovery goals	Meeting recovery goals anticipated to take decades
Condition of PBFs	Insufficient freshwater flow rates in spawning areas; Contaminants (e.g., pesticides); Impassable barriers limit spawning to limited sections in Sacramento River; Elevated water temperatures.

9.34 Shortnose Sturgeon

Table 6. Shortnose Sturgeon; overview table

Species	Common Name	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Acipenser brevirostrum	Sturgeon, Shortnose	Endangered	2010	1967 32 FR4001	1998	None Designated

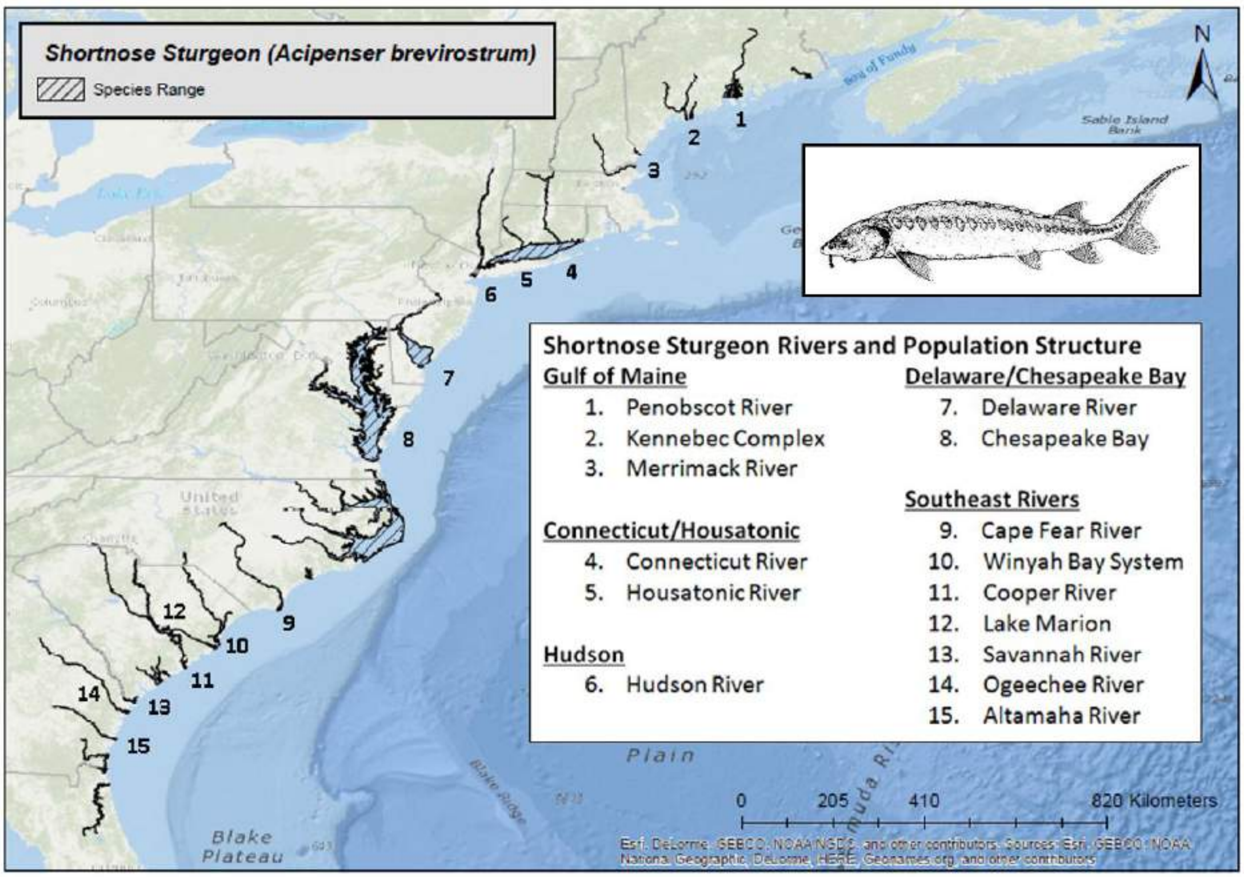

Figure 3. Shortnose Sturgeon range

Species Description The shortnose sturgeon (*Acipenser brevirostrum*) is the smallest of the three sturgeon species that occur in eastern North America. It has a benthic fusiform body and its head and snout are smaller while its mouth is larger relative to Atlantic sturgeon (Dadswell 1984). Shortnose sturgeon vary in color but are generally dark brown to olive/black on the dorsal surface, lighter along the row of lateral scutes and nearly white on the ventral surface (Gilbert 1989). The shortnose sturgeon was listed as endangered on March 11, 1967 (32 FR 4001). Shortnose sturgeon remained on the endangered species list with the enactment of the ESA in 1973. Shortnose sturgeon occur in estuaries and rivers along the east coast of North America (Vladykov and Greeley 1963). Their northerly distribution extends to the Saint John River, New

Brunswick, Canada, and their southerly distribution historically extended to the Indian River, Florida (Evermann and Bean 1898; Scott and Scott 1988).

Status The decline in abundance and slow recovery of shortnose sturgeon has been attributed to pollution, overfishing, bycatch in commercial fisheries, and an increase in industrial uses of the nation's large coastal rivers during the 20th century (e.g., hydropower, nuclear power, treated sewage disposal, dredging, construction) (NMFS 2010b). In addition, the effects of climate change may adversely impact shortnose sturgeon by reducing the amount of available habitat, exacerbating existing water quality problems, and interfering with migration and spawning cues (NMFS 2010b). Without substantial mitigation and management to improve access to historical habitats and water quality of these systems, shortnose sturgeon populations will likely continue to be depressed. This is particularly evident in some southern rivers that are suspected to no longer support reproducing populations of shortnose sturgeon (NMFS 2010b). The number of river systems in which spawning has been confirmed has been reduced to around 12 locations (NMFS 2010b).

Life history Shortnose sturgeon are relatively slow growing, late maturing and long-lived. Growth rate, maximum age and maximum size vary with latitude; populations in southern areas grow more rapidly and mature at younger ages but attain smaller maximum sizes than those in the north (Dadswell et al. 1984). In general, females reach sexual maturity in the south as early as age 4 and in the north as late as age 18, and males display similar difference in latitudinal development, maturing between ages 2 and 11 (NMFS 2010b). Shortnose sturgeon overwinter in the lower portions of rivers and migrate upriver to spawn in the spring. Spawning periodicity is poorly understood, but males seem to spawn more frequently than females. Dadswell (Dadswell) estimated that Saint John River males spawned at 2-year intervals; females at 3-5 year intervals. Spawning females deposit their eggs over gravel, rubble, and/or cobble often in the farthest accessible upstream reach of the river (Kynard 1997). After spawning, adult shortnose sturgeon move rapidly to downstream feeding areas where they forage on benthic insects, crustaceans, mollusks, and polychaetes (Buckley and Kynard 1985; Dadswell 1984; Kieffer and Kynard 1993; O'herron et al. 1993).

Upon hatching, shortnose sturgeon shelter in dark substrate or are found in schools swimming against the current. Around 4-12 days after hatching individuals begin to feed exogenously and are dispersed downstream. These larvae are often found in the deepest water, usually within the channel (Kieffer and Kynard 1993; O'Connor et al. 1981; Parker and Kynard 2014; Taubert and Dadswell 1980). Young of the Year remain in freshwater habitats upstream of the salt wedge for about one year (Dadswell et al. 1984; Kynard 1997). The age at which juveniles begin to utilize habitat associated with the salt/fresh water interface varies with river system from age one to eight (Collins et al. 2002; Dadswell 1979; Flournoy et al. 1992). Overwintering habitat and behavior of shortnose sturgeon varies with latitude: fish in northern rivers form tight aggregations with little movement and will inhabit either freshwater or saline reaches of the river, while fish in the south are more active and are found predominantly near the fresh/saltwater interface (Collins and Smith 1993; Kynard et al. 2012; Weber et al. 1998).

The general pattern of coastal migration of shortnose sturgeon indicates movement between groups of rivers proximal to each other across the geographic range (Altenritter et al. 2015; Dionne et al. 2013; Quattro et al. 2002; Wirgin et al. 2005). NMFS' 2010 biological assessment of shortnose sturgeon grouped the species into five regional population clusters: Gulf of Maine, Connecticut/Housatonic rivers, Hudson River, Delaware River/Chesapeake Bay, and Southeast. King et al. (King et al.) identified three metapopulations: 1) Maine rivers, 2) Delaware River and Chesapeake Bay proper, and 3) the Southeast assemblage. The shortnose sturgeon status review team recommends that recovery and management actions consider each riverine population as a management/recovery unit (NMFS 2010b).

Population Dynamics

Abundance The 2010 biological assessment of shortnose sturgeon identified five regional population clusters of shortnose sturgeon. See table below for abundance estimates for populations within each of these population clusters.

Table 7. Shortnose sturgeon populations and estimated abundances

Regional Population Cluster	Location[a]	Abundance Estimate (Upper/Lower 95% CI)[b]	(Source) Year of Collection Data
Gulf of Maine	Penobscot River	1,049 (673 / 6,939)	(NMFS 2012) 2006 – 2007
	Kennebec Complex	9,488 (6,942 / 13,358)	(Squiers 2004) 1998 – 2000
	Merrimack River	2000 (NA)	(NMFS 2010b) 2009
Connecticut and Housatonic Rivers	Connecticut River – upper*	143 (14 / 360)	(Kynard et al. 2012) 1994 – 2001
	Connecticut River – lower*	1,297 (NA)	(Savoy 2004) 1996 – 2002
Hudson River	Hudson River	30,311 (NA)	(NMFS 2010b) 1980
Delaware River/Chesapeake Bay	Delaware River	12,047 (10,757 / 13,580)	(Brundage III 2006) 1999 – 2003
Southeast Rivers	Cape Fear River	50 (NA)	(NMFS 2010b) NA
	Cooper River	301 (150 / 659)	(Cooke et al. 2004) 1996 – 1998
	Lake Marion	Unknown (NA)	(NMFS 2010b) NA
	Savannah River	940 adults (535 / 1753)	(Bahr and Peterson 2017) 2015
	Ogeechee River	147 (104 / 249)	(Fleming et al. 2003) 1999 – 2000
	Altamaha River	1,209 (556 / 2759)	(Bednarski 2012) 2004 – 2010

[a]Locations listed here are those for which population estimates are available. Additional waterbodies with confirmed shortnose sturgeon include Piscataqua River, Housatonic River, Chesapeake Bay, Susquehanna River, Potomac River, Roanoke River, Chowan River, Tar/Pamlico River, Neuse River, New River, North River, Santee River, ACE Basin – Edisto (Smith et al. 2002), Satilla River, St. Mary's River, St. Johns River (NMFS 2010b).

Regional Population Cluster	Location[a]	Abundance Estimate (Upper/Lower 95% CI)[b]	(Source) Year of Collection Data
[b]*Abundance estimates are established using different techniques and should be viewed with caution. Estimates listed here are those identified by NMFS in the 2010 Biological Assessment of Shortnose Sturgeon (NMFS 2010b).*			
**The Connecticut River population of shortnose sturgeon is separated into an upstream and downstream segment bisected by the Holyoke Dam.*			

Productivity / Population Growth Rate Precise estimates of population growth rate (intrinsic rates) are unknown due to lack of long-term abundance data.

Table 8. Shortnose sturgeon populations and productivity estimates

Regional Population Cluster	**Location[a]**	**Evidence of Spawning**	**Abundance Trend Estimate (Population Health Score)[b]**
Gulf of Maine	Penobscot River	No spawning locations found; no juveniles or larvae observed.	No estimates (4.35)
	Kennebec Complex	Spawning confirmed on Kennebec and Androscoggin rivers.	Increasing (10.42)
	Merrimack River	Spawning confirmed	Potentially stable (5.65)
Connecticut and Housatonic Rivers	Connecticut River – upper	Spawning confirmed	Potentially stable (8.35)
	Connecticut River - lower	Minimal spawning	Potentially stable (8.35)
Hudson River	Hudson River	Spawning confirmed	Potentially stable (10.00)
Delaware River/Chesapeake Bay	Delaware River	Spawning confirmed	Potentially stable (9.56)
Southeast Rivers	Cape Fear River	Gravid females documented	Declining (3.12)
	Winyah Bay System	Spawning confirmed	Potentially stable (6.23)
	Cooper River	Spawning confirmed	Potentially stable (6.23)
	Lake Marion	Spawning confirmed	No estimates (4.12)
	Savannah River	Spawning confirmed	Potentially stable (8.35)
	Ogeechee River	No spawning locations found; gravid females	Potentially stable (7.23)

Regional Population Cluster	Location[a]	Evidence of Spawning	Abundance Trend Estimate (Population Health Score)[b]
		and juveniles confirmed	
	Altamaha River	Spawning confirmed	Potentially stable (9.22)

[a] Locations listed here are those for which population estimates are available, and/or those in which spawning has been confirmed. Additional waterbodies with confirmed shortnose sturgeon include Piscataqua River, Housatonic River, Chesapeake Bay, Susquehanna River, Potomac River, Roanoke River, Chowan River, Tar/Pamlico River, Neuse River, New River, North River, Santee River, ACE Basin, Satilla River, St. Mary's River, St. Johns River (NMFS 2010b).

[b] Population Health Scores taken from NMFS 2010 Biological Assessment of shortnose sturgeon. Scale from 0 – 12, with larger values representing healthier populations (NMFS 2010b).

Genetic Diversity Genetic diversity estimates for shortnose sturgeon have been shown to be moderately high in both mitochondrial (Quattro et al. 2002; Wirgin et al. 2005; Wirgin et al. 2010) and nuclear genomes (King et al. 2014). The mtDNA and nDNA studies performed to date suggest that dispersal is a very important factor in maintaining these high levels of genetic diversity

Distribution Shortnose sturgeon occur along the East Coast of North America in rivers, estuaries and the sea. They were once present in most major rivers systems along the Atlantic coast (Evermann and Bean 1898; Scott and Scott 1988). Their current distribution extends north to the Saint John River, New Brunswick, Canada, and south to the St. Johns River, FL (NMFS 1998). Currently, the distribution of shortnose sturgeon across their range is disjunct, with northern populations separated from southern populations by a distance of about 400 km near their geographic center in North Carolina and Virginia. Some river systems host populations which rarely leave freshwater while in other areas coastal migrations between river systems are common. Spawning locations have been identified within a number of river systems (NMFS 2010b).

Designated Critical Habitat Critical habitat has not been proposed for shortnose sturgeon.

Recovery Goals The long-term recovery objective for the shortnose sturgeon is to recover all discrete population segments (as defined in the 1998 shortnose sturgeon recovery plan) to levels of abundance at which they no longer require protection under the ESA. Each population segment may become a candidate for downlisting when it reaches a minimum population size that: 1) is large enough to prevent extinction, and 2) will make the loss of genetic diversity unlikely. The minimum population size for each population segment has not yet been determined (NMFS 1998; NMFS 2010b).

Table 9. Summary of status; Shortnose Sturgeon

Criteria	Description
Abundance / productivity trends	Stable to increasing populations, fragmented populations, only 12 known spawning sites
Listing status	endangered

Attainment of recovery goals	none

9.35 Atlantic Sturgeon, Gulf of Maine DPS

Table 10. Atlantic Sturgeon, Gulf of Maine DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Acipenser oxyrinchus oxyrinchus	Sturgeon, Atlantic	Gulf of Maine	Threatened	2007	77 FR 5880	No	82 FR 39160

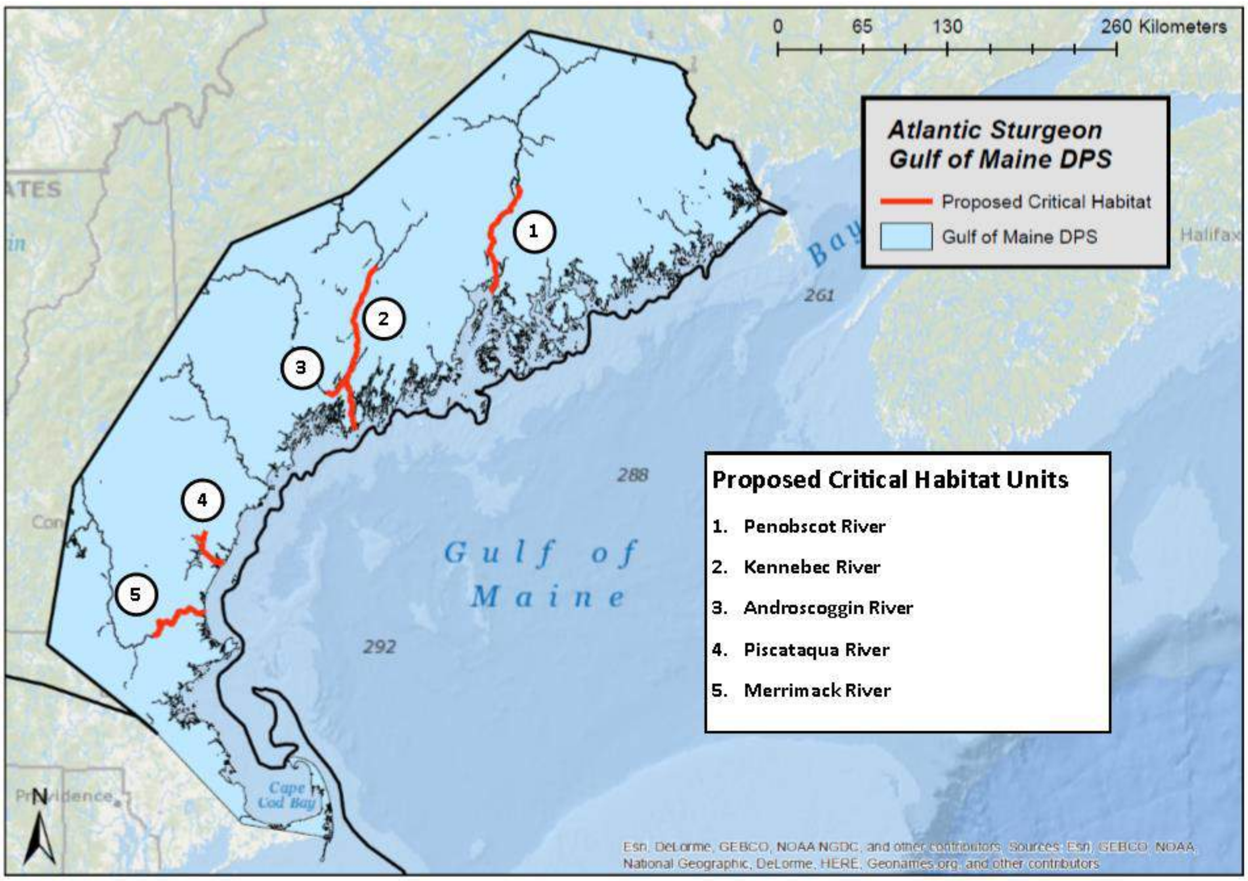

Figure 4. Atlantic Sturgeon, Gulf of Maine DPS range and proposed designated critical habitat

Species Description The Atlantic sturgeon is a long lived, late maturing, anadromous species. Atlantic sturgeon attain lengths of up to approximately 14 feet, and weights of more than 800 pounds. They are bluish black or olive brown dorsally with paler sides and a white ventral surface and have five major rows of dermal scutes (Colette and Klein-MacPhee 2002). On February 6, 2012, four DPSs of Atlantic sturgeon: New York Bight, Chesapeake Bay, Carolina, and South Atlantic, were listed as endangered and the Gulf of Maine DPS was listed as threatened (77 FR 5880; 77 FR 5914). Atlantic sturgeon occupy ocean waters and associated bays, estuaries, and coastal river systems from Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida (ASMFC 2006; Stein et al. 2004).

Status Atlantic sturgeon were once present in 38 river systems and, of these, spawned in 35 of them. Individuals are currently present in 36 rivers, and spawning occurs in at least 20 of these (ASSRT 2007). The decline in abundance of Atlantic sturgeon has been attributed primarily to the large U.S. commercial fishery which existed for the Atlantic sturgeon from the 1870's through the mid 1990's. The fishery collapsed in 1901 and landings remained at between 1 – 5% of the pre-collapse peak until ASMFC placed a two generation moratorium on the fishery in 1998 (ASMFC 1998). The majority of the populations show no signs of recovery, and new information suggests that stressors such as bycatch, ship strikes, and low DO can and do have substantial impacts on populations (ASSRT 2007). Additional threats to Atlantic sturgeon include habitat degradation from dredging, damming, and poor water quality (ASSRT 2007). Climate change related impacts on water quality (e.g., temperature, salinity, dissolved oxygen, contaminants) have the potential to impact Atlantic sturgeon populations using impacted river systems. These effects are expected to be more severe for southern portions of the U.S. range of Atlantic sturgeon (Carolina and South Atlantic DPSs). None of the spawning populations are currently large or stable enough to provide any level of certainty for continued existence of any of the DPSs.

Life history Atlantic Sturgeon size at sexual maturity varies with latitude with individuals reaching maturity in the Saint Lawrence River at 22 – 34 years (Scott and Crossman 1973). Atlantic sturgeon spawn in freshwater, but spend most of their adult life in the marine environment. Spawning adults generally migrate upriver in May-July in Canadian systems (Bain 1997; Caron et al. 2002; Murawski and Pacheco 1977; Smith 1985; Smith and Clugston 1997). Atlantic sturgeon spawning is believed to occur in flowing water between the salt front and fall line of large rivers at depths of 3-27 meters (Bain et al. 2000; Borodin 1925; Crance 1987; Leland 1968; Scott and Crossman 1973). Atlantic sturgeon likely do not spawn every year; spawning intervals range from 1-5 years for males (Caron et al. 2002; Collins et al. 2000; Smith 1985) and 2-5 for females (Stevenson and Secor 2000; Van Eenennaam et al. 1996; Vladykov and Greeley 1963).

Sturgeon eggs are highly adhesive and are deposited on the bottom substrate, usually on hard surfaces (Gilbert 1989; Smith and Clugston 1997) between the salt front and fall line of large rivers (Bain et al. 2000; Borodin 1925; Crance 1987; Scott and Crossman 1973). Following spawning in northern rivers, males may remain in the river or lower estuary until the fall; females typically exit the rivers within four to six weeks (Savoy and Pacileo 2003). Hatching occurs approximately 94-140 hours after egg deposition at temperatures of 20° and 18° Celsius, respectively (Theodore et al. 1980). The yolksac larval stage is completed in about 8-12 days, during which time larvae move downstream to rearing grounds over a 6 – 12 day period (Kynard and Horgan 2002). Juvenile sturgeon continue to move further downstream into waters ranging from 0 to up to 10 parts per thousand salinity. Older juveniles are more tolerant of higher salinities as juveniles typically spend two to five years in freshwater before eventually becoming coastal residents as sub-adults (Boreman 1997; Schueller and Peterson 2010; Smith 1985).

Upon reaching the subadult phase individuals may move to coastal and estuarine habitats (Dovel and Berggren 1983; Murawski and Pacheco 1977; Smith 1985; Stevenson 1997). Tagging and genetic data indicate that subadult and adult Atlantic sturgeon may travel widely once they emigrate from rivers. Despite extensive mixing in coastal waters, Atlantic sturgeon exhibit high fidelity to their natal rivers (Grunwald et al. 2008; King et al. 2001; Waldman et al. 2002). Because of high natal river fidelity, it appears that most rivers support independent populations

(Grunwald et al. 2008; King et al. 2001; Waldman and Wirgin 1998; Wirgin et al. 2002; Wirgin et al. 2000). Atlantic sturgeon feed primarily on polychaetes, isopods, American sand lances and amphipods in the marine environment, while in fresh water they feed on oligochaetes, gammarids, mollusks, insects, and chironomids (Guilbard et al. 2007; Johnson et al. 1997; Moser and Ross 1995; Novak et al. 2017; Savoy 2007).

Population Dynamics

Abundance Historically, the Gulf of Maine DPS likely supported more than 10,000 spawning adults (ASSRT 2007; KRRMP 1993; Secor 2002; NMFS 2007). The current abundance is estimated to be 1-2 orders of magnitude smaller than historical levels (ASSRT 2007).

Productivity / Population Growth Rate There are some positive signs for the Gulf of Maine DPS, which include observations of Atlantic sturgeon in rivers from which sturgeon observations have not been reported for many years (Saco, Presumpscot, and Charles rivers) and potentially higher catch-per-unit-effort levels than in the past (Kennebec) (NMFS 2007). Precise estimates of population growth rate (intrinsic rates) are unknown due to lack of long-term abundance data.

Genetic Diversity The genetic diversity of Atlantic sturgeon throughout its range has been well documented (Bowen and Avise 1990; Ong et al. 1996; Waldman et al. 1996; Waldman and Wirgin 1998). Overall, these studies have consistently found populations to be genetically diverse and the majority can be readily differentiated. Relatively low rates of gene flow reported in population genetic studies (King et al. 2001; Waldman et al. 2002) indicate that Atlantic sturgeon return to their natal river to spawn, despite extensive mixing in coastal waters.

Distribution The geomorphology of most small coastal rivers in Maine is not sufficient to support Atlantic sturgeon spawning populations, except for the Penobscot and the estuarial complex of the Kennebec, Androscoggin, and Sheepscot rivers. Spawning still occurs in the Kennebec and Androscoggin Rivers, and may occur in the Penobscot River. Atlantic sturgeon have more recently been observed in the Saco, Presumpscot, and Charles rivers.

Designated Critical Habitat Designated Critical Habitat was effective September 18, 2017. Based on the best scientific information available for the life history needs of the Gulf of Maine, DPS, the physical features essential to the conservation of the species and that may require special management considerations or protection are:

- Hard bottom substrate (*e.g.,* rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (*i.e.,* 0.0 to 0.5 parts per thousand (ppt) range) for settlement of fertilized eggs, refuge, growth, and development of early life stages;
- Aquatic habitat with a gradual downstream salinity gradient of 0.5 up to as high as 30 ppt and soft substrate (*e.g.,* sand, mud) between the river mouth and spawning sites for juvenile foraging and physiological development;
- Water of appropriate depth and absent physical barriers to passage (*e.g.,* locks, dams, thermal plumes, turbidity, sound, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support:
    - Unimpeded movement of adults to and from spawning sites;
    - Seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and
    - Staging, resting, or holding of subadults or spawning condition adults.

- Water depths in main river channels must also be deep enough (*e.g.,* at least 1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river.
- Water, between the river mouth and spawning sites, especially in the bottom meter of the water column, with the temperature, salinity, and oxygen values that, combined, support:
    - Spawning;
    - Annual and interannual adult, subadult, larval, and juvenile survival; and
    - Larval, juvenile, and subadult growth, development, and recruitment (*e.g.,* 13 °C to 26 °C for spawning habitat and no more than 30 °C for juvenile rearing habitat, and 6 milligrams per liter (mg/L) dissolved oxygen (DO) or greater for juvenile rearing habitat).

Recovery Goals Recovery Plans have not yet been drafted for the Atlantic Sturgeon.

Table 11. Summary of status; Atlantic Sturgeon, Gulf of Maine DPS

Criteria	**Description**
Abundance / productivity trends	10% of historical abundance, unknown population growth rate, range expanding
Listing status	threatened
Attainment of recovery goals	none

9.36 Atlantic Sturgeon, New York Bight DPS

Table 12. Atlantic Sturgeon, New York Bight DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Acipenser oxyrinchus oxyrinchus	Sturgeon, Atlantic	New York Bight	Endangered	2007	77 FR 5880	No	82 FR 39160

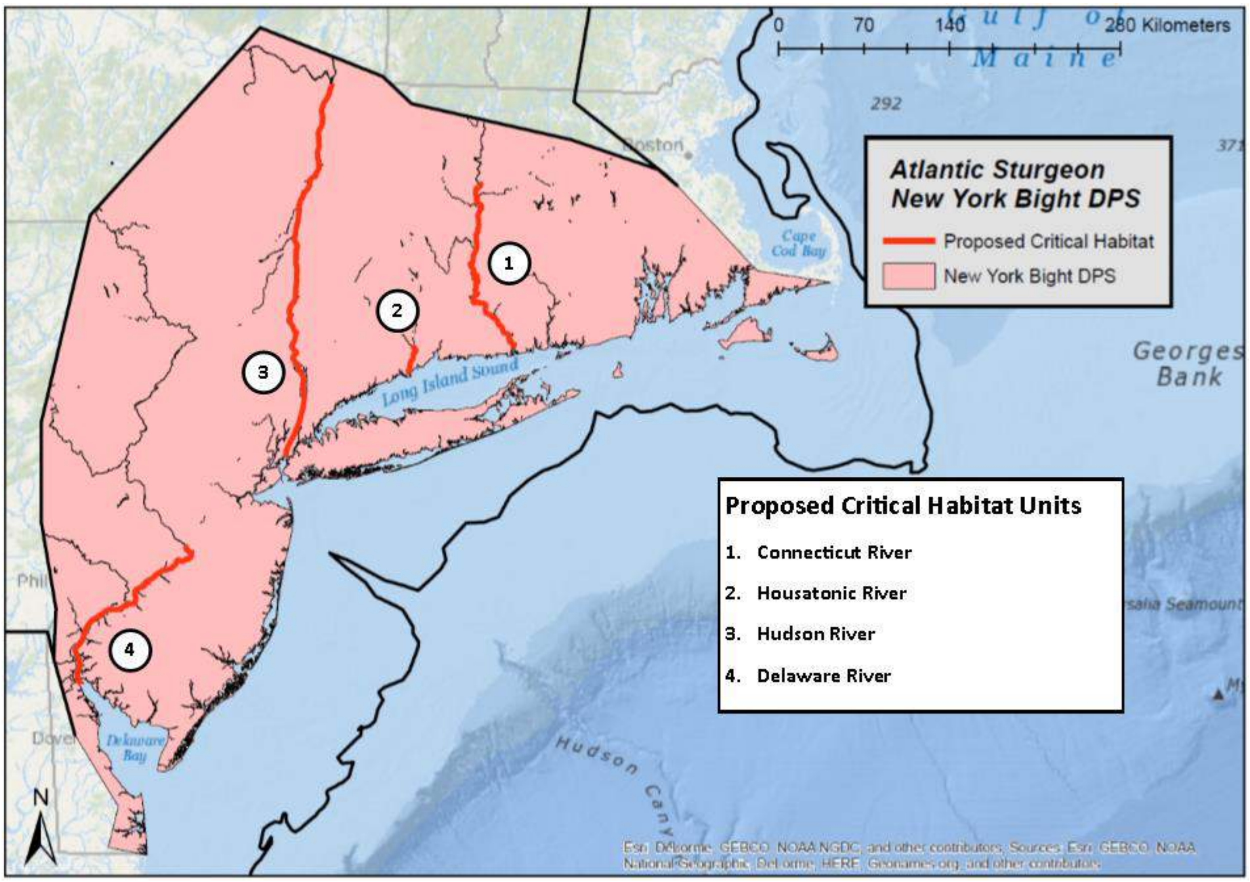

Figure 5. Atlantic Sturgeon, New York Bight DPS range and proposed designated critical habitat

Species Description The Atlantic sturgeon is a long lived, late maturing, anadromous species. Atlantic sturgeon attain lengths of up to approximately 14 feet, and weights of more than 800 pounds. They are bluish black or olive brown dorsally with paler sides and a white ventral surface and have five major rows of dermal scutes (Colette and Klein-MacPhee 2002). On February 6, 2012, four DPSs of Atlantic sturgeon: New York Bight, Chesapeake Bay, Carolina, and South Atlantic, were listed as endangered and the Gulf of Maine DPS was listed as threatened (77 FR 5880; 77 FR 5914). Atlantic sturgeon occupy ocean waters and associated bays, estuaries, and coastal river systems from Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida (ASMFC 2006; Stein et al. 2004).

Status Atlantic sturgeon were once present in 38 river systems and, of these, spawned in 35 of them. Individuals are currently present in 36 rivers, and spawning occurs in at least 20 of these (ASSRT 2007). The decline in abundance of Atlantic sturgeon has been attributed primarily to the large U.S. commercial fishery which existed for the Atlantic sturgeon from the 1870's through the mid 1990's. The fishery collapsed in 1901 and landings remained at between 1 – 5% of the pre-collapse peak until ASMFC placed a two generation moratorium on the fishery in 1998 (ASMFC 1998). The majority of the riverine populations show no signs of recovery, and new information suggests that stressors such as bycatch, ship strikes, and low DO can and do have substantial impacts on populations (ASSRT 2007). Additional threats to Atlantic sturgeon include habitat degradation from dredging, damming, and poor water quality (ASSRT 2007). Climate change related impacts on water quality (e.g., temperature, salinity, dissolved oxygen, contaminants) have the potential to impact Atlantic sturgeon populations using impacted river systems. These effects are expected to be more severe for southern portions of the U.S. range of Atlantic sturgeon (Carolina and South Atlantic DPSs). None of the spawning populations are currently large or stable enough to provide any level of certainty for continued existence of any of the DPSs.

Life history Atlantic Sturgeon size at sexual maturity varies with latitude with individuals reaching maturity in the Hudson River at 11 – 21 years (Young et al. 1988). Atlantic sturgeon spawn in freshwater, but spend most of their adult life in the marine environment. Spawning adults generally migrate upriver in April-May in mid-Atlantic systems, and May-July in Canadian systems (Bain 1997; Caron et al. 2002; Murawski and Pacheco 1977; Smith 1985; Smith and Clugston 1997). Atlantic sturgeon spawning is believed to occur in flowing water between the salt front and fall line of large rivers at depths of 3-27 meters (Bain et al. 2000; Borodin 1925; Crance 1987; Leland 1968; Scott and Crossman 1973). Atlantic sturgeon likely do not spawn every year; spawning intervals range from 1-5 years for males (Caron et al. 2002; Collins et al. 2000; Smith 1985) and 2-5 for females (Stevenson and Secor 2000; Van Eenennaam et al. 1996; Vladykov and Greeley 1963).

Sturgeon eggs are highly adhesive and are deposited on the bottom substrate, usually on hard surfaces (Gilbert 1989; Smith and Clugston 1997) between the salt front and fall line of large rivers (Bain et al. 2000; Borodin 1925; Crance 1987; Scott and Crossman 1973). Following spawning in northern rivers, males may remain in the river or lower estuary until the fall; females typically exit the rivers within four to six weeks (Savoy and Pacileo 2003). Hatching occurs approximately 94-140 hours after egg deposition at temperatures of 20° and 18° Celsius, respectively (Theodore et al. 1980). The yolksac larval stage is completed in about 8-12 days, during which time larvae move downstream to rearing grounds over a 6 – 12 day period (Kynard and Horgan 2002). Juvenile sturgeon continue to move further downstream into waters ranging from 0 to up to 10 parts per thousand salinity. Older juveniles are more tolerant of higher salinities as juveniles typically spend two to five years in freshwater before eventually becoming coastal residents as sub-adults (Boreman 1997; Schueller and Peterson 2010; Smith 1985).

Upon reaching the subadult phase individuals may move to coastal and estuarine habitats (Dovel and Berggren 1983; Murawski and Pacheco 1977; Smith 1985; Stevenson 1997). Tagging and genetic data indicate that subadult and adult Atlantic sturgeon may travel widely once they emigrate from rivers. Despite extensive mixing in coastal waters, Atlantic sturgeon exhibit high fidelity to their natal rivers (Grunwald et al. 2008; King et al. 2001; Waldman et al. 2002). Because of high natal river fidelity, it appears that most rivers support independent populations

(Grunwald et al. 2008; King et al. 2001; Waldman and Wirgin 1998; Wirgin et al. 2002; Wirgin et al. 2000). Atlantic sturgeon feed primarily on polychaetes, isopods, American sand lances and amphipods in the marine environment, while in fresh water they feed on oligochaetes, gammarids, mollusks, insects, and chironomids (Guilbard et al. 2007; Johnson et al. 1997; Moser and Ross 1995; Novak et al. 2017; Savoy 2007).

Population Dynamics

Abundance The New York Bight, ranging from the Delmarva Peninsula to Cape Cod, historically supported four or more spawning populations. Currently, this DPS only supports two spawning populations, the Delaware and Hudson River. Numbers of Atlantic Sturgeon in the New York Bight DPS are extremely low compared to historical levels and have remained so for the past 100 years. The spawning populations of this DPS are thought to be one to two orders of magnitude below historical levels.

Productivity / Population Growth Rate Historically the Delaware River is believed to have supported around 180,000 individuals (Secor 2002). In 2007, NMFS status review estimated that the population had declined to fewer than 300 individuals. In 2014 Hale et al. (2016) estimated that 3,656 (95% CI = 1,935-33,041) early juveniles (age 0-1) utilized the Delaware River estuary as a nursery. Based on commercial fishery landings from the mid 1980s to the mid 1990s. the total abundance of adult Hudson River Atlantic sturgeon was estimated to be 870 individuals (Kahnle et al. 2007). Based on the juvenile assessments from Peterson et al. (2000), the Hudson River suffered a series of recruitment failures, which triggered the ASMFC fishing moratorium to allow the populations to recover. Long-term juvenile surveys indicate that the Hudson River population supports successful annual year classes since 2000 and the annual production has been stable and/or slightly increasing in abundance (NMFS 2007). Precise estimates of population growth rate (intrinsic rates) are unknown due to lack of long-term abundance data.

Recently, juvenile Atlantic sturgeon collected in the Connecticut River suggest at least one successful colonizing spawning event may have occurred (Savoy et al. 2017). Around the same time, a dead 213cm Atlantic sturgeon was recovered on the banks of the Connecticut River (http://www.wfsb.com/story/25392783/rare-sturgeon-found-along-connecticut-riverin-lyme).

Genetic Diversity The genetic diversity of Atlantic sturgeon throughout its range has been well documented (Bowen and Avise 1990; Ong et al. 1996; Waldman et al. 1996; Waldman and Wirgin 1998). Overall, these studies have consistently found populations to be genetically diverse and the majority can be readily differentiated. Relatively low rates of gene flow reported in population genetic studies (King et al. 2001; Waldman et al. 2002) indicate that Atlantic sturgeon return to their natal river to spawn, despite extensive mixing in coastal waters.

Distribution The Connecticut River has long been known as a seasonal aggregation area for subadult Atlantic sturgeon, and both historical and contemporary records document presence of Atlantic sturgeon in the river as far upstream as Hadley, MA (Savoy and Shake, 1993; Savoy and Pacileo, 2003; NMFS and USFWS, 2007). The upstream limit for Atlantic sturgeon on the Hudson River is the Federal Dam at the fall line, approximately river kilometer 246 (Dovel and Berggren, 1983; Bain, 1998; Kahnle et al., 1998; Everly and Boreman, 1999). In the Delaware River, there is evidence of Atlantic sturgeon presence from the mouth of the Delaware Bay to the head-of-tide at the fall line near Trenton on the New Jersey side and Morrisville on the Pennsylvania side of the River, a distance of 220 river kilometers (Breece et al., 2013).

Designated Critical Habitat Designated Critical Habitat was effective September 18, 2017. Based on the best scientific information available for the life history needs of the New York Bight DPS, the physical features essential to the conservation of the species and that may require special management considerations or protection are:

- Hard bottom substrate (*e.g.,* rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (*i.e.,* 0.0 to 0.5 parts per thousand (ppt) range) for settlement of fertilized eggs, refuge, growth, and development of early life stages;
- Aquatic habitat with a gradual downstream salinity gradient of 0.5 up to as high as 30 ppt and soft substrate (*e.g.,* sand, mud) between the river mouth and spawning sites for juvenile foraging and physiological development;
- Water of appropriate depth and absent physical barriers to passage (*e.g.,* locks, dams, thermal plumes, turbidity, sound, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support:
    - Unimpeded movement of adults to and from spawning sites;
    - Seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and
    - Staging, resting, or holding of subadults or spawning condition adults.
- Water depths in main river channels must also be deep enough (*e.g.,* at least 1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river.
- Water, between the river mouth and spawning sites, especially in the bottom meter of the water column, with the temperature, salinity, and oxygen values that, combined, support:
    - Spawning;
    - Annual and interannual adult, subadult, larval, and juvenile survival; and
    - Larval, juvenile, and subadult growth, development, and recruitment (*e.g.,* 13 °C to 26 °C for spawning habitat and no more than 30 °C for juvenile rearing habitat, and 6 milligrams per liter (mg/L) dissolved oxygen (DO) or greater for juvenile rearing habitat).

Recovery Goals Recovery Plans have not yet been drafted for the Atlantic Sturgeon.

Table 13. Summary of status; Atlantic Sturgeon, New York Bight DPS

Criteria	Description
Abundance / productivity trends	4% of historical abundance, unknown population growth rate
Listing status	endangered
Attainment of recovery goals	none

9.37 Atlantic Sturgeon, Chesapeake Bay DPS

Table 14. Atlantic Sturgeon, Chesapeake Bay DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Acipenser oxyrinchus oxyrinchus	**Sturgeon, Atlantic**	Chesapeake Bay	Endangered	2007	77 FR 5880	No	82 FR 39160

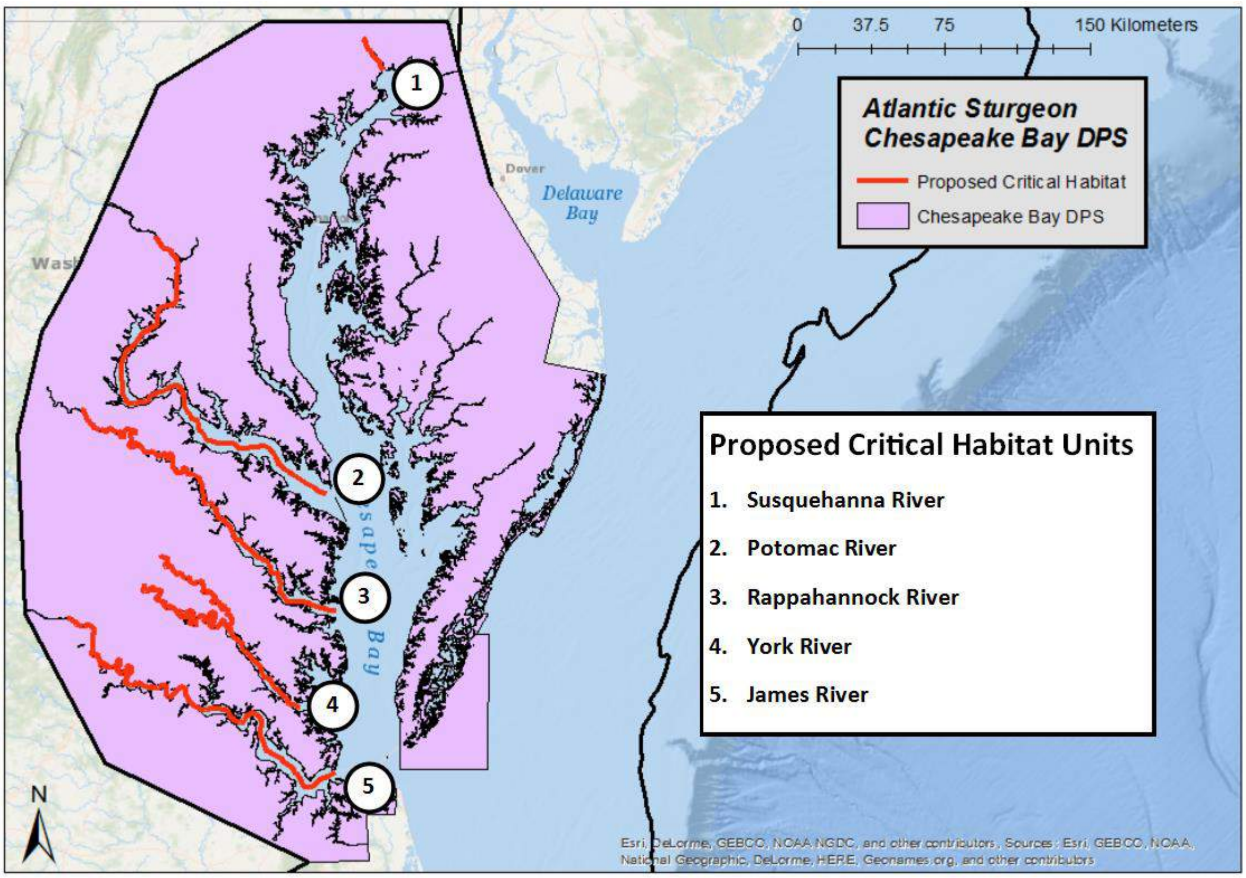

Figure 6. Atlantic Sturgeon, Chesapeake Bay DPS range and proposed designated critical habitat

Species Description The Atlantic sturgeon is a long lived, late maturing, anadromous species. Atlantic sturgeon attain lengths of up to approximately 14 feet, and weights of more than 800 pounds. They are bluish black or olive brown dorsally with paler sides and a white ventral surface and have five major rows of dermal scutes (Colette and Klein-MacPhee 2002). On February 6, 2012, four DPSs of Atlantic sturgeon: New York Bight, Chesapeake Bay, Carolina, and South Atlantic, were listed as endangered and the Gulf of Maine DPS was listed as threatened (77 FR 5880; 77 FR 5914). Atlantic sturgeon occupy ocean waters and associated bays, estuaries, and coastal river systems from Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida (ASMFC 2006; Stein et al. 2004).

Status Atlantic sturgeon were once present in 38 river systems and, of these, spawned in 35 of them. Individuals are currently present in 36 rivers, and spawning occurs in at least 20 of these (ASSRT 2007). The decline in abundance of Atlantic sturgeon has been attributed primarily to the large U.S. commercial fishery which existed for the Atlantic sturgeon from the 1870's through the mid 1990's. The fishery collapsed in 1901 and landings remained at between 1 – 5% of the pre-collapse peak until ASMFC placed a two generation moratorium on the fishery in 1998 (ASMFC 1998). The majority of the populations show no signs of recovery, and new information suggests that stressors such as bycatch, ship strikes, and low DO can and do have substantial impacts on populations (ASSRT 2007). Additional threats to Atlantic sturgeon include habitat degradation from dredging, damming, poor water quality, and invasive species (blue catfish) (ASSRT 2007). Climate change related impacts on water quality (e.g., temperature, salinity, dissolved oxygen, contaminants) have the potential to impact Atlantic sturgeon populations using impacted river systems. These effects are expected to be more severe for southern portions of the U.S. range of Atlantic sturgeon (Carolina and South Atlantic DPSs). None of the spawning populations are currently large or stable enough to provide any level of certainty for continued existence of any of the DPSs.

Life history Atlantic Sturgeon size at sexual maturity varies with latitude with individuals reaching maturity in the Hudson River at 11 – 21 years (Young et al. 1988). Atlantic sturgeon spawn in freshwater, but spend most of their adult life in the marine environment. Spawning adults generally migrate upriver in April-May in mid-Atlantic systems (Bain 1997; Caron et al. 2002; Murawski and Pacheco 1977; Smith 1985; Smith and Clugston 1997). There is a growing body of evidence that some Atlantic sturgeon river populations have two spawning seasons comprised of different spawning adults (Balazik and Musick 2015). Evidence of fall as well as spring spawning has been obtained for the Chesapeake Bay, Carolina, and South Atlantic DPSs (77 FR 5914; Balazik et al. 2012; Collins et al. 2000; Hager et al. 2014; Kahn et al. 2014; NMFS 1998; Smith 1985). Atlantic sturgeon spawning is believed to occur in flowing water between the salt front and fall line of large rivers at depths of 3-27 meters (Bain et al. 2000; Borodin 1925; Crance 1987; Leland 1968; Scott and Crossman 1973). Atlantic sturgeon likely do not spawn every year; spawning intervals range from 1-5 years for males (Caron et al. 2002; Collins et al. 2000; Smith 1985) and 2-5 for females (Stevenson and Secor 2000; Van Eenennaam et al. 1996; Vladykov and Greeley 1963).

Sturgeon eggs are highly adhesive and are deposited on the bottom substrate, usually on hard surfaces (Gilbert 1989; Smith and Clugston 1997) between the salt front and fall line of large rivers (Bain et al. 2000; Borodin 1925; Crance 1987; Scott and Crossman 1973). Following spawning in northern rivers, males may remain in the river or lower estuary until the fall; females typically exit the rivers within four to six weeks (Savoy and Pacileo 2003). Hatching occurs approximately 94-140 hours after egg deposition at temperatures of 20° and 18° Celsius, respectively (Theodore et al. 1980). The yolksac larval stage is completed in about 8-12 days, during which time larvae move downstream to rearing grounds over a 6 – 12 day period (Kynard and Horgan 2002). Juvenile sturgeon continue to move further downstream into waters ranging from 0 to up to 10 parts per thousand salinity. Older juveniles are more tolerant of higher salinities as juveniles typically spend two to five years in freshwater before eventually becoming coastal residents as sub-adults (Boreman 1997; Schueller and Peterson 2010; Smith 1985).

Upon reaching the subadult phase individuals may move to coastal and estuarine habitats (Dovel and Berggren 1983; Murawski and Pacheco 1977; Smith 1985; Stevenson 1997). Tagging and genetic data indicate that subadult and adult Atlantic sturgeon may travel widely once they emigrate from rivers. Despite extensive mixing in coastal waters, Atlantic sturgeon exhibit high fidelity to their natal rivers (Grunwald et al. 2008; King et al. 2001; Waldman et al. 2002). Because of high natal river fidelity, it appears that most rivers support independent populations (Grunwald et al. 2008; King et al. 2001; Waldman and Wirgin 1998; Wirgin et al. 2002; Wirgin et al. 2000). Atlantic sturgeon feed primarily on polychaetes, isopods, American sand lances and amphipods in the marine environment, while in fresh water they feed on oligochaetes, gammarids, mollusks, insects, and chironomids (Guilbard et al. 2007; Johnson et al. 1997; Moser and Ross 1995; Novak et al. 2017; Savoy 2007).

Population Dynamics

Abundance Historically, Atlantic sturgeon were common throughout the Chesapeake Bay and its tributaries (Kahnle et al. 1998, Wharton 1957, Bushnoe et al. 2005). At the time of listing, the James River was the only known spawning river for the Chesapeake Bay DPS (NMFS and USFWS, 2007; Hager, 2011; Balazik et al., 2012). Since the listing, spawning has been confirmed to occur in the Pamunkey River, a tributary of the York River (Hager et al., 2014; Kahn et al., 2014) and is suspected to be occurring in Marshyhope Creek, a tributary of the Nanticoke River. The historical and contemporary accounts of Atlantic sturgeon in the York, Rappahannock, Susquehanna, and Potomac Rivers (NMFS and USFWS, 1998; NMFS and USFWS, 2007; ASSRT, 2007), as well as the presence of the features necessary to support reproduction and recruitment in this river indicate that there is the potential for spawning to occur.

Productivity / Population Growth Rate The Chesapeake Bay once supported at least six historical spawning populations; however, today the bay is believed to support at the most, four to five spawning populations. Precise estimates of population growth rate (intrinsic rates) are unknown due to lack of long-term abundance data. The status review team (NMFS and USFWS, 2007) concluded that the populations in the James and York Rivers are at a moderate and moderately high risk of extinction.

Genetic Diversity The genetic diversity of Atlantic sturgeon throughout its range has been well documented (Bowen and Avise 1990; Ong et al. 1996; Waldman et al. 1996; Waldman and Wirgin 1998). Overall, these studies have consistently found populations to be genetically diverse and the majority can be readily differentiated. Relatively low rates of gene flow reported in population genetic studies (King et al. 2001; Waldman et al. 2002) indicate that Atlantic sturgeon return to their natal river to spawn, despite extensive mixing in coastal waters.

Distribution At the time of listing, the James River was the only known spawning river for the Chesapeake Bay DPS (NMFS and USFWS, 2007; Hager, 2011; Balazik et al., 2012). Since the listing, spawning has been confirmed to occur in the Pamunkey River, a tributary of the York River (Hager et al., 2014; Kahn et al., 2014) and is suspected to be occurring in Marshyhope Creek, a tributary of the Nanticoke River. The historical and contemporary accounts of Atlantic sturgeon in the York, Rappahannock, Susquehanna, and Potomac Rivers (NMFS and USFWS, 1998; NMFS and USFWS, 2007; ASSRT, 2007), as well as the presence of the features necessary to support reproduction and recruitment in this river indicate that there is the potential for spawning to occur. Adult Atlantic sturgeon enter the James River in the spring, with at least some eventually moving as far upstream as Richmond (river kilometer 155). Adults disperse through downriver sites and begin to move out of the river in late September to early October, occupy only lower river sites by November, and leave the river for the winter (Hager, 2011; Balazik et al., 2012). The condition of Atlantic sturgeon captured in the late summer-fall in the James and Pamunkey Rivers (e.g., adults expressing milt or eggs), the rapid upstream movement of adults in the fall, and the aggregation of adults relative to the salt wedge provide evidence that Chesapeake DPS Atlantic sturgeon also spawn in the fall. Genetic analyses suggest that Chesapeake Bay DPS Atlantic sturgeon travel great distances, including into Canadian waters, but occur most predominantly in marine waters of the New York and Mid-Atlantic Bight (Waldman et al., 2013; O'Leary et al., 2014; Wirgin et al., 2015a).

Designated Critical Habitat Designated Critical Habitat was effective September 18, 2017. Based on the best scientific information available for the life history needs of the Chesapeake Bay DPS, the physical features essential to the conservation of the species and that may require special management considerations or protection are:

- Hard bottom substrate (*e.g.,* rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (*i.e.,* 0.0 to 0.5 parts per thousand (ppt) range) for settlement of fertilized eggs, refuge, growth, and development of early life stages;
- Aquatic habitat with a gradual downstream salinity gradient of 0.5 up to as high as 30 ppt and soft substrate (*e.g.,* sand, mud) between the river mouth and spawning sites for juvenile foraging and physiological development;
- Water of appropriate depth and absent physical barriers to passage (*e.g.,* locks, dams, thermal plumes, turbidity, sound, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support:
    - Unimpeded movement of adults to and from spawning sites;
    - Seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and
    - Staging, resting, or holding of subadults or spawning condition adults.
- Water depths in main river channels must also be deep enough (*e.g.,* at least 1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river.
- Water, between the river mouth and spawning sites, especially in the bottom meter of the water column, with the temperature, salinity, and oxygen values that, combined, support:
    - Spawning;
    - Annual and interannual adult, subadult, larval, and juvenile survival; and
    - Larval, juvenile, and subadult growth, development, and recruitment (*e.g.,* 13 °C to 26 °C for spawning habitat and no more than 30 °C for juvenile rearing habitat, and 6 milligrams per liter (mg/L) dissolved oxygen (DO) or greater for juvenile rearing habitat).

Recovery Goals Recovery Plans have not yet been drafted for the Atlantic Sturgeon.

Table 15. Summary of status; Atlantic Sturgeon, Chesapeake Bay DPS

Criteria	Description
Abundance / productivity trends	4% of historical abundance, unknown population growth rate

Listing status	endangered
Attainment of recovery goals	none

9.38 Atlantic Sturgeon, Carolina DPS

Table 16. Atlantic Sturgeon, Carolina DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Acipenser oxyrinchus oxyrinchus	**Sturgeon, Atlantic**	Carolina	Endangered	2007	77 FR 5914	No	82 FR 39160

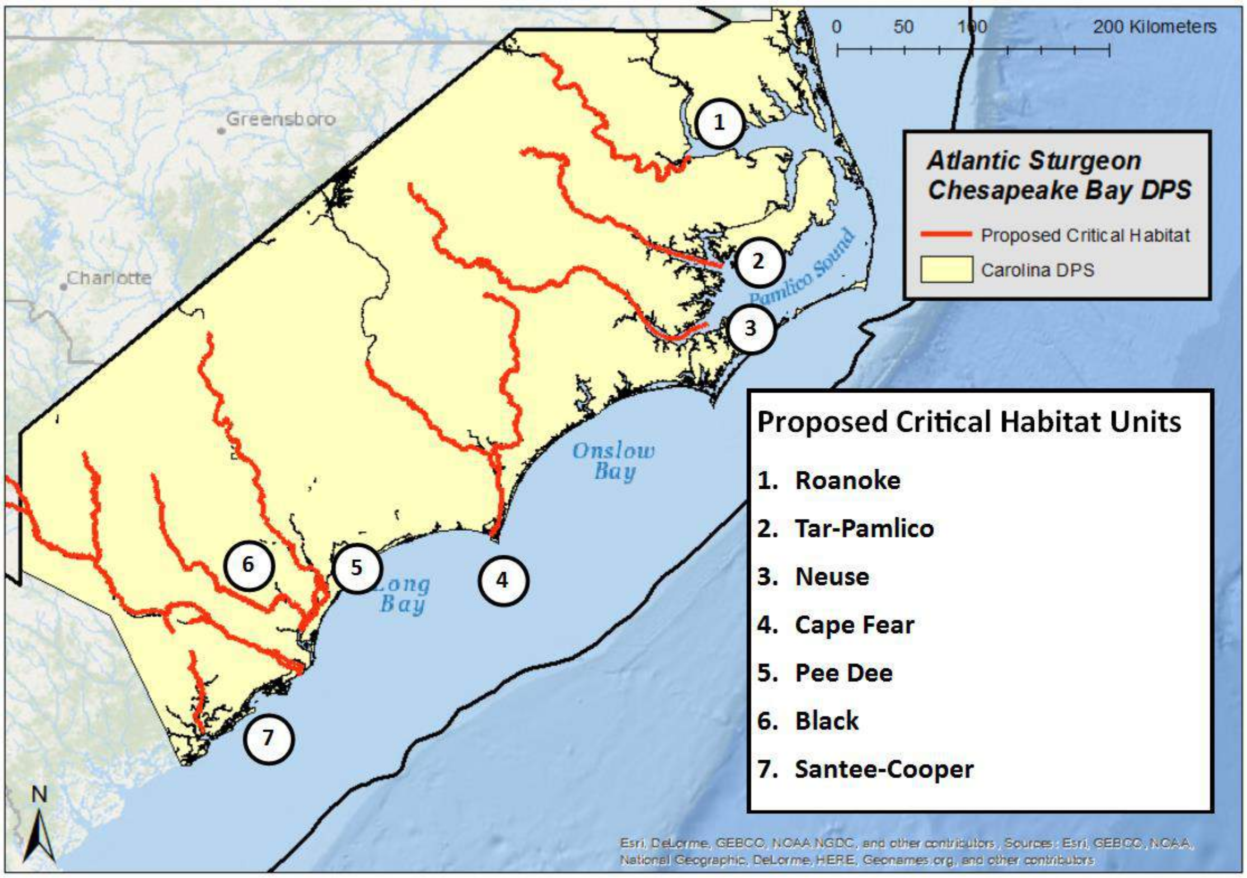

Figure 7. Atlantic Sturgeon, Carolina DPS range and proposed designated critical habitat

Species Description The Atlantic sturgeon is a long lived, late maturing, anadromous species. Atlantic sturgeon attain lengths of up to approximately 14 feet, and weights of more than 800 pounds. They are bluish black or olive brown dorsally with paler sides and a white ventral surface and have five major rows of dermal scutes (Colette and Klein-MacPhee 2002). On February 6, 2012, four DPSs of Atlantic sturgeon: New York Bight, Chesapeake Bay, Carolina, and South Atlantic, were listed as endangered and the Gulf of Maine DPS was listed as threatened (77 FR 5880; 77 FR 5914). The Carolina DPS ranges from the Santee-Cooper River to the Albemarle Sound and consists of seven extant populations; one population (Sampit) is believed to be extirpated.

Status Atlantic sturgeon were once present in 38 river systems and, of these, spawned in 35 of them. Individuals are currently present in 36 rivers, and spawning occurs in at least 20 of these (ASSRT 2007). The decline in abundance of Atlantic sturgeon has been attributed primarily to the large U.S. commercial fishery which existed for the Atlantic sturgeon from the 1870's through the mid 1990's. The fishery collapsed in 1901 and landings remained at between 1 – 5% of the pre-collapse peak until ASMFC placed a two generation moratorium on the fishery in 1998 (ASMFC 1998). The majority of the riverine subpopulations show no signs of recovery, and new information suggests that stressors such as bycatch, ship strikes, and low DO can and do have substantial impacts on populations (ASSRT 2007). Additional threats to Atlantic sturgeon include habitat degradation from dredging, damming, and poor water quality (ASSRT 2007). Climate change related impacts on water quality (e.g., temperature, salinity, dissolved oxygen, contaminants) have the potential to impact Atlantic sturgeon populations using impacted river systems. These effects are expected to be more severe for southern portions of the U.S. range of Atlantic sturgeon (Carolina and South Atlantic DPSs). None of the spawning populations are currently large or stable enough to provide any level of certainty for continued existence of any of the DPSs.

Life history Atlantic Sturgeon size at sexual maturity varies with latitude with individuals reaching maturity in South Carolina at 5 – 19 years (Smith et al. 1982). Atlantic sturgeon spawn in freshwater, but spend most of their adult life in the marine environment. Spawning adults generally migrate upriver in the spring/early summer; February- March in southern systems. There is a growing body of evidence that some Atlantic sturgeon river populations have two spawning seasons comprised of different spawning adults (Balazik and Musick 2015). Evidence of fall as well as spring spawning has been obtained for the Chesapeake Bay, Carolina, and South Atlantic DPSs (77 FR 5914; Balazik et al. 2012; Collins et al. 2000; Hager et al. 2014; Kahn et al. 2014; NMFS 1998; Smith 1985). Atlantic sturgeon spawning is believed to occur in flowing water between the salt front and fall line of large rivers at depths of 3-27 meters (Bain et al. 2000; Borodin 1925; Crance 1987; Leland 1968; Scott and Crossman 1973). Atlantic sturgeon likely do not spawn every year; spawning intervals range from 1-5 years for males and 2-5 for females (Caron et al. 2002; Collins et al. 2000; Smith 1985).

Sturgeon eggs are highly adhesive and are deposited on the bottom substrate, usually on hard surfaces (Gilbert 1989; Smith and Clugston 1997) between the salt front and fall line of large rivers (Bain et al. 2000; Borodin 1925; Crance 1987; Scott and Crossman 1973). Following spawning in northern rivers, males may remain in the river or lower estuary until the fall; females typically exit the rivers within four to six weeks (Savoy and Pacileo 2003). Hatching occurs approximately 94-140 hours after egg deposition at temperatures of 20° and 18° Celsius, respectively (Theodore et al. 1980). The yolksac larval stage is completed in about 8-12 days, during which time larvae move downstream to rearing grounds over a 6 – 12 day period (Kynard and Horgan 2002). Juvenile sturgeon continue to move further downstream into waters ranging from 0 to up to 10 parts per thousand salinity. Older juveniles are more tolerant of higher salinities as juveniles typically spend two to five years in freshwater before eventually becoming coastal residents as sub-adults (Boreman 1997; Schueller and Peterson 2010; Smith 1985).

Upon reaching the subadult phase individuals may move to coastal and estuarine habitats (Dovel and Berggren 1983; Murawski and Pacheco 1977; Smith 1985; Stevenson 1997). Tagging and genetic data indicate that subadult and adult Atlantic sturgeon may travel widely once they emigrate from rivers. Despite extensive mixing in coastal waters, Atlantic sturgeon exhibit high fidelity to their natal rivers (Grunwald et al. 2008; King et al. 2001; Waldman et al. 2002). Because of high natal river fidelity, it appears that most rivers support independent populations (Grunwald et al. 2008; King et al. 2001; Waldman and Wirgin 1998; Wirgin et al. 2002; Wirgin et al. 2000). Atlantic sturgeon feed primarily on polychaetes, isopods, American sand lances and amphipods in the marine environment, while in fresh water they feed on oligochaetes, gammarids, mollusks, insects, and chironomids (Guilbard et al. 2007; Johnson et al. 1997; Moser and Ross 1995; Novak et al. 2017; Savoy 2007).

Population Dynamics

Abundance The spawning populations are estimated to be at less than 3 % of their historic levels. Prior to 1890, there were estimated to be 7,000 – 10,500 adult female Atlantic sturgeon in North Carolina and approximately 8,000 adult females in South Carolina. Currently, the existing spawning populations in each of the rivers in the Carolina DPS are thought to have less than 300 adults spawning each year.

Productivity / Population Growth Rate Precise estimates of population growth rate (intrinsic rates) are unknown due to lack of long-term abundance data. The status review team (ASSRT 2007) concluded that the populations in the Roanoke, Tar/Pamlico, Neuse, Waccamaw, and Pee Dee river systems are at a moderate extinction risk and the populations in the Cape Fear and Santee-Cooper river systems are at a moderately high risk of extinction.

Genetic Diversity The genetic diversity of Atlantic sturgeon throughout its range has been well documented (Bowen and Avise 1990; Ong et al. 1996; Waldman et al. 1996; Waldman and Wirgin 1998). Overall, these studies have consistently found populations to be genetically diverse and the majority can be readily differentiated. Relatively low rates of gene flow reported in population genetic studies (King et al. 2001; Waldman et al. 2002) indicate that Atlantic sturgeon return to their natal river to spawn, despite extensive mixing in coastal waters.

Distribution The Carolina DPS ranges from the Santee-Cooper River to the Albemarle Sound and consists of seven extant subpopulations, one subpopulation (Sampit) is believed to be extirpated. In the Roanoke River, Atlantic sturgeon are restricted to the lower 17 RKM of fall zone habitat, which extends from the Roanoke Rapids Dam to Weldon, North Carolina at RKM 204 (Armstrong and Hightower, 2002; Smith et al., 2014). The Tar-Pamlico riverine habitat is fully accessible to Atlantic sturgeon because the lowermost dam, the Rocky Mount Mill Pond Dam (RKM199), is located at the fall line. Spatial distribution of Atlantic sturgeon within the Neuse River is unknown. The Cape Fear River is tidally influenced by diurnal tides up to at least RKM 96. While telemetry data have not indicated Atlantic sturgeon presence above Lock and Dam #1 (RKM 95), other evidence indicates fish passage at the dam is successful or that fish pass through the lock. Pee Dee River system appears to be utilized by Atlantic sturgeon for summer/winter seasonal habitat as well as for spawning. Exact spatial distribution within the Pee Dee river system in unknown (Post et al. 2014). During a telemetry study from 2011 to 2014, Post et al. (2014) detected 10 juveniles and 10 adults utilizing the Black River. An adult male was detected at the last receiver station in the river one year (RKM 70.4) and the next to last receiver station in a subsequent year. Access to suitable spawning habitat is limited in the Santee-Cooper River system due to the locations of the Wilson Dam and St. Stephen Powerhouse on the Santee River and the Pinopolis Dam on the Cooper River. Nonetheless, the Santee-Cooper River system appears to be important foraging and refuge habitat and could serve as important spawning habitat once access to historical spawning grounds is restored through a fishway prescription under the Federal Power Act (NMFS 2007).

Designated Critical Habitat Designated Critical Habitat was effective September 18, 2017. We determined that the key conservation objectives for the Carolina DPS of Atlantic sturgeon are to increase the abundance of each DPS by facilitating increased survival of all life stages and facilitating adult reproduction and juvenile and subadult recruitment into the adult population. We determined the physical features essential to the conservation of the species and that may require special management considerations or protection, which support the identified conservation objectives, are:

- Hard bottom substrate (*e.g.,* rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (*i.e.,* 0.0-0.5 ppt range) for settlement of fertilized eggs and refuge, growth, and development of early life stages;
- Transitional salinity zones inclusive of waters with a gradual downstream gradient of 0.5- up to 30 ppt and soft substrate (*e.g.,* sand, mud) between the river mouths and spawning sites for juvenile foraging and physiological development;
- Water of appropriate depth and absent physical barriers to passage (*e.g.,* locks, dams, thermal plumes, turbidity, sound, reservoirs, gear, etc.) between the river mouths and spawning sites necessary to support:
    - Unimpeded movement of adults to and from spawning sites;
    - Seasonal and physiologically-dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and
    - Staging, resting, or holding of subadults or spawning condition adults.
- Water depths in main river channels must also be deep enough (at least 1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river.
- Water quality conditions, especially in the bottom meter of the water column, between the river mouths and spawning sites with temperature and oxygen values that support:
    - Spawning;
    - Annual and inter-annual adult, subadult, larval, and juvenile survival; and
    - Larval, juvenile, and subadult growth, development, and recruitment. Appropriate temperature and oxygen values will vary interdependently, and depending on salinity in a particular habitat. For example, 6.0 mg/L DO or greater likely supports juvenile rearing habitat, whereas DO less than 5.0 mg/L for longer than 30 days is less likely to support rearing when water temperature is greater than 25 °C. In temperatures greater than 26 °C, DO greater than 4.3 mg/L is needed to protect survival and growth. Temperatures of 13 to 26 °C likely to support spawning habitat.

Recovery Goals Recovery Plans have not yet been drafted for the Atlantic Sturgeon.

Table 17. Summary of status; Atlantic Sturgeon, Carolina DPS

Criteria	Description

Abundance / productivity trends	<3% of historical abundance
Listing status	endangered
Attainment of recovery goals	none

9.39 Atlantic Sturgeon, South Atlantic DPS

Table 18. Atlantic Sturgeon, South Atlantic DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Acipenser oxyrinchus oxyrinchus	**Sturgeon, Atlantic**	South Atlantic	Endangered	2007	77 FR 5914	No	82 FR 39160

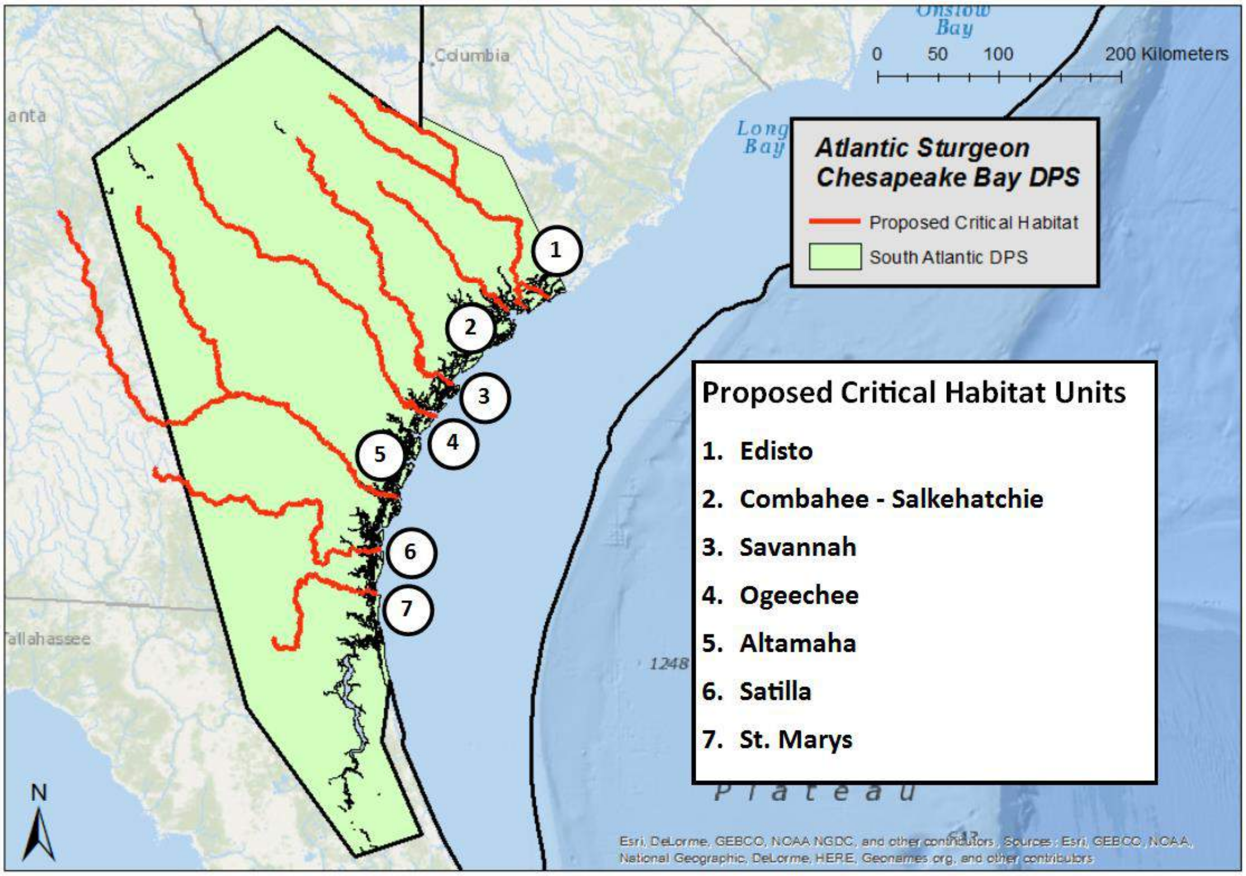

Figure 8. Atlantic Sturgeon, South Atlantic DPS range and proposed designated critical habitat

Species Description The Atlantic sturgeon is a long lived, late maturing, anadromous species. Atlantic sturgeon attain lengths of up to approximately 14 feet, and weights of more than 800 pounds. They are bluish black or olive brown dorsally with paler sides and a white ventral surface and have five major rows of dermal scutes (Colette and Klein-MacPhee 2002). On February 6, 2012, four DPSs of Atlantic sturgeon: New York Bight, Chesapeake Bay, Carolina, and South Atlantic, were listed as endangered and the Gulf of Maine DPS was listed as threatened (77 FR 5880; 77 FR 5914). Atlantic sturgeon occupy ocean waters and associated bays, estuaries, and coastal river systems from Hamilton Inlet, Labrador, Canada, to Cape Canaveral, Florida (ASMFC 2006; Stein et al. 2004).

Status Atlantic sturgeon were once present in 38 river systems and, of these, spawned in 35 of them. Individuals are currently present in 36 rivers, and spawning occurs in at least 20 of these (ASSRT 2007). The decline in abundance of Atlantic sturgeon has been attributed primarily to the large U.S. commercial fishery which existed for the Atlantic sturgeon from the 1870's through the mid 1990's. The fishery collapsed in 1901 and landings remained at between 1 – 5% of the pre-collapse peak until ASMFC placed a two generation moratorium on the fishery in 1998 (ASMFC 1998), which was followed by an offshore moratorium implemented by NMFS. The majority of the riverine populations show no signs of recovery, and new information suggests that stressors such as bycatch, ship strikes, and low DO can and do have substantial impacts on populations (ASSRT 2007). Additional threats to Atlantic sturgeon include habitat degradation from dredging, damming, and poor water quality (ASSRT 2007). Climate change related impacts on water quality (e.g., temperature, salinity, dissolved oxygen, contaminants) have the potential to impact Atlantic sturgeon populations using impacted river systems. These effects are expected to be more severe for southern portions of the U.S. range of Atlantic sturgeon (Carolina and South Atlantic DPSs). None of the spawning populations are currently large or stable enough to provide any level of certainty for continued existence of any of the DPSs.

Life history Atlantic Sturgeon age at sexual maturity varies with latitude with individuals reaching maturity in South Carolina at 5 – 19 years (Smith et al. 1982). Atlantic sturgeon spawn in freshwater, but spend most of their adult life in the marine environment. Spawning adults generally migrate upriver in the late summer/early fall; August-November in southern systems (77 FR 5914; Balazik et al. 2012; Collins et al. 2000; Hager et al. 2014; Kahn et al. 2014; NMFS 1998; Smith 1985). Atlantic sturgeon spawning is believed to occur in flowing water between the salt front and fall line of large rivers at depths of 3-27 meters (Bain et al. 2000; Borodin 1925; Crance 1987; Leland 1968; Scott and Crossman 1973). Atlantic sturgeon likely do not spawn every year; spawning intervals range from 1-5 years for males (Caron et al. 2002; Collins et al. 2000; Smith 1985) and 2-5 for females (Stevenson and Secor 2000; Van Eenennaam et al. 1996; Vladykov and Greeley 1963).

Sturgeon eggs are highly adhesive and are deposited on the bottom substrate, usually on hard surfaces (Gilbert 1989; Smith and Clugston 1997) between the salt front and fall line of large rivers (Bain et al. 2000; Borodin 1925; Crance 1987; Scott and Crossman 1973). Following spawning in northern rivers, males may remain in the river or lower estuary until the fall; females typically exit the rivers within four to six weeks (Savoy and Pacileo 2003). Hatching occurs approximately 94-140 hours after egg deposition at temperatures of 20° and 18° Celsius, respectively (Theodore et al. 1980). The yolksac larval stage is completed in about 8-12 days, during which time larvae move downstream to rearing grounds over a 6 – 12 day period (Kynard and Horgan 2002). Juvenile sturgeon continue to move further downstream into waters ranging from 0 to up to 10 parts per thousand salinity. Older juveniles are more tolerant of higher salinities as juveniles typically spend two to five years in freshwater before eventually becoming coastal residents as sub-adults (Boreman 1997; Schueller and Peterson 2010; Smith 1985).

Upon reaching the subadult phase individuals may move to coastal and estuarine habitats (Dovel and Berggren 1983; Murawski and Pacheco 1977; Smith 1985; Stevenson 1997). Tagging and genetic data indicate that subadult and adult Atlantic sturgeon may travel widely once they emigrate from rivers. Despite extensive mixing in coastal waters, Atlantic sturgeon exhibit high fidelity to their natal rivers (Grunwald et al. 2008; King et al. 2001; Waldman et al. 2002).

Because of high natal river fidelity, it appears that most rivers support independent populations (Grunwald et al. 2008; King et al. 2001; Waldman and Wirgin 1998; Wirgin et al. 2002; Wirgin et al. 2000). Atlantic sturgeon feed primarily on polychaetes, isopods, American sand lances and amphipods in the marine environment, while in fresh water they feed on oligochaetes, gammarids, mollusks, insects, and chironomids (Guilbard et al. 2007; Johnson et al. 1997; Moser and Ross 1995; Novak et al. 2017; Savoy 2007).

Population Dynamics

Abundance The South Atlantic DPS historically supported eight spawning populations ranging from the St. Johns River, FL to the ACE Basin in SC. Currently, this DPS supports five extant spawning populations. Of these populations, the Altamaha is believed to support the largest number of spawning adults. The current abundance of the Altamaha population is suspected to be less than 6% of historical abundance, extrapolated from the 1890s commercial landings (Secor 2002). Few captures have been documented in other populations within this DPS and are suspected to be less than 1% of their historic abundance (less than 300 spawning adults).

Productivity / Population Growth Rate Precise estimates of population growth rate (intrinsic rates) are unknown due to lack of long-term abundance data. During the last two decades, Atlantic sturgeon have been observed in most South Carolina coastal rivers, although it is not known if all rivers support a spawning population (Collins and Smith 1997). The status review team (ASSRT 2007) found that, overall, the South Atlantic DPS had a moderate risk (<50% chance) of becoming endangered over the next 20 years.

Genetic Diversity The genetic diversity of Atlantic sturgeon throughout its range has been well documented (Bowen and Avise 1990; Ong et al. 1996; Waldman et al. 1996; Waldman and Wirgin 1998). Overall, these studies have consistently found populations to be genetically diverse and the majority can be readily differentiated. Relatively low rates of gene flow reported in population genetic studies (King et al. 2001; Waldman et al. 2002) indicate that Atlantic sturgeon return to their natal river to spawn, despite extensive mixing in coastal waters.

Distribution Seventy-six Atlantic sturgeon were tagged in the Edisto River during a 2011 to 2014 telemetry study (Post et al., 2014). Fish entered the river between April and June and were detected in the saltwater tidal zone until water temperature decreased below 25° C. They then moved into the freshwater tidal area, and some fish made presumed spawning migrations in the fall around September–October. Spawning migrations were thought to be occurring based on fish movements upstream to the presumed spawning zone between RKM 78 and 210. Fish stayed in these presumed spawning zones for an average of 22 days. The tagged Atlantic sturgeon left the river system by November. In the winter and spring, Atlantic sturgeon were generally absent from the system except for a few fish that remained in the saltwater tidal zone (Post et al., 2014). The Combahee—Salkehatchie River was identified as a spawning river for Atlantic sturgeon based on capture location and tracking locations of adults and the spawning condition of an adult (Collins and Smith, 1997; ASSRT, 2007). The farthest upstream detection of any tagged Atlantic sturgeon was RKM 56 (Post et al., 2014). Atlantic sturgeon in the Savannah River were documented displaying similar behavior three years in a row—migrating upstream during the fall and then being absent from the system during spring and summer. Forty three Atlantic sturgeon larvae were collected in upstream locations (RKM 113–283) near presumed spawning locations (Collins and Smith, 1997). The Altamaha River supports one of the healthiest Atlantic sturgeon subpopulations in the Southeast In a telemetry study by Peterson et al. (2006), most tagged adult

Atlantic sturgeon were found between RKM 215 and 420 in October and November when water temperatures were appropriate for spawning. Two general migration patterns were observed for fish in this system. Early upriver migrations that began in April— May typically occurred in two steps, with fish remaining at mid-river locations during the summer months before continuing upstream in the fall. The late-year migrations, however, were typically initiated in August or September and were generally non-stop. Regardless of which migration pattern was used during upstream migration, all fish exhibited a one-step pattern of migrating downstream in December and early January (Ingram and Peterson in Post et al., 2014). The spatial distribution of Atlantic sturgeon in the Satilla, St. Marys, and St. Johns rivers is unknown.

Designated Critical Habitat Designated Critical Habitat was effective September 18, 2017. We determined that the key conservation objectives for the South Atlantic DPS of Atlantic sturgeon are to increase the abundance of each DPS by facilitating increased survival of all life stages and facilitating adult reproduction and juvenile and subadult recruitment into the adult population. We determined the physical features essential to the conservation of the species and that may require special management considerations or protection, which support the identified conservation objectives, are:

- Hard bottom substrate (*e.g.,* rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (*i.e.,* 0.0-0.5 ppt range) for settlement of fertilized eggs and refuge, growth, and development of early life stages;
- Transitional salinity zones inclusive of waters with a gradual downstream gradient of 0.5- up to 30 ppt and soft substrate (*e.g.,* sand, mud) between the river mouths and spawning sites for juvenile foraging and physiological development;
- Water of appropriate depth and absent physical barriers to passage (*e.g.,* locks, dams, thermal plumes, turbidity, sound, reservoirs, gear, etc.) between the river mouths and spawning sites necessary to support:
    - Unimpeded movement of adults to and from spawning sites;
    - Seasonal and physiologically-dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and
    - Staging, resting, or holding of subadults or spawning condition adults.
- Water depths in main river channels must also be deep enough (at least 1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river.
- Water quality conditions, especially in the bottom meter of the water column, between the river mouths and spawning sites with temperature and oxygen values that support:
    - Spawning;
    - Annual and inter-annual adult, subadult, larval, and juvenile survival; and
    - Larval, juvenile, and subadult growth, development, and recruitment. Appropriate temperature and oxygen values will vary interdependently, and depending on salinity in a particular habitat. For example, 6.0 mg/L DO or greater likely supports juvenile rearing habitat, whereas DO less than 5.0 mg/L for longer than 30 days is less likely to support rearing when water temperature is greater than 25 °C. In temperatures greater than 26 °C, DO greater than 4.3 mg/L is needed to protect survival and growth. Temperatures of 13 to 26 °C likely to support spawning habitat.

Recovery Goals Recovery Plans have not yet been drafted for the Atlantic Sturgeon.

Table 19. Summary of status; Atlantic Sturgeon, South Atlantic DPS

Criteria	Description
Abundance / productivity trends	<6% of historical abundance
Listing status	endangered
Attainment of recovery goals	none

9.40 Gulf Sturgeon

Table 20. Gulf Sturgeon; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Acipenser oxyrinchus desotoi	Sturgeon, Gulf	Entire	Threatened	2009	1991 56 FR 49653	1995	2003 68 FR 13370

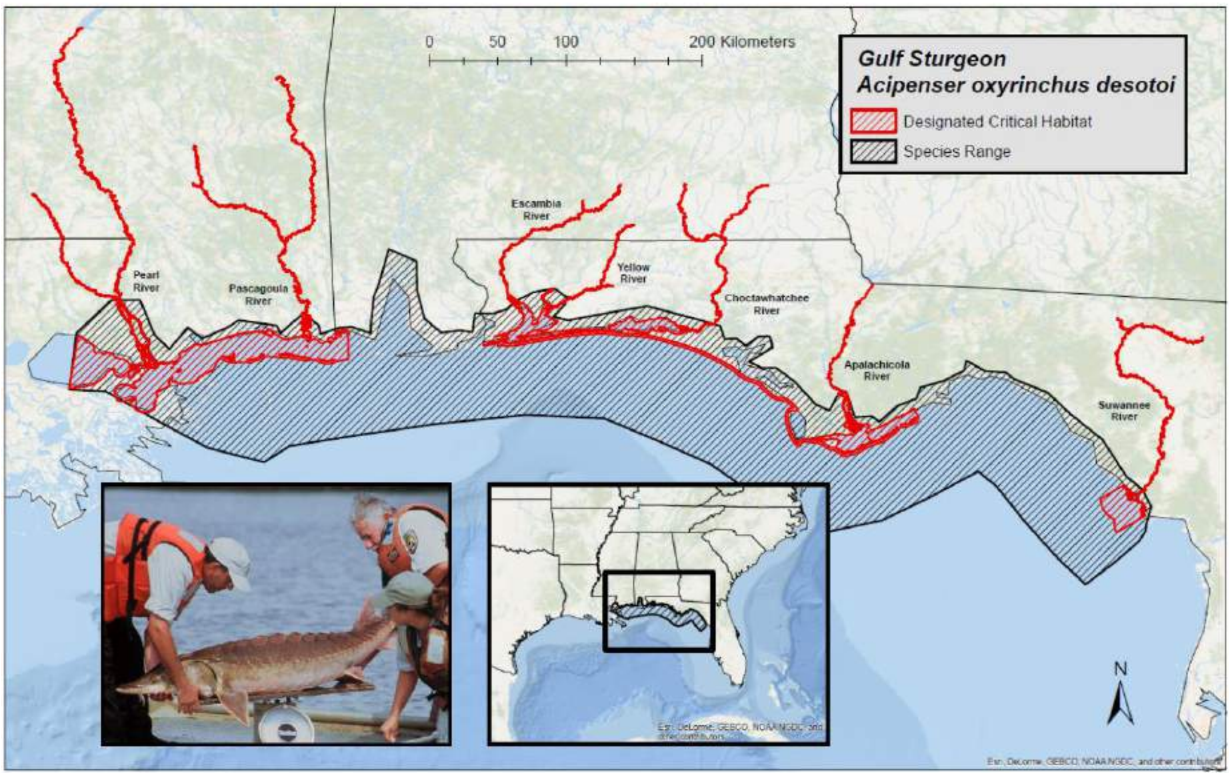

Figure 9. Gulf Sturgeon range and designated critical habitat

Species Description Gulf sturgeon are benthic fusiform fish with an extended snout, vertical mouth, five rows of scutes (bony plates surrounding the body), four barbels (slender, whisker-like feelers anterior to the mouth used for touch and taste), and a heterocercal (upper lobe is longer than lower) caudal fin. Adults range from 6-8 feet in length and weigh up to 200 pounds; females grow larger than males (USFWS 2009b). The Gulf sturgeon was listed as Threatened on September 30, 1991.

Status The decline in the abundance of gulf sturgeon has been attributed to targeted fisheries in the late 19th and early 20th centuries, habitat loss associated with dams and sills, habitat degradation associated with dredging, de-snagging, and contamination by pesticides, heavy metals, and other industrial contaminants, and certain life history characteristics (e.g. slow growth and late maturation) (56 FR 49653). Effects of climate change (warmer water, sea level rise and higher salinity levels) could lead to accelerated changes in habitats utilized by Gulf sturgeon. The rate that climate change and corollary impacts are occurring may outpace the ability of the Gulf sturgeon to adapt given its limited geographic distribution and low dispersal rate. In general, gulf sturgeon populations in the eastern portion of the range appear to be stable or slightly increasing, while populations in the western portion are associated with lower abundances and higher uncertainty (USFWS 2009b).

Life history Gulf sturgeon are long-lived, with some individuals reaching at least 42 years in age. Surveys in the Suwannee River suggest that a more common maximum age may be around 25 years (Sulak and Clugston 1999). Age at sexual maturity for females ranges from 8 to 17 years, and for males from 7 to 21 years (Huff 1975). In general, gulf sturgeon spawn up-river in spring, spend winter months in near-shore marine environments, and utilize pre- and post-spawn staging and nursery areas in the lower rivers and estuaries (Heise et al. 2005; Heise et al. 2004). There is some evidence of autumn spawning in the Suwannee River, however there is uncertainty as to whether this spawning is due to environmental conditions or represents a genetically distinct population (Randall and Sulak 2012). Gulf sturgeon spawn at intervals ranging from 3-5 years for females and 1-5 years for males (Fox et al. 2000; Smith 1985). The spring migration to up-river spawning sites begins in mid-February and continues through May. Fertilization is external; females deposit their eggs in the upper reaches of and show preference for hard, clean substrate (e.g. bedrock covered in gravel and small cobble).

Upon hatching from their eggs, gulf sturgeon larvae spend the first few days of life sheltered in interstitial spaces at the spawning site (Kynard and Parker 2004). At the onset of feeding, age-0 gulf sturgeon disperse and are often found on shallow sandbars and rippled sand shoals (<4 meters depth) (Sulak and Clugston 1998). Young-of-the-year spend 6-10 months slowing working their way downstream feeding on aquatic insects (e.g., mayflies and caddisflies), worms (oligochaetes), and bivalve molluscs, and arrive in estuaries and river mouths by mid-winter (Sulak and Clugston 1999) where they will spend their next 6 years developing. After spawning, adult gulf sturgeon migrate downstream to summer resting and holding areas in the mid to lower reaches of the rivers where they may hold until November (Wooley and Crateau 1985). While in freshwater adults lose a substantial amount of their weight, but regain it upon entering the estuaries. Sub adult and non-spawning adults also spend late spring through fall in these holding areas (Foster and Clugston 1997). By early December all adult and sub-adult gulf sturgeon return to the marine environment to forage on benthic (bottom dwelling) invertebrates along the shallow nearshore (2-4 meter depth), barrier island passes, and in unknown off-shore locations in the gulf (Carr et al. 1996; Fox et al. 2002; Huff 1975; Ross et al. 2009). Juvenile gulf sturgeon overwinter in estuaries, river mouths, and bays; juveniles do not enter the nearshore/offshore marine environments until around age 6 (Sulak and Clugston 1999). Gulf sturgeon show a high degree of river-specific fidelity (Rudd et al. 2014). Adult and sub-adult gulf sturgeon fast while in freshwater environments and are almost entirely dependent on the estuarine/marine environment for food (Gu et al. 2001; Wooley and Crateau 1985). Some juveniles (ages 1-6) will also fast in the freshwater summer holding areas, but the majority feed year round in the estuaries, river mouths, and bays (Sulak et al. 2009).

Population Dynamics

Abundance Currently, seven rivers are known to support reproducing populations of Gulf sturgeon. The most recent abundance estimates reported in the 5-Year Review (USFWS 2009b).

Table 21. Gulf sturgeon abundance estimates by river and year, with confidence intervals (CI) for the 7 major rivers with reproducing populations. Table modified from USFWS (2009b)

River	Year of Data Collection	Abundance Estimate[a]	Lower/Upper 95% CI[b]	Source
Pearl	2001	430	323/605	(Rogillio et al. 2001)
Pascagoula	2000	216	124/429	(Ross et al. 2001)
Escambia	2006	451	338/656	(USFWS 2007)
Yellow	2003 fall	911	550/1550	(Berg et al. 2007)
Choctawhatchee	2008	3314	not reported	(USFWS 2009a)
Apalachicola	2004	350	221/648	(USFWS 2004)
Suwannee	2007	14,000	not reported	(USFWS 2009b)

a Estimates refer to numbers of individuals greater than a certain size, which varies between studies depending on sampling gear, and in some cases, numbers of individuals that use a particular portion of the river. Refer to original publication for details.

b Large confidence intervals (CI) around the mean estimates reflect the low capture probability in mark-recapture survey.

Productivity / Population Growth Rate Gulf sturgeon abundance trends are typically assessed on a riverine basis. In general, gulf sturgeon populations in the eastern portion of the range appear to be stable or slightly increasing, while populations in the western portion are associated with lower abundances and higher uncertainty (USFWS 2009b). Pine and Martell (2009) reported that, due to low recapture rates and sparse data, the population viability of gulf sturgeon is currently uncertain.

Genetic Diversity When grouped by genetic relatedness, five regional or river-specific stocks emerge: (1) Lake Pontchartrain and Pearl River; (2) Pascagoula River; (3) Escambia, Blackwater and Yellow Rivers; (4) Choctawhatchee River; and (5) Apalachicola, Ochlocknee and Suwanee Rivers (Rudd et al. 2014; Stabile et al. 1996). Gene flow is low in Gulf sturgeon stocks, with each stock exchanging less than one mature female per generation (Waldman and Wirgin 1998).

Distribution The gulf sturgeon (*Acipenser oxyrinchus desotoi*) is one of two subspecies of the Atlantic Sturgeon (USFWS 1995). The gulf sturgeon is anadromous, and historically occurred in most river systems from the Mississippi river east to Tampa Bay, and in marine coastal/estuarine areas from the Central and Eastern Gulf of Mexico south to Florida Bay (Wooley and Crateau 1985). The current range of the sub-species extends from Lake Pontchartrain in Louisiana east to the Suwannee river system in Florida. Within that range, seven major rivers are known to support reproducing populations: Pearl, Pascagoula, Escambia, Yellow, Choctawhatchee, Apalachicola, and Suwannee (USFWS 2009b).

Designated Critical Habitat Critical Habitat for gulf sturgeon was established in 2003 68 FR 13370) and consists of 14 geographic units encompassing 2,783 river kilometers as well as 6,042 square kilometers of estuarine and marine habitat. PBFs considered essential for the conservation of Gulf Sturgeon are:

- Abundant food items, such as detritus, aquatic insects, worms, and/or molluscs, within riverine habitats for larval and juvenile life stages; and abundant prey items, such as amphipods, lancelets, polychaetes, gastropods, ghost shrimp, isopods, molluscs and/or crustaceans, within estuarine and marine habitats and substrates for subadult and adult life stages.

- Riverine spawning sites with substrates suitable for egg deposition and development, such as limestone outcrops and cut limestone banks, bedrock, large gravel or cobble beds, marl, soapstone, or hard clay;
- Riverine aggregation areas, also referred to as resting, holding, and staging areas, used by adult, subadult, and/or juveniles, generally, but not always, located in holes below normal riverbed depths, believed necessary for minimizing energy expenditures during fresh water residency and possibly for osmoregulatory functions;
- A flow regime (i.e., the magnitude, frequency, duration, seasonality, and rate-of-change of fresh water discharge over time) necessary for normal behavior, growth, and survival of all life stages in the riverine environment, including migration, breeding site selection, courtship, egg fertilization, resting, and staging, and for maintaining spawning sites in suitable condition for egg attachment, egg sheltering, resting, and larval staging;
- Water quality, including temperature, salinity, pH, hardness, turbidity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages;
- Sediment quality, including texture and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages; and
- Safe and unobstructed migratory pathways necessary for passage within and between riverine, estuarine, and marine habitats (e.g., an unobstructed river or a dammed river that still allows for passage).

Recovery Goals The 1995 Recovery Plan outlined three recovery objectives: (1) to prevent further reduction of existing wild populations of Gulf sturgeon within the range of the subspecies; (2) to establish population levels that would allow delisting of the Gulf sturgeon by management units (management units could be delisted by 2023 if required criteria are met); (3) to establish, following delisting, a self-sustaining population that could withstand directed fishing pressure within management units (USFWS 1995). Although the tasks outlined in the 1995 Recovery Plan address threats relative to listing factors (e.g., habitat modification, overutilization, water quality, etc.), the plan lacks criteria that would measure progress towards reducing these threats. The most recent Gulf sturgeon 5-year review recommended that criteria be developed in a revised recovery plan (USFWS 2009b).

Table 22. Summary of status; Gulf Sturgeon

Criteria	Description
Abundance / productivity trends	Eastern range populations stable to increasing, western population lower abundances and more uncertainty, little growth rate data
Listing status	threatened
Attainment of recovery goals	none
Condition of PBFs	Construction of water control structures, such as dams and sills exacerbated habitat loss; Dredging; Groundwater

	extraction, irrigation, and altered flows; Poor water quality; Contaminants, primarily from industrial sources.

9.41 Yelloweye Rockfish, Puget Sound/Georgia Basin DPS

Table 23. Yelloweye Rockfish, Puget Sound/Georgia Basin DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Sebastes ruberrimus	Rockfish, Yelloweye	Puget Sound/ Georgia Basin	Threatened	2016	75 FR 22276	N/A	79 FR 68041

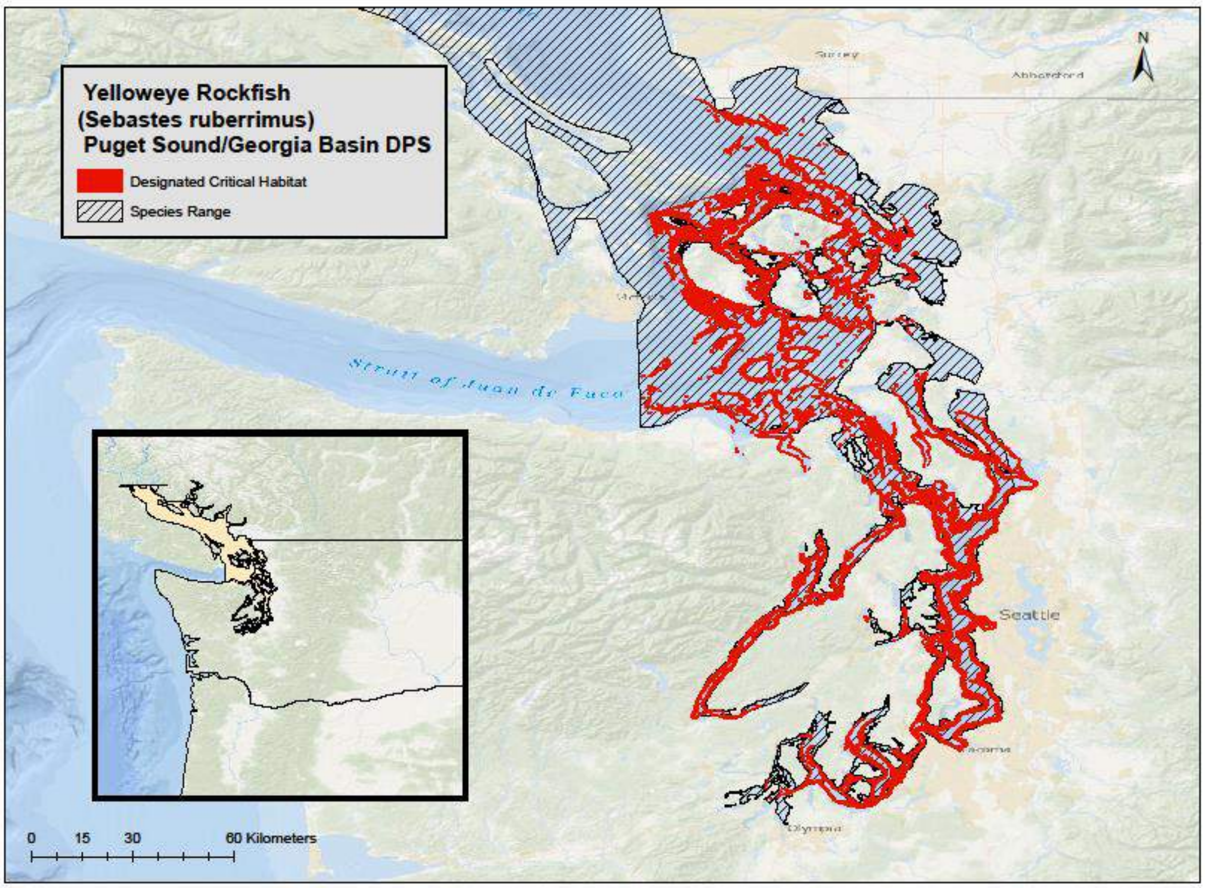

Figure 10. Yelloweye Rockfish, Puget Sound/Georgia Basin DPS range and designated critical habitat

Species Description Yelloweye rockfish occur throughout most of the eastern Pacific Ocean ranging from northern Baja California to the Aleutian Islands, Alaska. The Puget Sound/Georgia Basin DPS is located along the coastal/inlet waters off the state of Washington and province of British Columbia and is the only population listed on the Endangered Species Act. Yelloweye rockfish is one of the largest species belonging to the genus *Sebastes*. They are orange-red to orange-yellow in color and may have black fin tips with bright yellow eyes. Adults usually have a light to white stripe on the lateral line; juveniles have two light stripes, one on the lateral line and a shorter one below the lateral line (Yamanaka et al. 2006).

Status Puget Sound/Georgia Basin yelloweye rockfish were listed on the ESA as threatened on April 28, 2010 (75 FR 22276). Puget Sound/Georgia Basin yelloweye rockfish abundance is much less than it was historically. The fish face several threats including bycatch in commercial and recreational harvest, non-native species introductions, and habitat degradation. Results from a recent genetic study comparing yelloweye rockfish individuals from within the Puget Sound/Georgia Basin DPS to those outside the DPS concluded that a significant genetic difference exists between individuals (1) outside the DPS and (2) within the DPS and north of the DPS in inland Canadian waters to as far north as Johnstone Strait (Tonnes et al. 2016). Further, individuals within Hood Canal are genetically differentiated from the rest of the Puget Sound/Georgia Basin DPS; thereby indicating a previous unknown degree of population differentiation within the DPS (Tonnes et al. 2016). NMFS has determined that this DPS is likely to be in danger of extinction in the foreseeable future throughout all of its range; and in its 2016 status review (Tonnes et al. 2016), NMFS has recommended no change in the Puget Sound/Georgia Basin yelloweye rockfish's threatened classification.

Life history Yelloweye rockfish larvae are born at 4-5 millimeters in length and maintain a pelagic existence for the first 2 months of life, before moving to nearshore habitats and settling into rocky reef habitat at about 25 millimeters in length (DeLacy et al. 1964; Love et al. 2002; Matarese et al. 1989; Moser 1996). However, individuals shift to deeper habitats as they age. Juveniles tend to begin life in shallow rocky reefs and graduate to deeper rocky habitats as adults. Once adult habitat is established, individuals tend to remain at a particular site (Coombs 1979; Love 1978; DeMott 1983). Yelloweye growth is thought to vary by latitudinal gradient, with individuals in more northerly regions growing faster and larger. Year class strength appears to be most strongly linked to survival of the larval stage (Laidig et al. 2007). In general, sexual maturity appears to be reached by 50 % of individuals by 15-20 years of age and 40-50 centimeters in length (Yamanaka and Kronlund 1997). As with other rockfish, yelloweyes can be long-lived (reported oldest age is 118 years) (Munk 2001). Maximum size has been reported as 910 centimeters, but assymptotic size in Alaskan waters for both males and females was estimated to be 690 centimeters and 659-676 millimeters along British Columbia (Clemens and Wilby 1961; Love et al. 2005; Rosenthal et al. 1982; Westrheim and Harling 1975; Yamanaka et al. 2006).

Population Dynamics

Abundance The apparent steep reduction of ESA-listed rockfish in Puget Sound proper (and their consequent fragmentation) has led to concerns about the viability of these populations (Drake et al. 2010). Recreationally caught yelloweye rockfish in the 1970s spanned a broad size range. By the 2000s, fewer older fish in the population were observed (Drake et al. 2010). However, overall fish numbers in the database were also much lower, making it difficult to determine if clear size truncation occurred. With age truncation, the reproductive burden may have shifted to younger and smaller fish. This could alter larval release timing and condition, which may create a mismatch with habitat conditions and potentially reduce offspring viability (Drake et al. 2010).

In 2008, fishery-independent estimate surveys conducted by WDFW estimated that 47,407 yelloweye rockfish are present in the in the San Juan Islands basin. Since this estimate only includes the San Juan Island basin, this estimate is considered a conservative estimate of actual PS/GB yelloweye rockfish abundance. Though yelloweye rockfish were detected via bottom trawl surveys in Puget Sound proper, we do not consider the WDFW estimate of 600 fish to be a complete estimate and were not included. Since juvenile yelloweye rockfish are less dependent on rearing in shallow nearshore environments than canary rockfish and bocaccio, the drop camera surveys were not expected to result in any detections.

Productivity / Population Growth Rate Productivity measures a population's growth rate through all or a portion of its life-cycle. Yelloweye rockfish life-history traits suggest generally low inherent productivity levels because they are long-lived, mature slowly, and have sporadic episodes of successful reproduction (Tolimieri and Levin 2005, Drake et al. 2010). Adult yelloweye rockfish typically occupy relatively small ranges (Love et al. 2002) and may not move to find suitable mates. So as the density of mature fish has decreased, productivity may have also been impacted by Allee effects. Further, past commercial and recreational fishing may have depressed the DPS to a threshold beyond which optimal productivity is unattainable (Drake et al. 2010). Also, historic over-fishing may have had dramatic impacts on population size or age structure.

Genetic Diversity Rockfish diversity characteristics include fecundity, larvae release timing, larvae condition, morphology, age at reproductive maturity, physiology, and molecular genetic characteristics. The leading factors affecting diversity are the relatively small home ranges of juveniles and subadults (Love et al. 2002) and low population size of all life stages. Yelloweye rockfish spatial structure and connectivity are likely threatened by the apparently severe reduction of fish numbers throughout Hood Canal and South Puget Sound. At 2,330 square km, Puget Sound is a small geographic area compared with the entire yelloweye rockfish range in the northeastern Pacific.

Results from a recent genetic study comparing yelloweye rockfish individuals from within the PS/GB DPS (n=52) to those outside the DPS (n=52) provided multiple results (Tonnes et al. 2016). First, yelloweye rockfish in inland Canadian waters as far north as Johnstone Strait were genetically similar to those within the PS/GB DPS (the DPS was subsequently revised to include Johnstone strait individuals). Second, a significant genetic difference exists between individuals (1) outside the DPS and (2) within the DPS and north of the DPS in inland Canadian waters to as far north as Johnstone Strait. Lastly, individuals within Hood Canal are genetically differentiated from the rest of the DPS; thereby indicating a previous unknown degree of population differentiation within the DPS (Tonnes et al. 2016).

Distribution Spatial distribution provides a protective measure from larger scale anthropogenic changes that damage habitat suitability, such as oil spills or hypoxia, which can occur within one basin but not necessarily the other basins. When localized depletion of rockfish occurs, it can reduce stock resiliency, especially when exacerbated by the natural hydrologic constrictions within Puget Sound (Levin 1998, Hilborn et al. 2003, Hamilton 2008). Combining this with limited adult movement, yelloweye rockfish population viability may be highly influenced by the probable localized loss of populations within the DPS, thus decreasing spatial structure and connectivity.

Designated Critical Habitat Critical habitat was designated for Puget Sound/Georgia Basin yelloweye rockfish on November 13, 2014, when NMFS published a final rule in the *Federal Register* (79 FR 68042). The critical habitat in the U.S. is spread amongst five interconnected, biogeographic basins (San Juan/Strait of Juan de Fuca basin, Main basin, Whidbey basin, South Puget Sound, and Hood Canal) based upon presence and distribution of adult and juvenile yelloweye rockfish, geographic conditions, and habitat features. PBFs considered essential for the conservation of Yelloweye Rockfish, Puget Sound/Georgia Basin DPS are:

Adults

- Quantity, quality, and availability of prey species to support individual growth, survival, reproduction, and feeding opportunities,
- Water quality and sufficient levels of dissolved oxygen to support growth, survival, reproduction, and feeding opportunities, and
- The type and amount of structure and rugosity that supports feeding opportunities and predator avoidance.

Juvenile boccacio

- Quantity, quality, and availability of prey species to support individual growth, survival, reproduction, and feeding opportunities; and
- Water quality and sufficient levels of dissolved oxygen to support growth, survival, reproduction, and feeding opportunities.

Recovery Goals There is no final federal recovery plan for the Puget Sound/Georgia Basin yelloweye rockfish at this time; a draft recovery plan was released for public comment in August 2016.

Table 24. Summary of status; Yelloweye Rockfish, Puget Sound/Georgia Basin DPS

Criteria	**Description**
Abundance / productivity trends	Historically low abundance, fragmented populations, altered population age structure
Listing status	threatened
Attainment of recovery goals	none
Condition of PBFs	Adverse environmental factors have led to prey reductions and recruitment failures.

9.42 Boccacio, Puget Sound/Georgia Basin DPS

Table 25. Bocaccio, Puget Sound/Georgia Basin DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Sebastes paucispinis	Bocaccio	Puget Sound/Georgia Basin	Endangered	2016	E – 75 FR 22276	Draft Recovery Plan (2016)	79 FR 68042

Figure 11. Bocaccio, Puget Sound/Georgia Basin DPS range

Species Description The bocaccio is a long-lived, large species of rockfish, occupying the eastern Pacific Ocean in waters from California to Alaska. Puget Sound/Georgia Basin DPS bocaccio are those that reside in the Puget Sound/Georgia Basin. Bocaccio are a large (three feet, one meter) Pacific rockfish, olive to burnt orange-brown, with a distinctively long jaw (. The Puget Sound/Georgia Basin DPS was first listed as endangered by NMFS on April 28, 2010 (75 FR 22276). The listing was updated on January 23, 2017 (82 FR 7711), when NMFS amended the listing description to include fish residing within the Puget Sound/Georgia Basin rather than fish originating from the Puget Sound/Georgia Basin.


Figure 12. Bocaccio Rockfish. Photo credit: M. Yoklavich, NMFS

Status Bocaccio resistance to depletion and recovery is also hindered by demographic features (Love et al. 1998a). Bocaccio are long-lived fishes, taking several years to reach sexual maturity and becoming more fecund with age (Dorn 2002). As harvesting targeted the largest individuals available, bocaccio have become less capable of recovering population numbers (Love et al. 1998b).. Bocaccio reproduction appears to be characterized by frequent recruitment failures, punctuated by occasional high success years (Love et al. 1998b; MacCall and He 2002). Over the past 30 years, 1977, 1984, and 1988 are the only years in which recruitment appears to have been significant successes. Recruitment success appears to be linked to oceanographic/climactic patterns and may be related to cyclic warm/cool ocean periods, with cool periods having greater success (Love et al. 1998b; MacCall 1996; Moser et al. 2000; Sakuma and Ralston 1995). Harvey *et al.* (2006) suggested that bocaccio may have recently diverted resources from reproduction, potentially resulting in additional impairment to recovery.

Life history Bocaccio larvae and young juveniles tend to be found in offshore regions , associated with the surface and occasionally with floating kelp mats (NMFS 2016d). As adults, fish move into waters 18 to 30 meters deep and occupy rocky reefs (Carr 1983; Eschmeyer et al. 1983; Feder et al. 1974; Johnson 2006; Love and Yoklavich 2008). As adults, bocaccio may be found in depths of 12 to 478 meters, but tend to remain in shallow waters on the continental shelf (20 to 250 meters), still associating mostly with reefs or other hard substrate, but may move over mud flats.

Bocaccio are live-bearers with internal fertilization. Once females become mature (at 54 to 61 centimeters total length), they produce 20,000 to 2.3 million eggs annually, with the number increasing as females age and grow larger (Echeverria 1987; Hart 1973; Love et al. 2002). However, either sex has been known to attain sexual maturity as small as 35 centimeters or three years of age. In recent years as populations have declined, average age at sexual maturity may have declined as well (Echeverria 1987; Hart 1973; Love et al. 2002; MacCall 2002). Mating occurs between August and November, with larvae born between January and April (NMFS 2016d).

Upon birth, bocaccio larvae measure four to five millimeters in length. These larvae move into pelagic waters as juveniles when they are 1.5 to three centimeters and remain in oceanic waters from 3.5 to 5.5 months after birth (usually until early June), where they grow at ~0.5 to one millimeter per day (NMFS 2016d). However, growth can vary from year-to-year (Woodbury and

Ralston 1991). Once individuals are three to four centimeters in length, they return to nearshore waters, where they settle into bottom habitats. Females tend to grow faster than males, but fish may take five years to reach sexual maturity (MacCall 2003). Individuals continue to grow until they reach maximum sizes of 91 centimeters, or 9.6 kilograms, at an estimated maximum age of 50 years (Andrews et al. 2005; Eschmeyer et al. 1983; Halstead et al. 1990; Love et al. 2002; Piner et al. 2006; Ralston and Ianelli 1998). Prey of bocaccio vary with fish age, with bocaccio larvae starting with larval krill, diatoms, and dinoflagellates. Pelagic juveniles consume fish larvae, copepods, and krill, while older, nearshore juveniles and adults prey upon rockfishes, hake, sablefish, anchovies, lanternfish, and squid (Love et al. 2002; Reilly et al. 1992).

Population Dynamics

Abundance There is no current population abundance estimate for the Puget Sound/Georgia Basin DPS bocaccio. There is a lack of long-term information on the Puget Sound/Georgia Basin DPS bocaccio abundance, although among rockfish of the Puget Sound, bocaccio appear to have undergone a particular decline. This was likely because of the removal of the largest, most fecund individuals of the population due to overfishing and the frequent failure of recruitment classes, possibly because of unfavorable climactic/oceanographic conditions (MacCall and He 2002).

Productivity / Population Growth Rate The rate of decline for rockfish in Puget Sound has been estimated at 3.1 to 3.8 % annually for the period 1977 to 2014 (NMFS 2016d).

Genetic Diversity Puget Sound/Georgia Basin DPS bocaccio are distinct from bocaccio elsewhere in its range, likely due to its inhabitance of a geographically isolated area. There is no genetic information available for bocaccio in Puget Sound/Georgia Basin (NMFS 2016d).

Distribution Puget Sound/Georgia Basin bocaccio occupy the inland marine waters east of the Strait of Juan de Fuca and south of the northern Strait of Georgia.

Designated Critical Habitat Critical habitat for the Puget Sound/Georgia Basin DPS for bocaccio, canary rockfish, and yelloweye rockfish was finalized in 2014 (79 FR 68041). The critical habitat designation was updated in 2017 when canary rockfish were delisted and their critical habitat removed (82 FR 7711). The specific areas designated for bocaccio include approximately 1,184.75 mi^2 (3,068.5 km^2) of marine habitat in Puget Sound, Washington. Designated habitat was divided into two units—nearshore, to support juveniles, and deeper, rocky habitat for adults. Features essential for adult boccacio (greater than 30 meters deep) include sufficient prey resources, water quality, and rocks or highly rugose habitat. For juvenile boccacio, features essential for their conservation include sufficient prey resources and water quality.

Recovery Goals See the 2016 Draft Rockfish Recovery Plan: Puget Sound/Georgia Basin yelloweye rockfish (*Sebastes ruberrimus*) and bocaccio (*Sebastes paucispinis*), for complete down listing/delisting criteria for each of their respective recovery goals (NMFS 2016c). The following items were the top recovery objectives identified to support in the Draft Recovery Plan:

1. Improve our knowledge of the current and historical status of the yelloweye rockfish and bocaccio and their habitats.
2. Reduce or eliminate existing threats to listed rockfish from fisheries/anthropogenic mortality.

3. Reduce or eliminate existing threats to listed rockfish habitats and restore important rockfish habitat.

Table 26. Summary of status; Bocaccio, Puget Sound/Georgia Basin DPS

Criteria	**Description**
Abundance / productivity trends	There are no estimates of historic or current abundance across the DPS's full range. Indices suggest declining abundance trends.
Listing status	Endangered
Attainment of recovery goals	Recovery plan not yet developed
Condition of PBFs	Adverse environmental factors have led to prey reductions and recruitment failures.

9.43 Gulf Grouper

Table 27. Gulf Grouper; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Mycteroperca jordani	**Gulf grouper**	**N/A**	**Endangered**	2015	E – 81 FR 72545	**N/A**	N/A

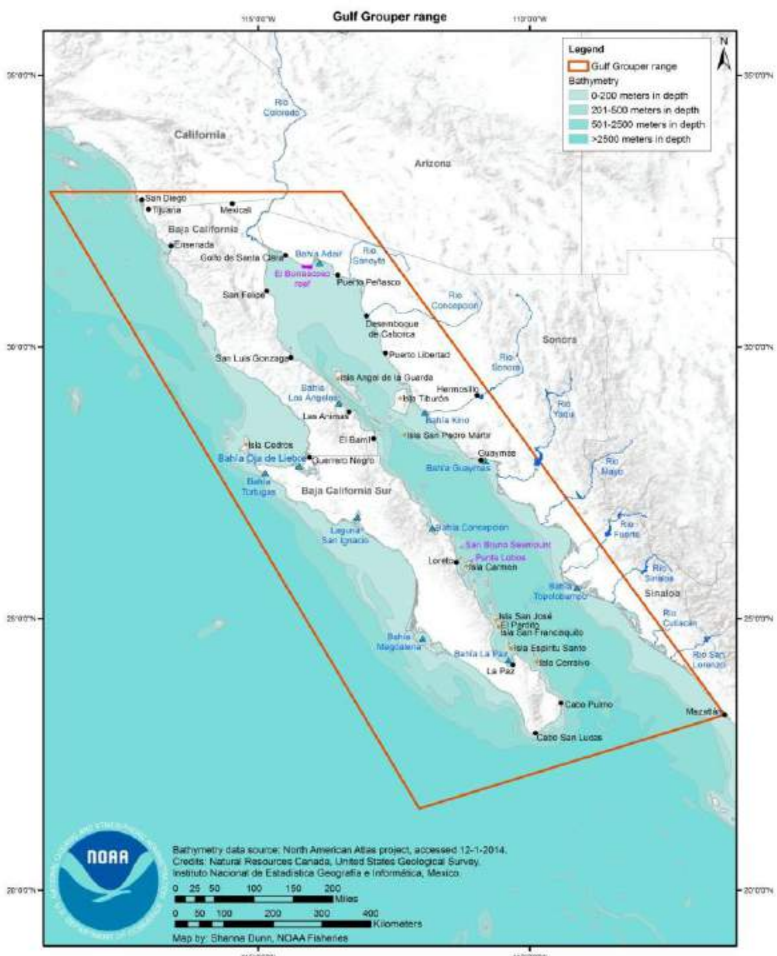

Figure 13. Gulf Grouper range. From Dennis (2015)

Species Description The gulf grouper is a large, long-lived fish primarily occupying shallow water throughout the subtropical Pacific Ocean and Gulf of California, from approximately La Jolla, California, to Mazatlán, Sinaloa, Mexico. They are most commonly found in the northern Gulf of California.

Status The life history of the gulf grouper make it particularly vulnerable to fishing pressure. It is a long-lived, late maturing fish that spawns annually in large aggregations, making harvest easy. In addition, males are older and larger, and targeted for harvest, skewing the sex ratio in the population. Historically, gulf groupers were caught in fisheries as far north as along the San Diego coastline, peaking in the early 1950s, and absent from landings data since 1970. In the Baja California, Mexico finfish fishery, the proportion of the catch made up by gulf grouper has steadily dropped since 1960, making up less than one % of the landings in 2007. Gulf grouper is still targeted by fisheries. Currently, peak harvest for gulf grouper is between April and June coinciding with the timing of spawning aggregations. There are no regulations protecting spawning aggregation sites (Dennis 2015). Gulf groupers are also susceptible to incidental bycatch, particularly in the commercial shrimp fishery. Shrimp aquaculture operations can cause habitat loss and degradation. Climate change is predicted to greatly impact coral reef habitat, through ocean acidification and warming sea temperature, and would in turn cause habitat loss for gulf grouper. Due to the uncertainty surrounding its current population status, the steep decline in abundance, continued fishing pressure, and lack of fishing regulations, the gulf grouper population is not resilient and vulnerable to future perturbations.

Life history Gulf groupers are known as transient aggregate spawners, meaning that they group in large numbers, drawing individuals from a large area to spawn during a specific time of the year for a short period. Gulf grouper spawn before and during the full moon, once a year, in May (Dennis 2015). Fertilized eggs drift offshore away from spawning sites. Larvae are pelagic for about 20 to 50 days. As juveniles, gulf groupers occupy shallow, coastal habitats, such as sargassum beds, seagrass areas, mangroves, and estuaries, for up to two years. Adults are found in reefs and seamounts at depths between five and 30 meters. In summer, adults tend to inhabit deeper waters (30 to 45 meters).

Gulf groupers are protogynous hermaphrodites, meaning that they can change from female to male as they age. Gulf groupers reach sexual maturity as females at six or seven years old, then transition to male. The sex ratio in gulf grouper populations has a higher proportion of females. In other grouper species, observed sex ratios range from one male for every 3.5 females to one male for every 17.3 females. Males are larger than females, and are targeted by fisheries, skewing sex ratios further. Gulf groupers live to a maximum of 48 years (Dennis 2015). Adult gulf groupers eat large fish, slipper lobster, and juvenile hammerhead sharks.

Population Dynamics

Abundance There is no abundance estimate available for gulf grouper. Available information from anecdotal evidence, landings data, and gray literature indicate that the species has undergone a drastic decrease in abundance (Dennis 2015).

Productivity / Population Growth Rate There is no population growth rate available for gulf grouper.

Genetic Diversity There is no genetic information available to determine if population structuring exists (Dennis 2015).

Distribution Historically, gulf groupers were found throughout the Gulf of California, on the western side of the Baja California Peninsula, and along the San Diego coastline. Currently gulf groupers are usually found northern Gulf of California, in a few scattered locations. Occasionally, they are found outside the Gulf of California, in Bahia Magdalena, on the Pacific side of the Baja California Peninsula.

Designated Critical Habitat No critical habitat has been designated for the gulf grouper. NMFS cannot designate critical habitat in foreign waters.

Recovery Goals NMFS has not prepared a recovery plan for the gulf grouper. In general, listed species which occur entirely outside U.S. jurisdiction are not likely to benefit from recovery plans (55 FR 24296; June 15, 1990).

Table 28. Summary of status; Gulf Grouper

Criteria	Description
Abundance / productivity trends	Presently abundance levels are believed to be less than 1% of their historical levels.
Listing status	endangered
Attainment of recovery goals	Recovery plan not yet developed

9.44 Nassau Grouper

Table 29. Nassau grouper; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Epinephelus striatus	Nassau grouper	N/A	Threatened	2013	T – 81 FR 42268	Draft Recovery Plan (2016)	N/A

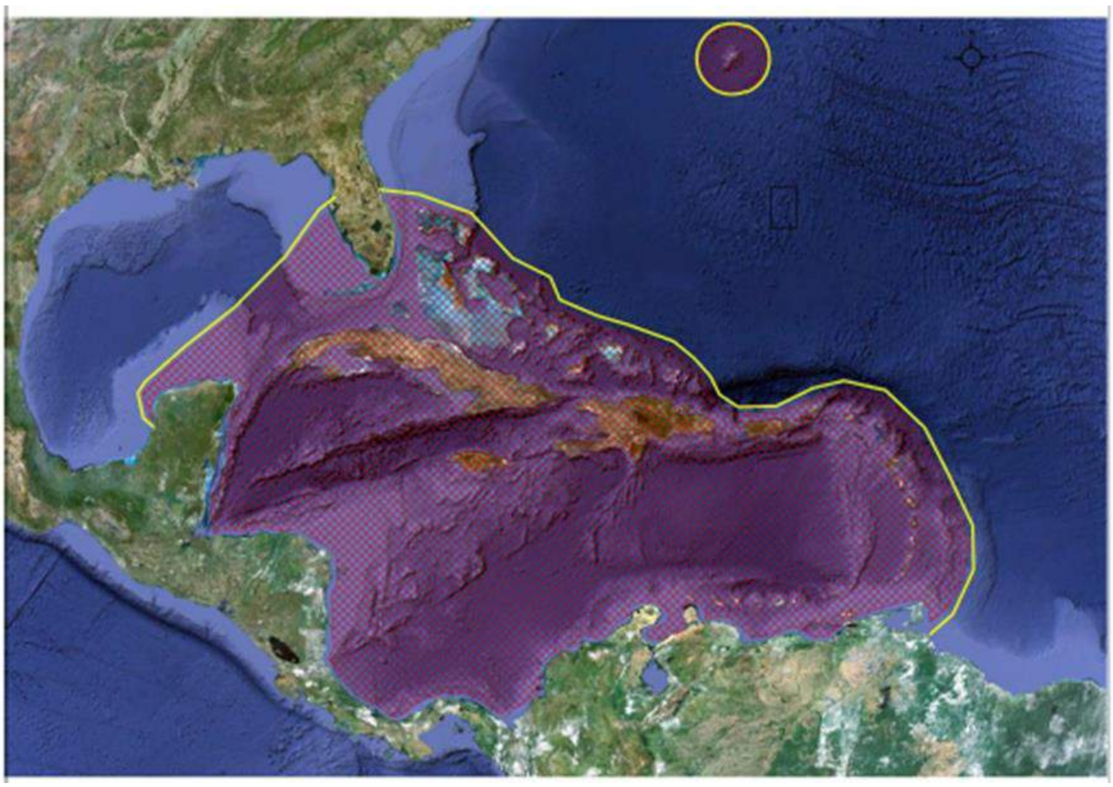

Figure 14. Nassau grouper range. From NMFS Biological Report 2013

Species Description The Nassau grouper is a large, long-lived fish primarily occupying shallow water throughout the Caribbean, south Florida, Bermuda, and the Bahamas.

Adult Nassau grouper are large (up to 0.45 meter or 1.5 feet), have distinctive black and white stripes, and are generally found in shallow reef habitat. The Nassau grouper was listed as threatened on June 29, 2016 (81 FR 42268;).

Figure 15. Nassau grouper. Photo: NOAA, Stephania Bolden.

Status Historically, tens of thousands of Nassau grouper spawned at aggregation sites throughout the Caribbean. Since grouper species were reported collectively in landings data, it is not possible to know how many Nassau grouper were harvested, or estimate historic abundance. That these large spawning aggregations occurred in predictable locations at regular times made the species susceptible to over-fishing, and was a cause of its decline. At some sites (e.g., Belize), spawning aggregations have decreased by over 80 % in the last 25 years (Sala et al. 2001), or have disappeared entirely (e.g., Mexico) (Aguilar-Perera 2006). Nassau groupers are also targeted for fishing throughout the year during non-spawning months. In some locations, spawning aggregations are increasing. Many Caribbean countries have banned or restricted Nassau grouper harvest, and it is believed that the areas of higher abundance are correlated with effective regulations (81 FR 42268). Since Nassau groupers are dependent upon coral reefs at various points in their life history, loss of coral reef habitat due to climate change. Increasing water temperatures may change the timing and location of spawning. Habitat degradation due to water pollution also poses a threat to the species. Nassau grouper populations have been reduced from historic abundance levels, and remain vulnerable to unregulated harvest, especially the spawning aggregations. NMFS determined that the species warrants listing as threatened.

Life history Nassau groupers spawn once a year in large aggregations, in groups of a few dozen to thousands spawning at once. Nassau groupers move in groups towards the spawning aggregation sites parallel to the coast or along the shelf edge at depths between 20 and 33 meters. Spawning runs occur in late fall through winter (i.e., a month or two before spawning is likely). Sea surface temperature is thought to be a key factor in the timing of spawning, with spawning occurring at waters temperatures between 25 and 26 degrees Celsius. Spawning aggregation sites are located near significant geomorphological features, such as reef projections (as close as 50 meters to shore) and close to a drop-off into deep water over a wide depth range (six to sixty meters). Sites are usually several hundred meters in diameter, with soft corals, sponges, stony coral outcrops, and sandy depressions. Nassau groupers stay on the spawning site for up to three months, spawning at the full moon or between the new and full moons. Spawning occurs within twenty minutes of sunset over the course of several days. There have been about fifty known spawning sites in insular areas throughout the Caribbean; many of these aggregations no longer form. Current spawning locations are found in Mexico, Bahamas, Belize, Cayman Islands, the Dominican Republic, Cuba, Puerto Rico and the U.S. Virgin Islands.

Fertilized eggs are transported offshore by ocean currents. Thirty-five to forty days after hatching, larvae recruit from oceanic environment to demersal habitats (at a size of about 32 millimeters total length). Juveniles inhabit macroalgae, coral clumps, and seagrass beds, and are relatively solitary. As they grow, they occupy progressively deeper areas and offshore reefs, and can be found in schools of up to forty individuals. When not spawning, adults are most commonly found in waters less than one hundred meters deep. Nassau grouper diet changes with age. Juveniles eat plankton, pteropods, amphipods, and copepods. Adults are unspecialized piscivores, bottom-dwelling ambush suction predators (NMFS 2013).

Male and female Nassau groupers reach sexual maturity at lengths between 40 and 45 centimeters standard length, about four to five years old. It is thought that sexual maturity is more determined by size, rather than age. Otolith studies indicate that the minimum age at maturity is between four and eight years; most groupers have spawned by age seven (Bush et al. 2006). Nassau groupers live to a maximum of 29 years.

Population Dynamics

Abundance There is no range-wide abundance estimate available for Nassau grouper. The species is characterized as having patchy abundance due largely to differences in habitat availability or quality, and differences in fishing pressure in different locations (81 FR 42268). Although abundance has been reduced compared to historical levels, spawning still occurs and abundance is increasing in some locations, such as the Cayman Islands and Bermuda.

Productivity / Population Growth Rate There is no population growth rate available for Nassau grouper. However, the available information from observations of spawning aggregations has shown steep declines (Aguilar-Perera 2006; Claro and Lindeman 2003; Sala et al. 2001); however, some aggregation sites are comparatively robust and showing signs of increase (Vo et al. 2014; Whaylen et al. 2004).

Genetic Diversity Recent studies on Nassau grouper genetic variation has found strong genetic differentiation across the Caribbean subpopulations, likely due to barriers created by ocean currents and larval behavior (Jackson et al. 2014a).

Distribution Nassau grouper is distributed throughout the Caribbean, south to the northern coast of South America. Current Nassau grouper distribution is considered equivalent to its historical range, although abundance has been severely depleted.

Designated Critical Habitat No critical habitat has been designated for the Nassau grouper.

Recovery Goals NMFS has not prepared a recovery plan for the Nassau grouper.

Table 30. Summary of status; Nassau grouper

Criteria	Description
Abundance / productivity trends	The species has patchy abundance with declining trends in many areas. Throughout its range reduction in the size and number of spawning aggregations has occurred.
Listing status	Threatened
Attainment of recovery goals	Recovery plan not yet developed

9.45 Smalltooth Sawfish, United States DPS

Table 31. Smalltooth Sawfish, United States DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Pristis pectinata	Sawfish, smalltooth	US portion of range	Endangered	2010	2003 68 FR 15674	2009	2009 74 FR 45353

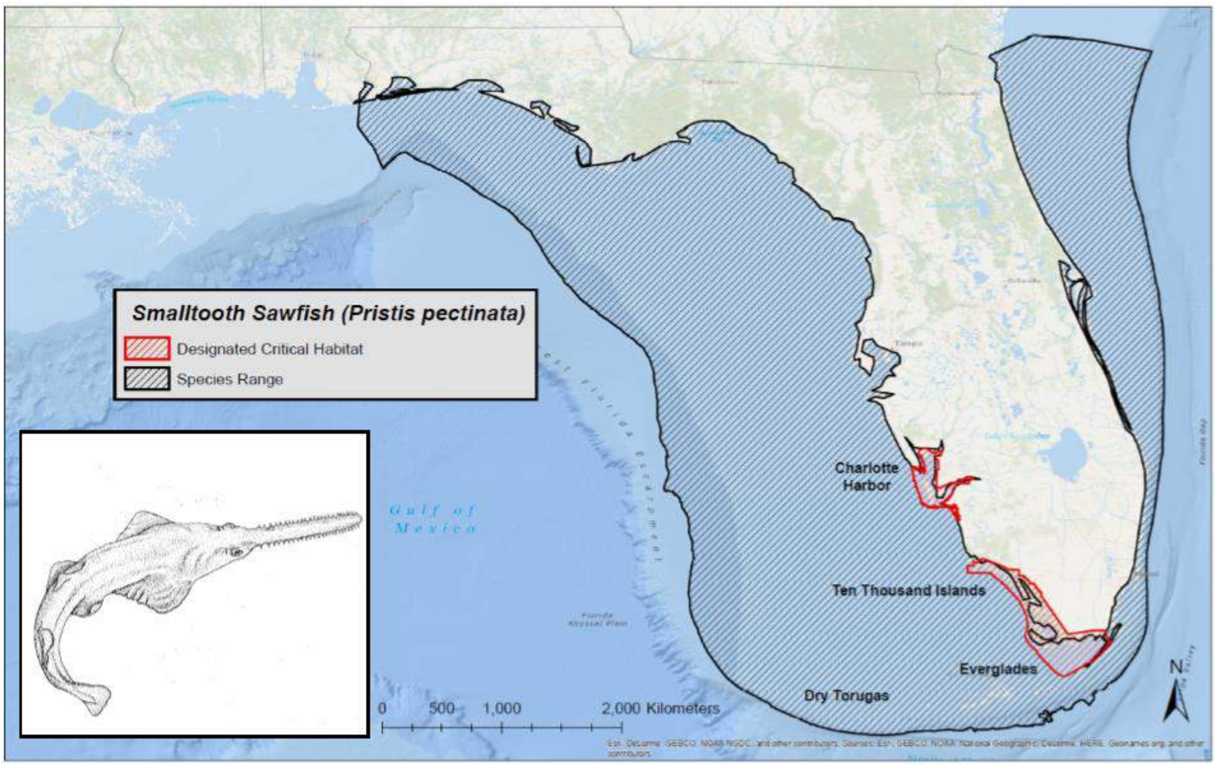

Figure 16. Smalltooth Sawfish, United States DPS range and designated critical habitat

Species Description The smalltooth sawfish (*Pristis pectinata*) is a tropical marine and estuarine elasmobranch. Although they are rays, sawfish physically resemble sharks, with only the trunk and especially the head ventrally flattened. Smalltooth sawfish are characterized by their "saw," a long, narrow, flattened rostral blade with a series of transverse teeth along either edge (NMFS 2009). The U.S. DPS of smalltooth sawfish was listed as endangered under the ESA effective May 1, 2003 (68 FR 15674). Although this species is reported to have a circumtropical distribution, NMFS identified smalltooth sawfish from the Southeast United States as a DPS. Within the United States, smalltooth sawfish have been captured in estuarine and coastal waters from New York southward through Texas, although peninsular Florida has historically been the region of the United States with the largest number of recorded captures (NMFS 2010c).

Status The decline in the abundance of smalltooth sawfish has been attributed to fishing (primarily commercial and recreational bycatch), habitat modification (including changes to freshwater flow regimes as a result of climate change), and life history characteristics (i.e. slow-growing, relatively late-maturing, and long-lived species) (NMFS 2009; Simpfendorfer et al. 2011). These factors continue to threaten the smalltooth sawfish population. Recent records indicate there is a resident reproducing population of smalltooth sawfish in south and southwest Florida from Charlotte Harbor through the Dry Tortugas, which is also the last U.S. stronghold for the species (Poulakis and Seitz 2004; Seitz and Poulakis 2002; Simpfendorfer and Wiley 2004). While the overall abundance appears to be stable, low intrinsic rates of population increase suggest that the species is particularly vulnerable to rapid population declines (NMFS 2010c).

Life history Smalltooth sawfish size at sexual maturity has been reported as 360cm total length (TL) by Simpfendorfer (2005). Carlson and Simpfendorfer (2015) estimated that sexual maturity for females occurs between 7 and 11 years of age. As in all elasmobranchs, smalltooth sawfish are viviparous; fertilization is internal. The gestation period for smalltooth sawfish is estimated at 5 months based on data from the largetooth sawfish (Thorson 1976). Females move into shallow estuarine and nearshore nursery areas to give birth to live young between November and July, with peak parturition occurring between April and May (Poulakis et al. 2011). Litter sizes range between 10 and 20 individuals (Bigalow and Schroeder 1953; Carlson and Simpfendorfer 2015; Simpfendorfer 2005).

Neonate smalltooth sawfish are born measuring 67 – 81 cm (TL) and spend the majority of their time in the shallow nearshore edges of sand and mud banks (Poulakis et al. 2011; Simpfendorfer et al. 2010). Once individuals reach 100 – 140cm (TL) they begin to expand their foraging range. Capture data suggests smalltooth sawfish in this size class may move throughout rivers and estuaries within a salinity range of 18 and 30 (practical salinity units). Individuals in this size class also appear to have the highest affinity to mangrove habitat (Simpfendorfer et al. 2011). Juvenile sawfish spend the first 2-3 years of their lives in the shallow waters provided in the lower reaches of rivers, estuaries, and coastal bays (Simpfendorfer et al. 2008; Simpfendorfer et al. 2011). As smalltooth sawfish approach 250 cm (TL) they become less sensitive to salinity changes and begin to move out of the protected shallow-water embayments and into the shorelines of barrier islands (Poulakis et al. 2011). Adult sawfish typically occur in more open-water, marine habitats (Poulakis and Seitz 2004).

Population Dynamics

Abundance The abundance of smalltooth sawfish in U.S. waters has decreased dramatically over the past century. Efforts are currently underway to provide better estimates of smalltooth sawfish abundance (NMFS 2014). Current abundance estimates are based on encounter data, genetic sampling, and geographic extent. Carlson and Simpfendorfer (2015) used encounter densities to estimate the female population size to be 600. Chapman et al. (2011) analyzed genetic data from tissue samples (fin clips) to estimate the effective genetic population size as 250-350 adults (95% C.I. 142-955). Simpfendorfer (2002) estimated that the U.S. population may number less than 5% of historic levels based on the contraction of the species' range.

Productivity / Population Growth Rate The abundance of juveniles encountered in recent studies (Poulakis et al. 2014; Seitz and Poulakis 2002; Simpfendorfer and Wiley 2004) suggests that the smalltooth sawfish population remains reproductively viable. The overall abundance appears to be stable (Wiley and Simpfendorfer 2010). Data analyzed from the Everglades portion of the smalltooth sawfish range suggests that the population growth rate for that region may be around 5% per year (Carlson and Osborne 2012; Carlson et al. 2007). Intrinsic rates of growth (λ) for smalltooth sawfish have been estimated at 1.08-1.14 per year and 1.237-1.150 per year by Simpfendorfer (2000) and Carlson and Simpfendorfer (2015) respectively. However, these intrinsic rates are uncertain due to the lack of long-term abundance data.

Genetic Diversity Chapman et al. (2011) investigated the genetic diversity within the smalltooth sawfish population. The study reported that the remnant population exhibits high genetic diversity (allelic richness, alleles per locus, heterozygosity) and that inbreeding is rare. The study also suggested that the protected population will likely retain >90% of its current genetic diversity over the next century.

Distribution Recent capture and encounter data suggests that the current distribution is focused primarily to south and southwest Florida from Charlotte Harbor through the Dry Tortugas (Poulakis and Seitz 2004; Seitz and Poulakis 2002). Water temperatures (no lower than 16-18°C) and the availability of appropriate coastal habitat (shallow, euryhaline waters and red mangroves) are the major environmental constraints limiting the distribution of smalltooth sawfish (Bigalow and Schroeder 1953).

Designated Critical Habitat Critical habitat for smalltooth sawfish was designated in 2009 74 FR 45353) and includes two major units: Charlotte Harbor (221,459 acres) and Ten Thousand Islands/Everglades (619,013 acres). These two units include essential sawfish nursery areas. The locations of nursery areas were determined by analyzing juvenile smalltooth sawfish encounter data in the context of shark nursery criteria (Heupel et al. 2007; Norton et al. 2012). Within the nursery areas, two features were identified as essential to the conservation of the species: red mangroves (*Rhizophora mangle*), and euryhaline habitats with water depths ≤0.9 m (74 FR 45353). The Charlotte Harbor unit includes areas which are moderate to highly developed (Cape Coral, Fort Myers) and includes a highly altered, flow-managed system (Caloosahatchee River). In contrast, the Ten Thousand Island/Everglades unit contains relatively undeveloped, pristine smalltooth sawfish habitat (Poulakis et al. 2014; Poulakis et al. 2011).

Recovery Goals The 2009 Smalltooth Sawfish Recovery Plan (NMFS 2009) contains complete downlisting/delisting criteria for each of the three following recovery goals.

1. Minimize human interactions and associated injury and mortality. Specific criteria include:

    - Educational programs;
    - Handling and release guidelines;
    - Injury and mortality regulations; and,
    - Other State and/or Federal measures (not including those provided under the ESA).

2. Protect and/or restore smalltooth sawfish habitats. Specific criteria include:

    - protection of existing mangrove shoreline habitat;
    - assurance of availability and accessibility of both mangrove and non-mangrove habitat sufficient to support subpopulations of juvenile sawfish;
    - appropriate freshwater flow regimes; and,
    - identification and protection of habitat areas utilized by adult smalltooth sawfish.

3. Ensure smalltooth sawfish abundance increases substantially and the species reoccupies areas from which it had been previously extirpated. Specific criteria include:

    - 1) annual increases in the relative abundance of juvenile smalltooth sawfish;
    - 2) annual increases in the relative abundance of adult smalltooth sawfish;
    - 3) verified records of adult smalltooth sawfish in outer regions of the species range.

Table 32. Summary of status; Smalltooth Sawfish, United States DPS

Criteria	**Description**
Abundance / productivity trends	Stable abundance, low population growth rates, <5% of historical abundance
Listing status	endangered
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Loss and degradation of female pupping sites and juvenile rearing habitats; Point and non-point contaminants; Marine Debris.

9.46 Black Abalone

Table 33. Black Abalone; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Haliotis cracherodii	Abalone, Black	N/A	Endangered	N/A	74 FR 1 937	73 FR 62257	76 FR 66806

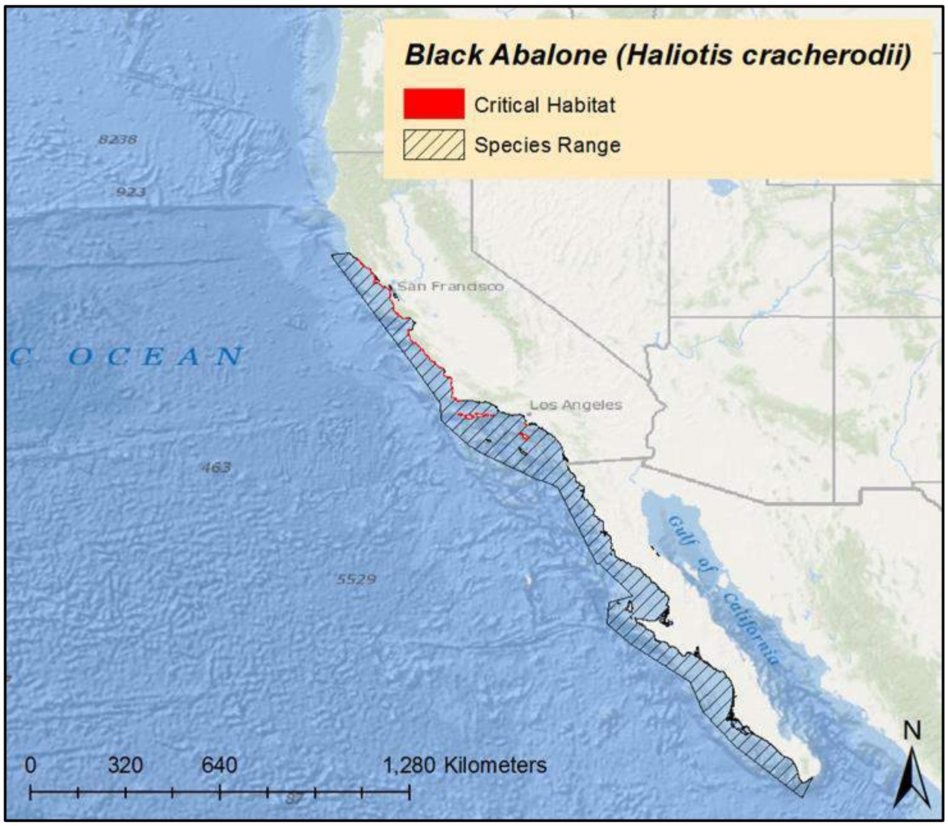

Figure 17. Black Abalone range and designated critical habitat

Species Description Black abalone is a lare marine gastropod mollusk belonging to the taxonomic genus of Haliotidae, a group of sea snails with convex spiral structured shells. The majority of experts concur that the present range of black abalone extends from Point Arena (Mendocino County, California) to Northern Baja California. The black abalone is a moderately large aquatic gastropod mollusk found along rocky shorelines and coastal habitats. The majority of experts concur that the present range of black abalone extends from Point Arena (Mendocino County, California) to Northern Baja California. Black abalone are uncommon north of San Francisco (Morris et al. 1980) and south of Punta Eugenia (P.Raimondi, pers. comm. as cited in Butler et al. 2009) Black Abalone, as with all abalone are benthic, occurring on hard substrata, relatively stationary, and are for the most part herbivorous, feeding on attached or floating algal material(Geiger 1999). The mollusk possesses a shell that is smooth, circular, and black to slate blue in colors (Leach 1814 as cited in Butler et al. 2009). There are five to nine open respiratory pores, known as tremata, that are level with the shell's outer surface. Normally the shell's interior is white (Haaker et al. 1986), with ill-defined or no muscle scar (Howorth 1978). The muscular foot of the black abalone permits the animal to firmly fasten itself to rocky surfaces without being displaced by wave action. A rolling motion of the foot completes movement for the species as a column of muscle attaches the body to the shell. The epipodium, a sensory structure and extension of the foot which holds lobed tentacles of the same color (Cox 1962), circles the foot and extends beyond the shell of a healthy black abalone. The internal organs are arranged around the foot and under the shell.

Status Black abalone has experienced substantial decline, which is reflected by the decrease in commercial catches until 1993, when commercial harvests were halted. Historic levels approached 2,200 tons in California in 1879 and declined to around 1000 tons in the 1970's. Commercial landings then decreased to 19.1 tons in the last year of harvests, when mortality from withering syndrome devastated remaining black abalone stocks throughout southern California (Haaker 1994). Over 20 years, densities of more than 100 individuals per cubic yard disappeared from most of their former range south of Point Conception (Davis 1993). A similar mass mortality was reported at Palos Verdes Peninsula in the late 1950's, where average density decreased from more than 2.8 individuals per square yard from 1975 to 1979 down to about 0.03 individuals per square yard from 1987 to 1991 (Cox 1962). Island habitats experienced more severe trends; 99% of black abalone vanished from Anacapa, Santa Barbara, and Santa Rosa Islands in less than 5 years (Haaker et al. 1989; Richards and Davis 1993).

Black abalone have also experienced severe declines due to a temperature-related disease called withering syndrome. This bacteria-based disease prevents assimilation of nutrients in the digestive system and results in abalone that "wither" as individuals consume body tissues. The disease was first identified west of Santa Cruz and Anacapa islands in 1985 and 1986 before spreading to Santa Rosa Island and Santa Barbara Island by 1988. The disease made its appearance along the mainland in 1988 in San Luis Obispo county, where 85% of the resident black abalone died in Diablo Cove. This die-off was attributed to the presence of warm-water effluent from a nuclear power facility. From 1988 to the early 1990's, withering syndrome continued to spread throughout the Channel islands to 2000, when it was estimated that only 1% of the original population remained (Richards 2000).

However, as previously expressed, signs of possible recovery are can be seen in recent Channel Island surveys that have demonstrated growth in juvenile abundance (Eckdahl 2015). Nonetheless, issues stemming from previous declines are very much ostensible on several mainland and island sites from Point Conception to San Diego, which show density estimates to be well below the minimum needed for successful recruitment of the species to occur. Densities at island sites ranged from 0.06-0.64/m^2 and mainland sites ranged from 0-0.01/m^2 whereas the estimated minimum density needed is between 0.75-1.1/m^2 (Eckdahl 2015).

Life history Black abalone have separate sexes and are broadcast spawners. As spawning occurs, gametes are dispersed from the gonads of both parents into the sea and fertilization is entirely external. The embryos and larvae that result from this process are small and unprotected, obtain no parental care or safeguard of any kind, and are exposed to a wide range of physical and biological sources of mortality. Nevertheless, the average life expectancy for an abalone that reaches adulthood is 30 years. Adults attain a maximum shell length of approximately 200 millimeters (indexed by linear measure of the maximum diameter of the elliptical shell). Female black abalone become sexually mature at a length of about 50 millimeters, and males at about 40 millimeters (Ault 1985). Ault (1985) projected that sexually mature female black abalone may discharge over two million unfertilized eggs per spawning episode and are capable of undergoing multiple episodes each spawning season. Black abalone spawning season is between April and September with peak times occurring during the late summer and early autumn (Leighton 2005 as cited in Butler et al. 2009).

Population Dynamics

Abundance Using landings data obtained from the height of the black abalone commercial and recreational fisheries era (1972-1981), Rogers-Bennett et al. (2002) estimated baseline abundance of the species to be approximately 3.54 million animals. Due to significant declines throughout the 20th century as a result of overfishing, habitat loss, and disease (most notably withering syndrome), the abundance of black abalone currently stands as small fraction of historical numbers. Through the analysis of both fishery and fishery-independent long-term monitoring data, identification of substantial declines of black abalone throughout central and southern California have been made. Neuman et al. (2010) states that overall rates of decline exceed 95 % for populations of black abalone south of Monterrey County, CA. Recent NOAA surveys off the shores of the South Farallon Islands (coastal islands located 30 miles west of San Francisco) show no current presence of black abalone (Roletto 2015). However, recent surveys on the Channel Islands have shown an increase in juvenile abundance, which may deem positive for recruitment (Eckdahl 2015). Nevertheless, in a recent 2015 survey that explored several mainland and island sites from Point Conception to San Diego, density estimates were well below the minimum density needed for successful recruitment of the species to occur. Densities at island sites ranged from 0.06-0.64/m^2 and mainland sites ranged from 0-0.01/m^2 whereas the estimated minimum density needed is between 0.75-1.1/m^2 (Eckdahl 2015).

Productivity / Population Growth Rate As stated, population growth rates for black abalone have experienced steep declines since the late 1970s. Butler et al. (2009) states due to the large declines of the species south of Monterrey County, CA it is doubtful that black abalone populations will be able to recover naturally to their former abundance levels, at least in the near future. Furthermore, due the persistent decline of most populations and the continued northward expansion of withering syndrome as a result of warming events (Raimondi et al. 2002), it seems likely that black abalone populations will continue to decline on a large scale.

Genetic Diversity Neuman et al. (2010) states that black abalone populations exhibit a heterogeneous genetic structure among populations and it is possible that localized genetic diversity has been lost in areas where populations have declined to extremely low abundance levels, rendering extant populations less capable of dealing with both long- and short- term environmental or anthropogenic challenges.

Distribution As stated in the description of the species, black abalone is found off the Western Coast of the United States from Point Arena (Mendocino County, California) to Northern Baja California. Inside this broad geographic range, black abalone mostly inhabits coastal and offshore island intertidal habitats on uncovered rough shores where bedrock offers profound, protective crevice shelter (Leighton 2005 as cited in Butler et al. 2009). Compared to other native species of abalone found along California and its coastal islands, black abalone bathymetrically inhabits shallower locations situated predominantly in rocky intertidal environments (Morris et al. 1980). Bathymetry distribution for black abalone ranges from the high intertidal zone (i.e. shoreline) to six meters depth, with most animals found in middle and lower intertidal

Designated Critical Habitat On October 27, 2011, the NMFS designated critical habitat for black abalone. This includes rocky areas from mean high water to six meters water depth in the Farallon, Channel, and Año Nuevo islands, as well as the California coastline from Del Mar Ecological Reserve south to Government Point (excluding some stretches, such as in Monterey Bay and between Cayucos and Montaña de Oros State Park) in northern and central California and between the Palos Verdes and Torrance border south to Los Angeles Harbor. PBFs considered essential for the conservation of Black Abalone are:

- Rocky substrate: Rocky benches, crevices, large boulders
- Food resources: Bacterial and diatom films, algae
- Juvenile settlement habitat: Rocky habitat with coralline algae and/or crevices, cryptic biogenic structures
- Suitable water quality
- Suitable nearshore circulation patterns

Recovery Goals There is currently no national recovery plan for the black abalone.

Table 34. Summary of status; Black Abalone

Criteria	**Description**
Abundance / productivity trends	5% of historical abundance, declining population trend
Listing status	endangered
Attainment of recovery goals	none
Condition of PBFs	Habitat destruction; Disease.

9.47 White Abalone

Table 35. White Abalone; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Haliotis sorenseni	Abalone, White	N/A	Endangered	N/A	66 FR 29046	73 FR 62257	None Designated

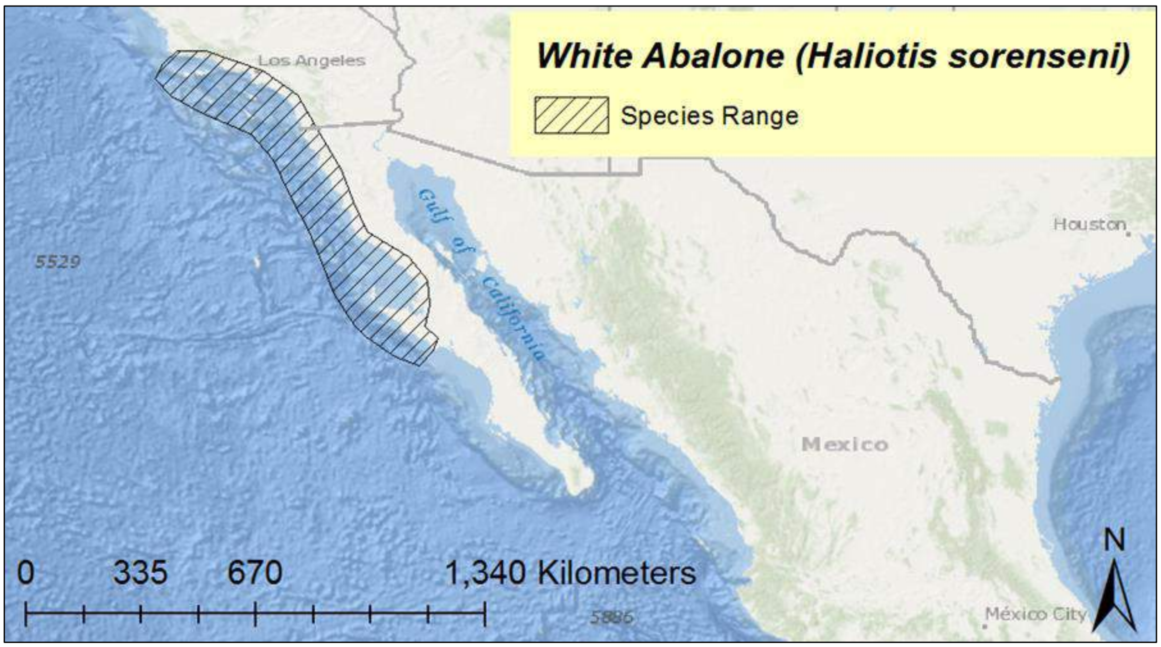

Figure 18. White Abalone range

Species Description The white abalone is an herbivorous gastropod found in shallow rocky ocean waters. White Abalone occurs between Punta Abreojos, Baja California, Mexico and Point Conception, California, USA. White abalone occupies open low relief rock or boulder habitat surrounded by sand (Tutschulte 1976). Historically, white abalone were reported to occur at depths of 20–60 meters with the greatest abundance occurring between 25–30 meters (Cox 1960; Tutschulte 1976). However, later surveys show that they occur from 30 to 65 meters with a median depth of 48 meters (Haaker et al. 1986). Maximum shell length reached by white abalone in California is about 20-25 centimeters while in Mexico the species will only grow to 17 centimeters (Hobday and Tegner 2000). Adults have a speckled orange and tan epipodium with foliose epipodial papillae and brown cephalic tentacles. The epipodium, a sensory structure and extension of the foot which holds lobed tentacles of the same color (Cox 1962), circles the foot and extends beyond the shell of a healthy white abalone. The internal organs are organized around the foot and under the shell.

Status On May 29, 2001, the white abalone was listed as an endangered species throughout its range under the ESA (66 FR 29046). White abalone numbers were severely reduced due to excessive harvest. This has led to below-threshold spawning densities in many areas that are blamed for recruitment failure and an inability of the species to recover. Estimates of population size have been difficult to calculate because estimates are only based upon adults, as juveniles are infrequently observed. White abalone observed during surveys were of large size which corresponds to predicted ages near the end of the anticipated life span (Davis 1996; Davis et al. 1998; Hobday and Tegner 2000; Hobday et al. 2001). Because no white abalone were observed in the smaller age/size classes during the surveys there appears to be a lack of successful recruitment since the 1960s (Hobday and Tegner 2000). Recent surveys off the southern coast of California illustrate this continued trend (Catton et al. 2016).

Life history Recent evidence from bomb carbon research indicates that the life span for white abalone is roughly 28 to 30 years(Rogers-Bennett et al. 2016). Abalone aggregate for spawning, but low numbers and physical barriers can prevent large spawning aggregations from forming (Babcock and Keesing 1999; Leet et al. 2001). A brief annual spawning event occurs *en mass* generally between February and April (Tutschulte 1976). Although an average female is capable of producing over 20 million larvae over her lifetime, larval survival to adulthood is estimated at less than one % (Leighton 2000). Twenty four hours after fertilization, a free-swimming larva emerges from the fertilized egg and joins the plankton (Leighton 1989; Leighton 2000). After two to three weeks in the plankton, the larvae settle to the bottom. One to three months after settlement juveniles are fully formed and resemble adults. After two to four years, white abalone are mature and inhabit the tops and sides of rocky substrates. (Saunders et al. 2009a; Saunders et al. 2009b).

Population Dynamics

Abundance Hobday and Tegner (2000) estimated pre-exploitation abundance at 2,221,800 abalone and 1996 to 1997 population estimates only at 1,613 individuals, representing a 99.9 % decline. However based upon updated survey data, Hobday et al. (2001) updated the 1996 to 1997 white abalone abundance estimate to 2,540.

Productivity / Population Growth Rate From 2002 to the present, population surveys of white abalone in southern California show declining densities (Catton et al. 2016). From 2002 to 2014, survey results at Tanner Bank, California showed population growth rates had a 12 % mean decline in abundance(Catton et al. 2016). This decline was hinted at in the 2000 status review in which Hobday and Tegner (2000) cautioned that due to the prevalence of older individuals within white abalone populations at the time, the populace would vanish due to natural mortality without human intercession. This resulted in the 2001 creation of a population rebuilding strategy for white abalone, which identified hatchery production and stocking of cultured white abalone as the primary restoration action recommended. The California and federal recovery plans both promote restoration of white abalone populations through captive-rearing and stocking efforts, which have significantly increased captive-bred populations (Rogers-Bennett et al. 2016).

Genetic Diversity / **Distribution** In reference to distribution, white abalone occur along the U.S. west coast among offshore islands and banks (particularly Santa Catalina and San Clemente islands) and mainland inshore waters from Point Conception, California south to Punta Abreojos, Baja California, Mexico (Cox 1960; Cox 1962; Bartsch 1940). White abalone occur primarily along the mainland coast in their northern and southern range, but are more frequently at the offshore islands (especially San Clemente and Santa Catalina islands) in the middle portion of the California range (Cox 1962; Leighton 1972). However, individuals have also been found around several Mexican islands including Isla Cedros and Isla Natividad (Guzmán Del Proó 1992). There are no recognized subspecies of white abalone although there is one possible subspecies of white abalone inhabiting Guadalupe Island, Mexico (Hobday and Tegner 2000). Nevertheless, recent commercial fisheries data has shown that white abalone along the Mexican coast are believed to be depleted, but their status is generally unknown (NMFS 2008)

Designated Critical Habitat Critical habitat has not been designated for white abalone.

Recovery Goals The following contains requirements needed for downlisting/delisting white abalone:

- The density of emergent (detectable by human observation without substrate disturbance) animals (short term) is greater than 2,000 per hectare for 75 % of the geographic localities;
- A total of 380,000 animals are maintained in the wild, distributed among all geographic localities in the USA and Mexico;
- The proportion of size of emergent animals in 75 % of geographic localities includes at least 85 % intermediate-size animals (90 to 130 millimeters);
- Proportion of size of emergent animals in 75 % of geographic localities includes no more than 15 % large animals (>130 millimeters);
- There is a stable or increasing estimate of geometric population growth (lambda ≥1) for >75 % of the geographic localities over a ten year period; and
- There is reoccupation of white abalone over a spatial scale that encompasses their historic range such that 75 % of the geographic localities in the USA and Mexico are reoccupied and meet the recovery criteria.

Table 36. Summary of status; White Abalone

Criteria	Description
Abundance / productivity trends	Declining population trend, lack of recruitment, no current estimated population size
Listing status	endangered
Attainment of recovery goals	criteria not yet met

9.48 Staghorn Coral

Table 37. Staghorn Coral; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Acropora cervicornis	Staghorn	N/A	Threatened	2014	2006 71 FR 26852	2015 80 FR 12146	2008 73 FR 72210

Figure 19. Staghorn Coral distribution. Off-white = no record, dark green = confirmed record, pale green = predicted record, tan = published record that needs further investigation(Veron 2014).

Figure 20. Image of a staghorn coral (Acropora cervicornis)

Species Description The staghorn coral is a cnidarian belonging to the taxonomic order of Scleractinia, a group of stony corals that secrete calcium carbonate to form hard exoskeletons.Staghorn coral occurs throughout coastal areas in the Caribbean, Gulf of Mexico, and southwestern Atlantic. Staghorn coral is characterized by antler-like colonies with straight or slightly curved, cylindrical branches. The diameter of branches ranges from 0.25-5 centimeters in Lirman et al. (2010), and linear branch growth rates have been reported to range between 3-11.5 centimeters per year (Acropora Biological Review Team 2005). The species can exist as isolated branches, individual colonies up to about 1.5 meters diameter, and thickets comprised of multiple colonies that are difficult to distinguish from one another (Acropora Biological Review Team

2005). Staghorn corals, as with all corals are composed of single polyp body forms, often present in numbers of hundreds to thousands creating dense clusters along the shallow ocean floor called colonies. Polyps are capable of catching and eating their own food, and have their own digestive, nervous, respiratory, and reproductive systems. In addition to being able to catch and eat their own food, Staghorn coral, along with most coral species contain zooxanthellae, a unicellular, symbiotic dinoflagellate, living within the endodermic tissues of individual polyps to provide photosynthetic support to the coral's energy budget and calcium carbonate secretion (NMFS 2005).

Staghorn coral naturally occurs on spur and groove, bank reef, patch reef, and transitional reef habitats, as well as on limestone ridges, terraces, and hard bottom habitats (Cairns 1982; Davis 1982; Gilmore and Hall 1976; Goldberg 1973; Jaap 1984b; Miller et al. 2008; Wheaton and Jaap 1988). Historically it grew in thickets in water ranging from approximately five to twenty meters in depth; though it has rarely been found to approximately 60 meters (Davis 1982; Jaap 1984b; Jaap et al. 1989; Schuhmacher and Zibrowius 1985; Wheaton and Jaap 1988). At the northern extent of its range, it grows in deeper water 16-30 meters (Goldberg 1973). Historically, staghorn coral was one of the primary constructors of mid-depth 10-15 meter reef terraces in the western Caribbean, including Jamaica, the Cayman Islands, Belize, and some reefs along the eastern Yucatan peninsula (Adey 1978). In the Florida Keys, staghorn coral occurs in various habitats but is most prevalent on patch reefs as opposed to their former abundance in deeper fore-reef habitats (i.e., 5 to 22 meters) (Miller et al. 2008). There is no evidence of range constriction, though loss of staghorn coral at the reef level has occurred (*Acropora* Biological Review Team 2005).

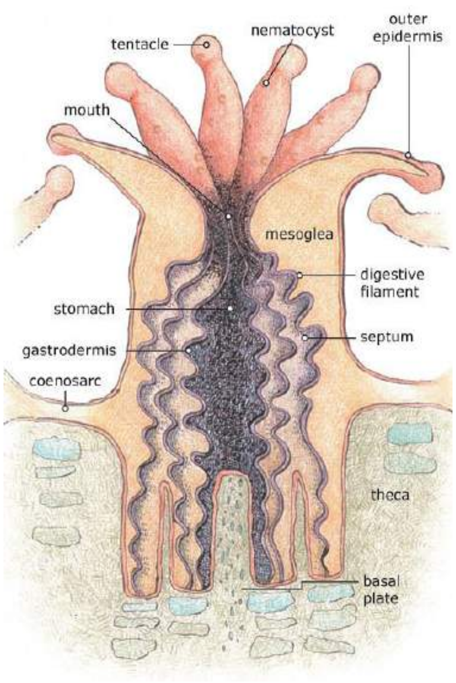

Figure 21. Anatomy of a single coral polyp

Precht and Aronson (2004) suggest that coincident with climate warming, staghorn coral only recently re-occupied its historic range after contracting to south of Miami, Florida, during the late Holocene. They based this idea on the presence of large thickets off Ft. Lauderdale, Florida, which were discovered in 1998 and had not been reported in the 1970s or 1980s (Precht and Aronson 2004). However, because the presence of sparse staghorn coral colonies in Palm Beach County, north of Ft. Lauderdale, was reported in the early 1970s(though no thicket formation was reported) (Goldberg 1973), there is uncertainty associated with whether these thickets were present prior to their discovery or if they recently appeared coincident with warming. The proportion of reefs with staghorn coral present decreased dramatically after the Caribbean-wide mass mortality in the 1970s and 1980s, indicating the spatial structure of the species has been affected by extirpation from many localized areas throughout its range (Jackson et al. 2014b).

Staghorn coral was observed in 21 out of 301 stations between 2011 and 2013 in stratified random surveys designed to detect Acropora colonies along the south, southeast, southwest, and west coasts of Puerto Rico (García Sais et al.2013). Staghorn coral was also observed at 16 sites outside of the surveyed area. The largest colony was 60 centimeters and density ranged from one to ten colonies per fifteen square meters (García Sais et al.2013).

Status The species has undergone substantial population decline and decreases in the extent of occurrence throughout its range due mostly to disease. Although localized mortality events have continued to occur, percent benthic cover and proportion of reefs where staghorn coral is dominant have remained stable over its range since the mid-1980s. There is evidence of synergistic effects of threats for this species where the effects of increased nutrients are combined with acidification and sedimentation. Staghorn coral is highly susceptible to a number of threats, and cumulative effects of multiple threats are likely to exacerbate vulnerability to extinction. Despite the large number of islands and environments that are included in the species' range, geographic distribution in the highly disturbed Caribbean exacerbates vulnerability to extinction over the foreseeable future because staghorn coral is limited to areas with high, localized human impacts and predicted increasing threats. Staghorn coral commonly occurs in water ranging from five to twenty meters in depth, though it occurs in depths of 16-30 meters at the northern extent of its range, and has been rarely found to 60 meters in depth. It occurs in spur and groove, bank reef, patch reef, and transitional reef habitats, as well as on limestone ridges, terraces, and hard bottom habitats. This habitat heterogeneity moderates vulnerability to extinction over the foreseeable future because the species occurs in numerous types of reef and hard bottom environments that are predicted, on local and regional scales, to experience highly variable thermal regimes and ocean chemistry at any given point in time. Its absolute population abundance has been estimated as at least tens of millions of colonies in the Florida Keys and Dry Tortugas combined and is higher than the estimate from these two locations due to the occurrence of the species in many other areas throughout its range. Staghorn coral has low sexual recruitment rates, which exacerbates vulnerability to extinction due to decreased ability to recover from mortality events when all colonies at a site are extirpated. In contrast, its fast growth rates and propensity for formation of clones through asexual fragmentation enables it to expand between rare events of sexual recruitment and increases its potential for local recovery from mortality events, thus moderating vulnerability to extinction. Its abundance and life history characteristics, combined with spatial variability in ocean warming and acidification across the species' range, moderate the species' vulnerability to extinction because the threats are non-uniform. Subsequently, there will likely be a large number of colonies that are either not exposed or do not negatively respond to a threat at any given point in time. However, we also anticipate that the population abundance is likely to decrease in the future with increasing threats.

Life history Relative to other corals, staghorn coral has a high growth rate that has allowed acroporid reef growth to keep pace with past changes in sea level (Fairbanks 1989). Growth rates, measured as skeletal extension of the end of branches, range from approximately four to eleven centimeters per year (*Acropora* Biological Review Team 2005). Annual linear extension has been found to be dependent on the size of the colony. New recruits and juveniles typically grow at slower rates. Stressed colonies and fragments may also exhibit slower growth.

Staghorn coral is a hermaphroditic broadcast spawning species. The spawning season occurs several nights after the full moon in July, August, or September depending on location and timing of the full moon and may be split over the course of more than one lunar cycle (Szmant 1986; Vargas-Angel et al. 2006). The estimated size at sexual maturity is approximately seventeen centimeters branch length, and large colonies produce proportionally more gametes than small colonies (Soong and Lang 1992). Basal and branch tip tissue is not fertile (Soong and Lang 1992). Sexual recruitment rates are low, and this species is generally not observed in coral settlement studies. Laboratory studies have found that certain species of crustose-coralline algae produce exudates which facilitate larval settlement and post-settlement survival (Ritson-Williams et al. 2010).

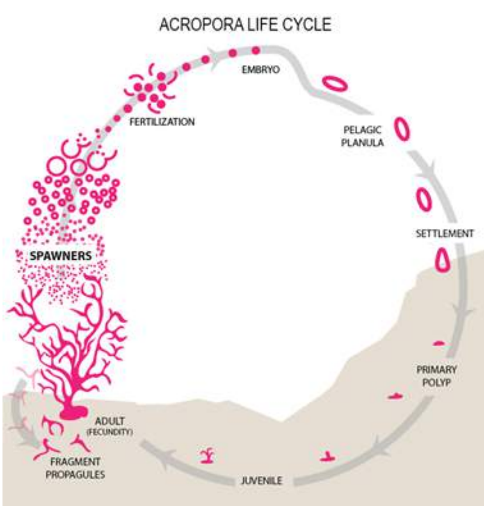

Figure 22. Staghorn sexual reproduction flowchart.

Reproduction occurs primarily through asexual fragmentation that produces multiple colonies that are genetically identical (Tunnicliffe 1981). The combination of branching morphology, asexual fragmentation, and fast growth rates, relative to other corals, can lead to persistence of large areas dominated by staghorn coral. The combination of rapid skeletal growth rates and frequent asexual reproduction by fragmentation can enable effective competition and can facilitate potential recovery from disturbances when environmental conditions permit. However, low sexual reproduction can lead to reduced genetic diversity and limits the capacity to repopulate spatially dispersed sites.

Population Dynamics

Abundance Miller et al.(2013b) extrapolated population abundance of staghorn coral in the Florida Keys and Dry Tortugas from stratified random samples across habitat types. Population estimates of staghorn coral in the Florida Keys were 10.2 ± 4.6 (standard error [SE]) million colonies in 2005, 6.9 ± 2.4 (SE) million colonies in 2007 and 10.0 ± 3.1 (SE) million colonies in 2012. Population estimates in the Dry Tortugas were 0.4 ± 0.4 (SE) million colonies in 2006 and 3.5 ± 2.9 (SE) million colonies in 2008, though the authors note their sampling scheme in the Dry Tortugas was not optimized for staghorn coral. Because these population estimates were based on random sampling, differences in abundance estimates between years is more likely to be a function of sample design rather than population trends. In both the Florida Keys and Dry Tortugas, most of the population was dominated by small colonies less than 12 in (30 cm) diameter. Further, partial mortality was reported as highest in 2005 with up to 80 % mortality observed and lowest in 2007 with a maximum of 30 %. In 2012, partial mortality ranged from 20-50 % across most size classes.

Based on population estimates, there are at least tens of millions of colonies present in the Florida Keys and Dry Tortugas combined. Absolute abundance is higher than the estimate from these two locations given the presence of this species in many other locations throughout its range. The effective population size is smaller than indicated by abundance estimates due to the tendency for asexual reproduction. There is no evidence of range constriction or extirpation at the island level. However the species is absent at the reef level. Populations appear to consist mostly of isolated colonies or small groups of colonies compared to the vast thickets once prominent throughout its range. Thickets are a prominent feature at only a few known locations. Across the Caribbean, percent cover appears to have remained relatively stable since the population crash in the 1980s. Frequency of occurrence has decreased since the 1980s. There are examples of increasing trends in some locations (Dry Tortugas and southeast Florida), but not over larger spatial scales or longer periods. Population model projections from Honduras at one of the only known remaining thickets indicate the retention of this dense stand under undisturbed conditions. If refuge populations are able to persist, it is unclear whether they would be able to repopulate nearby reefs as observed sexual recruitment is low. Thus, we conclude that the species has undergone substantial population decline and decreases in the extent of occurrence throughout its range. Percent benthic cover and proportion of reefs where staghorn coral is dominant have remained stable since the mid-1980s and since the listing of the species as threatened in 2006. We also conclude that population abundance is at least tens of millions of colonies, but likely to decrease in the future with increasing threats.

Productivity / Population Growth Rate Staghorn coral historically was one of the dominant species on most Caribbean reefs, forming large, single-species thickets and giving rise to the nominal distinct zone in classical descriptions of Caribbean reef morphology (Goreau 1959b). Massive, Caribbean-wide mortality, apparently primarily from white band disease (Aronson and Precht 2001), spread throughout the Caribbean in the mid-1970s to mid-1980s and precipitated widespread and radical changes in reef community structure (Brainard et al. 2011b). In addition, continuing coral mortality from periodic acute events such as hurricanes, disease outbreaks, and mass bleaching events has added to the decline of staghorn coral (Brainard et al. 2011b). In locations where quantitative data are available (Florida, Jamaica, U.S.Virgin Islands, Belize), there was a reduction of approximately 92 to greater than 97 % between the 1970s and early 2000s (*Acropora* Biological Review Team 2005).

Since the 2006 listing of staghorn coral as threatened, continued population declines have occurred in some locations with certain populations of both listed *Acropora* species(Staghorn and Elkhorn) decreasing up to an additional 50 % or more (Colella et al. 2012; Lundgren and Hillis-Starr 2008; Muller et al. 2008; Rogers and Muller 2012; Williams et al. 2008). There are some small pockets of remnant robust populations such as in southeast Florida (Vargas-Angel et al. 2003), Honduras (Keck et al. 2005; Riegl et al. 2009), and Dominican Republic (Lirman et al. 2010). Additionally, Lidz and Zawada (2013) observed 400 colonies of staghorn coral along 44 miles (70.2 km) of transects near Pulaski Shoal in the Dry Tortugas where the species had not been seen since the cold-water die-off of the 1970s. Cover of staghorn coral increased on a Jamaican reef from 0.6 % in 1995 to 10.5 % in 2004 (Idjadi et al. 2006).

Riegl et al.(2009) monitored staghorn coral in photo plots on the fringing reef near Roatan, Honduras from 1996 to 2005. Staghorn coral cover declined from 0.42 % in 1996 to 0.14 % in 1999 after the Caribbean bleaching event in 1998 and mortality from run-off associated with a Category 5 hurricane. Staghorn coral cover further declined to 0.09 % in 2005. Staghorn coral colony frequency decreased 71 % between 1997 and 1999. In sharp contrast, offshore bank reefs near Roatan had dense thickets of staghorn coral with 31 % cover in photo-quadrats in 2005 and appeared to survive the 1998 bleaching event and hurricane, most likely due to bathymetric separation from land and greater flushing. Modeling showed that under undisturbed conditions, retention of the dense staghorn coral stands on the banks off Roatan is likely with a possible increased shift towards dominance by other coral species. However, the authors note that because their data and the literature seem to point to extrinsic factors as driving the decline of staghorn coral, it is unclear what the future may hold for this dense population (Riegl et al. 2009).

While cover of staghorn coral increased from 0.6 % in 1995 to 10.5 % in 2004 (Idjadi et al. 2006) and 44 % in 2005 on a Jamaican reef, it collapsed after the 2005 bleaching event and subsequent disease to less than 0.5 % in 2006 (Quinn and Kojis 2008). A cold water die-off across the lower to upper Florida Keys in January 2010 resulted in the complete mortality of all staghorn coral colonies at 45 of the 74 reefs surveyed (61 %) (Schopmeyer et al. 2012). Walker et al.(2012) report increasing size of 2 thickets (expansion of up to 7.5 times the original size of 1 of the thickets) monitored off southeast Florida, but also noted that cover within monitored plots concurrently decreased by about 50 % highlighting the dynamic nature of staghorn coral distribution via fragmentation and re-attachment.

A report on the status and trends of Caribbean corals over the last century indicates that cover of staghorn coral has remained relatively stable (though much reduced) throughout the region since the large mortality events of the 1970s and 1980s. The frequency of reefs at which staghorn coral was described as the dominant coral has remained stable. The number of reefs with staghorn coral present declined during the 1980s (from approximately 50 to 30 % of reefs), remained relatively stable at 30 % through the 1990s, and decreased to approximately 20 % of the reefs in 2000-2004 and approximately 10 % in 2005-2011 (Jackson et al. 2014b).

Genetic Diversity Vollmer and Palumbi (2007) examined 22 populations of staghorn coral from 9 regions in the Caribbean (Panama, Belize, Mexico, Florida, Bahamas, Turks and Caicos, Jamaica, Puerto Rico, and Curaçao) and concluded that populations greater than approximately 500 kilometers apart are genetically different from each other with low gene flow across the greater Caribbean. Fine-scale genetic differences have been detected at reefs separated by as little as two kilometers, suggesting that gene flow in staghorn coral may not occur at much smaller spatial scales (Garcia Reyes and Schizas 2010; Vollmer and Palumbi 2007). This fine-scale population structure was greater when considering genes of elkhorn coral were found in staghorn coral due to back-crossing of the hybrid *A.prolifera* with staghorn coral (Garcia Reyes and Schizas 2010; Vollmer and Palumbi 2007). Populations in Florida and Honduras are genetically distinct from each other and other populations in the U.S.Virgin Islands, Puerto Rico, Bahamas, and Navassa (Baums et al. 2010), indicating little to no larval connectivity overall. However, some potential connectivity between the U.S.Virgin Islands and Puerto Rico was detected and also between Navassa and the Bahamas (Baums et al. 2010).

Distribution Staghorn coral is distributed throughout the Caribbean Sea, in the southwestern Gulf of Mexico, and in the western Atlantic Ocean. The fossil record indicates that during the Holocene epoch, staghorn coral was present as far north as Palm Beach County in southeast Florida (Lighty et al. 1978), which is also the northern extent of its current distribution (Goldberg 1973).Staghorn coral commonly occurs in water ranging from five to twenty meters in depth, though it occurs in depths of 16-30 m at the northern extent of its range, and has been rarely found to 60 meters in depth.

Designated Critical Habitat In 2008 critical habitat for staghorn and elkhorn corals was designated in areas in or around Southeast Florida and the Florida Keys, Puerto Rico, and the Virgin Islands. These 4 distinct areas comprise of approximately 2,959 square miles of marine habitat. The essential features chosen to select critical habitat was substrate of suitable quality and availability, in water depths from the mean high water (MHW) line to 30 meters to allow for successful sexual and asexual reproduction. Successful sexual and asexual reproduction includes flourishing larval settlement, recruitment, and reattachment of coral fragments (73 FR 72210). "Substrate of suitable quality and availability" means consolidated hard bottom or dead coral skeletons free from fleshy macroalgae or turf algae and sediment cover.

Recovery Goals The 2015 Elkhorn Coral (*Acropora palmata*) and Staghorn Coral (*A. cervicornis*) Recovery Plan contains complete downlisting/delisting criteria for each of the two following recovery goals:

1. **Ensure Population Viability**
   Specific criteria include: 1) preserving abundance; 2) maintaining genotypic diversity; and 3) properly observing and recording recruitment rates.

2. **Eliminate or sufficiently abate global, regional, and local threats**
   Specific criteria include: 1) developing quantitative recovery criterion through research to identify, treat, and reduce outbreaks of coral disease; 2) controlling the local and global impacts of rising ocean temperature and acidification; 3) reducing the loss of recruitment habitat; 4) reducing sources of nutrients, sediments, and contaminants; 5) developing and adopting appropriate and effective regulatory mechanisms to abate threats; 6) reducing impacts of natural and anthropogenic abrasion and breakage; and 7) reducing impacts of predation.

Table 38. Summary of status; Staghorn Coral

Criteria	**Description**
Abundance / productivity trends	Massive decline in abundance in some portions of its range. Populations remain stable at depressed levels.
Listing status	threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Disease (white band); Habitat destruction; Bleaching (temperature variations); Sedimentation; Algal overgrowth (nutrification).

9.49 Elkhorn Coral

Table 39. Elkhorn Coral; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Acropora palmata	Elkhorn	N/A	Threatened	2014	2006 71 FR 26852	2015 80 FR 12146	2008 73 FR 72210

Figure 23. Elkhorn Coral distribution. Off-white = no record, dark green = confirmed record, pale green = predicted record, tan = published record that needs further investigation(Veron 2014).

Species Description The elkhorn coral is a cnidarian belonging to the taxonomic order of scleractinia, a group of stony corals that secrete calcium carbonate to form hard exoskeletons. Elkhorn coral occurs throughout coastal areas in the Caribbean, Gulf of Mexico, and southwestern Atlantic. The Elkhorn coral *Acropora palmata* is a cnidarian belonging to the taxonomic order of scleractinia, a group of stony corals that secrete calcium carbonate to form hard exoskeletons. Elkhorn corals, as with all corals are composed of single polyp body forms, often present in numbers of hundreds to thousands creating dense clusters along the shallow ocean floor called colonies. Polyps are capable of catching and eating their own food, and have their own digestive, nervous, respiratory, and reproductive systems. In addition to being able to catch and eat their own food, Elkhorn coral, along with most coral species contain zooxanthellae, a unicellular, symbiotic dinoflagellate, living within the endodermic tissues of individual polyps to provide photosynthetic support to the coral's energy budget and calcium carbonate secretion (NMFS 2005).

Acropora palmata was listed as threatened under the ESA in 2006. In 2012, a proposal to change the listing to endangered was made, but in 2014 its threatened status was upheld. In 2008, critical habitat for Elkhorn coral was designated in areas surrounding the Florida Keys, Puerto Rico, and portions of the Virgin Islands. Along with staghorn coral, elkhorn coral is the only other large, branching species of coral to produce and occupy vast complex environments within the Caribbean Sea's reef system. In all, there appears to be two distinct populations of elkhorn coral, a western Caribbean population and an eastern (Baums et al. 2005).

Status The decline in the total abundance of elkhorn coral has been attributed to a series of stressors consisting of disease, temperature-induced bleaching, excessive sedimentation, nitrification, pollution(i.e. oxybenzone from sunscreen) ,and large hurricanes/tropical storms (Brainard et al. 2011b; Downs et al. 2016; Hernandez-Delgado et al. 2011; Mayor et al. 2006; Rogers and Muller 2012). It is believed that these effects act synergistically with one another thereby increasing the overall damage to already-stressed *A. palmata* colonies that have undergone disturbance by another threat. The current population trend appears to be steady, although there are places where populations continue to decrease and others where there appears to be modest or contained recovery (Miller et al. 2013a). However, even if growth and recruitment end up surpassing mortality, this species requires prompt analysis and monitoring on a regional scale. Reasoning for this includes the current presence of areas with low genetic diversity and density within western Caribbean populations along with localized high rates of disease and bleaching (Miller et al. 2013a).

Life history Elkhorn coral, like most stony corals, employ both sexual and asexual reproductive strategies to propagate. Sexual reproduction in corals includes gametogenesis, the process in which cells undergo meiosis to form gametes within the polyps near the base of the mesenteries. Since Acropora palmata is hermaphroditic, each polyp contains both sperm and egg cells that are released together in a 'bundle', causing the coral gametes to develop externally from the parental colony. Elkhorn coral reproduces sexually after the full moon of July, August, and/or September, depending on location and timing of the full moon (Acropora Biological Review Team 2005). Split spawning (spawning over a 2 month period) has been reported from the Florida Keys (Fogarty et al. 2012). The estimated size at sexual maturity is approximately 250 in2 (1,600 cm2), and growing edges and encrusting base areas are not fertile (Soong and Lang 1992). Larger colonies have higher fecundity per unit area, as do the upper branch surfaces (Soong and Lang 1992). Although self-fertilization is possible, elkhorn coral is largely self-incompatible (Baums et al. 2005a; Fogarty et al. 2012). Sexual recruitment rates are low, and this species is generally not observed in coral settlement studies in the field. Rates of post-settlement mortality after nine months are high based on settlement experiments (Szmant and Miller 2005).

Reproduction occurs primarily through asexual reproduction, generating multiple colonies that are genetically identical. Elkhorn coral can quickly monopolize large spaces of shallow ocean floor through fragment dissemination. A branch of A. palmata can be carried by waves and currents away from the mother colony to distances that range from 0.1 – 100 meters, but fragments usually travel less than 30 meters (NMFS 2005).

Because large colonies of A. palmata contain several thousand partially autonomous polyps, growth rates for the species are conveyed through the measurement of linear extensions of the organisms' skeletal branches. Depending on the size and location of the colony, physical growth rates for elkhorn corals range from approximately four to eleven centimeters per year. Branches are up to approximately 50 centimeters wide and range in thickness of about four to five centimeters. Individual colonies can grow to at least two meters in height and four meters in diameter(NMFS 2005). Total lifespan for the species is unknown(NMFS 2014).

Population Dynamics

Abundance / Productivity Colonial species present a special challenge in determining the appropriate unit to evaluate for abundance. However, the present population of Elkhorn coral is continuing at a very low abundance due to large declines in the past several decades (NMFS 2005). The western Caribbean is characterized by genetically depauperate populations with lower densities (0.13 ± 0.08 colonies per m^2). The eastern Caribbean populations are characterized by denser (0.30 ± 0.21 colonies per m^2), genotypically richer stands(Baums et al. 2006a).

Based on population estimates from both the Florida Keys and St. Croix, U.S. Virgin Islands, there are at least hundreds of thousands of elkhorn coral colonies. Absolute abundance is higher than estimates from these two locations given the presence of this species in many other locations throughout its range. The effective population size is smaller than indicated by abundance estimates due to the tendency for asexual reproduction. Across the Caribbean, percent cover appears to have remained relatively stable, albeit it at extremely low levels, since the population crash in the 1980s. Frequency of occurrence has decreased since the 1980s, indicating potential decreases in the extent of occurrence and effects on the species' range. However, the proportions of Caribbean sites where elkhorn coral is present and dominant have recently stabilized since the mid-2000s. There are locations such as the U.S. Virgin Islands where populations of elkhorn coral appear stable or possibly increasing in abundance and some such as the Florida Keys where population number appears to be decreasing.

Genetic Diversity Genetic samples from 11 locations throughout the Caribbean indicate that elkhorn coral populations in the eastern Caribbean (St. Vincent and the Grenadines, U.S. Virgin Islands, Curaçao, and Bonaire) have had little or no genetic exchange with populations in the western Atlantic and western Caribbean (Bahamas, Florida, Mexico, Panama, Navassa, and Puerto Rico) (Baums et al. 2005). While Puerto Rico is more closely connected with the western Caribbean, it is an area of mixing with contributions from both regions (Baums et al. 2005). Models suggest that the Mona Passage between the Dominican Republic and Puerto Rico promotes dispersion of larval and gene flow between the eastern Caribbean and western Caribbean (Baums et al. 2006b).

Distribution Elkhorn coral occurs in turbulent water on the back reef, fore reef, reef crest, and spur and groove zone in water ranging from one to thirty meters in depth. Historically, *A. palmata* inhabited most waters of the Caribbean between one to five meters depth. This included a diverse set of areas comprising of zones along Puerto Rico, Hispaniola, the Yucatan peninsula, the Bahamas, the southwestern Gulf of Mexico, the Florida Keys, the Southeastern Caribbean islands, and the northern coast of South America (Dustan and Halas 1987; Goreau 1959a; Jaap 1984a; Kornicker and Boyd 1962; Scatterday 1974; Storr 1964). While the present-day spatial distribution of elkhorn coral is similar to its historic spatial distribution, its presence within its range has become increasingly sparse due to declines in the latter half of the 20th century from a variety of abiotic and biotic threats.

Designated Critical Habitat Critical habitat units for elkhorn and staghorn coral were designated in 2008 and include Florida (portions of Southeastern Florida and the Florida Keys), Puerto Rico, St. Thomas/St. John, and St. Croix. The Florida unit comprises approximately 1,329 square miles of marine habitat; Puerto Rico approximately 1,383 square miles; St. Thomas/St. John approximately 121 square miles; and St. Croix approximately 126 square miles. Thus, the total area covered by the designation is approximately 2,959 square miles. Within the geographic area occupied by a listed species, critical habitat consists of specific areas on which are found those physical or biological features essential to the conservation of the species. The feature essential to the conservation of acroporid corals is substrate of suitable quality and availability in water depths from the mean high water line to 30 meters to allow for successful sexual and asexual reproduction. Successful sexual and asexual reproduction includes flourishing larval settlement, recruitment, and reattachment of coral fragments (73 FR 72210). "Substrate of suitable quality and availability" means consolidated hard bottom or dead coral skeletons free from fleshy macroalgae or turf algae and sediment cover.

Recovery Goals The 2015 Elkhorn Coral (*Acropora palmata*) and Staghorn Coral (*A. cervicornis*) Recovery Plan contains complete downlisting/delisting criteria for each of the two following recovery goals.

1. **Ensure Population Viability**
   Specific criteria include: 1) preserving abundance; 2) maintaining genotypic diversity; and 3) properly observing and recording recruitment rates.

2. **Eliminate or sufficiently abate global, regional, and local threats**
   Specific criteria include: 1) developing quantitative recovery criterion through research to identify, treat, and reduce outbreaks of coral disease; 2) controlling the local and global impacts of rising ocean temperature and acidification; 3) reducing the loss of recruitment habitat; 4) reducing sources of nutrients, sediments, and contaminants; 5) developing and adopting appropriate and effective regulatory mechanisms to abate threats; 6) reducing impacts of natural and anthropogenic abrasion and breakage; and 7) reducing impacts of predation.

Table 40. Summary of status; Elkhorn Coral

Criteria	Description
Abundance / productivity trends	Low abundance, large declines over past decades. Genetically depauparate populations in Caribbean. However, in eastern Caribbean, population is doing better and is genetically richer.
Listing status	threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Disease (white band); Habitat destruction; Bleaching (temperature variations); Sedimentation; Algal overgrowth (nutrification).

9.50 Boulder Star Coral

Table 41. Boulder Star Coral; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Orbicella franksi	Boulder Star	N/A	Threatened	2014	2014 79 FR 53851	N/A	N/A

Figure 24. Boulder Star coral distribution. Off-white = no record, dark green = confirmed record, pale green = predicted record, tan = published record that needs further investigation(Veron 2014).

Species Description The boulder star coral is a cnidarian belonging to the taxonomic genus of Orbicella, a group of stony corals that secrete calcium carbonate to form hard exoskeletons. Boulder Star coral occurs in the western Atlantic and throughout the Caribbean, including the Bahamas, Flower Garden Banks, and the entire Caribbean coastline. On September 10, 2014, NMFS listed boulder star coral as threatened (79 FR 53851). Lobed star coral (*Orbicella annularis*), mountainous star coral (*Orbicella faveolata*), and boulder star coral (*Orbicella franksi*) are the three species in the *Orbicella* spp. complex. These three species were formerly in the genus *Montastraea*; however, recent work has reclassified the three species in the *annularis* complex to the genus *Orbicella* (Budd et al. 2012). The star coral species complex was historically one of the primary reef framework builders throughout the wider Caribbean. The complex was considered a single species –*Montastraea annularis*– with varying growth forms ranging from columns, to massive

Figure 25. Image of boulder star coral (Orbicella franksi) colony.

boulders, to plates. In the early 1990s, Weil and Knowlton (1994) suggested the partitioning of these growth forms into separate species, resurrecting the previously described taxa, *Montastraea* (now *Orbicella*) *faveolata*, and *Montastraea* (now *Orbicella*) *franksi.* The three species were differentiated on the basis of morphology, depth range, ecology, and behavior (Weil and Knowton 1994). Subsequent reproductive and genetic studies have supported the partitioning of the *annularis* complex into three species.

Boulder star corals, as with all corals are composed of single polyp body forms, often present in numbers of hundreds to thousands creating dense clusters along the shallow ocean floor called colonies. Polyps are capable of catching and eating their own food, and have their own digestive, nervous, respiratory, and reproductive systems. In addition to being able to catch and eat their own food, Boulder star coral, along with most coral species contain zooxanthellae, a unicellular, symbiotic dinoflagellate, living within the endodermic tissues of individual polyps to provide photosynthetic support to the coral's energy budget and calcium carbonate secretion (NMFS 2005).

Some studies report on the star coral species complex rather than individual species because visual distinction can be difficult where colony structure cannot be discerned (e.g., small colonies or photographic methods). Information from these studies is reported for the species complex. Where species-specific information is available, it is reported. Information about boulder star coral published prior to 1994 will be attributed to the species complex, since it is dated prior to the split of *Orbicella annularis* into three separate species.

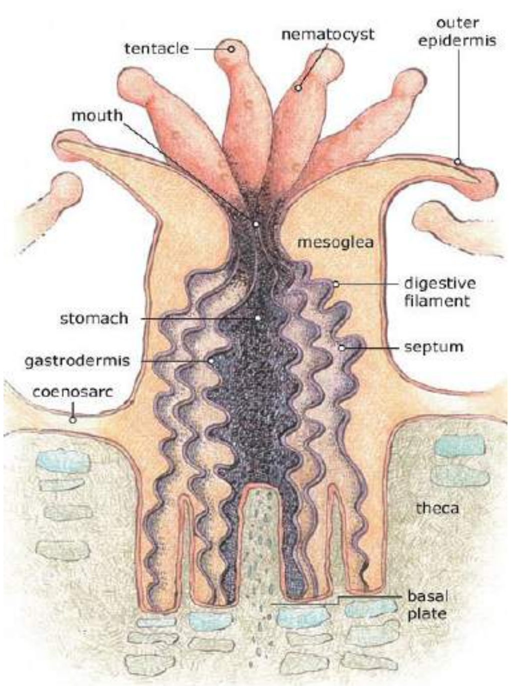

Figure 26. Anatomy of a single coral polyp.

Boulder star coral is distinguished by large, unevenly arrayed polyps that give the colony its characteristic irregular surface. Colony form is variable, and the skeleton is dense with poorly developed annual bands. Colony diameter can reach up to five meters with a height of up to two meters.

Status Boulder star coral has undergone declines most likely from disease and warming-induced bleaching. There is evidence of synergistic effects of threats for this species including increased disease severity with nutrient enrichment. Boulder star coral is highly susceptible to a number of threats, and cumulative effects of multiple threats have likely contributed to its decline and exacerbate vulnerability to extinction. Despite declines, the species is still common and remains one of the most abundant species on Caribbean reefs. Its life history characteristics of large colony size and long life span have enabled it to remain relatively persistent despite slow growth and low recruitment rates, thus moderating vulnerability to extinction. However, the buffering capacity of these life history characteristics is expected to decrease as colonies shift to smaller size classes as has been observed in locations in its range. Its absolute population abundance has been estimated as at least tens of millions of colonies in both a portion of the U. S. Virgin Islands and the Dry Tortugas and is higher than the estimate from these two locations due to the occurrence of the species in many other areas throughout its range. Despite the large number of islands and environments that are included in the species' range, geographic distribution in the highly disturbed Caribbean exacerbates vulnerability to extinction over the foreseeable future because boulder star coral is limited to a areas with high localized human impacts and predicted increasing threats. Its depth range of approximately five to fifty meters, possibly up to 90 meters, moderates vulnerability to extinction over the foreseeable future because deeper areas of its range will usually have lower temperatures than surface waters, and acidification is generally predicted to accelerate most in waters that are deeper and cooler than those in which the species occurs. Boulder star coral occurs in most reef habitats, including both shallow and mesophotic reefs, which moderates vulnerability to extinction over the foreseeable future because the species occurs in numerous types of reef environments that are predicted, on local and regional scales, to experience highly variable temperatures and ocean chemistry at any given point in time. Its abundance, life history characteristics, and depth distribution, combined with spatial variability in ocean warming and acidification across the species' range, moderate vulnerability to extinction because the threats are non-uniform. Subsequently, there will likely be a large number of colonies that are either not exposed or do not negatively respond to a threat at any given point in time. However, we anticipate that the population abundance is likely to decrease in the future with increasing threats.

Life history All three species of the star coral complex are hermaphroditic broadcast spawners[3], with spawning concentrated on six to eight nights following the full moon in late August, September, or early October, depending on timing of the full moon and location. Boulder star coral spawning is reported to be about one to two hours earlier than lobed star coral and mountainous star coral. All three species are largely self-incompatible (Knowlton et al. 1997; Szmant et al. 1997). Fertilization success measured in the field was generally below 15 % for all three species, as it was closely linked to the number of colonies concurrently spawning. In Puerto Rico, minimum size at reproduction for the star coral species complex was 83 square centimeters.

Successful recruitment by the star coral species complex appears to always have been rare. Only a single recruit of *Orbicella* was observed over 18 years of intensive observation of approximately 12 square meters of reef in Discovery Bay, Jamaica. Many other studies throughout the Caribbean also report negligible to absent recruitment of the species complex. Of 351 colonies of boulder star coral tagged in Bocas del Toro, Panama, larger colonies were noted to spawn more frequently than smaller colonies between 2002 and 2009 (Levitan et al. 2011).

Population Dynamics

Abundance Boulder star coral is reported as common. In a 1995 survey of 16 reefs in the Florida Keys, boulder star coral had the highest percent cover of all species (Murdoch and Aronson 1999). In surveys throughout the Florida Keys, boulder star coral in 2005 ranked 26th most abundant out of 47 coral species, 32nd out of 43 in 2009, and 33rd out of 40 in 2012. Extrapolated population estimates from stratified random surveys were 8.0 ± 3.5 million (standard error [SE]) colonies in 2005, 0.3 ± 0.2 million (SE) colonies in 2009, and 0.4 ± 0.4 million (SE) colonies in 2012. The authors note that differences in extrapolated abundance between years were more likely a function of sampling design rather than an indication of population trends. In 2005, the

[3] Simultaneously containing both sperm and eggs, which are released into the water column for fertilization.

greatest proportions of colonies were in the smaller size classes of approximately 10-20 centimeters and approximately 20-30 centimeter. Partial colony mortality ranged from zero % to approximately 73 % and was generally higher in larger colonies (Miller et al. 2013a).

In the Dry Tortugas, Florida, boulder star coral ranked fourth highest in abundance out of 43 coral species in 2006 and 8th out of 40 in 2008. Extrapolated population estimates were 79 ± 19 million (SE) colonies in 2006 and 18.2 ± 4.1 million (SE) colonies in 2008. Miller et al. (2013a) notes the difference in estimates between years was more likely a function of sampling design rather than population decline. In the first year of the study (2006), the greatest proportion of colonies were in the size class approximately 20-30 centimeters with twice as many colonies as the next most numerous size class and a fair number of colonies in the largest size class of greater than 90 centimeters. Partial colony mortality ranged from approximately 10-55 %. Two years later (2008), no size class was found to dominate, and proportion of colonies in the medium-to-large size classes (approximately 60-90 centimeters) appeared to be less than in 2006. The number of colonies in the largest size class of greater than 90 centimeters remained consistent. Partial colony mortality ranged from approximately 15-75 % (Miller et al. 2013a).

Abundance in Curaçao and Puerto Rico appears to be stable over an eight to ten year period. In Curaçao, abundance was stable between 1997 and 2005, with partial mortality similar or less in 2005 compared to 1998 (Bruckner and Bruckner 2006). Abundance was also stable between 1998-2008 at nine sites off Mona and Desecheo Islands, Puerto Rico. In 1998, four % of all corals at six sites surveyed off Mona Island were boulder star coral colonies and approximately five % in 2008; at Desecheo Island, about two % of all coral colonies were boulder star coral in both 2000 and 2008 (Bruckner and Hill 2009).

Based on population estimates, there are at least tens of millions of colonies present in both the Dry Tortugas and U. S. Virgin Islands. Absolute abundance is higher than the estimate from these two locations given the presence of this species in many other locations throughout its range. The frequency and extent of partial mortality, especially in larger colonies of boulder star coral, appear to be high in some locations such as Florida and Cuba, though other locations like the Flower Garden Banks appear to have lower amounts of partial mortality. A decrease in boulder star coral percent cover by 38 % and a shift to smaller colony size across five countries suggest that population decline has occurred in some areas; colony abundance appears to be stable in other areas. We anticipate that while population decline has occurred, boulder star coral is still common with the number of colonies at least in the tens of millions. Additionally, we conclude that the buffering capacity of boulder star coral's life history strategy that has allowed it to remain abundant has been reduced by the recent population declines and amounts of partial mortality, particularly in large colonies. We also anticipate that the population abundance is likely to decrease in the future with increasing threats.

Productivity / Population Growth Rate The star coral species complex has growth rates ranging from 0.06-1.2 centimeters per year and averaging approximately one-centimeter linear growth per year. Boulder star coral is reported to be the slowest of the three species in the complex (Brainard et al. 2011a). They grow slower in deep or murky waters.

In addition to low recruitment rates, lobed star corals have late reproductive maturity. Colonies can grow very large and live for centuries. Large colonies have lower total mortality than small colonies, and partial mortality of large colonies can result in the production of clones. The historical absence of small colonies and few observed recruits, even though large numbers of gametes are produced on an annual basis, suggests that recruitment events are rare and were less important for the survival of the lobed star coral species complex in the past (Bruckner 2012). Large colonies in the species complex maintain the population until conditions favorable for recruitment occur; however, poor conditions can influence the frequency of recruitment events. While the life history strategy of the star coral species complex has allowed the taxa to remain abundant, the buffering capacity of this life history strategy has likely been reduced by recent population declines and partial mortality, particularly in large colonies.

Genetic Diversity Of 351 boulder star coral colonies observed to spawn at a site off Bocas del Toro, Panama, 324 were unique genotypes. Over 90 % of boulder star coral colonies on this reef were the product of sexual reproduction, and 19 genetic individuals had asexually propagated colonies made up of two to four spatially adjacent clones of each. Individuals within a genotype spawned more synchronously than individuals of different genotypes. Additionally, within five meters, colonies nearby spawned more synchronously than farther spaced colonies, regardless of genotype. At distances greater than five meters, spawning was random between colonies (Levitan et al. 2011).

Distribution Boulder star coral is found in the western Atlantic Ocean and throughout the Caribbean Sea including in the Bahamas, Bermuda, and the Flower Garden Banks. Boulder star coral tends to have a deeper distribution than the other two species in the *Orbicella* species complex. It occupies most reef environments and has been reported from water depths ranging from approximately five to fifty meters, with the species complex reported to 90 meters. *Orbicella* species are a common, often dominant, component of Caribbean mesophotic reefs (e. g. , > 30 meters), suggesting the potential for deep refugia for boulder star coral.

Designated Critical Habitat No critical habitat has been designated for the Boulder Star Coral.

Recovery Goals No final recovery plan currently exists for boulder star coral; however, a recovery outline was developed in 2014 to serve as interim guidance to direct recovery efforts, including recovery planning, until a final recovery plan is developed and approved. The following contains the recovery goals listed in the document:

Short Term Goals:

- Increase understanding of population dynamics, population distribution, abundance, trends, and structure through research, monitoring, and modeling
- Through research, increase understanding of genetic and environmental factors that lead to variability of bleaching and disease susceptibility
- Decrease locally-manageable stress and mortality sources (e. g. , acute sedimentation, nutrients, contaminants, over-fishing).
- Prioritize implementation of actions in the recovery plan for elkhorn and staghorn corals that will benefit D. cylindrus, M. ferox, and Orbicella spp.
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Long Term Goals:

- Cultivate and implement U. S. and international measures to reduce atmospheric carbon dioxide concentrations to curb warming and acidification impacts and possibly disease threats.

- Implement ecosystem-level actions to improve habitat quality and restore keystone species and functional processes to maintain adult colonies and promote successful natural recruitment.

Table 42. Summary of status; Boulder Star Coral

Criteria	Description
Abundance / productivity trends	While there has been some declines, the population is in relatively good shape and is stable
Listing status	threatened
Attainment of recovery goals	Recovery plan not yet developed

9.51 Lobed Star Coral

Table 43. Lobed Star Coral; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Orbicella annularis	Lobed Star	N/A	Threatened	2014	2014 79 FR 53852	N/A	N/A

Figure 27. Lobed Star Coral distribution. Off-white = no record, dark green = confirmed record, pale green = predicted record, tan = published record that needs further investigation(Veron 2014).

Species Description The lobed star coral is a cnidarian belonging to the taxonomic genus of Orbicella, a group of stony corals that secrete calcium carbonate to form hard exoskeletons. Lobed Star coral occurs in the western Atlantic and greater Caribbean as well as the Flower Garden Banksbut may be absent from Bermuda. On September 10, 2014, NMFS listed lobed star coral as threatened (79 FR 53851). Lobed star coral (*Orbicella annularis*), mountainous star coral (*Orbicella faveolata*), and boulder star coral (*Orbicella franksi*) are the three species in the *Orbicella* spp. complex. These three species were formerly in the genus *Montastraea*; however, recent work has reclassified the three species in the *annularis* complex to the genus *Orbicella* (Budd et al. 2012). The star coral species complex was historically one of the primary reef framework builders throughout the wider Caribbean. The complex was considered a single species –*Montastraea annularis*– with varying growth forms ranging from columns, to massive boulders, to plates. In the early 1990s, Weil and Knowlton (1994) suggested the partitioning of these growth forms into separate species, resurrecting the previously described taxa, *Montastraea* (now *Orbicella*) *faveolata*, and *Montastraea* (now *Orbicella*) *franksi.* The three species were differentiated on the basis of morphology, depth range, ecology, and behavior (Weil and Knowton 1994). Subsequent reproductive and genetic studies have supported the partitioning of the *annularis* complex into three species.

Lobed star corals, as with all corals are composed of single polyp body forms, often present in numbers of hundreds to thousands creating dense clusters along the shallow ocean floor called colonies.Polyps are capable of catching and eating their own food, and have their own digestive, nervous, respiratory, and reproductive systems.In addition to being able to catch and eat their own food, Lobed star coral, along with most coral species contain zooxanthellae, a unicellular, symbiotic dinoflagellate, living within the endodermic tissues of individual polyps to provide photosynthetic support to the coral's energy budget and calcium carbonate secretion (NMFS 2005). Lobed star coral colonies grow in columns that exhibit rapid and regular upward growth. In contrast to the other two star coral species, margins on the sides of columns are typically dead. Live colony surfaces usually lack ridges or bumps.

Lobed star coral is reported from most reef environments within the Caribbean (except for Bermuda) in depths of approximately 0.5-20 meters. The star coral species complex is a common, often dominant component of Caribbean mesophotic (e.g., >30 meters) reefs, suggesting the potential for deep refuge across a broader depth range, but lobed star coral is generally described with a shallower distribution.

Status Lobed star coral has undergone major declines mostly due to warming-induced bleaching and disease. Several population projections indicate population decline in the future is likely at specific sites and that local extirpation is possible within 25-50 years at conditions of high mortality, low recruitment, and slow growth rates. There is evidence of synergistic effects of threats for this species including disease outbreaks following bleaching events and increased disease severity with nutrient enrichment. Lobed star coral is highly susceptible to a number of threats, and cumulative effects of multiple threats have likely contributed to its decline and exacerbate vulnerability to extinction. Despite high declines, the species is still common and remains one of the most abundant species on Caribbean reefs. Its life history characteristics of large colony size and long life span have enabled it to remain relatively persistent despite slow growth and low recruitment rates, thus moderating vulnerability to extinction. However, the buffering capacity of these life history characteristics is expected to decrease as colonies shift to smaller size classes, as has been observed in locations in the species' range. Its absolute population abundance has been estimated as at least tens of millions of colonies in the Florida Keys and Dry Tortugas combined and is higher than the estimate from these two locations due to the occurrence of the species in many other areas throughout its range. Despite the large number of islands and environments that are included in the species' range, geographic distribution in the highly disturbed Caribbean exacerbates vulnerability to extinction over the foreseeable future because lobed star coral is limited to an area with high localized human impacts and predicted increasing threats. Star coral occurs in most reef habitats 0.5-20 meters in depth which moderates vulnerability to extinction over the foreseeable future because the species occurs in numerous types of reef environments that are predicted, on local and regional scales, to experience high temperature variation and ocean chemistry at any given point in time. Its abundance and life history characteristics, combined with spatial variability in ocean warming and acidification across the species' range, moderate vulnerability to extinction because the threats are non-uniform. Subsequently, there will likely be a large number of colonies that are either not exposed or do not negatively respond to a threat at any given point in time. We also anticipate that the population abundance is likely to decrease in the future with increasing threats.

Life history The star coral species complex has growth rates ranging from 0.06-1.2 centimeters per year and averaging approximately one centimeter in linear growth per year. The reported growth rate of lobed star coral is 0.4 to 1.2 centimeters per year (Cruz-Piñón et al. 2003; Tomascik 1990). They grow slower in deep and murky waters.

All three species of the star coral complex are hermaphroditic broadcast spawners[4], with spawning concentrated on six to eight nights following the full moon in late August, September, or early October depending on location and timing of the full moon. All three species are largely self-incompatible (Knowlton et al. 1997; Szmant et al. 1997). Further, mountainous star coral is largely reproductively incompatible with boulder star coral and lobed star coral, and it spawns about one to two hours earlier. Fertilization success measured in the field was generally below 15 % for all three species, as it is closely linked to the number of colonies concurrently spawning. Lobed star coral is reported to have slightly smaller egg size and potentially smaller size/age at first reproduction that the other two species of the *Orbicella* genus. In Puerto Rico, minimum size at reproduction for the star coral species complex was 83 square centimeters.

Successful recruitment by the star coral complex species has seemingly always been rare. Only a single recruit of *Orbicella* was observed over 18 years of intensive observation of twelve square meters of reef in Discovery Bay, Jamaica. Many other studies throughout the Caribbean also report negligible to absent recruitment of the species complex.

In addition to low recruitment rates, lobed star corals have late reproductive maturity. Colonies can grow very large and live for centuries. Large colonies have lower total mortality than small colonies, and partial mortality of large colonies can result in the production of clones. The historical absence of small colonies and few observed recruits, even though large numbers of gametes are produced on an annual basis, suggests that recruitment events are rare and were less important for the survival of the lobed star coral species complex in the past (Bruckner 2012). Large colonies in the species complex maintain the population until conditions favorable for recruitment occur; however, poor conditions can influence the frequency of recruitment events. While the life history strategy of the star coral species complex has allowed the taxa to remain abundant, the buffering capacity of this life history strategy has likely been reduced by recent population declines and partial mortality, particularly in large colonies

Population Dynamics

Abundance Lobed star corals are the third most abundant coral species by percent cover in permanent monitoring stations in the U.S.Virgin Islands. A decline of 60 % was observed between 2001 and 2012 primarily due to bleaching in 2005. However, most of the mortality was partial mortality and colony density in monitoring stations did not change (Smith 2013).

Lobed star coral was historically considered to be one of the most abundant species in the Caribbean (Weil and Knowton 1994). Percent cover has declined to between 37 % and 90 % over the past several decades at reefs at Jamaica, Belize, Florida Keys, The Bahamas, Bonaire, Cayman Islands, Curaçao, Puerto Rico, U.S.Virgin Islands, and St.Kitts and Nevis. Based on population estimates, there are at least tens of millions of lobed star coral colonies present in the Florida Keys and Dry Tortugas combined. Absolute abundance is higher than the estimate from these two locations given the presence of this species in many other locations throughout its range. Lobed star coral remains common in occurrence. Abundance has decreased in some areas to between 19 % and 57 %, and shifts to smaller size classes have occurred in locations such as

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[4] Simultaneously containing both sperm and eggs, which are released into the water column for fertilization.

Jamaica, Colombia, The Bahamas, Bonaire, Cayman Islands, Puerto Rico, U.S. Virgin Islands, and St. Kitts and Nevis. At some reefs, a large proportion of the population is comprised of non-fertile or less-reproductive size classes. Several population projections indicate population decline in the future is likely at specific sites, and local extirpation is possible within 25-50 years at conditions of high mortality, low recruitment, and slow growth rates. We conclude that while substantial population decline has occurred in lobed star coral, it is still common throughout the Caribbean and remains one of the dominant species numbering at least in the tens of millions of colonies. We conclude that the buffering capacity of lobed star coral's life history strategy that has allowed it to remain abundant has been reduced by the recent population declines and amounts of partial mortality, particularly in large colonies. We also conclude that the population abundance is likely to decrease in the future with increasing threats.

In the Florida Keys, abundance of lobed star coral ranked 30 out of 47 coral species in 2005, 13 out of 43 in 2009, and 12 out of 40 in 2012. Extrapolated population estimates from stratified random samples were 5.6 million ± 2.7 million (standard error [SE]) in 2005, 11.5 million ± 4.5 million (SE) in 2009, and 24.3 million ± 12.4 million (SE) in 2012. Size class distribution was somewhat variable between survey years, with a larger proportion of colonies in the smaller size classes in 2005 compared to 2009 and 2012 and a greater proportion of colonies in the greater than 90 centimeters size class in 2012 compared to 2005 and 2009. Partial colony mortality was lowest at less than ten centimeters (as low as approximately five %) and up to approximately 70 % in the larger size classes. In the Dry Tortugas, Florida, abundance of lobed star coral ranked 41 out of 43 in 2006 and 31 out of 40 in 2008. The extrapolated population estimate was 0.5 million ± 0.3 million (SE) colonies in 2008. Differences in population estimates between years may be attributed to sampling effort rather than population trends (Miller et al. 2013a).

Lobed star coral has been described as common overall. Demographic data collected in Puerto Rico over nine years before and after the 2005 bleaching event showed that population growth rates were stable in the pre-bleaching period (2001–2005) but declined one year after the bleaching event. Population growth rates declined even further two years after the bleaching event, but they returned and then stabilized at the lower rate the following year.

Productivity / Population Growth Rate Population trends are available from a number of studies. In a study of sites inside and outside a marine protected area in Belize, lobed star coral cover declined significantly over a ten year period (1998/99 to 2008/09) (Huntington et al. 2011). In a study of ten sites inside and outside of a marine reserve in the Exuma Cays, Bahamas, cover of lobed star coral increased between 2004 and 2007 inside the protected area and decreased outside the protected area (Mumby and Harborne 2010). Between 1996 and 2006, lobed star coral declined in cover by 37 % in permanent monitoring stations in the Florida Keys (Waddell and Clarke 2008a). Cover of lobed star coral declined 71 % in permanent monitoring stations between 1996 and 1998 on a reef in the upper Florida Keys (Porter et al. 2001).

Cover of lobed star coral at Yawzi Point, St.John, U.S.Virgin Islands declined from 41 % in 1988 to approximately 12 % by 2003 as a rapid decline began with the aftermath of Hurricane Hugo in 1989 (Edmunds and Elahi 2007). This decline continued between 1994 and 1999 during a time of two hurricanes (1995) and a year of unusually high sea temperature (1998) but percent cover remained statistically unchanged between 1999 and 2003. Colony abundances declined from 47 to 20 colonies per approximately one square meter between 1988 and 2003, due mostly to the death and fission of medium-to-large colonies (≥ 151 square centimeters). Meanwhile, the population size class structure shifted between 1988 and 2003 to a higher proportion of smaller colonies in 2003 (60 % less than 50 square centimeters in 1988 versus 70 % in 2003) and lower proportion of large colonies (six % greater than 250 square centimeters in 1988 versus three % in 2003. The changes in population size structure indicated a population decline coincident with the period of apparent stable coral cover. Population modeling forecasted the 1988 size structure would not be reestablished by recruitment and a strong likelihood of extirpation of lobed star coral at this site within 50 years (Edmunds and Elahi 2007).

Genetic Diversity Asexual fission and partial mortality can lead to multiple clones of the same colony. The percentage of unique individuals is variable by location and is reported to range between 18 % and 86 % (thus, 14-82 % are clones). Colonies in areas with higher disturbance from hurricanes tend to have more clonality. Genetic data indicate that there is some population structure in the eastern, central, and western Caribbean with population connectivity within but not across areas. Although lobed star coral is still abundant, it may exhibit high clonality in some locations, meaning that there may be low genetic diversity.

Distribution Colony density varies by habitat and location, and ranges from less than 0.1 to greater than one colony per approximately ten square meters. In surveys of 1,176 sites in southeast Florida, the Dry Tortugas, and the Florida Keys between 2005 and 2010, density of lobed star coral ranged between 0.09 and 0.84 colonies per approximately ten square meters and was highest on mid-channel reefs followed by inshore reefs, offshore patch reefs, and fore-reefs (Burman et al. 2012). Along the east coast of Florida, density was highest in areas south of Miami (0.34 colonies per approximately ten square meters) compared to Palm Beach and Broward Counties (ten square meters; Burman et al. 2012). In surveys between 2005 and 2007 along the Florida reef tract from Martin County to the lower Florida Keys, density of lobed star coral was approximately 1.3 colonies per approximately ten square meters (Wagner et al. 2010). Off southwest Cuba on remote reefs, lobed star coral density was 0.31 ± 0.46 (SD) per approximately ten meters transect on 38 reef-crest sites and 1.58 ± 1.29 colonies per approximately ten meters transect on 30 reef-front sites. Colonies with partial mortality were far more frequent than those with no partial mortality which only occurred in the size class less than 100 centimeters) (Alcolado et al. 2010).

Designated Critical Habitat No critical habitat has been designated for lobed star coral.

Recovery Goals No final recovery plan currently exists for lobed star coral; however a recovery outline was published in 2014. The following contains the recovery goals listed in the document:

Short Term Goals:

- Increase understanding of population dynamics, population distribution, abundance, trends, and structure through research, monitoring, and modeling
- Through research, increase understanding of genetic and environmental factors that lead to variability of bleaching and disease susceptibility
- Decrease locally manageable stress and mortality sources (e.g., acute sedimentation, nutrients, contaminants, over-fishing).
- Prioritize implementation of actions in the recovery plan for elkhorn and staghorn corals that will benefit *D. cylindrus*, *M. ferox*, and *Orbicella* spp.
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Long Term Goals:

- Cultivate and implement U.S.and international measures to reduce atmospheric carbon dioxide concentrations to curb warming and acidification impacts and possibly disease threats.
- Implement ecosystem-level actions to improve habitat quality and restore keystone species and functional processes to maintain adult colonies and promote successful natural recruitment.

Table 44. Summary of status; Lobed Star Coral

Criteria	**Description**
Abundance / productivity trends	60% decline 2001-2012 due to bleaching. Most were considered "partial" mortalities to the colony. Species is described as "common." Population is stable.
Listing status	threatened
Attainment of recovery goals	Recovery plan not yet developed

9.52 Mountainous Star Coral

Table 45. Mountainous Star Coral; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Orbicella faveolata	Mountainous Star	N/A	Threatened	2014	2014 79 FR 53851	N/A	N/A

Figure 28. Mountainous Star Coral distribution. Off-white = no record, dark green = confirmed record, pale green = predicted record, tan = published record that needs further investigation(Veron 2014).

Species Description Mountainous Star coral belongs to the taxonomic family of Merulinidae, a group of stony corals whose hard exoskeletons are highly fused and lack paliform lobes. Mountainous Star coral occurs in the western Atlantic and throughout the Caribbean, including the Bahamas, Flower Garden Banks, and the entire Caribbean coastline.

On September 10, 2014, NMFS listed mountainous star coral as threatened (79 FR 53851). Lobed star coral (*Orbicella annularis*), mountainous star coral (*Orbicella faveolata*), and boulder star coral (*Orbicella franksi*) are the three species in the *Orbicella* spp. complex. These three species were formerly in the genus *Montastraea*; however, recent work has reclassified the three species in the *annularis* complex to the genus *Orbicella* (Budd et al. 2012). The star coral species complex was historically one of the primary reef framework builders throughout the wider Caribbean. The complex was considered a single species –*Montastraea annularis*– with varying growth forms ranging from columns, to massive boulders, to plates. In the early 1990s, Weil and Knowlton (1994) suggested the partitioning of these growth forms into separate species, resurrecting the previously described taxa, *Montastraea* (now *Orbicella*) *faveolata*, and *Montastraea* (now *Orbicella*) *franksi.* The three species were differentiated on the basis of morphology, depth range, ecology, and behavior (Weil and Knowton 1994). Subsequent reproductive and genetic studies have supported the partitioning of the *annularis* complex into three species.

Mountainous star corals, as with all corals are composed of single polyp body forms, often present in numbers of hundreds to thousands creating dense clusters along the shallow ocean floor called colonies.Polyps are capable of catching and eating their own food, and have their own digestive, nervous, respiratory, and reproductive systems.In addition to being able to catch and eat their own food, Lobed star coral, along with most coral species contain zooxanthellae, a unicellular, symbiotic dinoflagellate, living within the endodermic tissues of individual polyps to provide photosynthetic support to the coral's energy budget and calcium carbonate secretion (NMFS 2005).

Mountainous star coral grows in heads or sheets, the surface of which may be smooth or have keels or bumps. The skeleton is much less dense than in the other two star coral species. Colony diameters can reach up to ten meters with heights of four to five meters.

As stated, mountainous star coral is found in the western Atlantic and throughout the Caribbean. There is conflicting information on whether or not it occurs in Bermuda. Mountainous star coral has been reported in most reef habitats and is often the most abundant coral at ten to twenty meters in fore-reef environments. The depth range of mountainous star coral has been reported as approximately 0.5-40 meters, though the species complex has been reported to depths of 90 meters.Star coral species are a common, often dominant component of Caribbean mesophotic reefs (e.g., > 30 meters), suggesting the potential for deep refugia for mountainous star coral.

Status Mountainous star coral has undergone major declines mostly due to warming-induced bleaching and disease (Manzello et al. 2015). There is evidence of synergistic effects of threats for this species including disease outbreaks following bleaching events and reduced thermal tolerance due to chronic local stressors stemming from land-based sources of pollution(Grottoli et al. 2014). Mountainous star coral is highly susceptible to a number of threats, and cumulative effects of multiple threats have likely contributed to its decline and exacerbate its vulnerability to extinction(Grottoli et al. 2014). Despite high declines, the species is still common and remains one of the most abundant species on Caribbean reefs (Smith 2013). Its life history characteristics of large colony size and long life span have enabled it to remain relatively persistent despite slow growth and low recruitment rates, thus moderating vulnerability to extinction. The buffering capacity of these life history characteristics, however, is expected to decrease as colonies shift to smaller size classes as has been observed in locations in its range. Its absolute population abundance has been estimated as at least tens of millions of colonies in each of several locations including the Florida Keys, Dry Tortugas, and the U.S. Virgin Islands and is higher than the estimate from these three locations due to the occurrence of the species in many other areas throughout its range. Despite the large number of islands and environments that are included in the species' range, geographic distribution in the highly disturbed Caribbean exacerbates vulnerability to extinction over the foreseeable future because mountainous star coral is limited to an area with high, localized human impacts and predicted increasing threats. Its depth range of 0.5 meters to at least 40 meters, moderates vulnerability to extinction over the foreseeable future because deeper areas of its range will usually have lower temperatures than surface waters, and acidification is generally predicted to accelerate most in waters that are deeper and cooler than those in which the species occurs. Mountainous star coral occurs in most reef habitats, including both shallow and mesophotic reefs, which moderates vulnerability to extinction over the foreseeable future because the species occurs in numerous types of reef environments that are predicted, on local and regional scales, to experience highly variable temperatures and ocean chemistry at any given point in time. Its abundance, life history characteristics, and depth distribution, combined with spatial variability in ocean warming and acidification across the species' range, decreases its vulnerability to extinction because the threats are non-uniform (Smith 2013). Subsequently, there will likely be a large number of colonies that are either not exposed or do not negatively respond to a threat at any given point in time. We also anticipate that the population abundance is likely to decrease in the future with increasing threats.

Life history The star coral species complex has growth rates ranging from 0.06 - 1.2 centimeters per year and averaging approximately one-centimeter linear growth per year. Mountainous star coral's growth rate is intermediate between the other star coral complex species (Szmant et al., 1997).

The star coral complex species are hermaphroditic broadcast spawners[5].Spawning is concentrated on six to eight nights following the full moon in late August, September, or early October. All three species of star coral are largely self-incompatible (Knowlton et al. 1997; Szmant et al. 1997). Fertilization success measured in the field was generally below 15 % for all three species. In Puerto Rico, the minimum size at reproduction for a star coral species complex was 83 square centimeters.

Successful recruitment by star corals has seemingly always been rare. Only a single recruit of *Orbicella* was observed over 18 years of intensive observation of 12 square meters of reef in Discovery Bay, Jamaica. Many other studies throughout the Caribbean also report negligible to absent recruitment of the species complex.

Life history characteristics of mountainous star coral is considered intermediate between lobed star coral and boulder star coral especially regarding growth rates, tissue regeneration, and egg size. Spatial distribution may affect fecundity on the reef, with deeper colonies of mountainous star coral being less fecund due to greater polyp spacing. Reported growth rates of mountainous star coral range between 0.3 and 1.6 centimeters per year (Cruz-Piñón et al. 2003; Tomascik 1990; Villinski 2003; Waddell 2005). Graham and van Woesik (2013) report that 44 % of small colony mountainous star coral in Puerto Morelos, Mexico that resulted from partial colony mortality produced eggs at sizes smaller than those typically characterized as being mature. The number of eggs produced per unit area of smaller fragments was significantly less than in larger size classes. Szmant and Miller (2005) reported low post-settlement survivorship for mountainous star coral transplanted to the field with only three to 15 % remaining alive after 30 days. Post-settlement survivorship was much lower than the 29 % observed for elkhorn coral after seven months (Szmant and Miller 2005).

Mountainous star coral has slow growth rates, late reproductive maturity, and low recruitment rates. Colonies can grow very large and live for centuries. Large colonies have lower total mortality than small colonies, and partial mortality of large colonies can result in the production of clones. The historical absence of small colonies and few observed recruits, even though large numbers of gametes are produced on an annual basis, suggests that recruitment events are rare and were less important for the survival of the star coral species complex in the past (Bruckner 2012). Large colonies in the species complex maintain the population until conditions favorable

[5] Simultaneously containing both sperm and eggs, which are released into the water column for fertilization.

for recruitment occur; however, poor conditions can influence the frequency of recruitment events. While the life history strategy of the star coral species complex has allowed the taxa to remain abundant, we conclude that the buffering capacity of this life history strategy has been reduced by recent population declines and partial mortality, particularly in large colonies.

Population Dynamics

Abundance / Productivity Population trend data exists for several locations. At nine sites off Mona and Desecheo Islands, Puerto Rico, no species extirpations were noted at any site over ten years of monitoring between 1998 and 2008 (Bruckner and Hill 2009). Both mountainous star coral and lobed star coral sustained large losses during the period. The number of colonies of mountainous star coral decreased by 36 % and 48 % at Mona and Desecheo Islands, respectively (Bruckner and Hill 2009). In 1998, 27 % of all corals at six sites surveyed off Mona Island were mountainous star coral colonies, but this statistic decreased to approximately 11 % in 2008 (Bruckner and Hill 2009). At Desecheo Island, 12 % of all coral colonies were mountainous star coral in 2000, compared to seven % in 2008.

Extrapolated population estimates from stratified random samples in the Florida Keys were 39.7 ± eight million (standard error [SE]) colonies in 2005, 21.9 ± 7 million (SE) colonies in 2009, and 47.3 ± 14.5 million (SE) colonies in 2012. The greatest proportion of colonies tended to fall in the 10-20 centimeter and 20-30 centimeter size classes in all survey years, but there was a fairly large proportion of colonies in the greater than 90 centimeter-size class. Partial mortality of the colonies was between ten % and 60 % of the surface across all size classes. In the Dry Tortugas, Florida, mountainous star coral ranked seventh most abundant out of 43 coral species in 2006 and fifth most abundant out of 40 in 2008. Extrapolated population estimates were 36.1 ± 4.8 million (SE) colonies in 2006 and 30 ± 3.3 million (SE) colonies in 2008. The size classes with the largest proportion of colonies were 10-20 centimeter and 20-30 centimeter, but there was a fairly large proportion of colonies in the greater-than-90 centimeter size class. Partial mortality of the colonies ranged between approximately two % and 50 %. Because these population abundance estimates are based on random surveys, differences between years may be attributed to sampling effort rather than population trends (Miller et al. 2013a).

In the U.S. Virgin Islands, the reproductive performance of O.faveolata was assessed over a five-week period at three depth ranges five ten meters, 15–22 meters and 35–40 meters. The results showed that corals at the upper edge of the mesophotic zone 35–40 meters were more fecund and produced more eggs than those at shallower depths (Holstein et al. 2016).

Genetic Diversity Information regarding population structure is limited. Observations of mountainous star coral from 182 sample sites in the upper and lower Florida Keys and Mexico showed three well-defined populations based on five genetic markers, but the populations were not stratified by geography, indicating they were shared among the three regions (Baums et al. 2010). Of ten mountainous star coral colonies observed to spawn at a site off Bocas del Toro, Panama, there were only three genotypes (Levitan et al. 2011) potentially indicating 30 % clonality.

Distribution In a survey of 31 sites in Dominica between 1999 and 2002, mountainous star coral was present at 80 % of the sites at one to ten % cover (Steiner 2003a). In a 1995 survey of 16 reefs in the Florida Keys, mountainous star coral ranked as the coral species with the second highest percent cover (Murdoch and Aronson 1999). On 84 patch reefs three meters to five meters depth spanning 149 miles (240 kilometers) in the Florida Keys, mountainous star coral was the third most abundant coral species comprising seven % of the 17,568 colonies encountered. It was present at 95 % of surveyed reefs between 2001 and 2003 (Lirman and Fong 2007). In surveys of 280 sites in the upper Florida Keys in 2011, mountainous star coral was present at 87 % of sites visited (Miller et al. 2011). In 2003 on the East Flower Garden Bank, mountainous star coral comprised ten % of the 76.5 % coral cover on reefs 32-40 meters, and partial mortality due to bleaching, disease, and predation were rare at monitoring stations (Precht et al. 2005).

Colony density ranges from approximately 0.1-1.8 colonies per ten square meters and varies by habitat and location. In surveys along the Florida reef tract from Martin County to the lower Florida Keys, density of mountainous star coral was approximately 1.6 colonies per ten square meters (Wagner et al. 2010). On remote reefs off southwest Cuba, density of mountainous star coral was 0.12 ± 0.20 (SE) colonies per ten meters transect on 38 reef-crest sites and 1.26 ± 1.06 (SE) colonies per ten meters transect on 30 reef-front sites (Alcolado et al. 2010). In surveys of 1,176 sites in southeast Florida, the Dry Tortugas, and the Florida Keys between 2005 and 2010, density of mountainous star coral ranged between 0.17 and 1.75 colonies per ten square meters and was highest on mid-channel reefs followed by offshore patch reefs and fore-reefs (Burman et al. 2012). Along the east coast of Florida, density was highest in areas south of Miami at 0.94 colonies per ten square meters compared to 0.11 colonies per ten square meters in Palm Beach and Broward Counties (Burman et al. 2012).

Designated Critical Habitat No critical habitat has been designated for the Mountainous Star Coral.

Recovery Goals No final recovery plans currently exists for mountainous star coral; however a recovery outline for the species was published in 2014.

Table 46. Summary of status; Mountainous Star Coral

Criteria	Description
Abundance / productivity trends	Some areas have shown major declines due to warming induced bleaching and disease; however this species is still relatively abundant.
Listing status	threatened
Attainment of recovery goals	Recovery plan not yet developed

9.53 Pillar Coral

Table 47. Pillar Coral; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Dendrogyra cylindrus	Pillar Coral	N/A	Threatened	2014	2014 79 FR 53851	N/A	N/A

Figure 29. Pillar Coral distribution. Off-white = no record, dark green = confirmed record, pale green = predicted record, tan = published record that needs further investigation(Veron 2014).

Species Description The pillar coral is a cnidarian belonging to the taxonomic order of Scleractinia, a group of stony corals that secrete calcium carbonate to form hard exoskeletons. Pillar coral is present in the western Atlantic Ocean and throughout the greater Caribbean Sea, though absent from the southwest Gulf of Mexico (Tunnell 1988).

On September 10, 2014, NMFS listed pillar star coral as threatened (79 FR 53851). Pillar corals form tubular columns on top of encrusted foundations. Colonies are generally grey-brown in color and may reach approximately three meters in height. Polyps' tentacles remain extended during the day, giving columns a furry appearance. Pillar corals, as with all corals are composed of single polyp body forms, often present in numbers of hundreds to thousands creating dense clusters along the shallow ocean floor called colonies. Polyps are capable of catching and eating their own food, and have their own digestive, nervous, respiratory, and reproductive systems. In addition to being able to catch and eat their own food, Pillar coral, along with most coral species contain zooxanthellae, a unicellular, symbiotic dinoflagellate, living within the endodermic tissues of individual polyps to provide photosynthetic support to the coral's energy budget and calcium carbonate secretion (NMFS 2005).

Brainard et al. (2011b) identified a single known colony in Bermuda that is in poor condition. There is fossil evidence of the presence of the species off Panama less than 1,000 years ago, but it has been reported as absent today (Florida Fish and Wildlife Conservation Commission 2013). Pillar coral inhabits most reef environments in water depths ranging from approximately one to twenty-five meters, but it is most common in water between approximately five to fifteen meters deep (Acosta and Acevedo 2006; Cairns 1982; Goreau and Wells 1967).

Status Pillar coral survival is susceptible to a number of threats, and there is evidence of population declines in some locations. Despite the large number of islands and environments that are included in the species' range, geographic distribution in the highly disturbed Caribbean exacerbates vulnerability to extinction over the foreseeable future because pillar coral is limited to an area with high, localized human impacts and predicted increasing threats. *Dendrogyra cylindrus* inhabits most reef environments in water depths ranging from one to twenty-five meters, but is naturally rare. It is a gonochoric broadcast spawner with observed low sexual recruitment. Its low abundance, combined with its geographic location, exacerbates vulnerability to extinction. This is because increasingly severe conditions within the species' range are likely to affect a high proportion of its population at any given point in time. Also, low sexual recruitment, combined with its gonochoric, broadcast spawning reproduction mode and low density, is likely to inhibit recovery potential from mortality events, further exacerbating its vulnerability to extinction. We anticipate that pillar coral is likely to decrease in abundance in the future with increasing threats.

Life history Reported average growth rates for pillar coral have been documented to be approximately 1.8-2.0 centimeters per year in linear extension within the Florida Keys, compared to 0.8 centimeters per year as reported in Colombia and Curaçao. Partial mortality rates are size-specific with larger colonies having greater rates. Frequency of partial mortality can be high (e.g., 65 % of 185 colonies surveyed in Colombia), while the amount of partial mortality per colony is generally low (average of three % of tissue area affected per colony).

Pillar coral is a gonochoric broadcast spawning[6] species with relatively low annual egg production for its size. The combination of gonochoric spawning with persistently low population densities is expected to yield low rates of successful fertilization and low larval supply. Sexual recruitment of this species is low, and reports indicate juvenile colonies are lacking in the Caribbean. Spawning has been observed to occur several nights after the full moon of August in the Florida Keys (Neely et al. 2013; Waddell and Clarke 2008b) and in La Parguera, Puerto Rico (Szmant 1986). Pillar coral can also reproduce asexually by fragmentation following storms or other physical disturbance, but it is uncertain how much storm-generated fragmentation contributes to asexually produced offspring.

Population Dynamics

Abundance / Productivity Pillar coral is uncommon but conspicuous with scattered, isolated colonies and is rarely found in aggregations. In coral surveys, it generally has a rare encounter rate, low percent cover, and low density.

Information on pillar coral is most extensive for Florida. Pillar coral ranked as the least abundant to third least abundant coral species in stratified random surveys of the Florida Keys between

[6] Parents only contain one gamete (egg or sperm), which are released into the water column for fertilization by another parent's gamete.

2005 and 2009 and was not encountered in surveys in 2012 (Miller et al. 2013b). Pillar coral was seen only on the ridge complex and mid-channel reefs at densities of approximately 1 and 0.1 colonies per 10 m^2 (approximately 100 ft^2), respectively, between 2005 and 2010 in surveys from West Palm Beach to the Dry Tortugas (Burman et al. 2012). In surveys conducted between 1999 and 2016 from Palm Beach to the Dry Tortugas, pillar coral was present at 2% of sites surveyed and ranged in density from 0 to 0.4 colonies per m^2 with an average density of 0.004 colonies per 10 m^2 (approximately 100 ft^2)(NOAA, unpublished data). In 2014, there were 714 known colonies of pillar coral along the Florida reef tract from southeast Florida to the Dry Tortugas. By 2017, many of these colonies had suffered tissue loss, and over half (57%) suffered complete mortality due to disease, most likely associated with multiple years of warmer than normal temperatures (K. Neely and C. Lewis, unpublished data). The majority of these colonies were lost from the northern portion of the reef tract (***Figure 30***).

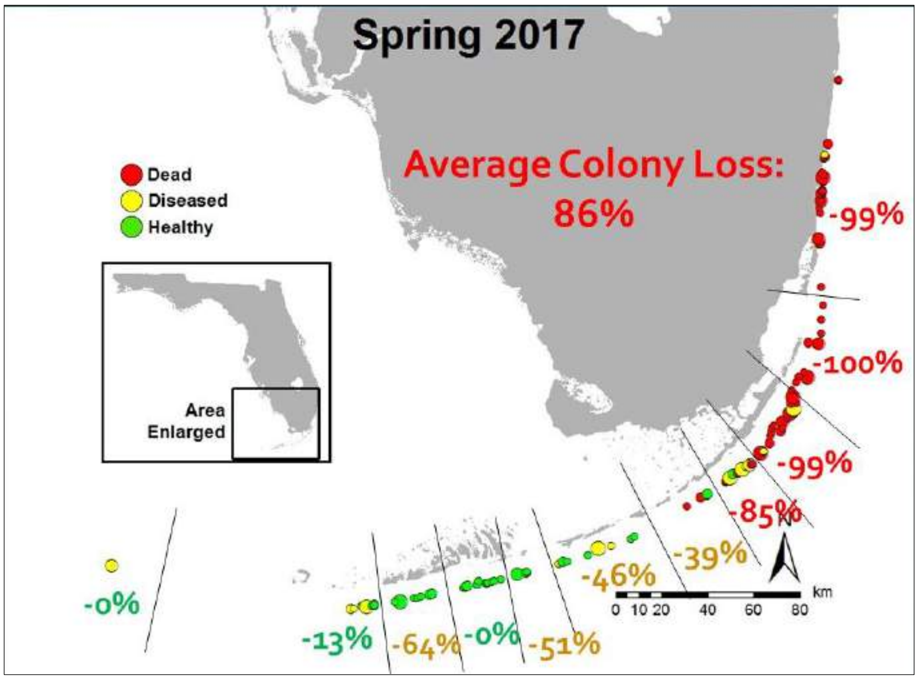

Figure 30. Condition of known pillar coral colonies in Florida between 2014 and 2017 (Figure curtesy of K. Neely and C. Lewis).

Density of pillar corals in other areas of the Caribbean is also low and on average less than 0.1 colonies per 10 m^2. The average number of pillar coral colonies in remote reefs off southwest Cuba was 0.013 ± 0.045 colonies per 10 m (approximately 32 ft) transect, and the species ranked sixth rarest out of 38 coral species (Alcolado et al. 2010). In a study of pillar coral demographics at Providencia Island, Colombia, a total of 283 pillar coral colonies were detected in a survey of 1.66 km^2 (0.6 square miles) for an overall density of approximately 0.000017 colonies per 10 m^2 (approximately 100 ft^2)(Acosta and Acevedo 2006). In Puerto Rico, density of pillar coral ranged from 0 to 0.3 colonies per m^2 with an average density of 0.03 colonies per 10 m^2 (approximately 100 ft^2); it occurred at 4% of the sites surveyed between 2008 and 2016 (NOAA unpublished data). In the US Virgin Islands, density of pillar coral ranged between 0 and 0.3 colonies per m^2 with an average density of 0.01 colonies per 10 m^2 (approximately 100 ft^2); it occurred in 3% of the sites surveyed between 2002 and 2015 (NOAA unpublished data).

Benthic cover is generally less than 1% in monitoring studies. Pillar coral's average cover was 0.002% on patch reefs and 0.303% in shallow offshore reefs in annual surveys of 37 sites in the Florida Keys between 1996 and 2003 (Somerfield et al. 2008). In surveys conducted in Florida between 1996 and 2016, cover of pillar coral ranged from 0 to 0.5% with an average of 0.0002% (NOAA, unpublished data). At permanent monitoring stations in the U.S. Virgin Islands, pillar coral was observed in low abundance at 10 of 33 sites and ranged in cover from less than 0.05-0.22% where present (Smith 2013). In surveys conducted in the U.S. Virgin Islands between 1992 and 2015, percent cover of pillar coral ranged from 0 to 6% with an average cover of 0.03% (NOAA, unpublished data). In Puerto Rico, cover of pillar coral ranged between 0 and 4% with an average of 0.02% in surveys conducted between 2001 and 2016 (NOAA, unpublished data). In Dominica, pillar coral comprised less than 0.9% cover and was present at 13.3% of 31 surveyed sites (Steiner 2003b). Pillar coral was observed on 1 of 7 fringing reefs surveyed off Barbados, and cover was 2.7 ± 1.4% (Tomascik and Sander 1987).

Other than the declining population in Florida, there are two reports of population trends from the Caribbean. In monitored photo-stations in Roatan, Honduras, cover of pillar coral increased slightly from 1.35% in 1996 to 1.67% in 1999 and then declined to 0.44% in 2003 and to 0.43% in 2005 (Riegl et al. 2009). In the U.S. Virgin Islands, 7% of 26 monitored colonies experienced total colony mortality between 2005 and 2007, though the very low cover of pillar coral (0.04%) remained relatively stable during this time period (Smith et al. 2013).

Pillar coral is currently uncommon to rare throughout Florida and the Caribbean. Low abundance and infrequent encounter rate in monitoring programs result in small samples sizes. The low coral cover of this species renders monitoring data difficult to extrapolate to realize trends. The few studies that report pillar coral population trends indicate a general decline at some specific sites, though it is likely that the population remains stable at other sites. Low density and gonochoric broadcast spawning reproductive mode, coupled with no observed sexual recruitment, indicate that natural recovery potential from mortality is low.

Genetic Diversity / Distribution Out of 283 pillar coral colonies at Providencia Island, Colombia, 70 colonies resulted from asexual fragmentation and no sexual recruits were observed. Size class distribution was skewed to smaller size classes less than 60 centimeters in height, and average colony height was approximately 0.73 meters (Acosta and Acevedo 2006). During surveys of Utila, Honduras, between 1999 and 2000, pillar coral was sighted in 19.6 % of 784 surveys and ranked 26th most common in abundance out of 48 coral species (Afzal et al. 2001).

Pillar coral's average percent cover was 0.002 on patch reefs and 0.303 in shallow offshore reefs in annual surveys of 37 sites in the Florida Keys between 1996 and 2003 (Somerfield et al. 2008). At permanent monitoring stations in the U.S. Virgin Islands, pillar coral has been observed in low abundance at 10 of 33 sites and ranged in cover from less than 0.05-0.22 % where present (Smith 2013). In Dominica, pillar coral comprised less than 0.9 % cover and was present at 13.3 % of 31 surveyed sites (Steiner 2003b). Of seven fringing reefs surveyed off Barbados, pillar coral was observed on one of them, and cover was 2.7 ± 1.4 % (Tomascik and Sander 1987). In monitored photo-stations in Roatan, Honduras, cover of pillar coral increased slightly from 1.35 % in 1996 to 1.67 % in 1999 and then declined to 0.44 % in 2003 and to 0.43 % in 2005 (Riegl et al. 2009). In the U.S. Virgin Islands, seven % of 26 monitored colonies experienced total colony mortality between 2005 and 2007, though the very low cover of pillar coral (0.04 %) remained relatively stable during this time period (Smith et al. 2013).

In stratified random surveys from Palm Beach County to the Dry Tortugas, Florida, between 2005 and 2010, pillar coral was seen only on the ridge complex and mid-channel reefs at densities of approximately one and 0.1 colonies per approximately ten square meters, respectively (Burman et al. 2012). Average number of pillar coral colonies in remote reefs off southwest Cuba was 0.013 ± 0.045 colonies per approximately ten meter transect, and the species ranked sixth rarest out of 38 coral species (Alcolado et al. 2010). In surveys of the upper Florida Keys in 2011, pillar coral was the second rarest out of 37 coral species and encountered at one % of sites (Miller et al. 2011).

Designated Critical Habitat No critical habitat has been designated for pillar coral.

Recovery Goals No final recovery plans currently exists for pillar coral, however a recovery outline was published in 2015.

Table 48. Summary of status; Pillar Coral

Criteria	Description
Abundance / productivity trends	Uncommon, rarely found in aggregations - yet little evidence of population declines over years of monitoring
Listing status	threatened
Attainment of recovery goals	Recovery plan not yet developed

9.54 Rough Cactus Coral

Table 49. Rough Cactus Corall; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Mycetophylllia ferox	Rough Cactus	N/A	Threatened	2014	2014 79 FR 53851	N/A	N/A

Figure 31. Rough Cactus Coral distribution. Off-white = no record, dark green = confirmed record, pale green = predicted record, tan = published record that needs further investigation(Veron 2014).

Species Description The rough cactus coral is a cnidarian belonging to the taxonomic genus of Mycetophyllia, a group of ridged corals that form colonies with a flat disc shape. Rough cactus coral occurs in the western Atlantic Ocean and throughout the wider Caribbean Sea.

Rough cactus coral forms a thin, encrusting plate that is weakly attached to substrate. Rough cactus coral is taxonomically distinct (i.e., separate species), though difficult to distinguish in the field from other *Mycetophyllia* species. The maximum colony size of the species is 50 centimeters in diameter. Rough Cactus corals, as with all corals are composed of single polyp body forms, often present in numbers of hundreds to thousands creating dense clusters along the shallow ocean floor called colonies. Polyps are capable of catching and eating their own food, and have their own digestive, nervous, respiratory, and reproductive systems. As with most corals, in addition to being able to catch and eat their own food, Pillar coral contains zooxanthellae, a unicellular, symbiotic dinoflagellate, living within the endodermic tissues of individual polyps to provide photosynthetic support to the coral's energy budget and calcium carbonate secretion (NMFS 2005).

Rough star corals, as with all corals are composed of single polyp body forms, often present in numbers of hundreds to thousands creating dense clusters along the shallow ocean floor called colonies. Polyps are capable of catching and eating their own food, and have their own digestive, nervous, respiratory, and reproductive systems. In addition to being able to catch and eat their own food, Rough star coral, along with most coral species contain zooxanthellae, a unicellular, symbiotic dinoflagellate, living within the endodermic tissues of individual polyps to provide photosynthetic support to the coral's energy budget and calcium carbonate secretion (NMFS 2005).

While rough cactus coral occurs in the western Atlantic Ocean and throughout the wider Caribbean Sea, it has not been reported in the Flower Garden Banks (Gulf of Mexico) or in Bermuda. It inhabits reef environments in water depths of five to ninety meters, including shallow and mesophotic habitats (e.g., > 30 meters).

Status Rough cactus coral has declined due to disease in at least a portion of its range and has low recruitment, which limits its capacity for recovery from mortality events and exacerbates vulnerability to extinction. Its depth range of 5 to 90 meters moderates vulnerability to extinction over the foreseeable future because deeper areas of its range will usually have lower temperatures than surface waters. Acidification is predicted to accelerate most in deeper and cooler waters than those in which the species occurs. Its habitat includes shallow and mesophotic reefs which moderates vulnerability to extinction over the foreseeable future because the species occurs in numerous types of reef environments that are predicted, on local and regional scales, to experience highly variable thermal regimes and ocean chemistry at any given point in time. Rough cactus coral is usually uncommon to rare throughout its range. Its abundance, combined with spatial variability in ocean warming and acidification across the species' range, moderate vulnerability to extinction because the threats are non-uniform. Subsequently, there will likely be a large number of colonies that are either not exposed or do not negatively respond to a threat at any given point in time.

Life history Rough cactus coral is a hermaphroditic brooding[7] species. Colony size at first reproduction is greater than 100 square centimeters. Recruitment of rough cactus coral appears to be very low, even in studies from the 1970s. Rough cactus coral has a lower fecundity compared to other species in its genus (Morales Tirado 2006). Over a ten year period, no colonies of rough cactus coral were observed to recruit to an anchor-damaged site in the U.S. Virgin Islands, although adults were observed on the adjacent reef (Rogers and Garrison 2001). No other life history information appears to exist for rough cactus coral.

Population Dynamics

Abundance / Productivity Rough cactus coral is usually uncommon or rare according to published and unpublished records, indicating that it constitutes < 0.1 % species contribution (percent of all colonies counted) and occurs at densities < 0.8 colonies per ten square meters in Florida and at 0.8 colonies per 100 m transect in Puerto Rico sites sampled by the Atlantic and Gulf Rapid Reef Assessment (Veron 2002, Wagner el al., 2010, and AGRRA database as cited in Brainard et al. 2011c). Recent monitoring data (e.g., since 2000) from Florida (National Park Service permanent monitoring stations), La Parguera Puerto Rico, and St. Croix (USVI/NOAA Center for Coastal Monitoring and Assessment randomized monitoring stations) show

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[7] Simultaneously containing both sperm and eggs, which are fertilized within the parent colony and grows for a period of time before release.

Mycetophyllia ferox cover to be consistently less occasional observations up to two % and no apparent temporal trend (Brainard et al. 2011c).

Dustan (1977) proposes that rough cactus coral was much more abundant in the upper Florida Keys in the early mid- 1970s (the methods are not well described for that study) than current observations, but that it was highly affected by disease. This could be interpreted as a substantial decline. Long-term CREMP monitoring data in Florida on species presence/absence from fixed sites (stations) show a dramatic decline; for 97 stations in the main Florida Keys, occurrence had declined from 20 stations in 1996 to four stations in 2009; in Dry Tortugas occurrence had declined from eight out of twenty-one stations in 2004 to three stations in 2009 (R. Ruzicka and M. Colella, Florida Marine Research Institute, St. Petersburg, FL. pers. comm., Oct 2010 cited in Brainard et al. 2011c).

Genetic Diversity / **Distribution** According to the IUCN Species Account and the CITES species database, rough cactus coral occurs throughout the U.S. waters of the western Atlantic but has not been reported from Flower Garden Banks (Hickerson et al. 2008). The following areas include locations within federally protected waters where rough cactus coral has been observed and recorded(cited in Brainard et al. 2011c):Dry Tortugas National Park;Virgin Island National Park/Monument; Florida Keys; National Marine Sanctuary; Navassa Island National Wildlife Refuge; Biscayne National Park; Buck Island Reef National Monument.

On reefs where rough cactus coral is found, it generally occurs at abundances of less than one colony per approximately ten square meters and percent cover of less than 0.1 (Burman et al. 2012).Based on population estimates, there are at least hundreds of thousands of rough cactus coral colonies present in the Florida Keys and Dry Tortugas combined. Absolute abundance is higher than the estimate from these two locations given the presence of this species in many other locations throughout its range. Low encounter rate and percent cover coupled with the tendency to include Mycetophyllia spp. at the genus level make it difficult to discern population trends of rough cactus coral from monitoring data. However, reported losses of rough cactus coral from monitoring stations in the Florida Keys and Dry Tortugas (63-80 % loss) indicate population decline in these locations. Based on declines in Florida, we conclude rough cactus coral has likely declined throughout its range, and will continue to decline based on increasing threats. As a result it is presumed that genetic diversity for the species is low.

Designated Critical Habitat No critical habitat has been designated for rough cactus coral.

Recovery Goals No final recovery plan currently exists for rough cactus coral, however a recovery outline was developed in 2014 to serve as interim guidance to direct recovery efforts, including recovery planning, until a final recovery plan is developed and approved.

Table 50. Summary of status; Rough Cactus Coral

Criteria	Description
Abundance / productivity trends	Uncommon to rare. Species has undergone substantial declines since the 1970's. Highly affected by "disease."
Listing status	threatened
Attainment of recovery goals	Recovery plan not yet developed

9.55 Coral species: Acropora globiceps

Table 51. Acropora globiceps; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Acropora globiceps	Not Available	NA	Threatened	2014	79 FR 53852	NA	None Designated

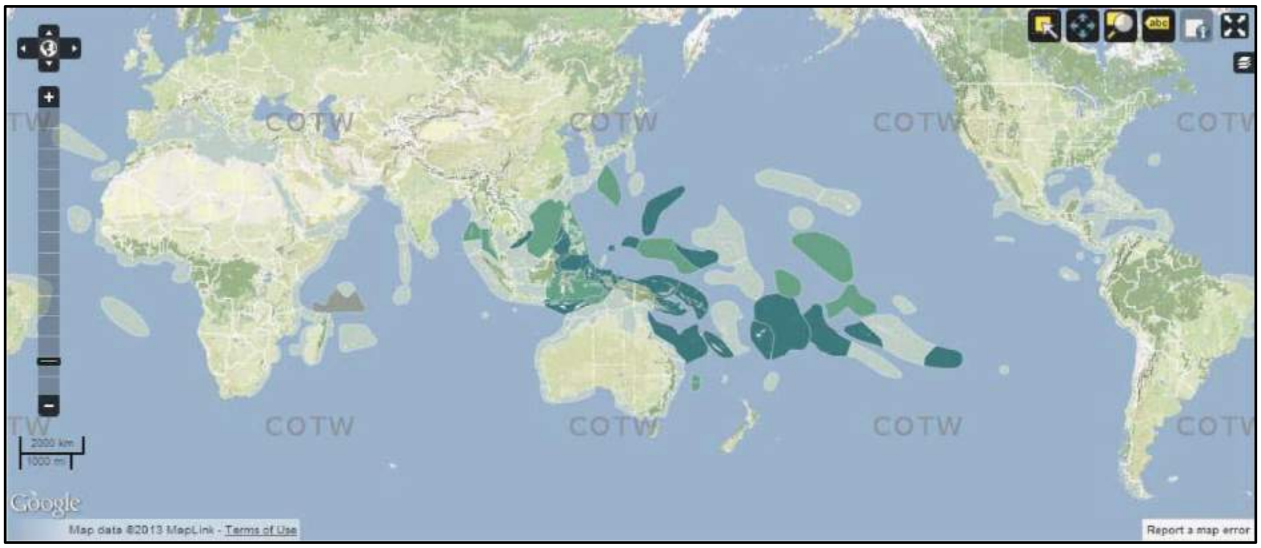

Figure 32. Acropora globiceps distribution. Off-white = no record, dark green = confirmed record, pale green = predicted record, tan = published record that needs further investigation(Veron 2014).

Species Description Colonies of Acropora globiceps are digitate and usually small. The size and appearance of branches depend on degree of exposure to wave action but are always short and closely compacted. Colonies exposed to strong wave action have pyramid-shaped branchlets. Corallites are irregular in size, those on colonies on reef slopes are tubular, and those on reef flat colonies are more immersed. Axial corallites are small and sometimes indistinguishable. Radial corallites are irregular in size and are sometimes arranged in rows down the sides of branches. Colonies are uniform blue (which may photograph purple) or cream in color (Veron, 2000).

Acropora globiceps is distributed from the oceanic west Pacific to the central Pacific as far east as the Pitcairn Islands. In the US *Acropora globiceps* occurs in American Samoa, the Northern Mariana Islands, and the U.S. minor outlying islands.

Status Acropora globiceps is highly susceptible to ocean warming, disease, ocean acidification, trophic effects of fishing, nutrients, and predation. These threats are expected to continue and increase into the future. In addition, existing regulatory mechanisms to address global threats that contribute to extinction risk for this species are inadequate. Acropora globiceps occurs primarily in depths of zero to eight meters which can be considered a shallow depth range compared to the overall depth of occurrence for reef building corals in general. Shallow reef areas are often subjected to highly variable environmental conditions, extremes, high irradiance, and simultaneous effects from multiple stressors, both local and global in nature. A limited depth range reduces the absolute area in which the species may occur throughout its geographic range and indicates that a large proportion of the population is likely to be exposed to threats that are worse in shallow habitats, such as simultaneously elevated irradiance and seawater temperatures, as well as localized impacts. The combination of these characteristics and future projections of threats indicates that the species is likely to be in danger of extinction within the foreseeable future throughout its range.

Life history Acropora are sessile colonies that spawn their gametes into the water column, and the azooxanthellate larvae can survive in the planktonic stage from 4 to 209 days (Graham et al., 2008). This has allowed many Acropora species to have very wide geographic ranges, both longitudinally and latitudinally (Wallace, 1999). However, sessile colonies must be within a few meters of each other to have reasonable success in fertilization (Coma and Lasker, 1997). Vollmer and Palumbi (2007), using DNA sequence data, determined that Acropora cervicornis in the Caribbean have limited realized gene flow despite long-distance dispersal potential. Although spawners with long larval lives can eventually become distributed over broad geographic areas, as is typical for Acropora, the year-by-year replenishment of populations requires local source populations. All species of the genus Acropora studied to date are simultaneous hermaphrodites (Baird et al., 2009), with a gametogenic cycle in which eggs develop over a period of about 9 months and testes over about 10 weeks (Babcock et al., 1986; Szmant, 1986; Wallace, 1985). Fecundity in Acropora colonies is generally described as ranging from 3.6 to 15.8 eggs per polyp (Kenyon, 2008; Wallace, 1999). Mature eggs of species of Acropora are large when compared with those of other corals, ranging from 0.53 to 0.90 mm in mean diameter (Wallace, 1999). For five Acropora species examined by Wallace (1985), the minimum reproductive size ranged from 4 to 7 cm, and the estimated ages ranged from 3 to 5 years.

Acropora spp. release gametes as egg-sperm bundles that float to the sea surface, each polyp releasing all its eggs and sperm in one bundle. Fertilization takes place after the bundles break open at the sea surface. Sperm concentrations of 106 ml-1 have been found to be optimal for fertilization in the laboratory, and concentrations of this order have been recorded in the field during mass spawning events. Self-fertilization, although possible, is infrequent. Gametes remain viable and achieve high fertilization rates for up to 8 hours after spawning (Kenyon, 1994). Embryogenesis takes place over several hours, and further development leads to a planula that is competent to settle in 4 to 5 days after fertilization. Acropora spp. can show a high degree of hybridization (Kenyon, 1994; Richards et al., 2008b; Van Oppen et al., 2002; Van Oppen et al., 2000), which can complicate taxonomic classification but allow persistence of the genus if the hybrids are reproductively viable.

As sessile spawners with planktonic larvae, the Critical Risk Threshold assessments for Acropora species must weigh the broad distributions that provide replicated opportunities for potential escape from local disturbances against the necessity to have colonies in close enough proximity to have successful fertilization of enough eggs to replenish the attrition of the spawning stock. If the effective population size (i.e., the number of genotypes [might be substantially less than the number of colonies in highly clonal species] close enough for successful fertilization) becomes too low to replenish the population, then the positive-feedback depensatory processes begin. It is worth noting that Edinger and Risk (1995) concluded that brooding corals survived the harsh environmental conditions better than did the spawners in the western Atlantic during the major extinctions of the Oligocene-Miocene transition period. Many

Acropora have branching morphologies, making them potentially susceptible to fragmentation. Fragment survival can increase coral abundance in the short-term but does not contribute new genotypes (or evolutionary opportunities) to the population.

Population Dynamics

Abundance Veron (2014) reports that A. globiceps occupied 3.2 % of 2,984 dive sites sampled in 30 ecoregions of the Indo-Pacific, and had a mean abundance rating of 1.95 on a 1 to 5 rating scale at those sites in which it was found. Based on this semi-quantitative system, the species' abundance was characterized as "uncommon." Overall abundance was described as "sometimes common." Veron did not infer trends in abundance from these data. As described in the Indo-Pacific Species Determinations introduction above, based on results from Richards et al. (2008) and Veron (2014), the absolute abundance of this species is likely at least tens of millions of colonies.

Productivity The overall decline in abundance ("Percent Population Reduction") was estimated at 35 %, and the decline in abundance before the 1998 bleaching event ("Back-cast Percent Population Reduction") was estimated at 14 % (Carpenter et al., 2008). However, live coral cover trends are highly variable both spatially and temporally, producing patterns on small scales that can be easily taken out of context, thus quantitative inferences to species-specific trends should be interpreted with caution. At the same time, an extensive body of literature documents broad declines in live coral cover and shifts to reef communities dominated by hardier coral species or algae over the past 50 to 100 years (Birkeland, 2004; Fenner, 2012; Pandolfi et al., 2003; Sale and Szmant, 2012). These changes have likely occurred, and are occurring, from a combination of global and local threats. Given that A. globiceps occurs in many areas affected by these broad changes, and that it has some susceptibility to both global and local threats, we conclude that it is likely to have declined in abundance over the past 50 to 100 years, but a precise quantification is not possible due to the limited species-specific information.

Genetic Diversity Although spawners with long larval lives can eventually become distributed over broad geographic areas, as is typical for Acropora, the year-by-year replenishment of populations requires local source populations. For example, Vollmer and Palumbi (2007), using DNA sequence data, determined that Acropora cervicornis in the Caribbean have limited realized gene flow despite long-distance dispersal potential.

Distribution Acropora globiceps has been reported from intertidal, upper reef slopes and reef flats (Veron, 2000). Acropora globiceps has been reported in water depths ranging from 0 m to 8 m (Veron, 2000).

Designated Critical Habitat Critical habitat has not yet been designated for this species

Recovery Goals A recovery plan has not yet been developed for this species.

Table 52. Summary of status; Acropora globiceps

Criteria	Description
Abundance / productivity trends	The range of these corals is extensive throughout the Indo-Pacific region. Less than 5 % of the population is within the range of the action area. Over-all status unknown. Growth rates of decline or increase are unknown.

Listing status	threatened
Attainment of recovery goals	Recovery plan not yet developed

9.56 Coral species: Acropora jacquelineae

Table 53. Acropora jacquelineae; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Acropora jacquelineae	Not Available	NA	Threatened	2014	79 FR 53852	NA	None Designated

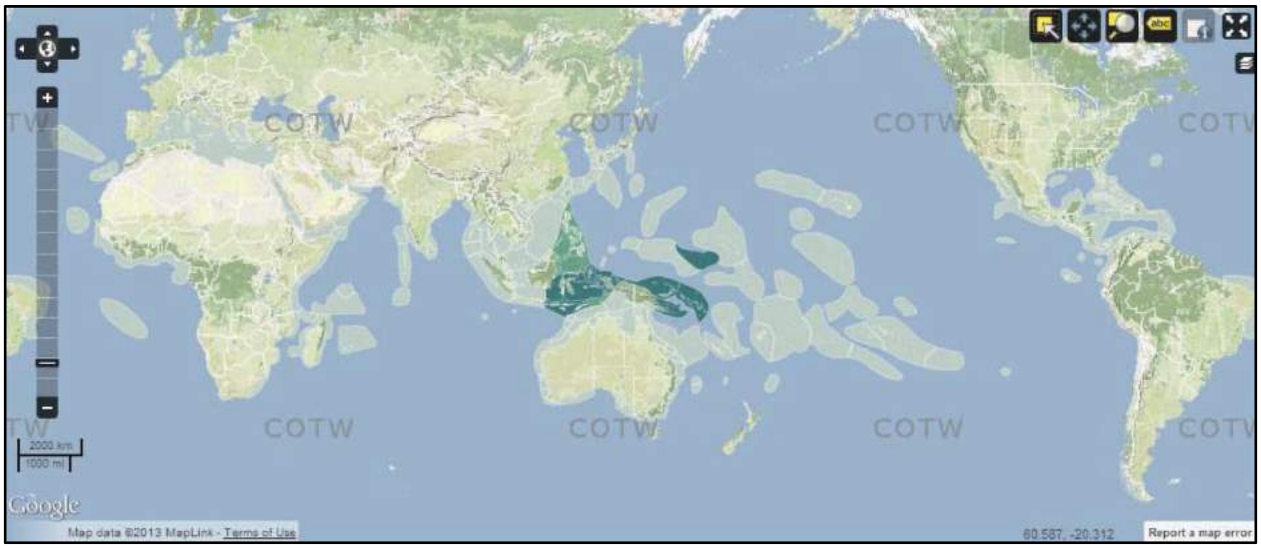

Figure 33. Acropora jacquelineae distribution. Off-white = no record, dark green = confirmed record, pale green = predicted record, tan = published record that needs further investigation(Veron 2014).

Species Description Colonies of Acropora jacquelineae are flat plates up to 1 m in diameter. Viewed from above, plates are covered with a mass of fine delicately-curved axial corallites giving an almost moss-like appearance. There is almost no development of radial corallites. Colonies are uniform grey-brown or pinkish in color (Veron, 2000). *Acropora jacquelineae* is distributed within the Coral Triangle including Papua New Guinea, and is reported from American Samoa.

Status Acropora jacquelineae is highly susceptible to ocean warming, disease, ocean acidification, trophic effects of fishing, predation, and nutrient enrichment. These threats are expected to continue and increase into the future. In addition existing regulatory mechanisms to address global threats that contribute to extinction risk for this species are inadequate. Acropora jacquelineae' s distribution is constrained mostly to the Coral Triangle and western equatorial Pacific, which is projected to have the most rapid and severe impacts from climate change and localized human impacts for coral reefs over the 21st century, as described in the Threats Evaluation. Multiple ocean warming events have already occurred within the western equatorial Pacific that suggest future ocean warming events may be more severe than average in this part of the world. A range constrained to this particular geographic area that is likely to experience severe and increasing threats indicates that a high proportion of the population of this species is likely to be exposed to those threats over the foreseeable future. Considering the limited range of this species in an area where severe and increasing impacts are predicted, this level of abundance leaves the species vulnerable to becoming of such low abundance within the foreseeable future that it may be at risk from depensatory processes, environmental stochasticity, or catastrophic events. The combination of these characteristics and projections of future threats indicates that the species is likely to be in danger of extinction within the foreseeable future throughout its range.

Life history Acropora are sessile colonies that spawn their gametes into the water column, and the azooxanthellate larvae can survive in the planktonic stage from 4 to 209 days (Graham et al., 2008). This has allowed many Acropora species to have very wide geographic ranges, both longitudinally and latitudinally (Wallace, 1999). However, sessile colonies must be within a few meters of each other to have reasonable success in fertilization (Coma and Lasker, 1997). Vollmer and Palumbi (2007), using DNA sequence data, determined that Acropora cervicornis in the Caribbean have limited realized gene flow despite long-distance dispersal potential. Although spawners with long larval lives can eventually become distributed over broad geographic areas, as is typical for Acropora, the year-by-year replenishment of populations requires local source populations. All species of the genus Acropora studied to date are simultaneous hermaphrodites (Baird et al., 2009), with a gametogenic cycle in which eggs develop over a period of about 9 months and testes over about 10 weeks (Babcock et al., 1986; Szmant, 1986; Wallace, 1985). Fecundity in Acropora colonies is generally described as ranging from 3.6 to 15.8 eggs per polyp (Kenyon, 2008; Wallace, 1999). Mature eggs of species of Acropora are large when compared with those of other corals, ranging from 0.53 to 0.90 mm in mean diameter (Wallace, 1999). For five Acropora species examined by Wallace (1985), the minimum reproductive size ranged from 4 to 7 cm, and the estimated ages ranged from 3 to 5 years.

Acropora spp. release gametes as egg-sperm bundles that float to the sea surface, each polyp releasing all its eggs and sperm in one bundle. Fertilization takes place after the bundles break open at the sea surface. Sperm concentrations of 106 ml-1 have been found to be optimal for fertilization in the laboratory, and concentrations of this order have been recorded in the field during mass spawning events. Self-fertilization, although possible, is infrequent. Gametes remain viable and achieve high fertilization rates for up to 8 hours after spawning (Kenyon, 1994). Embryogenesis takes place over several hours, and further development leads to a planula that is competent to settle in 4 to 5 days after fertilization. Acropora spp. can show a high degree of hybridization (Kenyon, 1994; Richards et al., 2008b; Van Oppen et al., 2002; Van Oppen et al., 2000), which can complicate taxonomic classification but allow persistence of the genus if the hybrids are reproductively viable.

As sessile spawners with planktonic larvae, the Critical Risk Threshold assessments for Acropora species must weigh the broad distributions that provide replicated opportunities for potential escape from local disturbances against the necessity to have colonies in close enough proximity to have successful fertilization of enough eggs to replenish the attrition of the spawning stock. If the effective population size (i.e., the number of genotypes [might be substantially less than the number of colonies in highly clonal species] close enough for successful fertilization) becomes too low to replenish the population, then the positive-feedback depensatory processes begin. It is worth noting that Edinger and Risk (1995) concluded that brooding corals survived the harsh environmental conditions better than did the spawners in the western Atlantic during the major extinctions of the Oligocene-Miocene transition period. Many

Acropora have branching morphologies, making them potentially susceptible to fragmentation. Fragment survival can increase coral abundance in the short-term but does not contribute new genotypes (or evolutionary opportunities) to the population.

Population Dynamics

Abundance The total world population of this species is estimated at 31,599,000 colonies, with an effective population size of 3,476,000 colonies (Richards et al. 2008; Veron 2014).

Productivity The overall decline in abundance ("Percent Population Reduction") was estimated at 37 %, and the decline in abundance before the 1998 bleaching event ("Back-cast Percent Population Reduction") was estimated at 14 %. However, live coral cover trends are highly variable both spatially and temporally, producing patterns on small scales that can be easily taken out of context, thus quantitative inferences to species-specific trends should be interpreted with caution. At the same time, an extensive body of literature documents broad declines in live coral cover and shifts to reef communities dominated by hardier coral species or algae over the past 50 to 100 years (Birkeland, 2004; Fenner, 2012; Pandolfi et al., 2003; Sale and Szmant, 2012). These changes have likely occurred, and are occurring, from a combination of global and local threats. Given that A. jacquelineae occurs in many areas affected by these broad changes, and has some susceptibility to both global and local threats, we conclude that it is likely to have declined in abundance over the past 50 to 100 years, but a precise quantification is not possible based on the limited species-specific information.

Genetic Diversity Although spawners with long larval lives can eventually become distributed over broad geographic areas, as is typical for Acropora, the year-by-year replenishment of populations requires local source populations. For example, Vollmer and Palumbi (2007), using DNA sequence data, determined that Acropora cervicornis in the Caribbean have limited realized gene flow despite long-distance dispersal potential.

Distribution Acropora jacquelineae has been reported to occupy subtidal, walls, ledges on walls, and shallow reef slopes protected from wave action (Veron, 2000; Wallace, 1999). Acropora horrida has been reported in water depths ranging from 10 m to 35 m (Carpenter et al., 2008; Wallace, 1999).

Designated Critical Habitat Critical habitat has not yet been designated for this species

Recovery Goals A recovery plan has not yet been developed for this species.

Table 54. Summary of status; Acropora jacquelineae

Criteria	Description
Abundance / productivity trends	The range of these corals is extensive throughout the Indo-Pacific region. Less than 5 % of the population is within the range of the action area. Over-all status unknown. Growth rates of decline or increase are unknown.
Listing status	threatened
Attainment of recovery goals	Recovery plan not yet developed

9.57 Coral species: Acropora retusa

Table 55. Acropora retusa; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Acropora retusa	Not Available	NA	Threatened	2014	79 FR 53852	NA	None Designated

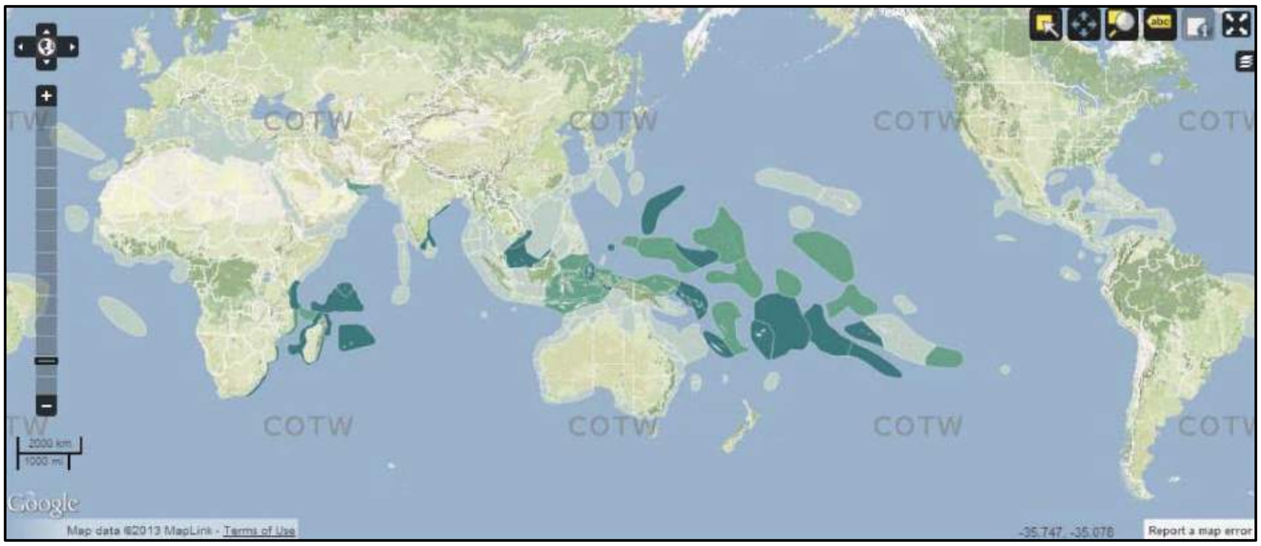

Figure 34. Acropora retusa distribution. Off-white = no record, dark green = confirmed record, pale green = predicted record, tan = published record that needs further investigation(Veron 2014).

Species Description Colonies of Acropora retusa are flat plates with short thick digitate branchlets. Corallites have thick rounded walls and wide openings. Axial corallites are indistinct. Radial corallites are laying flat against each other, becoming nariform near branch ends. Colonies are brown in color. (Veron, 2000; Veron and Wallace, 1984). *Acropora retusa* is distributed from the Red Sea and the Indian Ocean to the central Pacific.

Status Acropora retusa is highly susceptible to ocean warming, disease, ocean acidification, trophic effects of fishing, predation, and nutrients. These threats are expected to continue and increase into the future. In addition, existing regulatory mechanisms addressing global threats that contribute to extinction risk for this species inadequate. Acropora retusa is restricted to shallow habitat (zero to five meters), where many global and local threats may be more severe, especially near populated areas. Shallow reef areas are often subjected to highly variable environmental conditions, extremes, high irradiance, and simultaneous effects from multiple stressors, both local and global in nature. A limited depth range also reduces the absolute area in which the species may occur throughout its geographic range, and indicates that a large proportion of the population is likely to be exposed to threats that are worse in shallow habitats, such as simultaneously elevated irradiance and seawater temperatures, as well as localized impacts. Acropora retusa' s abundance is considered rare overall. This level of abundance, combined with its restricted depth distribution where impacts are more severe, leaves the species vulnerable to becoming of such low abundance within the foreseeable future that it may be at risk from depensatory processes, environmental stochasticity, or catastrophic events. The combination of these characteristics and future projections of threats indicates that the species is likely to be in danger of extinction within the foreseeable future throughout its range**.**

Life history Acropora are sessile colonies that spawn their gametes into the water column, and the azooxanthellate larvae can survive in the planktonic stage from 4 to 209 days (Graham et al., 2008). This has allowed many Acropora species to have very wide geographic ranges, both longitudinally and latitudinally (Wallace, 1999). However, sessile colonies must be within a few meters of each other to have reasonable success in fertilization (Coma and Lasker, 1997). Vollmer and Palumbi (2007), using DNA sequence data, determined that Acropora cervicornis in the Caribbean have limited realized gene flow despite long-distance dispersal potential. Although spawners with long larval lives can eventually become distributed over broad geographic areas, as is typical for Acropora, the year-by-year replenishment of populations requires local source populations. All species of the genus Acropora studied to date are simultaneous hermaphrodites (Baird et al., 2009), with a gametogenic cycle in which eggs develop over a period of about 9 months and testes over about 10 weeks (Babcock et al., 1986; Szmant, 1986; Wallace, 1985). Fecundity in Acropora colonies is generally described as ranging from 3.6 to 15.8 eggs per polyp (Kenyon, 2008; Wallace, 1999). Mature eggs of species of Acropora are large when compared with those of other corals, ranging from 0.53 to 0.90 mm in mean diameter (Wallace, 1999). For five Acropora species examined by Wallace (1985), the minimum reproductive size ranged from 4 to 7 cm, and the estimated ages ranged from 3 to 5 years.

Acropora spp. release gametes as egg-sperm bundles that float to the sea surface, each polyp releasing all its eggs and sperm in one bundle. Fertilization takes place after the bundles break open at the sea surface. Sperm concentrations of 106 ml-1 have been found to be optimal for fertilization in the laboratory, and concentrations of this order have been recorded in the field during mass spawning events. Self-fertilization, although possible, is infrequent. Gametes remain viable and achieve high fertilization rates for up to 8 hours after spawning (Kenyon, 1994). Embryogenesis takes place over several hours, and further development leads to a planula that is competent to settle in 4 to 5 days after fertilization. Acropora spp. can show a high degree of hybridization (Kenyon, 1994; Richards et al., 2008b; Van Oppen et al., 2002; Van Oppen et al., 2000), which can complicate taxonomic classification but allow persistence of the genus if the hybrids are reproductively viable.

As sessile spawners with planktonic larvae, the Critical Risk Threshold assessments for Acropora species must weigh the broad distributions that provide replicated opportunities for potential escape from local disturbances against the necessity to have colonies in close enough proximity to have successful fertilization of enough eggs to replenish the attrition of the spawning stock. If the effective population size (i.e., the number of genotypes [might be substantially less than the number of colonies in highly clonal species] close enough for successful fertilization) becomes too low to replenish the population, then the positive-feedback depensatory processes begin. It is worth noting that Edinger and Risk (1995) concluded that brooding corals survived the harsh environmental conditions better than did the spawners in the western Atlantic during the major extinctions of the Oligocene-Miocene transition period. Many Acropora have branching morphologies, making them potentially susceptible to fragmentation.

Fragment survival can increase coral abundance in the short-term but does not contribute new genotypes (or evolutionary opportunities) to the population.

Population Dynamics

Abundance Veron (2014) reports that A. retusa occupied 0.5 % of 2,984 dive sites sampled in 30 ecoregions of the Indo-Pacific, and had a mean abundance rating of 1.21 on a 1 to 5 rating scale at those sites in which it was found. Based on this semi-quantitative system, the species' abundance was characterized as “rare.” Overall abundance was described as “common in South Africa, rare elsewhere.” The absolute abundance of this species is likely at least millions of colonies (Richards et al. 2008; Veron 2014).

Productivity The overall decline in abundance (“Percent Population Reduction”) was estimated at 49 %, and the decline in abundance before the 1998 bleaching event (“Back-cast Percent Population Reduction”) was estimated at 18 %. However, live coral cover trends are highly variable both spatially and temporally, producing patterns on small scales that can be easily taken out of context, thus quantitative inferences to species-specific trends should be interpreted with caution. At the same time, an extensive body of literature documents broad declines in live coral cover and shifts to reef communities dominated by hardier coral species or algae over the past 50 to 100 years (Birkeland, 2004; Fenner, 2012; Pandolfi et al., 2003; Sale and Szmant, 2012). These changes have likely occurred, and are occurring, from a combination of global and local threats. Given that A. retusa occurs in many areas affected by these broad changes, and that it has some susceptibility to both global and local threats, we conclude that it is likely to have declined in abundance over the past 50 to 100 years, but a precise quantification is not possible due to the limited amount of species-specific information.

Genetic Diversity Although spawners with long larval lives can eventually become distributed over broad geographic areas, as is typical for Acropora, the year-by-year replenishment of populations requires local source populations. For example, Vollmer and Palumbi (2007), using DNA sequence data, determined that Acropora cervicornis in the Caribbean have limited realized gene flow despite long-distance dispersal potential.

Distribution Acropora retusa has been reported to occupy upper reef slopes and tidal pools (Veron, 2000; Veron and Wallace, 1984). Acropora retusa has been reported in water depths ranging from 1 m to 5 m (Carpenter et al., 2008).

Designated Critical Habitat Critical habitat has not yet been designated for this species

Recovery Goals A recovery plan has not yet been developed for this species.

Table 56. Summary of status; Acropora retusa

Criteria	Description
Abundance / productivity trends	The range of these corals is extensive throughout the Indo-Pacific region. Less than 5 % of the population is within the range of the action area. Over-all status unknown. Growth rates of decline or increase are unknown.
Listing status	threatened
Attainment of recovery goals	Recovery plan not yet developed

9.58 Coral species: Acropora speciose

Table 57. Acropora speciosa; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Acropora speciosa	Not Available	NA	Threatened	2014	79 FR 53852	NA	None Designated

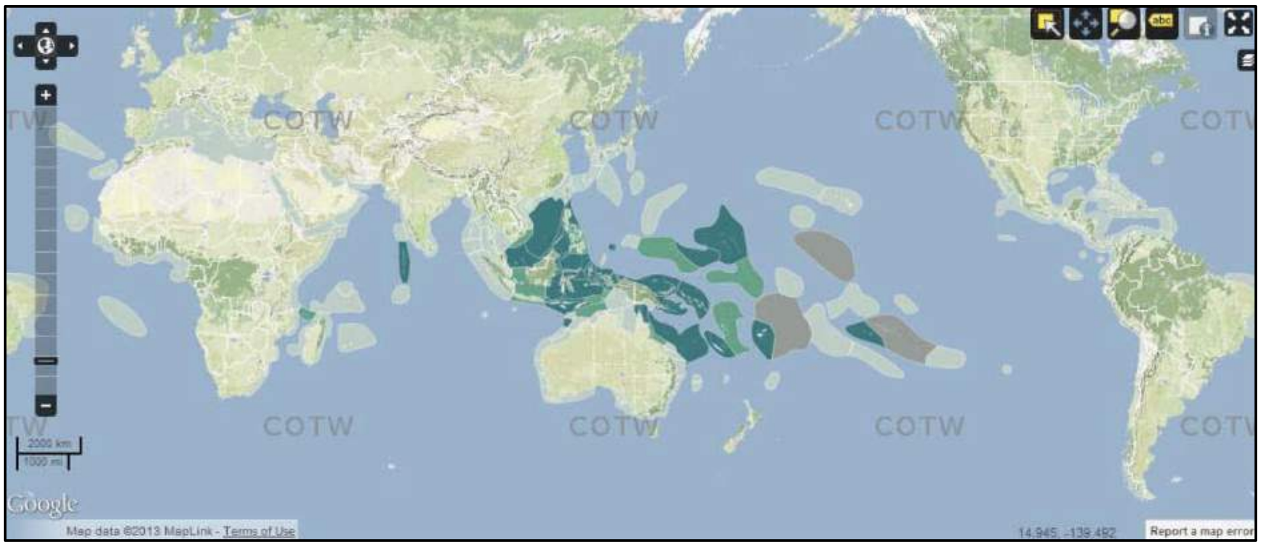

Figure 35. Acropora speciosa distribution. Off-white = no record, dark green = confirmed record, pale green = predicted record, tan = published record that needs further investigation (Veron 2014).

Species Description Colonies of Acropora speciosa form thick cushions or bottlebrush branches. They have large and elongate axial corallites; radial corallites are small and tubular or pocketed. Colonies are cream in color with delicately colored branch tips (Veron, 2000). *Acropora speciosa* is distributed from Indonesia to French Polynesia. The IUCN database lists it in American Samoa, and U.S. minor outlying islands.

Status Acropora speciosa is highly susceptible to ocean warming, disease, ocean acidification, trophic effects of fishing, predation, and nutrient enrichment. These threats are expected to continue and increase into the future. In addition, existing regulatory mechanisms to address global threats that contribute to extinction risk for this species are inadequate. Although A. speciosa' s habitat includes mesophotic depths which may provide some buffering capacity against threats that are more severe in shallower reef environments such as warming, its habitat is quite specialized, which may limit buffering capacity if threats are more pronounced within the type of habitat where the species occurs within. Acropora speciosa's effective population size of 1.2 million genetically distinct colonies could increase vulnerability to extinction if a high proportion of the effective population occurs within the parts of its range most affected by threats, potentially causing the species to decline to such low abundance within the foreseeable future that it may be at risk from depensatory processes, environmental stochasticity, or catastrophic events. The combination of these characteristics and projections of future threats indicates that the species is likely to be in danger of extinction within the foreseeable future throughout its range.

Life history Acropora are sessile colonies that spawn their gametes into the water column, and the azooxanthellate larvae can survive in the planktonic stage from 4 to 209 days (Graham et al., 2008). This has allowed many Acropora species to have very wide geographic ranges, both longitudinally and latitudinally (Wallace, 1999). However, sessile colonies must be within a few meters of each other to have reasonable success in fertilization (Coma and Lasker, 1997). Vollmer and Palumbi (2007), using DNA sequence data, determined that Acropora cervicornis in the Caribbean have limited realized gene flow despite long-distance dispersal potential. Although spawners with long larval lives can eventually become distributed over broad geographic areas, as is typical for Acropora, the year-by-year replenishment of populations requires local source populations. All species of the genus Acropora studied to date are simultaneous hermaphrodites (Baird et al., 2009), with a gametogenic cycle in which eggs develop over a period of about 9 months and testes over about 10 weeks (Babcock et al., 1986; Szmant, 1986; Wallace, 1985). Fecundity in Acropora colonies is generally described as ranging from 3.6 to 15.8 eggs per polyp (Kenyon, 2008; Wallace, 1999). Mature eggs of species of Acropora are large when compared with those of other corals, ranging from 0.53 to 0.90 mm in mean diameter (Wallace, 1999). For five Acropora species examined by Wallace (1985), the minimum reproductive size ranged from 4 to 7 cm, and the estimated ages ranged from 3 to 5 years.

Acropora spp. release gametes as egg-sperm bundles that float to the sea surface, each polyp releasing all its eggs and sperm in one bundle. Fertilization takes place after the bundles break open at the sea surface. Sperm concentrations of 106 ml-1 have been found to be optimal for fertilization in the laboratory, and concentrations of this order have been recorded in the field during mass spawning events. Self-fertilization, although possible, is infrequent. Gametes remain viable and achieve high fertilization rates for up to 8 hours after spawning (Kenyon, 1994). Embryogenesis takes place over several hours, and further development leads to a planula that is competent to settle in 4 to 5 days after fertilization. Acropora spp. can show a high degree of hybridization (Kenyon, 1994; Richards et al., 2008b; Van Oppen et al., 2002; Van Oppen et al., 2000), which can complicate taxonomic classification but allow persistence of the genus if the hybrids are reproductively viable.

As sessile spawners with planktonic larvae, the Critical Risk Threshold assessments for Acropora species must weigh the broad distributions that provide replicated opportunities for potential escape from local disturbances against the necessity to have colonies in close enough proximity to have successful fertilization of enough eggs to replenish the attrition of the spawning stock. If the effective population size (i.e., the number of genotypes [might be substantially less than the number of colonies in highly clonal species] close enough for successful fertilization) becomes too low to replenish the population, then the positive-feedback depensatory processes begin. It is worth noting that Edinger and Risk (1995) concluded that brooding corals survived the harsh environmental conditions better than did the spawners in the western Atlantic during the major extinctions of the Oligocene-Miocene transition period. Many Acropora have branching morphologies, making them potentially susceptible to fragmentation. Fragment survival can increase coral abundance in the short-term but does not contribute new genotypes (or evolutionary opportunities) to the population.

Population Dynamics

Abundance The total world population of this species has been estimated at 10,942,000 colonies, with an effective population size of 1,204,000 colonies (Richards et al. 2008; Veron 2014).

Productivity The overall decline in abundance ("Percent Population Reduction") was estimated at 35 %, and the decline in abundance before the 1998 bleaching event ("Back-cast Percent Population Reduction") was estimated at 14 % (Carpenter et al. 2008). However, live coral cover trends are highly variable both spatially and temporally, producing patterns on small scales that can be easily taken out of context, thus quantitative inferences to species-specific trends should be interpreted with caution. At the same time, an extensive body of literature documents broad declines in live coral cover and shifts to reef communities dominated by hardier coral species or algae over the past 50 to 100 years (Birkeland, 2004; Fenner, 2012; Pandolfi et al., 2003; Sale and Szmant, 2012). These changes have likely occurred, and are occurring, from a combination of global and local threats. Given that A. speciosa occurs in many areas affected by these broad changes, and likely has some susceptibility to both global and local threats, we conclude that it is likely to have declined in abundance over the past 50 to 100 years, but a precise quantification is not possible based on the limited species-specific information.

Genetic Diversity There is little information available regarding the genetic diversity of this species.

Distribution Acropora speciosa has been reported to occupy protected environments with clear water and high diversity of Acropora (Veron, 2000) and steep slopes or deep, shaded waters (IUCN, 2010). Acropora speciosa has been reported in water depths ranging from 12 m to 30 m (Carpenter et al., 2008) and 15 m to 40 m (Richards, 2009). It is found in mesophotic assemblages in American Samoa (Bare et al., 2010), suggesting the potential for deep refugia.

Designated Critical Habitat Critical habitat has not yet been designated for this species

Recovery Goals A recovery plan has not yet been developed for this species.

Table 58. Summary of status; Acropora speciosa

Criteria	Description
Abundance / productivity trends	The range of these corals is extensive throughout the Indo-Pacific region. Less than 5 % of the population is within the range of the action area. Over-all status unknown. Growth rates of decline or increase are unknown.
Listing status	threatened
Attainment of recovery goals	Recovery plan not yet developed

9.59 Coral species: Euphyllia pardivisa

Table 59. Euphyllia pardivisa; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Euphyllia pardivisa	Not Available	NA	Threatened	2014	79 FR 53852	NA	None Designated

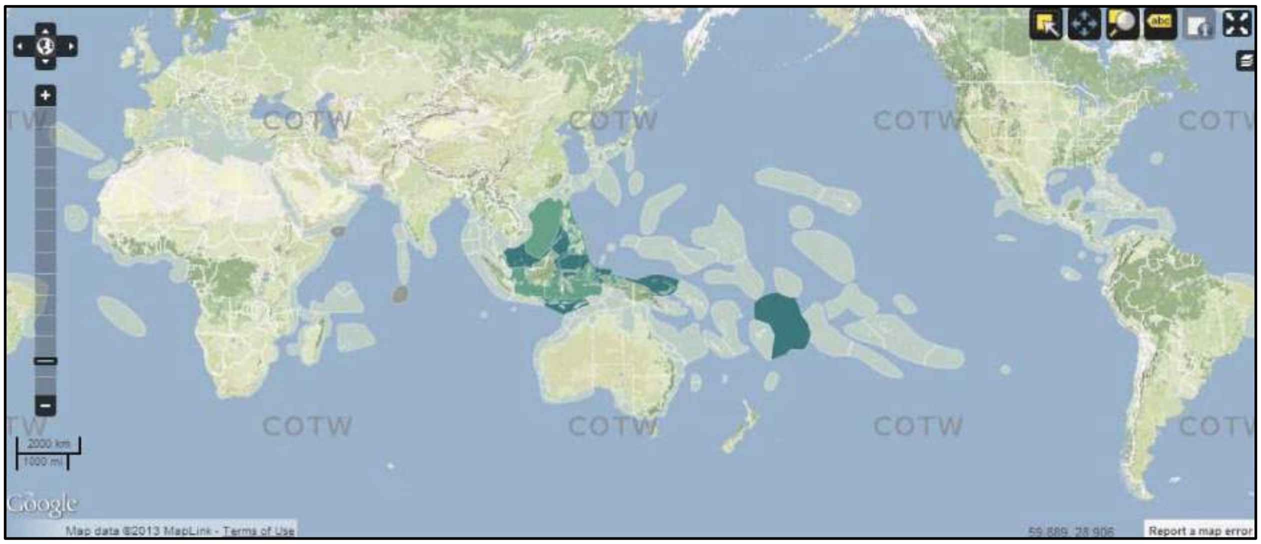

Figure 36. Euphyllia pardivisa distribution. Off-white = no record, dark green = confirmed record, pale green = predicted record, tan = published record that needs further investigation (Veron 2014).

Species Description Colonies are phaceloid, made up of branching separate corallites. Several species in this genus (including Euphyllia glabrescens, Euphyllia paraglabrescens, and Euphyllia paraancora) cannot be distinguished based on skeletal characters, but only by the characters of polyp tentacles. Polyps have branching tentacles almost identical to those of Euphyllia divisa. Color is pale greenish-grey with lighter tentacle tips (Veron, 2000). *Euphyllia paradivisa* has a restricted range, existing only in the highly disturbed Coral Triangle Region. According to the IUCN Species Account, *Euphyllia paradivisa* occurs in American Samoa.

Status Euphyllia paradivisa is susceptible to warming-induced bleaching, disease, ocean acidification, trophic effects of fishing, nutrients, predation, and collection and trade. These threats are expected to continue and worsen into the future. In addition, the species has inadequate existing regulatory mechanisms for global threats. Euphyllia paradivisa' s distribution is limited mostly to the Coral Triangle, which is projected to have the most rapid and severe impacts from climate change and localized human impacts for coral reefs over the 21st century. Multiple ocean warming events have already occurred within the Coral Triangle that suggest future ocean warming events may be more severe than average in this part of the world. A range constrained to this particular geographic area that is likely to experience severe and increasing threats indicates that a high proportion of the population of this species is likely to be exposed to those threats over the foreseeable future. Euphyllia paradivisa' s semi-quantitative abundance is rare. Considering the limited range of this species in an area where severe and increasing impacts are predicted, this level of abundance leaves the species vulnerable to becoming of such low abundance within the foreseeable future that it may be at risk from depensatory processes, environmental stochasticity, or catastrophic events. The combination of these characteristics and projections of future threats indicates that the species is likely to be in danger of extinction within the foreseeable future throughout its range.

Life history Reproductive mode is not known. One congener (Euphyllia ancora) is a gonochoric spawner (Guest et al., 2005a; Willis et al., 1985) while another congener (Euphyllia glabrescens) is reported to be a hermaphroditic brooder in southern Taiwan (Fan et al., 2006). No other information regarding its ecology or life history is available.

Population Dynamics

Abundance Veron (2014) reports that E. paradivisa occupied 0.2 % of 2,984 dive sites sampled in 30 ecoregions of the Indo-Pacific, and had a mean abundance rating of 1.5 on a 1 to 5 rating scale at those sites in which it was found. Based on this semi-quantitative system, the species' abundance was characterized as “rare,” and overall abundance was described as “uncommon.” Veron did not infer trends in abundance from these data. The absolute abundance of this species is likely at least tens of millions of colonies (Richards et al. 2008; Veron 2014).

Productivity The overall decline in abundance was estimated at 38 %, and the decline in abundance before the 1998 bleaching event (“Back-cast Percent Population Reduction”) was estimated at 15 % (Carpenter et al. 2008). However, live coral cover trends are highly variable both spatially and temporally, producing patterns on small scales that can be easily taken out of context. Thus, quantitative inferences to species-specific trends should be interpreted with caution. At the same time, an extensive body of literature documents broad declines in live coral cover and shifts to reef communities dominated by hardier coral species or algae over the past 50 to 100 years (Birkeland, 2004; Fenner, 2012; Pandolfi et al., 2003; Sale and Szmant, 2012). These changes have likely occurred, and are occurring, from a combination of global and local threats. Given that E. paradivisa occurs in many areas affected by these broad changes, and likely has some susceptibility to both global and local threats, we conclude that it is likely to have declined in abundance over the past 50 to 100 years, but a precise quantification is not possible due to the limited species-specific information.

Genetic Diversity There is little information available regarding the genetic diversity of this species.

Distribution Euphyllia paradivisa has been reported from shallow or mid-slope reef environments protected from wave action (Veron, 2000). Euphyllia paradivisa occurs at depths of 5 m to 20 m (IUCN Species Account).

Designated Critical Habitat Critical habitat has not yet been designated for this species

Recovery Goals A recovery plan has not yet been developed for this species.

Table 60. Summary of status; Euphyllia pardivisa

Criteria	Description

Abundance / productivity trends	The range of these corals is extensive throughout the Indo-Pacific region. Less than 5 % of the population is within the range of the action area. Over-all status unknown. Growth rates of decline or increase are unknown.
Listing status	threatened
Attainment of recovery goals	Recovery plan not yet developed

9.60 Coral species: Isopora crateriformis

Table 61. Isopora crateriformis; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Isopora crateriformis	Not Available	NA	Threatened	2014	79 FR 53852	NA	None Designated

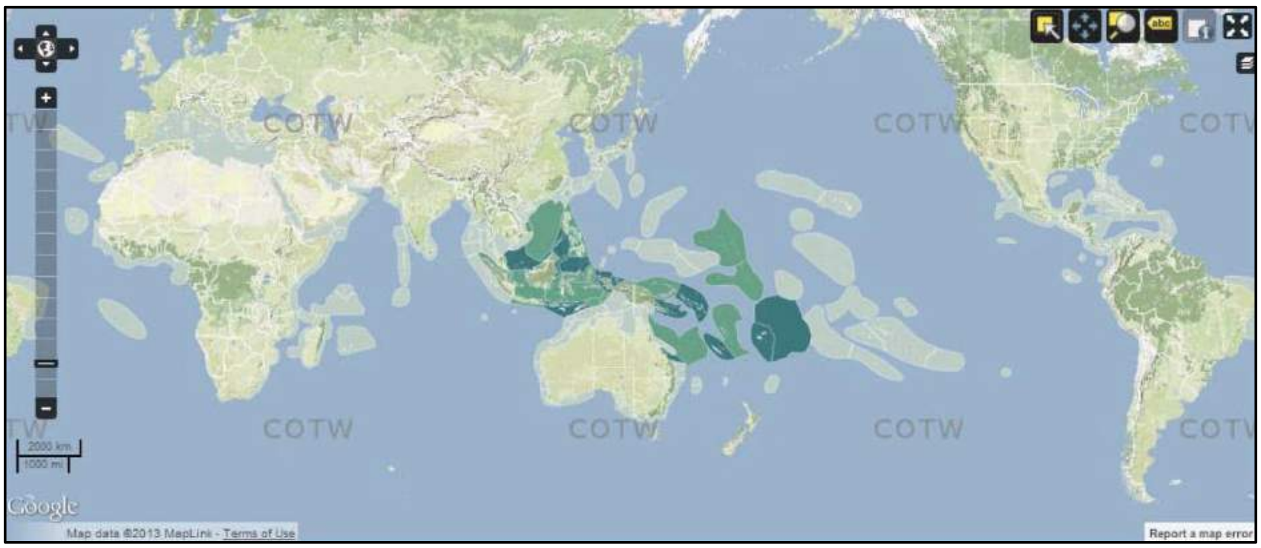

Figure 37. Isopora crateriformis distribution. Off-white = no record, dark green = confirmed record, pale green = predicted record, tan = published record that needs further investigation (Veron 2014).

Species Description Isopora crateriformis forms flattened solid encrusting plates sometimes referred to as "cowpies." They can sometimes be over a meter in diameter. Colonies are brown in color (Veron, 2000). Isopora crateriformis' distribution is from Sumatra (Indonesia) to American Samoa, and there are reports from the western and central Indian Ocean that need confirmation. According to both the IUCN Species Account and the CITES species database, Isopora crateriformis occurs in American Samoa.

Status Isopora crateriformis is highly susceptible to ocean warming, disease, acidification, trophic effects of fishing, and nutrients, and predation. In addition, existing regulatory mechanisms to address global threats that contribute to extinction risk for this species are inadequate. The majority of Isopora crateriformis' distribution is within the Coral Triangle and western equatorial Pacific, which is projected to have the most rapid and severe impacts from climate change and localized human impacts for coral reefs over the 21st century. Multiple ocean warming events have already occurred within the western equatorial Pacific that suggest future ocean warming events may be more severe than average in this part of the world. A range constrained to this particular geographic area that is likely to experience severe and increasing threats indicates that a high proportion of the population of this species is likely to be exposed to those threats over the foreseeable future. Isopora crateriformis' qualitative abundance is rare overall. Considering that much of the range of this species includes areas where severe and increasing impacts are predicted, this level of abundance combined with its restricted depth distribution, leaves the species vulnerable to becoming of such low abundance within the foreseeable future that it may be at risk from depensatory processes, environmental stochasticity, or catastrophic events. The combination of these biological and environmental characteristics and future projections of threats indicates that the species is likely to be in danger of extinction within the foreseeable future throughout its range.

Life history Isopora crateriformis is most likely a simultaneous hermaphroditic brooder as is the closely related Isopora cuneata (Bothwell, 1981). Isopora cuneata planulae lack zooxanthellae, and in some areas the species can undergo several seasonal cycles of larval production (Kojis, 1986). Its brooding life history allows Isopora spp. to locally dominate recruitment at Lord Howe Island, Australia; colonies of this genus also dominate the adult population there, suggesting brooding may drive community structure in remote areas (Harriott, 1992; 1995). Isopora cuneata is not prone to asexual reproduction via fragmentation, based on its semi-encrusting morphology (Bothwell, 1981). The species shows moderate gene flow (Mackenzie et al., 2004) but little potential for large-scale dispersal (Ayre and Hughes, 2004).

Population Dynamics

Abundance Veron (2014) reports that I. crateriformis occupied 0.3 % of 2,984 dive sites sampled in 30 ecoregions of the Indo-Pacific, and had a mean abundance rating of 1.4 on a 1 to 5 rating scale at those sites in which it was found. Based on this semi-quantitative system, the species' abundance was characterized as “rare.” Overall abundance was described as “occasionally common on reef flats.” The absolute abundance of this species is likely at least millions of colonies (Richards et al. 2008; Veron 2014).

Productivity The overall decline in abundance was estimated at 38 %, and the decline in abundance before the 1998 bleaching event (“Back-cast Percent Population Reduction”) was estimated at 14 %. However, live coral cover trends are highly variable both spatially and temporally, producing patterns on small scales that can be easily taken out of context, thus quantitative inferences of species-specific trends should be interpreted with caution. At the same time, an extensive body of literature documents broad declines in live coral cover and shifts to reef communities dominated by hardier coral species or algae over the past 50 to 100 years (Birkeland, 2004; Fenner, 2012; Pandolfi et al., 2003; Sale and Szmant, 2012). These changes have likely occurred, and are occurring, from a combination of global and local threats. Given that I. crateriformis occurs in many areas affected by these broad changes, and likely has some susceptibility to both global and local threats, we conclude that it is likely to have declined in abundance over the past 50 to 100 years, but a precise quantification is not possible based on the limited species-specific information.

Genetic Diversity The species shows moderate gene flow (Mackenzie et al., 2004) but little potential for large-scale dispersal (Ayre and Hughes, 2004).

Distribution Isopora crateriformis is found most commonly in shallow, high-wave energy environments. Isopora craterformis has been reported in water depths ranging from low tide commonly to at least 12 m (Birkeland, 1987). The species was recently reported (as Acropora crateriformis) on mesophotic reefs (< 50 m depth) in American Samoa (Bare et al., 2010).

Designated Critical Habitat Critical habitat has not yet been designated for this species

Recovery Goals A recovery plan has not yet been developed for this species.

Table 62. Summary of status; Isopora crateriformis

Criteria	**Description**
Abundance / productivity trends	The range of these corals is extensive throughout the Indo-Pacific region. Less than 5 % of the population is within the range of the action area. Over-all status unknown. Growth rates of decline or increase are unknown.
Listing status	threatened
Attainment of recovery goals	Recovery plan not yet developed

9.61 Coral species: Seriatopora aculata

Table 63. Seriatopora aculeata; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Seriatopora aculeata	Not Available	NA	Threatened	2014	79 FR 53852	NA	None Designated

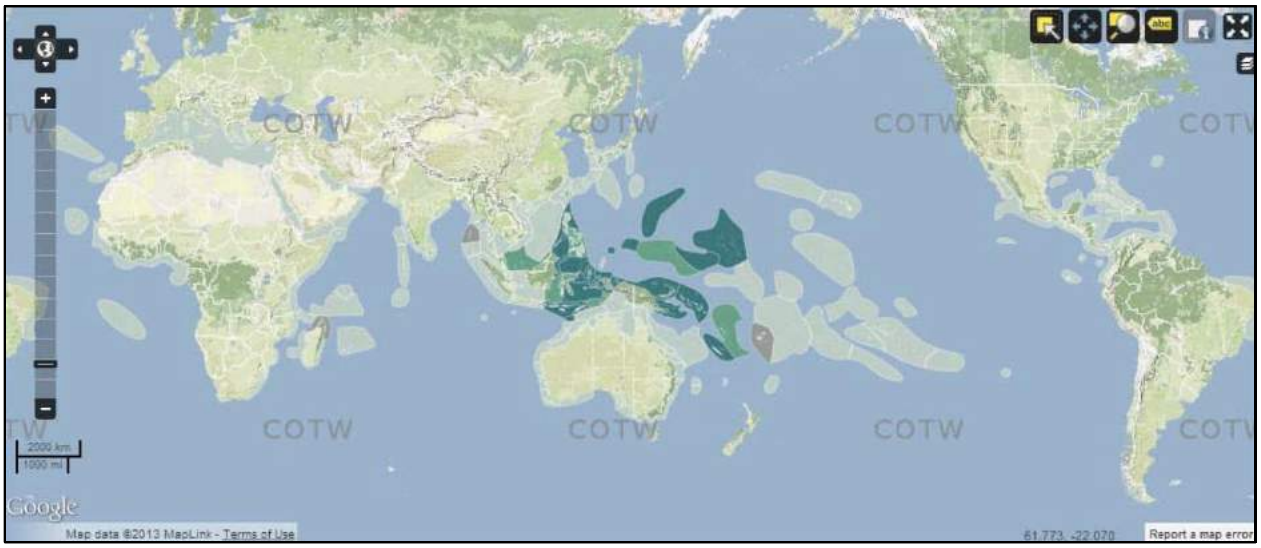

Figure 38. Seriatopora aculeata distribution. Off-white = no record, dark green = confirmed record, pale green = predicted record, tan = published record that needs further investigation (Veron 2014).

Species Description Colonies of Seriatopora aculeata have thick, short, tapered branches, usually in fused clumps. Their corallites are irregularly distributed, and tentacles are commonly extended during the day. Colonies are pink or cream in color (Veron, 2000). Seriatopora aculeata is distributed from Australia, Fiji, Indonesia, Japan, Papua New Guinea, and Madagascar to the Marshall Islands. According to the IUCN Species Account, Seriatopora aculeata has also been recorded in the Northern Mariana Islands.

Status Seriatopora aculeata is highly susceptible to ocean warming, disease, ocean acidification, trophic effects of fishing, nutrients, and collection and trade. In addition, existing regulatory mechanisms to address global threats that contribute to extinction risk for this species are inadequate. Seriatopora aculeata's distribution is constrained to the Coral Triangle and western equatorial Pacific, which is projected to have the most rapid and severe impacts from climate change and localized human impacts for coral reefs over the 21st century, as described in the Threats Evaluation. Multiple ocean warming events have already occurred within the western equatorial Pacific that suggest future ocean warming events may be more severe than average in this part of the world. A range constrained to this particular geographic area that is likely to experience severe and increasing threats indicates that a high proportion of the population of this species is likely to be exposed to those threats over the foreseeable future. The combination of these characteristics and projections of future threats indicates that the species is likely to be in danger of extinction within the foreseeable future throughout its range.

Life history The reproductive characteristics of Seriatopora aculeata have not been determined, but its congeners are hermaphroditic brooders (Rinkevich and Loya, 1979a; Shlesinger and Loya, 1985; Yamazato et al., 1991). The larvae of the other Seriatopora species studied contain zooxanthellae, leading to the development of autotrophic larvae that can supplement maternal provisioning with energy sources provided by their photosynthetic symbionts (Baird et al., 2009). The minimum size and estimated age at first reproduction have not been determined for Seriatopora aculeata. However, for the congener Seriatopora hystrix, the minimum diameter is 8 cm and the estimated age at first reproduction is 1–2 years (Stimson, 1978). Larval longevity has not been determined in this genus. Seriatopora hystrix can undergo polyp bailout during environmentally stressful conditions and successfully reattach (though at low rates) to the substrate (Sammarco, 1982); however, this potential mode of asexual reproduction has not been documented for Seriatopora aculeata.

Population Dynamics

Abundance Veron (2014) reports that S. aculeata occupied 10.3 % of 2,984 dive sites sampled in 30 ecoregions of the Indo-Pacific, and had a mean abundance rating of 1.70 on a 1 to 5 rating scale at those sites in which it was found. Based on this semi-quantitative system, the species' abundance was characterized as “common,” and overall abundance was described as “uncommon.” The absolute abundance of this species is likely at least millions of colonies (Richards et al. 2008; Veron 2014).

Productivity The overall decline in abundance was estimated Start Printed Page 53981at 37 %, and the decline in abundance before the 1998 bleaching event (“Back-cast Percent Population Reduction”) was estimated at 14 % (Carpenter et a. 2014). However, as summarized above in the Inter-basin Comparison sub-section, live coral cover trends are highly variable both spatially and temporally, producing patterns on small scales that can be easily taken out of context, thus quantitative inferences to species-specific trends should be interpreted with caution. At the same time, an extensive body of literature documents broad declines in live coral cover and shifts to reef communities dominated by hardier coral species or algae over the past 50 to 100 years (Birkeland, 2004; Fenner, 2012; Pandolfi et al., 2003; Sale and Szmant, 2012). These changes have likely occurred, and are occurring, from a combination of global and local threats. Given that S. aculeata occurs in many areas affected by these broad changes, and that it has some susceptibility to both global and local threats, we conclude that it is likely to have declined in abundance over the past 50 to 100 years, but quantification is not possible based on the limited species-specific information.

Genetic Diversity There is little information available regarding the genetic diversity of this species.

Distribution Seriatopora aculeata has been reported to occupy shallow reef environments (Veron, 2000). Seriatopora aculeata has been reported in water depths ranging from 3 m to 40 m (Carpenter et al., 2008).

Designated Critical Habitat Critical habitat has not yet been designated for this species

Recovery Goals A recovery plan has not yet been developed for this species.

Table 64. Summary of status; Seriatopora aculeata

Criteria	Description
Abundance / productivity trends	The range of these corals is extensive throughout the Indo-Pacific region. Less than 5 % of the population is within the range of the action area. Over-all status unknown. Growth rates of decline or increase are unknown.
Listing status	threatened
Attainment of recovery goals	Recovery plan not yet developed

CHAPTER 9C

STATUS OF SPECIES AND CRITICAL HABITAT LIKELY TO BE ADVERSELY AFFECTED

SEA TURTLES, CETACEANS, PINNIPEDS, SEAGRASS

TABLE OF CONTENTS

9 STATUS OF SPECIES AND CRITICAL HABITAT LIKELY TO BE ADVERSELY AFFECTED

9.1 Introduction

The purpose of this section is to characterize the condition and status of the 77 species[1] that are likely to be adversely affected by the action, and to describe the status, conservation role and function of their respective critical habitats.
The status of species includes the existing level of risk that the Endangered Species Act (ESA)-listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. The species status section helps to inform the description of the species' current "reproduction, numbers, or distribution," which is part of the jeopardy determination as described in 50 C.F.R. §402.02.

This section also examines the condition of critical habitat throughout the designated area (such as various watersheds and coastal and marine environments that make up the designated area), and discusses the condition and current function of designated critical habitat, including the essential physical and biological features that contribute to that conservation value of the critical habitat.

The National Marine Fisheries Service (NMFS) has determined that the following species and critical habitat designations may occur in the action area (***Table 1***). More detailed information on the status of these species and critical habitat are found in a number of published documents including recent recovery plans, status reviews, stock assessment reports, and technical memorandums. Many are available on the Internet at http://www.nmfs.noaa.gov/pr/species/.

Table 1. Listed Species and Critical Habitat (denoted by asterisk) in the Action Area.

Common Name (Distinct Population Segment(DPS) or Evolutionarily Significant Unit (ESU))	Scientific Name	Status
Atlantic salmon, Gulf of Maine ESU*	Salmo salar	ENDANGERED
Chum salmon , Columbia River ESU*	Oncorhynchus keta	THREATENED
Chum salmon, Hood Canal summer-run ESU*		THREATENED
Chinook salmon, California coastal ESU*	Oncorhynchus tshawytscha	THREATENED
Chinook salmon, Central Valley spring-run ESU*		THREATENED
Chinook salmon, Lower Columbia River ESU*		THREATENED
Chinook salmon, Puget Sound ESU*		THREATENED
Chinook salmon, Sacramento River winter-run ESU*		ENDANGERED
Chinook salmon, Snake River fall-run ESU*		THREATENED
Chinook salmon, Snake River spring/summer run ESU*		THREATENED
Chinook salmon, Upper Columbia River spring-run ESU*		ENDANGERED

[1] We use the word "species" as it has been defined in section 3 of the ESA, which include "species, subspecies, and any distinct population segment (DPS) of any species of vertebrate fish or wildlife which interbreeds when mature (16 U.S.C 1533)." Pacific salmon other than steelhead that have been listed as endangered or threatened were listed as "evolutionarily significant units" (ESU), which NMFS uses to identify distinct population segments of Pacific salmon. Any ESU or DPS is a "species" for the purposes of the ESA.

Common Name (Distinct Population Segment(DPS) or Evolutionarily Significant Unit (ESU))	Scientific Name	Status
Chinook salmon, Upper Willamette River ESU*		THREATENED
Coho salmon, Central California coast ESU*	Oncorhynchus kisutch	ENDANGERED
Coho salmon, Lower Columbia River ESU*		THREATENED
Coho salmon, Oregon coast ESU*		THREATENED
Coho salmon, S. Oregon and N. Calif coasts ESU*		THREATENED
Sockeye, Ozette Lake ESU*	Oncorhynchus nerka	THREATENED
Sockeye, Snake River ESU*		ENDANGERED
Steelhead, California Central Valley DPS*	Oncorhynchus mykiss	THREATENED
Steelhead, Central California coast DPS*		THREATENED
Steelhead, Lower Columbia River DPS*		THREATENED
Steelhead, Middle Columbia River DPS*		THREATENED
Steelhead, Northern California DPS*		THREATENED
Steelhead, Puget Sound DPS*		THREATENED
Steelhead, Snake River Basin DPS*		THREATENED
Steelhead, South-Central California coast DPS*		THREATENED
Steelhead, Southern California DPS*		ENDANGERED
Steelhead, Upper Columbia River DPS*		THREATENED
Steelhead, Upper Willamette River DPS*		THREATENED
Eulachon, Pacific smelt, Southern DPS*	Thaleichthys pacificus	THREATENED
Green sturgeon, Southern DPS*	Acipenser medirostris	THREATENED
Shortnose sturgeon	Acipenser brevirostrum	ENDANGERED
Atlantic sturgeon, Carolina DPS	Acipenser oxyrinchus desotoi	ENDANGERED
Atlantic sturgeon, Chesapeake Bay DPS		ENDANGERED
Atlantic sturgeon, Gulf of Maine DPS		THREATENED
Atlantic sturgeon, New York Bight DPS		ENDANGERED
Atlantic sturgeon, South Atlantic DPS		ENDANGERED
Gulf sturgeon*	Acipenser oxyrinchus oxyrinchus	THREATENED
Yelloweye rockfish*	Sebastes ruberrimus	THREATENED
Boccacio, Puget Sound/Georgia Basin*	Sebastes paucispinis	ENDANGERED
Gulf grouper	Mycteroperca jordani	ENDANGERED
Nassau grouper	Epinephelus striatus	THREATENED
Smalltooth sawfish, U.S. DPS*	Pristis pectinata	ENDANGERED
Black abalone*	Haliotis cracherodii	ENDANGERED
White abalone	Haliotis sorenseni	ENDANGERED
Staghorn coral*	Acropora cervicornis	THREATENED
Elkhorn coral*	Acropora palmata	THREATENED
Coral, no common name	Acropora globiceps	THREATENED
Coral, no common name	Acropora jacquelineae	THREATENED
Coral, no common name	Acropora retusa	THREATENED
Coral, no common name	Acropora speciosa	THREATENED
Coral, no common name	Euphyllia pardivisa	THREATENED
Coral, no common name	Isopora crateriformis	THREATENED
Coral, no common name	Seriatopora aculeata	THREATENED
Boulder star coral	Orbicella franksi	THREATENED

Common Name (Distinct Population Segment(DPS) or Evolutionarily Significant Unit (ESU))	Scientific Name	Status
Lobed star coral	Orbicella annularis	THREATENED
Mountainous star coral	Orbicella faveolata	THREATENED
Pillar coral	Dendrogyra cylindrus	THREATENED
Rough cactus coral	Mycetophyllia ferox	THREATENED
Green sea turtle, Central North Pacific DPS	Chelonia mydas	THREATENED
Green sea turtle, Central South Pacific DPS		ENDANGERED
Green sea turtle, Central West Pacific DPS		ENDANGERED
Green sea turtle, East Pacific DPS		THREATENED
Green sea turtle, North Atlantic DPS*		THREATENED
Green sea turtle, South Atlantic DPS		THREATENED
Hawksbill sea turtle*	Eretmochelys imbricata	ENDANGERED
Kemp's ridley sea turtle	Lepidochelys kempii	ENDANGERED
Leatherback sea turtle*	Dermochelys coriacea	ENDANGERED
Loggerhead sea turtle, North Pacific Ocean DPS	Caretta caretta	ENDANGERED
Loggerhead sea turtle, Northwest Atlantic Ocean DPS*		THREATENED
Olive ridley sea turtle, Mexico's Pacific Coast breeding colonies	Lepidochelys olivacea	ENDANGERED
Olive ridley sea turtle, all other areas		THREATENED
Killer whale, Southern Resident DPS*	Orcinus orca	ENDANGERED
Steller sea lion, Western*	Eumetopias jubatus	ENDANGERED
Guadalupe fur seal	Arctocephalus townsendi	THREATENED
Hawaiian monk seal*	Monachus schauinslandi	ENDANGERED
Johnson's seagrass*	Halophila johnsonii	THREATENED

The following narratives summarize the biology and ecology of threatened and endangered species that are likely to be adversely affected by EPA's proposed action. The summaries include a description of the timing and duration of each life stage (e.g. adult river entry, spawning, egg incubation, freshwater rearing, smolt outmigration, and ocean migration). We also highlight information related to the viability of populations and the physical or biological features essential for the conservation of the species (PBFs) of designated critical habitats. These summaries provide a foundation for NMFS' evaluation of the effects of the proposed action on these listed species.

In assessing the status of the listed species NMFS made use of the viable salmonid population (VSP) concept and its four criteria. NMFS used these criteria to assess salmonids and, where appropriate, non-salmonid species. A VSP is an independent population (a population of which extinction probability is not substantially affected by exchanges of individuals with other populations) with a negligible risk of extinction, over a 100-year period, when threats from random catastrophic events, local environmental variation, demographic variation, and genetic diversity changes are taken into account (McElhany et al. 2000). The four factors defining a viable population are a population's: (1) spatial structure; (2) abundance; (3) annual growth rate, including trends and variability of annual growth rates; and (4) diversity (McElhany et al. 2000).

A population's tendency to increase in abundance and its variation in annual population growth defines a viable population (McElhany et al. 2000; Morris and Doak 2002). A negative long-term trend in average annual population growth rate will eventually result in extinction. Further, a weak positive long-term growth rate will increase the risk of extinction as it maintains a small population at low abundances over a longer time frame. A large variation in the growth rates also increases the likelihood of extinction (Lande 1993; Morris and Doak 2002). Thus, in our status reviews of each listed species, we provide information on population abundance and annual growth rate of extant populations.

The action area for this consultation contains designated critical habitat. Critical habitat is defined as the specific areas within the geographical area occupied by the species, at the time it is listed, on which are found those physical or biological features that are essential to the conservation of the species, and which may require special management considerations or protection. Critical habitat can also include specific areas outside the geographical area occupied by the species at the time it is listed that are determined by the Secretary to be essential for the conservation of the species (ESA of 1973, as amended, section 3(5)(A)).

The primary purpose in evaluating the status of critical habitat is to identify for each ESU or DPS the function of the critical habitat to support the intended conservation role for each species. Such information is important for an adverse modification analysis as it establishes the context for evaluating whether the proposed action results in negative changes in the function and role of the critical habitat for species conservation. NMFS bases its critical habitat analysis on the areas of the critical habitat that are affected by the proposed action and the area's physical or biological features that are essential to the conservation of a given species, and not on how individuals of the species will respond to changes in habitat quantity and quality.

In evaluating the status of designated critical habitat, we consider the current quantity, quality, and distribution of the physical or biological features (PBFs[2]) that are essential for the conservation of the species. NMFS has identified PBFs of critical habitat for each life stage (*e.g.,* migration, spawning, rearing, and estuary) common for a number of species (see Appendix C). To fully understand the conservation role of these habitats, specific physical and biological habitat features (*e.g.,* water temperature, water quality, forage, natural cover, etc.) were identified for each life stage.

Besides potential toxicity, water free of contaminants is important as contaminants can disrupt normal behavior necessary for successful migration, spawning, and juvenile rearing. Sufficient forage is necessary for juveniles to maintain growth that reduces freshwater predation mortality, increases overwintering success, initiates smoltification, and increases ocean survival. Natural cover such as submerged and overhanging large wood and aquatic vegetation provides shelter from predators, shades freshwater to prevent increase in water temperature, and creates important side channels. A description of the past, ongoing, and continuing activities that threaten the functional condition of PBFs and their attributes are described in the environmental baseline section of this Opinion.

The information from the status of the species section may be used as a "risk modifier" in the Integration and Synthesis section (Chapters 19-24). Factors which have the potential to "modify" the risk of the action jeopardizing the species are those which are able to interact with the effects of the action. While many of the factors described in this section have the potential to modify the

[2] Some of the critical habitat designations used the term "primary constituent elements" or PCEs, a regulatory that is no longer in effect. PCEs are generally the same as PBFs, and we will use the terms interchangeably based on the description in the critical habitat designation.

risk, and were thus considered, three of the factors within the status of the species were consistently found to have a high potential to modify the risk. Those three factors are: 1) trends in abundance, spatial distribution, and productivity; 2) listing status; and 3) achievement of recovery goals. We therefore developed three key questions to guide our synthesis of the information within the status of the species section:

1. Are abundance, spatial distribution, and productivity trends increasing, decreasing or stable?
2. Is the species listed as threatened or endangered?
3. Have recovery goals been met or are they on a sustained positive trajectory toward recovery?

Each status section within Chapter 9 concludes with a table providing a brief response to each of these questions.

Within the Integration and Synthesis section (Chapters 19-24) we characterize the overall magnitude of influence of the species status as either “low” or “high”. This characterization includes directionality (i.e. positive influence which equates to less risk or negative influence which equates to more risk) as well as confidence. The magnitude, directionality, and confidence of the influence are determined primarily by answers provided to the three key questions outlined above. We acknowledge that the magnitude, and directionality of these three factors varies on a species-by-species basis (for example, the significance of the attainment of recovery goals are relative to the specifics of the recovery goals themselves). We further acknowledge that the quantitative data (e.g. estimates of population growth rates) are incomplete without considering the more qualitative data often provided in recovery plans, status reports and listing documents. Therefore, we characterized magnitude and directionality with the following guidelines: 1) If the listing status of the species is “endangered”, the magnitude is high and the directionality is negative; 2) If the listing status is “threatened” and both of the other two factors indicates stability and/or recovery and/or uncertainty than the magnitude is low and the directionality is negative; 3) if the listing status is “threatened” and the other two factors indicate population decline and failure to meet recovery goals than the magnitude is high and the directionality is negative. It is conceivable directionality could also be positive. For example, if the listing status is “threatened” and the population’s growth rate, abundance, and spatial distribution has been consistently increasing between status reports, the direction could be positive. However, none of the species evaluated in this Opinion exhibited this.

The overall confidence in the magnitude and directionality is then characterized as either “low” or “high”. Confidence is determined by assessing the amount of evidence provided, as well as by further considering the species specific implications of the three factors.

9.2 Green Sea Turtle, Central North Pacific DPS

Table 2. Green Sea Turtle, Central North Pacific DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Chelonia mydas	Green Turtle	Central North Pacific	Threatened	2015	81 FR 20057	63 FR 28359	None Designated

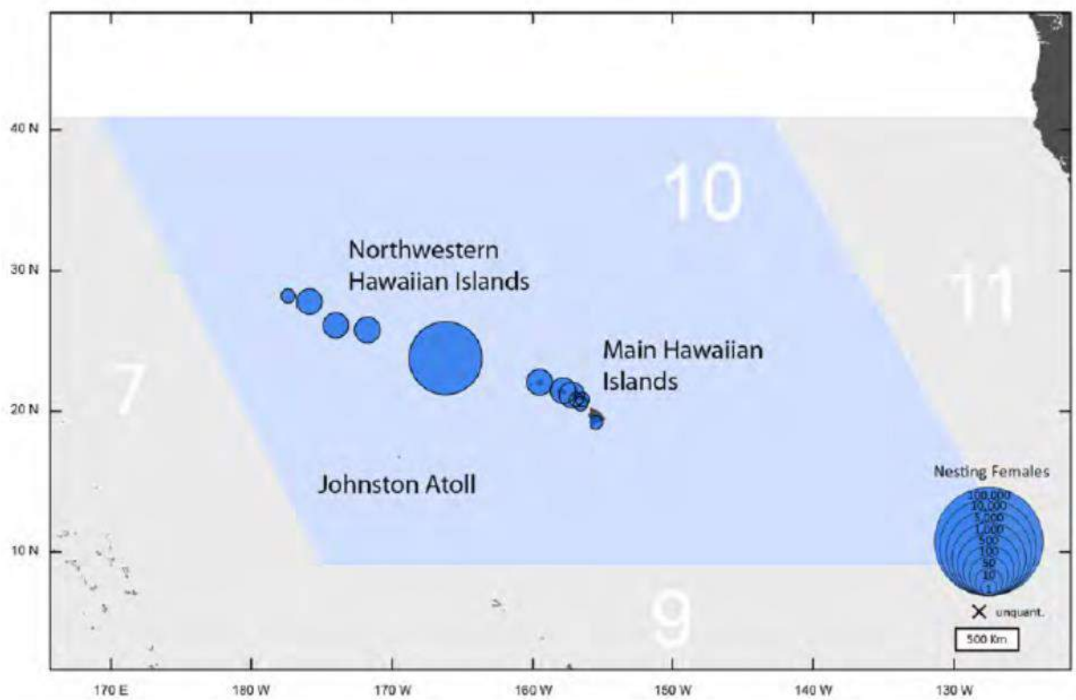

Figure 1. Green Sea Turtle, Central North Pacific DPS range. From Seminoff et al. 2015.

Species Description The green sea turtle is globally distributed and commonly inhabits nearshore and inshore waters. The Central North Pacific DPS green turtle is found in the Pacific Ocean near the Hawaiian Archipelago and Johnston Atoll.

Figure 2. Green sea turtle. Photo: Mark Sullivan, NOAA.

The green sea turtle is the largest of the hardshell marine turtles, growing to a weight of 350 pounds (159 kilograms) and a straight carapace length of greater than 3.3 feet (1 meter) (***Figure 2***). The species was listed under the ESA on July 28, 1978 (43 FR 32800). The species was separated into two listing designations: endangered for breeding populations in Florida and the Pacific coast of Mexico and threatened in all other areas throughout its range. On April 6, 2016, NMFS listed eleven DPSs of green sea turtles as threatened or endangered under the ESA (81 FR 20057). The Central North Pacific DPS is listed as threatened.

Status Green turtles in the Hawaiian Archipelago were subjected to hunting pressure for subsistence and commercial trade, which was largely responsible for the decline in the region. Though the practice has been banned, there are still anecdotal reports of harvest. Incidental bycatch in fishing gear, ingestion of marine debris, and the loss of nesting habitat due to sea level rise are current threats to the population. Although these threats persist, the increase in annual nesting abundance, continuous scientific monitoring, legal enforcement and conservation programs are all factors that favor the resiliency of the DPS.

Life history Age at first reproduction for females is twenty to forty years. Green sea turtles lay an average of three nests per season with an average of one hundred eggs per nest. The remigration interval (i.e., return to natal beaches) is two to five years. Nesting occurs primarily on beaches with intact dune structure, native vegetation and appropriate incubation temperatures during summer months. After emerging from the nest, hatchlings swim to offshore areas and go through a post-hatchling pelagic stage where they are believed to live for several years. During this life stage, green sea turtles feed close to the surface on a variety of marine algae and other life associated with drift lines and debris. Adult turtles exhibit site fidelity and migrate hundreds to thousands of kilometers from nesting beaches to foraging areas. Green sea turtles spend the majority of their lives in coastal foraging grounds, which include open coastlines and protected bays and lagoons. Adult green turtles feed primarily on seagrasses and algae, although they also eat jellyfish, sponges and other invertebrate prey.

Population Dynamics

Abundance Worldwide, nesting data at 464 sites indicate that 563,826 to 564,464 females nest each year. There are thirteen known nesting sites for the Central North Pacific DPS, with an estimated 3,846 nesting females. The DPS is very thoroughly monitored, and it is believed there is little chance that there are undocumented nesting sites. The largest nesting site is at French Frigate Shoals, Hawaii, which hosts 96% of the nesting females for the DPS (Seminoff et al. 2015).

Productivity / Population Growth Rate Nesting surveys have been conducted since 1973. Nesting abundance at East Island, French Frigate Shoals, increases at 4.8% annually (Seminoff et al. 2015).

Genetic Diversity The majority of nesting for the Central North Pacific DPS is centered at one site on French Frigate Shoals, and there is little diversity in nesting areas. Overall, the Central North Pacific has a relatively low level of genetic diversity and stock sub-structuring (Seminoff et al. 2015).

Distribution The green turtle has a circumglobal distribution, occurring throughout nearshore tropical, subtropical and, to a lesser extent, temperate waters. Green turtles in the Central North Pacific DPS are found in the Hawaiian Archipelago and Johnston Atoll. The major nesting site for the DPS is at East Island, French Frigate Shoals, in the Northwestern Hawaiian islands; lesser nesting sites are found throughout the Northwestern Hawaiian Islands and the Main Hawaiian Islands.

Designated Critical Habitat No critical habitat has been designated for the Central North Pacific DPS green turtle.

Recovery Goals See the 1998 and 1991 recovery plans for the Pacific, East Pacific and Atlantic populations of green turtles for complete down-listing/delisting criteria for recovery goals for the species. Broadly, recovery plan goals emphasize the need to protect and manage nesting and marine habitat, protect and manage populations on nesting beaches and in the marine environment, increase public education, and promote international cooperation on sea turtle conservation topics.

Table 3. Summary of status; Green Sea Turtle, Central North Pacific DPS

Criteria	**Description**
Abundance / productivity trends	Population nesting abundance is increasing at estimated rate of 4.8% annually. DPS has low level of genetic diversity. Population currently resilient.
Listing status	threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	NA

9.3 Green Sea Turtle, Central South Pacific DPS

Table 4. Green Sea Turtle, Central South Pacific DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Chelonia mydas	Green Turtle	Central South Pacific	Endangered	2015	81 FR 20057	N/A	None Designated

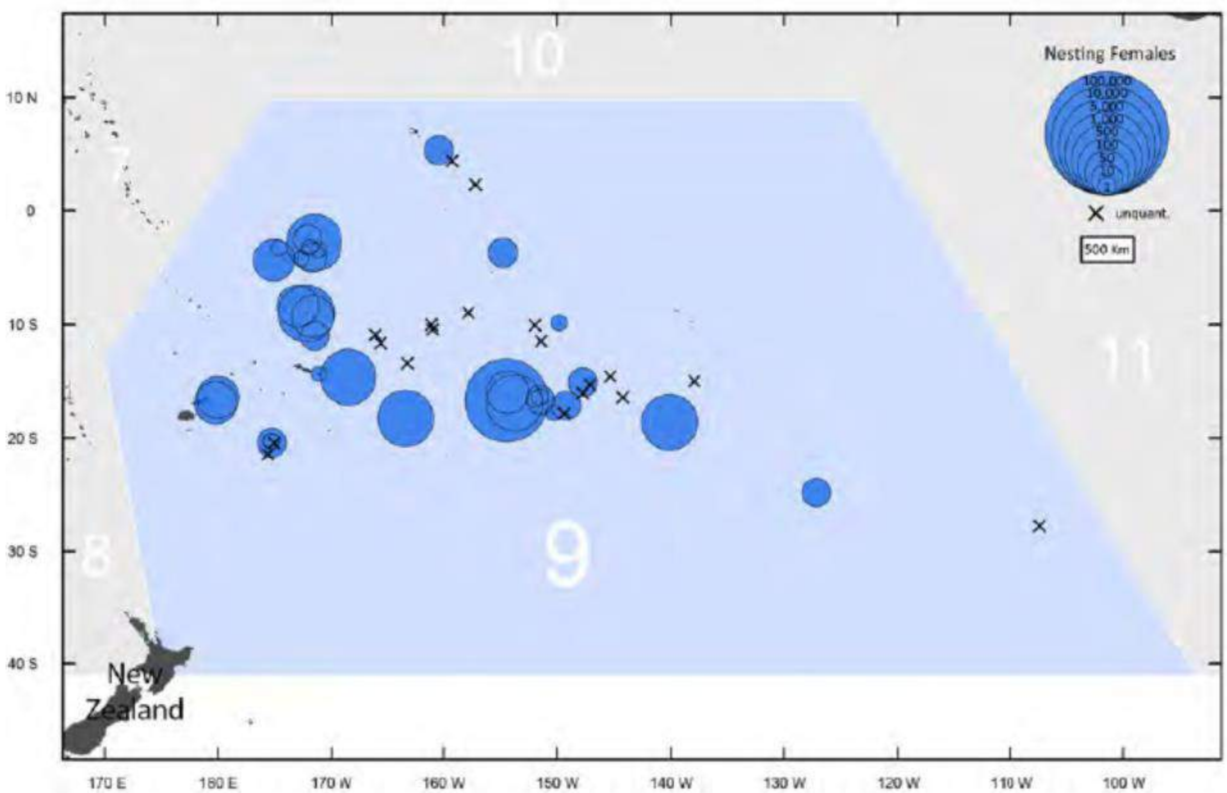

Figure 3. Green Sea Turtle, Central South Pacific DPS range. From seminoff et al. 2015.

Species Description The green sea turtle is globally distributed and commonly inhabits nearshore and inshore waters. The Central South Pacific DPS green turtle is found in the South Pacific Ocean throughout several island groups.

The green sea turtle is the largest of the hardshell marine turtles, growing to a weight of 350 pounds (159 kilograms) and a straight carapace length of greater than 3.3 feet (1 meter). The species was listed under the ESA on July 28, 1978 (43 FR 32800). The species was separated into two listing designations: endangered for breeding populations in Florida and the Pacific coast of Mexico and threatened in all other areas throughout its range. On April 6, 2016, NMFS listed eleven DPSs of green sea turtles as threatened or endangered under the ESA (81 FR 20057). The Central South Pacific DPS is listed as endangered.

Status Historically, the Central South Pacific DPS declined due to harvest of eggs and females for human consumption or for their shells, a practice that still continues throughout the region. Incidental bycatch in commercial and artisanal fishing gear, lack of regulatory mechanisms and climate change are significant threats to the long-term viability of the DPS.

Life history Age at first reproduction for females is twenty to forty years. Green sea turtles lay an average of three nests per season with an average of one hundred eggs per nest. The remigration interval (i.e., return to natal beaches) is two to five years. Nesting occurs primarily on beaches with intact dune structure, native vegetation and appropriate incubation temperatures during summer months. After emerging from the nest, hatchlings swim to offshore areas and go through a post-hatchling pelagic stage where they are believed to live for several years. During this life stage, green sea turtles feed close to the surface on a variety of marine algae and other life associated with drift lines and debris. Adult turtles exhibit site fidelity and migrate hundreds to thousands of kilometers from nesting beaches to foraging areas. Green sea turtles spend the majority of their lives in coastal foraging grounds, which include open coastlines and protected bays and lagoons. Adult green turtles feed primarily on seagrasses and algae, although they also eat jellyfish, sponges and other invertebrate prey.

Population Dynamics

Abundance Worldwide, nesting data at 464 sites indicate that 563,826 to 564,464 females nest each year. Nesting abundance information for the Central South Pacific DPS is limited, but is considered to be at low levels and spread out over a large geographic area. There are 59 known nesting sites (22 are unquantified), with an estimated 2,677 nesting females. The largest nesting site is at Scilly Atoll in French Polynesia, which hosts 36% of the nesting females for the DPS (Seminoff et al. 2015).

Figure 4. Green sea turtle. Photo: Mark Sullivan, NOAA.

Productivity / Population Growth Rate There are no estimates of population growth for the Central South Pacific DPS. The DPS suffers from a lack of consistent, systematic nesting monitoring, with no nesting site having even five years of continuous data. What data are available indicate steep declines at Scilly Atoll due to illegal harvest, with some smaller nesting sites (e.g., Rose Atoll) showing signs of stability (Seminoff et al. 2015).

Genetic Diversity There is very limited information available for the Central South Pacific DPS. Mitochondrial DNA studies indicate at least two genetic stocks in the DPS—American Samoa and French Polynesia. Overall, there is a moderate level of diversity for the DPS, and the presence of unique haplotypes (Seminoff et al. 2015).

Distribution The green turtle has a circumglobal distribution, occurring throughout nearshore tropical, subtropical and, to a lesser extent, temperate waters. The Southwest Pacific DPS extends off the eastern coast of Australia, south of Papua New Guinea and goes east to encompass Vanuatu and New Caledonia. Major nesting sites for the DPS include the Great Barrier Reef, eastern Torres Strait and the northern Great Barrier Reef. Nesting also occurs in New Caledonia, Vanuatu and the Coral Sea Islands.

Designated Critical Habitat No critical habitat has been designated for the Central South Pacific DPS green turtle. NMFS cannot designate critical habitat in foreign waters.

Recovery Goals NMFS has not prepared a Recovery Plan for the Central South Pacific DPS green turtle. In general, listed species which occur entirely outside U.S. jurisdiction are not likely to benefit from recovery plans (55 FR 24296; June 15, 1990).

Table 5. Summary of status; Green Sea Turtle, Central South Pacific DPS

Criteria	**Description**
Abundance / productivity trends	Nesting abundance considered low with only 59 known sites. Estimation of population growth rates have been difficult to make due to paucity of data. What little data that does exist suggests steep declines due to illegal harvest of eggs. Much of the nesting areas is outside of the action area
Listing status	endangered
Attainment of recovery goals	criteria not yet met
Condition of PBFs	NA

9.4 Green Sea Turtle, Central West Pacific DPS

Table 6. Green Sea Turtle, Central West Pacific DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Chelonia mydas	Green Turtle	Central West Pacific	Endangered	2015	81 FR 20057	N/A	None Designated

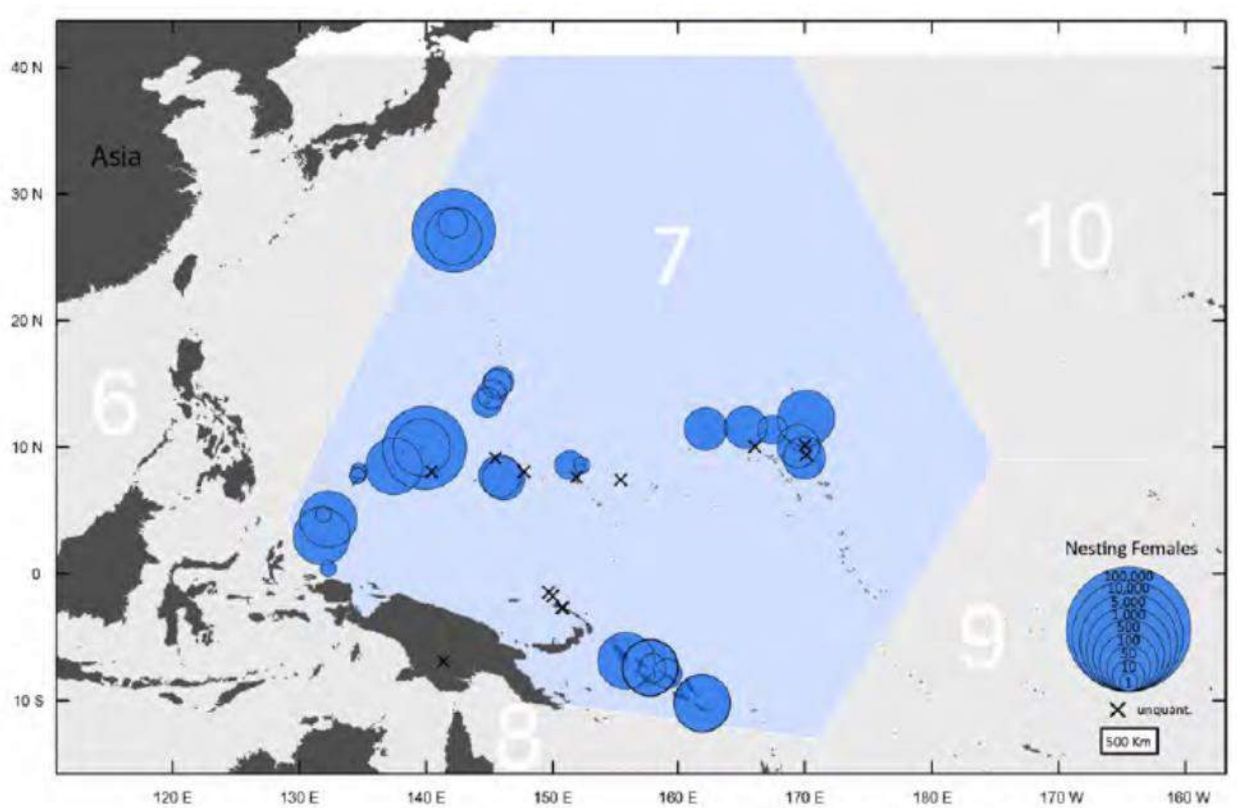

Figure 5. Green Sea Turtle, Central West Pacific DPS range. From Seminoff et al. 2015.

Species Description The green sea turtle is globally distributed and commonly inhabits nearshore and inshore waters. The Central West Pacific DPS green turtle is found in the Pacific Ocean near Papua New Guinea, and West Papua, Indonesia.

The green sea turtle is the largest of the hardshell marine turtles, growing to a weight of 350 pounds (159 kilograms) and a straight carapace length of greater than 3.3 feet (1 meter). The species was listed under the ESA on July 28, 1978 (43 FR 32800). The species was separated into two listing designations: endangered for breeding populations in Florida and the Pacific coast of Mexico and threatened in all other areas throughout its range. On April 6, 2016, NMFS listed eleven DPSs of green sea turtles as threatened or endangered under the ESA (81 FR 20057). The Central West Pacific DPS is listed as endangered.

Status The Central West Pacific DPS is impacted by incidental bycatch in fishing gear, predation of eggs by ghost crabs and rats, and directed harvest eggs and nesting females for human consumption. Historically, intentional harvest of eggs from nesting beaches was one of the principal causes for decline, and this practice continues today in many locations. The Central West Pacific DPS has a small number of nesting females and a widespread geographic range. These factors, coupled with the threats facing the DPS and the unknown status of many nesting sites makes the DPS vulnerable to future perturbations.

Figure 6. Green sea turtle. Photo: Mark Sullivan, NOAA.

Life history Age at first reproduction for females is twenty to forty years. Green sea turtles lay an average of three nests per season with an average of one hundred eggs per nest. The remigration interval (i.e., return to natal beaches) is two to five years. Nesting occurs primarily on beaches with intact dune structure, native vegetation and appropriate incubation temperatures during summer months. After emerging from the nest, hatchlings swim to offshore areas and go through a post-hatchling pelagic stage where they are believed to live for several years. During this life stage, green sea turtles feed close to the surface on a variety of marine algae and other life associated with drift lines and debris. Adult turtles exhibit site fidelity and migrate hundreds to thousands of kilometers from nesting beaches to foraging areas. Green sea turtles spend the majority of their lives in coastal foraging grounds, which include open coastlines and protected bays and lagoons. Adult green turtles feed primarily on seagrasses and algae, although they also eat jellyfish, sponges and other invertebrate prey.

Population Dynamics

Abundance Worldwide, nesting data at 464 sites indicate that 563,826 to 564,464 females nest each year. There are 51 nesting sites in the Central West Pacific DPS, with an estimated 6,518 nesting females. The largest nesting site is in the Federated States of Micronesia, which hosts 22% of the nesting females for the DPS (Seminoff et al. 2015).

Productivity / Population Growth Rate There are no estimates of population growth rates for the Central West Pacific DPS. Long-term nesting data is lacking for many of the nesting sites in the Central West Pacific DPS, making it difficult to assess population trends. The only site which as long-term data available—Chichijima, Japan—shows a positive trend in population growth (Seminoff et al. 2015).

Genetic Diversity The Central West Pacific DPS is made up of insular rookeries separated by broad geographic distances. Rookeries that are more than 1,000 km apart are significantly differentiated, while rookeries 500 km apart are not. Mitochondrial DNA analyses suggest that there are at least seven independent stocks in the region (Dutton et al. 2014).

Distribution The green turtle has a circumglobal distribution, occurring throughout nearshore tropical, subtropical and, to a lesser extent, temperate waters. The Central West Pacific DPS is composed of nesting assemblages in the Federated States of Micronesia, the Japanese islands of

Chichijima and Hahajima, the Marshall Islands, and Palau. Green turtles in this DPS are found throughout the western Pacific Ocean, in Indonesia, the Philippines, the Marshall Islands and Papua New Guinea.

Designated Critical Habitat No critical habitat has been designated for the Central West Pacific DPS green turtle. NMFS cannot designate critical habitat in foreign waters.

Recovery Goals NMFS has not prepared a Recovery Plan for the Central West Pacific DPS green turtle. In general, listed species which occur entirely outside U.S. jurisdiction are not likely to benefit from recovery plans (55 FR 24296; June 15, 1990).

Table 7. Summary of status; Green Sea Turtle, Central West Pacific DPS

Criteria	Description
Abundance / productivity trends	Population vulnerable to future perturbations because of continuing practice to harvest eggs. Genetic studies suggest there are at least seven independent stocks that comprise the DPS. There are no estimates of population growth rates for the Central West Pacific DPS. Long-term nesting data is lacking for many of the nesting sites in the Central West Pacific DPS, making it difficult to assess population trends. The only site which as long-term data available—Chichijima, Japan—shows a positive trend in population growth. Most of species range is outside of the action area.
Listing status	endangered
Attainment of recovery goals	criteria not yet met
Condition of PBFs	NA

9.5 Green Sea Turtle, East Pacific DPS

Table 8. Green Sea Turtle, East Pacific DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Chelonia mydas	Green Turtle	East Pacific	Threatened	2015	81 FR 20057	63 FR 28359	None Designated

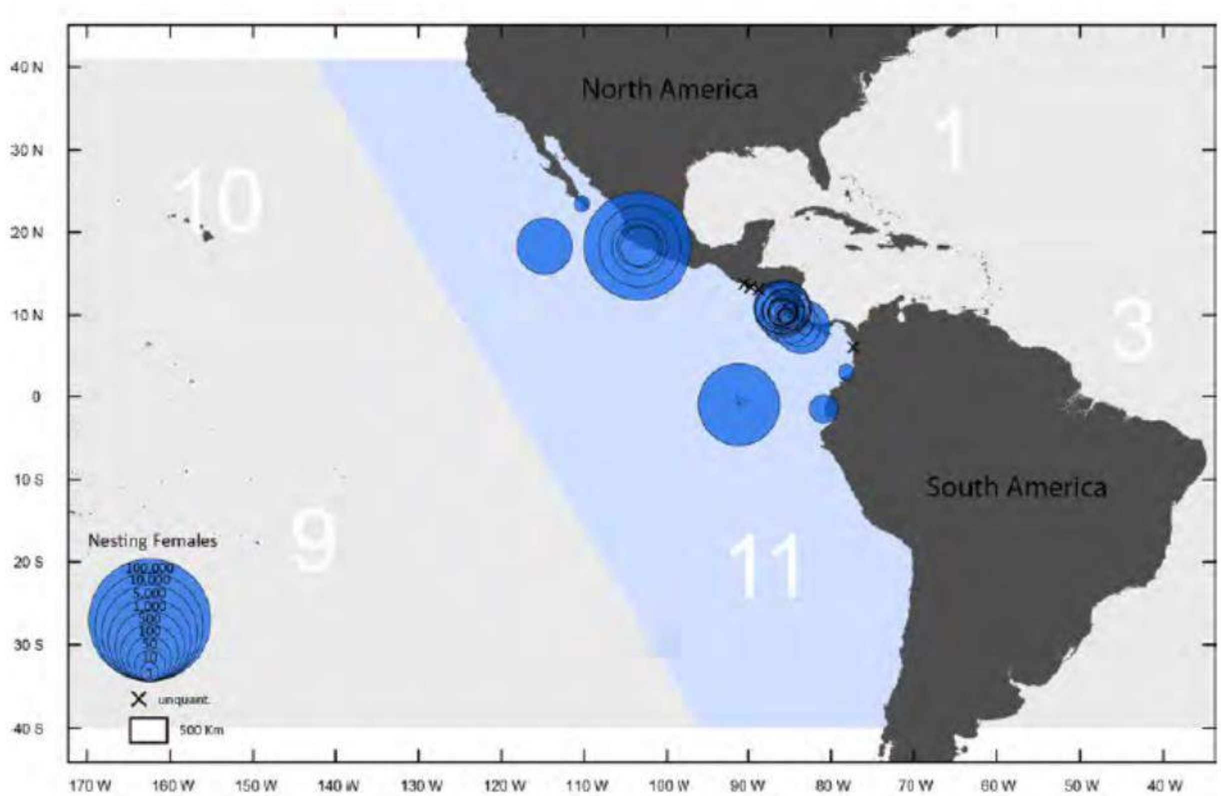

Figure 7. Green Sea Turtle, East Pacific DPS range. From Seminoff et al. 2015.

Species Description The green sea turtle is globally distributed and commonly inhabits nearshore and inshore waters. The East Pacific DPS green turtle is found in the Pacific Ocean from California south to Chile.

The green sea turtle is the largest of the hardshell marine turtles, growing to a weight of 350 pounds (159 kilograms) and a straight carapace length of greater than 3.3 feet (1 meter). The species was listed under the ESA on July 28, 1978 (43 FR 32800). The species was separated into two listing designations: endangered for breeding populations in Florida and the Pacific coast of Mexico and threatened in all other areas throughout its range. On April 6, 2016, NMFS listed eleven DPSs of green sea turtles as threatened or endangered under the ESA (81 FR 20057). The East Pacific DPS is listed as threatened.

Status The population decline for the East Pacific DPS was primarily caused by commercial harvest of green turtles for subsistence and other uses (e.g., sea turtle oil as a cold remedy). Conservation laws are in place in several countries across the range of the DPS, but enforcement is inconsistent, limiting effectiveness. Incidental bycatch in commercial fishing gear, continued harvest, coastal development and beachfront lighting are all continuing threats for the DPS. The observed increases in nesting abundance for the largest nesting aggregation in the region (Michocán, Mexico), a stable trend at Galapagos, and record high numbers at sites in Costa Rica suggest that the population is resilient, particularly in Mexico.

Life history Age at first reproduction for females is twenty to forty years. Green sea turtles lay an average of three nests per season with an average of one hundred eggs per nest. The remigration interval (i.e., return to natal beaches) is two to five years. Nesting occurs primarily on beaches with intact dune structure, native vegetation and appropriate incubation temperatures during summer months. After emerging from the nest, hatchlings swim to offshore areas and go through a post-hatchling pelagic stage where they are believed to live for several years. During this life stage, green sea turtles feed close to the surface on a variety of marine algae and other life associated with drift lines and debris. Adult turtles exhibit site fidelity and migrate hundreds to thousands of kilometers from nesting beaches to foraging areas. Green sea turtles spend the majority of their lives in coastal foraging grounds, which include open coastlines and protected bays and lagoons. Adult green turtles feed primarily on seagrasses and algae, although they also eat jellyfish, sponges and other invertebrate prey.

Population Dynamics

Abundance Worldwide, nesting data at 464 sites indicate that 563,826 to 564,464 females nest each year. There are 39 nesting sites for the East Pacific DPS, with an estimated 20,062 nesting females. The largest nesting site is at Colola, Mexico, which hosts 58% of the nesting females for the DPS (Seminoff et al. 2015).

Figure 8. Green sea turtle. Photo: Mark Sullivan, NOAA.

Productivity / Population Growth Rate There are no estimates of population growth for the East Pacific DPS. Only one nesting site in the East Pacific DPS at Colola, Mexico, has sufficient long-term data to determine population trends. Data analysis indicates that the population there is increasing and is likely to continue to do so (Seminoff et al. 2015).

Genetic Diversity Genetic sampling has identified four regional stocks in the East Pacific DPS—Revillagigedos Archipelago, Mexico, Michoacán, Mexico, Central America (Costa Rica), and the Galapagos Islands, Ecuador (Seminoff et al. 2015).

Distribution The green turtle has a circumglobal distribution, occurring throughout nearshore tropical, subtropical and, to a lesser extent, temperate waters. Green turtles in the East Pacific DPS are found from the California/Oregon border south to central Chile. Major nesting sites occur at Michoacán, Mexico, and the Galapagos Islands, Ecuador. Smaller nesting sites are found on the Pacific Coast of Costa Rica, and in the Revillagigedos Archipelago, Mexico. Scattered nesting occurs in Columbia, Ecuador, Guatemala and Peru (Seminoff et al. 2015).

Designated Critical Habitat No critical habitat has been designated for the East Pacific DPS green turtle.

Recovery Goals See the 1998 and 1991 recovery plans for the Pacific, East Pacific and Atlantic populations of green turtles for complete down-listing/delisting criteria for recovery goals for the species. Broadly, recovery plan goals emphasize the need to protect and manage nesting and marine habitat, protect and manage populations on nesting beaches and in the marine environment, increase public education, and promote international cooperation on sea turtle conservation topics.

Table 9. Summary of status; Green Sea Turtle, East Pacific DPS

Criteria	Description
Abundance / productivity trends	There are 39 nesting sites for the East Pacific DPS, with an estimated 20,062 nesting females. The largest nesting site is at Colola, Mexico, which hosts 58% of the nesting females for the DPS where monitoring data suggests the population is increasing.
Listing status	threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	NA

9.6 Green Sea Turtle, North Atlantic DPS

Table 10. Green Sea Turtle, North Atlantic DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Chelonia mydas	Green Turtle	North Atlantic (4 sub-populations)	Threatened	2015	81 FR 20057	1991	63 FR 46693

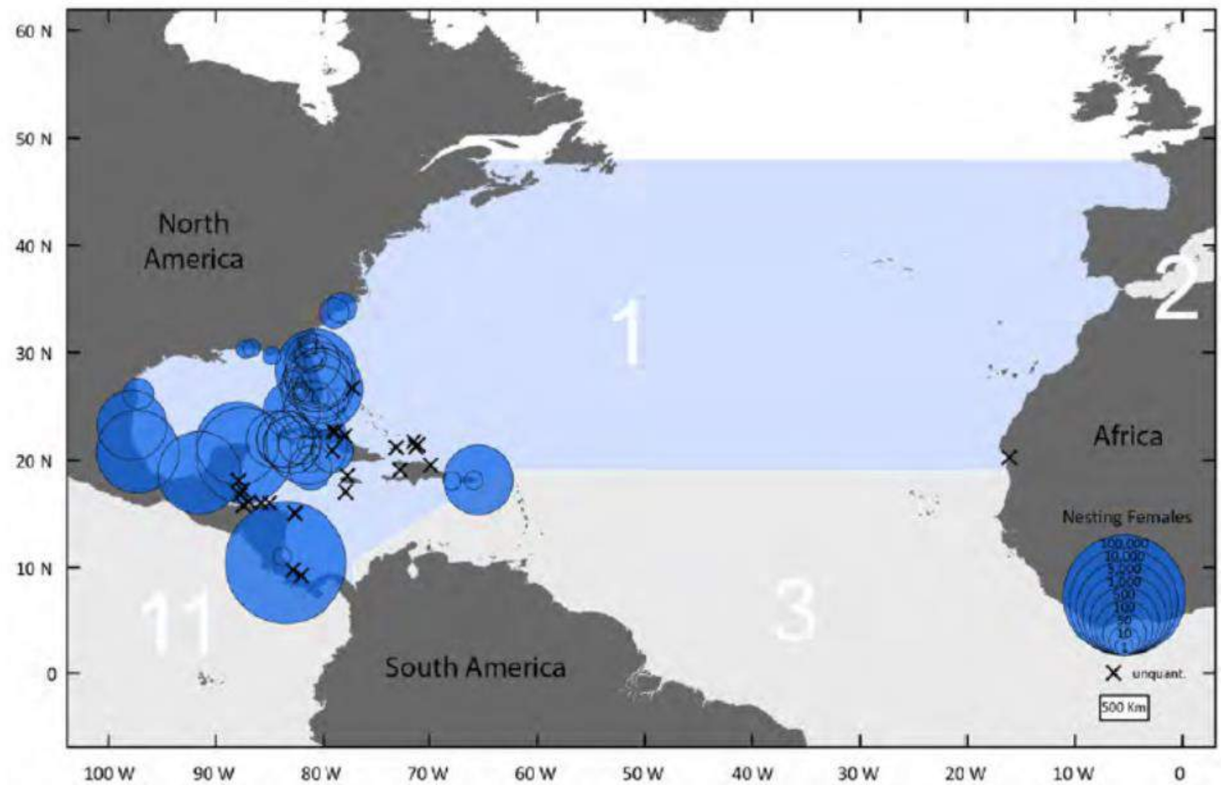

Figure 9. Green Sea Turtle, North Atlantic DPS range. From Seminoff et al. 2015.

Species Description The green sea turtle is globally distributed and commonly inhabits nearshore and inshore waters. The North Atlantic DPS green turtle is found in the north Atlantic Ocean and Gulf of Mexico.

The green sea turtle is the largest of the hardshell marine turtles, growing to a weight of 350 pounds (159 kilograms) and a straight carapace length of greater than 3.3 feet (1 meter). The species was listed under the ESA on July 28, 1978 (43 FR 32800). The species was separated into two listing designations: endangered for breeding populations in Florida and the Pacific coast of Mexico and threatened in all other areas throughout its range. On April 6, 2016, NMFS listed eleven DPSs of green sea turtles as threatened or endangered under the ESA (81 FR 20057). The North Atlantic DPS is listed as threatened.

Status Historically, green turtles in the North Atlantic DPS were hunted for food, which was the principle cause of the population's decline. Apparent increases in nester abundance for the North Atlantic DPS in recent years are encouraging but must be viewed cautiously, as the datasets represent a fraction of a green sea turtle generation, up to fifty years. While the threats of pollution, habitat loss through coastal development, beachfront lighting, and fisheries bycatch continue, the North Atlantic DPS appears to be somewhat resilient to future perturbations.

Life history Age at first reproduction for females is twenty to forty years. Green sea turtles lay an average of three nests per season with an average of one hundred eggs per nest. The remigration interval (i.e., return to natal beaches) is two to five years. Nesting occurs primarily on beaches with intact dune structure, native vegetation and appropriate incubation temperatures during summer months. After emerging from the nest, hatchlings swim to offshore areas and go through a post-hatchling pelagic stage where they are believed to live for several years. During this life stage, green sea turtles feed close to the surface on a variety of marine algae and other life associated with drift lines and debris. Adult turtles exhibit site fidelity and migrate hundreds to thousands of kilometers from nesting beaches to foraging areas. Green sea turtles spend the majority of their lives in coastal foraging grounds, which include open coastlines and protected bays and lagoons. Adult green turtles feed primarily on seagrasses and algae, although they also eat jellyfish, sponges and other invertebrate prey.

Population Dynamics

Abundance Worldwide, nesting data at 464 sites indicate that 563,826 to 564,464 females nest each year (Seminoff et al. 2015). Compared to other DPSs, the North Atlantic DPS exhibits the highest nester abundance, with approximately 167,424 females at 73 nesting sites, and available data indicate an increasing trend in nesting. The largest nesting site in the North Atlantic DPS is in Tortuguero, Costa Rica, which hosts 79% of nesting females for the DPS (Seminoff et al. 2015).

Figure 10. Green sea turtle. Photo: Mark Sullivan, NOAA.

Productivity / Population Growth Rate For the North Atlantic DPS, the available data indicate an increasing trend in nesting. There are no reliable estimates of population growth rate for the DPS as a whole, but estimates have been developed at a localized level. Modeling by Chaloupka et al. (2008) using data sets of twenty-five years or more show the Florida nesting stock at the Archie Carr National Wildlife Refuge growing at an annual rate of 13.9%, and the Tortuguero, Costa Rica, population growing at 4.9%.

Genetic Diversity The North Atlantic DPS has a globally unique haplotype, which was a factor in defining the discreteness of the population for the DPS. Evidence from mitochondrial DNA studies indicates that there are at least four independent nesting subpopulations in Florida, Cuba, Mexico and Costa Rica (Seminoff et al. 2015). More recent genetic analysis indicates that designating a new western Gulf of Mexico management unit might be appropriate (Shamblin et al. 2016).

Distribution The green turtle has a circumglobal distribution, occurring throughout nearshore tropical, subtropical and, to a lesser extent, temperate waters. Green turtles from the North Atlantic DPS range from the boundary of South and Central America (7.5°N, 77°W) in the south, throughout the Caribbean, the Gulf of Mexico, and the U.S. Atlantic coast to New Brunswick, Canada (48°N, 77°W) in the north. The range of the DPS then extends due east along latitudes 48°N and 19°N to the western coasts of Europe and Africa. Nesting occurs primarily in Costa Rica, Mexico, Florida and Cuba.

Designated Critical Habitat On September 2, 1998, NMFS designated critical habitat for green sea turtles (63 FR 46694), which include coastal waters surrounding Culebra Island, Puerto Rico. Seagrass beds surrounding Culebra provide important foraging resources for juvenile, subadult and adult green sea turtles. Additionally, coral reefs surrounding the island provide resting shelter and protection from predators. This area provides important developmental habitat for the species. Activities that may affect the critical habitat include beach renourishment, dredge and fill activities, coastal construction, and freshwater discharge. Due to its location, this critical habitat would be accessible by individuals of the North Atlantic DPS.

Recovery Goals See the 1998 and 1991 recovery plans for the Pacific, East Pacific and Atlantic populations of green turtles for complete down-listing/delisting criteria for recovery goals for the species. Broadly, recovery plan goals emphasize the need to protect and manage nesting and marine habitat, protect and manage populations on nesting beaches and in the marine environment, increase public education, and promote international cooperation on sea turtle conservation topics.

Table 11. Summary of status; Green Sea Turtle, North Atlantic DPS

Criteria	**Description**
Abundance / productivity trends	There are 39 nesting sites for the East Pacific DPS, with an estimated 20,062 nesting females. The largest nesting site is at Colola, Mexico, which hosts 58% of the nesting females for the DPS where monitoring data suggests the population is increasing.
Listing status	threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Disease; Point and non-point pollution; Marine debris continues to build in critical habitat.

9.7 Green Sea Turtle, South Atlantic DPS

Table 12. Green Sea Turtle, South Atlantic DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Chelonia mydas	Green Turtle	South Atlantic	Threatened	2015	81 FR 20057	N/A	None Designated

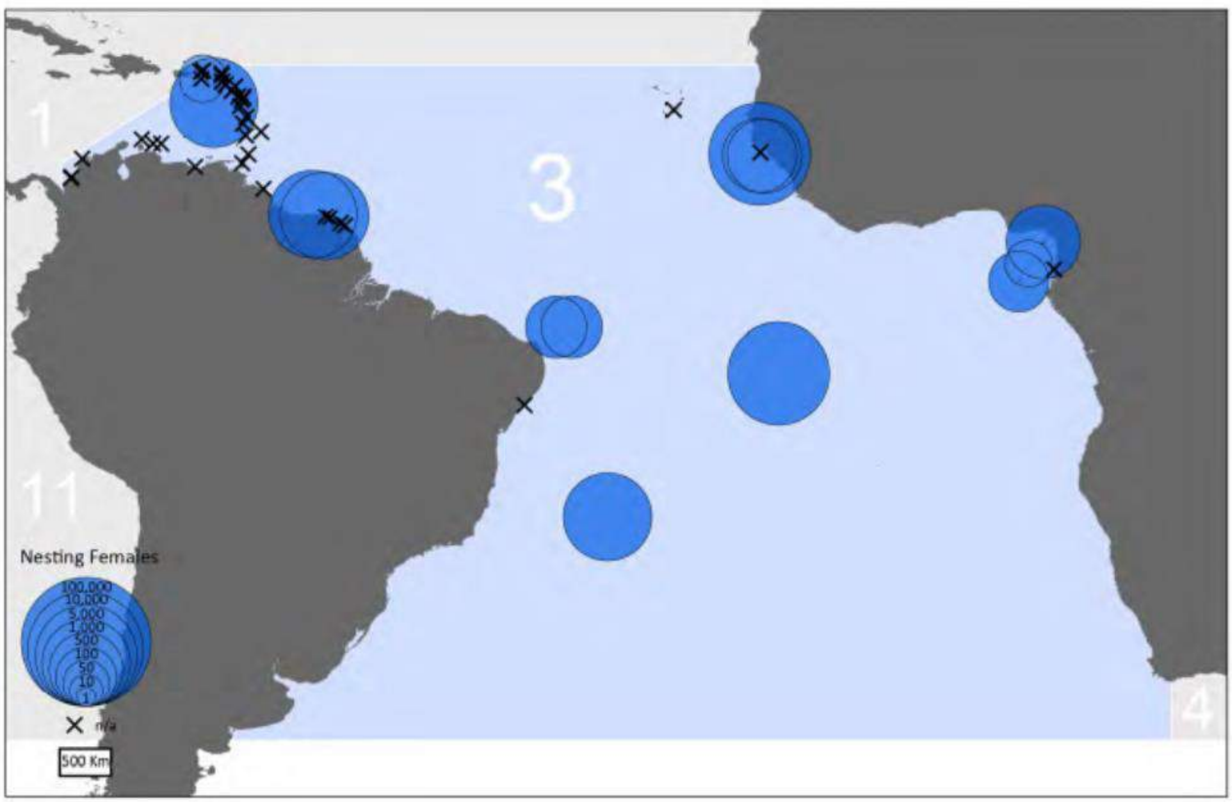

Figure 11. Green Sea Turtle, South Atlantic DPS range. From Seminoff et al. 2015.

Species Description The green sea turtle is globally distributed and commonly inhabits nearshore and inshore waters. The South Atlantic DPS green turtle is found in the Atlantic Ocean from South America to the west coast of Africa.

The green sea turtle is the largest of the hardshell marine turtles, growing to a weight of 350 pounds (159 kilograms) and a straight carapace length of greater than 3.3 feet (1 meter). The species was listed under the ESA on July 28, 1978 (43 FR 32800). The species was separated into two listing designations: endangered for breeding populations in Florida and the Pacific coast of Mexico and threatened in all other areas throughout its range. On April 6, 2016, NMFS listed eleven DPSs of green sea turtles as threatened or endangered under the ESA (81 FR 20057). The South Atlantic DPS is listed as threatened.

Status Though there is some evidence that the South Atlantic DPS is increasing, there is a considerable amount of uncertainty over the impacts of threats to the South Atlantic DPS. The DPS is threatened by habitat degradation at nesting beaches, and mortality from fisheries bycatch remains a primary concern.

Life history Age at first reproduction for females is twenty to forty years. Green sea turtles lay an average of three nests per season with an average of one hundred eggs per nest. The remigration interval (i.e., return to natal beaches) is two to five years. Nesting occurs primarily on beaches with intact dune structure, native vegetation and appropriate incubation temperatures during summer months. After emerging from the nest, hatchlings swim to offshore areas and go through a post-hatchling pelagic stage where they are believed to live for several years. During this life stage, green sea turtles feed close to the surface on a variety of marine algae and other life associated with drift lines and debris. Adult turtles exhibit site fidelity and migrate hundreds to thousands of kilometers from nesting beaches to foraging areas. Green sea turtles spend the majority of their lives in coastal foraging grounds, which include open coastlines and protected bays and lagoons. Adult green turtles feed primarily on seagrasses and algae, although they also eat jellyfish, sponges and other invertebrate prey.

Figure 12. Green sea turtle. Photo: Mark Sullivan, NOAA.

Population Dynamics

Abundance Worldwide, nesting data at 464 sites indicate that 563,826 to 564,464 females nest each year. The South Atlantic DPS has 51 nesting sites, with an estimated nester abundance of 63,332. The largest nesting site is at Poilão, Guinea-Bissau, which hosts 46% of nesting females for the DPS (Seminoff et al. 2015).

Productivity / Population Growth Rate There are fifty-one nesting sites for the South Atlantic DPS, and many have insufficient data to determine population growth rates or trends. Of the nesting sites where data are available, such as Ascension Island, Suriname, Brazil, Venezuela, Equatorial Guinea, and Guinea-Bissau, there is evidence that population abundance is increasing (Seminoff et al. 2015).

Genetic Diversity Individuals from nesting sites in Brazil, Ascension Island, and western Africa have a shared haplotype found in high frequencies. Green turtles from rookeries in the eastern Caribbean however, are dominated by a different haplotype (Seminoff et al. 2015).

Distribution The green turtle has a circumglobal distribution, occurring throughout nearshore tropical, subtropical and, to a lesser extent, temperate waters. Nesting for the green turtle South Atlantic DPS occurs on both sides of the Atlantic Ocean, along the western coast of Africa, Ascension Island, the U.S. Virgin Islands in the Caribbean and eastern South America, from Brazil north to the Caribbean. Juveniles and adults can be found on feeding grounds in the Caribbean and the nearshore waters of Brazil, Uruguay and Argentina. In the east, South Atlantic

DPS green turtles can be found on foraging grounds off the coast of west Africa, from Equatorial Guinea, Gabon, Congo, Angola and Principe Island.

Designated Critical Habitat No critical habitat has been designated for the South Atlantic DPS green turtle. NMFS cannot designate critical habitat in foreign waters.

Recovery Goals NMFS has not prepared a Recovery Plan for the South Atlantic DPS green turtle. In general, listed species which occur entirely outside U.S. jurisdiction are not likely to benefit from recovery plans (55 FR 24296; June 15, 1990).

Table 13. Summary of status; Green Sea Turtle, South Atlantic DPS

Criteria	**Description**
Abundance / productivity trends	Meager data suggests population is increasing. Most of DPS range is outside of the action area.
Listing status	threatened
Attainment of recovery goals	some criteria met
Condition of PBFs	NA

9.8 Hawksbill Sea Turtle

Table 14. Hawksbill Sea Turtle; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Eretmochelys imbricata	Hawksbill turtle	None Designated	Endangered range wide	2013	35 FR 8491	57 FR 38818 Atlantic	63 FR 46693 Atlantic

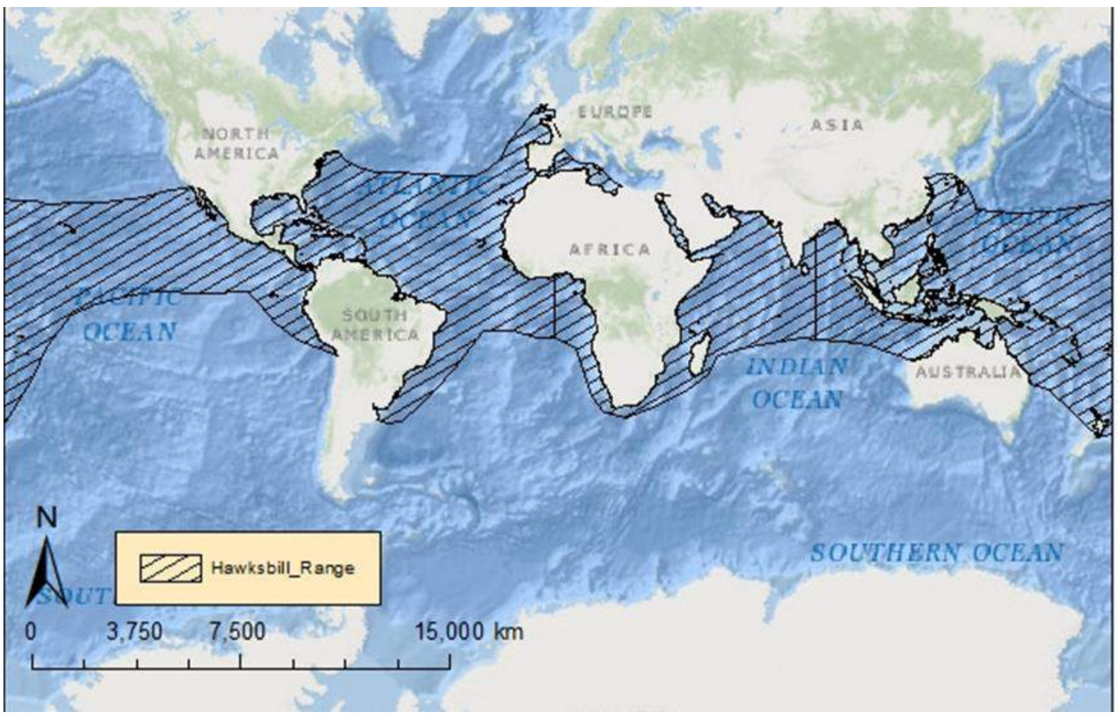

Figure 13. Hawksbill Sea Turtle range

Species Description The hawksbill turtle has a circumglobal distribution throughout tropical and, to a lesser extent, subtropical oceans.

The hawksbill sea turtle has a sharp, curved, beak-like mouth and a "tortoiseshell" pattern on its carapace, with radiating streaks of brown, black, and amber. The species was first listed under the Endangered Species Conservation Act (35 FR 8491) and listed as endangered under the ESA since 1973.

Figure 14. Hawksbill turtle. Photo: John Chevalier

Status Long-term data on the hawksbill sea turtle indicate that sixty-three sites have declined over the past 20 to 100 years (historic trends are unknown for the remaining 25 sites). Recently, 28 sites (68%) have experienced nesting declines, 10 have experienced increases, three have remained stable, and 47 have unknown trends. The greatest threats to hawksbill sea turtles are overharvesting of turtles and eggs, degradation of nesting habitat, and fisheries interactions. Adult hawksbills are harvested for their meat and carapace, which is sold as tortoiseshell. Eggs are taken at high levels, especially in southeast Asia where collection approaches 100% in some areas. In addition, lights on or adjacent to nesting beaches are often fatal to emerging hatchlings and alters the behavior of nesting adults. The species' resilience to additional perturbation is low.

Life history Hawksbill sea turtles reach sexual maturity at twenty to forty years of age. Females return to their natal beaches every two to five years to nest and nest an average of three to five times per season. Clutch sizes are large (up to 250 eggs). Sex determination is temperature dependent, with warmer incubation producing more females. Hatchlings migrate to and remain in pelagic habitats until they reach approximately twenty two to twenty five centimeters in straight carapace length. As juveniles, they take up residency in coastal waters to forage and grow. As adults, hawksbills use their sharp beak-like mouths to feed on sponges and corals. Hawksbill sea turtles are highly migratory and use a wide range of habitats during their lifetimes (Musick and Limpus 1997; Plotkin 2003). Satellite tagged turtles have shown significant variation in movement and migration patterns. Distance traveled between nesting and foraging locations ranges from a few hundred to a few thousand kilometers (Horrocks et al. 2001; Miller et al. 1998).

Population Dynamics

Abundance Surveys at eighty eight nesting sites worldwide indicate that 22,004 to 29,035 females nest annually (NMFS 2013a). In general, hawksbills are doing better in the Atlantic and Indian Ocean than in the Pacific Ocean, where despite greater overall abundance, a greater proportion of the nesting sites are declining.

Productivity / Population Growth Rate From 1980 to 2003, the number of nests at three primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) increased 15% annually (Heppell et al. 2005); however, due to recent declines in nest counts, decreased survival at other life stages, and updated population modeling, this rate is not expected to continue (NMFS 2013a).

Genetic Diversity Populations are distinguished generally by ocean basin and more specifically by nesting location. Our understanding of population structure is relatively poor. Genetic analysis of hawksbill sea turtles foraging off the Cape Verde Islands identified three closely-related haplotypes in a large majority of individuals sampled that did not match those of any known nesting population in the western Atlantic, where the vast majority of nesting has been documented (McClellan et al. 2010; Monzon-Arguello et al. 2010). Hawksbills in the Caribbean seem to have dispersed into separate populations (rookeries) after a bottleneck roughly 100,000 to 300,000 years ago (Leroux et al. 2012).

Distribution The hawksbill has a circumglobal distribution throughout tropical and, to a lesser extent, subtropical waters of the Atlantic, Indian, and Pacific Oceans. In their oceanic phase, juvenile hawksbills can be found in *Sargassum* mats; post-oceanic hawksbills may occupy a range of habitats that include coral reefs or other hard-bottom habitats, sea grass, algal beds, mangrove bays and creeks (Bjorndal and Bolten 2010; Musick and Limpus 1997).

Designated Critical Habitat On September 2, 1998, NMFS established critical habitat for hawksbill sea turtles around Mona and Monito Islands, Puerto Rico (63 FR 46693). Aspects of these areas that are important for hawksbill sea turtle survival and recovery include important natal development habitat, refuge from predation, shelter between foraging periods, and food for hawksbill sea turtle prey.

Recovery Goals See the 1992 and 1998 Recovery Plans for the U.S. Caribbean, Atlantic and Gulf of Mexico and U.S. Pacific populations of hawksbill sea turtles, respectively, for complete down listing/delisting criteria for each of their respective recovery goals. The following items were the top recovery actions identified to support in the Recovery Plans:

1. Identify important nesting beaches
2. Ensure long-term protection and management of important nesting beaches
3. Protect and manage nesting habitat; prevent the degradation of nesting habitat caused by seawalls, revetments, sand bags, other erosion-control measures, jetties and breakwaters
4. Identify important marine habitats; protect and manage populations in marine habitat
5. Protect and manage marine habitat; prevent the degradation or destruction of important [marine] habitats caused by upland and coastal erosion
6. Prevent the degradation of reef habitat caused by sewage and other pollutants
7. Monitor nesting activity on important nesting beaches with standardized index surveys
8. Evaluate nest success and implement appropriate nest-protection on important nesting beaches
9. Ensure that law-enforcement activities prevent the illegal exploitation and harassment of sea turtles and increase law-enforcement efforts to reduce illegal exploitation
10. Determine nesting beach origins for juveniles and subadult populations

Table 15. Summary of status; Hawksbill Sea Turtle

Criteria	Description
Abundance / productivity trends	Species population is doing better in Atlantic and Indian Ocean than in the Pacific where nesting abundance has been declining over the last 20 - 100 years. Recently 68% of sites have exhibited declines (28). Other sites have shown

	increases (10) and a few are stable (3). However there are many sites where trends have not been established (47).
Listing status	endangered
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Disease; Point and non-point pollution; Marine debris

9.9 Kemp's Ridley Sea Turtle

Table 16. Kemp's Ridley Sea Turtle; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Lepidochelys kempii	Kemp's ridley turtle	None Designated	Endangered range wide	2015	35 FR 18319	75 FR 12496 U.S. Caribbean, Atlantic, and Gulf of Mexico (draft) U.S. Caribbean, Atlantic, and Gulf of Mexico	None Designated

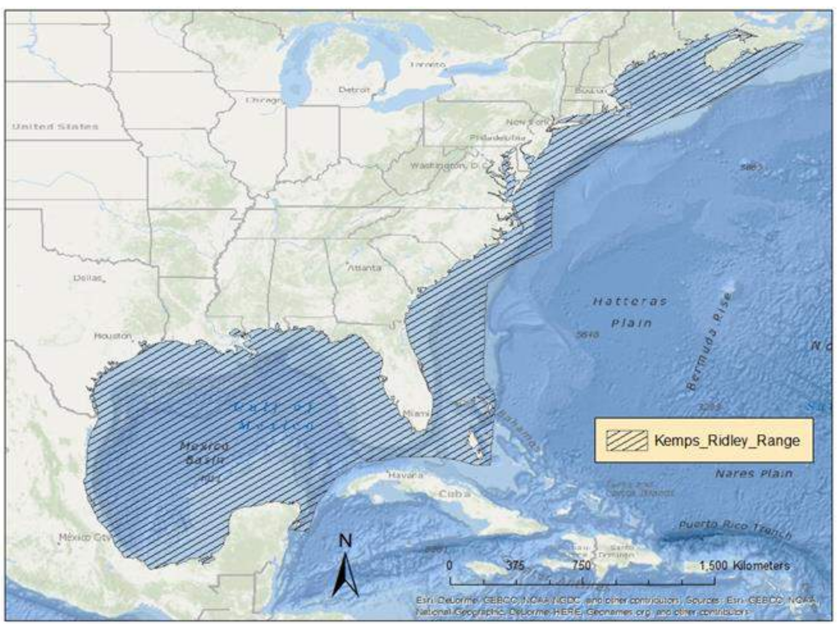

Figure 15. Kemp's Ridley Sea Turtle range

Species Description The Kemp's ridley turtle is considered to be the most endangered sea turtle, internationally (Groombridge 1982; Zwinenberg 1977). Its range extends from the Gulf of Mexico to the Atlantic coast, with nesting beaches limited to a few sites in Mexico and Texas.

Kemp's ridley sea turtles the smallest of all sea turtle species, with a nearly circular top shell and a pale yellowish bottom shell. The species was first listed under the Endangered Species Conservation Act (35 FR 8491) and listed as endangered under the ESA since 1973.

Status The Kemp's ridley was listed as endangered in response to a severe population decline, primarily the result of egg collection. In 1973, legal ordinances prohibited the harvest of sea turtles from May to August, and in 1990, the harvest of all sea turtles was prohibited by presidential decree. In 2002, Rancho Nuevo was declared a Sanctuary. A successful head-start program has resulted in the reestablishment of nesting at Texan beaches. While fisheries bycatch remains a threat, the use of turtle excluder devices mitigates take. Fishery interactions and strandings, possibly due to forced submergence, appear to be the main threats to the species. It is clear that the species is steadily increasing; however, the species' limited range and low global abundance make it vulnerable to new sources of mortality as well as demographic and environmental randomness, all of which are often difficult to predict with any certainty. Therefore, its resilience to future perturbation is low.

Figure 16. Kemp's ridley turtle. Photo: NOAA

Life history Females mature at twelve years of age. The average remigration is two years. Nesting occurs from April to July in large arribadas, primarily at Rancho Nuevo, Mexico. Females lay an average of 2.5 clutches per season. The annual average clutch size is ninety-seven to one hundred eggs per nest. The nesting location may be particularly important because hatchlings can more easily migrate to foraging grounds in deeper oceanic waters, where they remain for approximately two years before returning to nearshore coastal habitats. Juvenile Kemp's ridley sea turtles use these nearshore coastal habitats from April through November, but move towards more suitable overwintering habitat in deeper offshore waters (or more southern waters along the Atlantic coast) as water temperature drops. Adult habitat largely consists of sandy and muddy areas in shallow, nearshore waters less than 120 feet (37 meters) deep, although they can also be found in deeper offshore waters. As adults, Kemp's ridleys forage on swimming crabs, fish, jellyfish, mollusks, and tunicates (NMFS 2011).

Population Dynamics

Abundance Of the sea turtles species in the world, the Kemp's ridley has declined to the lowest population level. Nesting aggregations at a single location (Rancho Nuevo, Mexico) were estimated at 40,000 females in 1947. By the mid-1980s, the population had declined to an estimated 300 nesting females. In 2014, there were an estimated 10,987 nests and 519,000 hatchlings released from three primary nesting beaches in Mexico (NMFS 2015). The number of nests in Padre Island, Texas has increased over the past two decades, with one nest observed in 1985, four in 1995, fifty in 2005, 197 in 2009, and 119 in 2014 (NMFS 2015).

Productivity / Population Growth Rate From 1980 to 2003, the number of nests at three primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) increased 15% annually (Heppell et al. 2005); however, due to recent declines in nest counts, decreased survival at other life stages, and updated population modeling, this rate is not expected to continue (NMFS 2015).

Genetic Diversity Genetic variability in Kemp's ridley turtles is considered to be high, as measured by heterozygosis at microsatellite loci (NMFS 2011). Additional analysis of the mitochondrial DNA taken from samples of Kemp's ridley turtles at Padre Island, Texas, showed six distinct haplotypes, with one found at both Padre Island and Rancho Nuevo (Dutton et al. 2006).

Distribution The Kemp's ridley occurs from the Gulf of Mexico and along the Atlantic coast of the U.S. (TEWG 2000). Kemp’s ridley sea turtles have occasionally been found in the Mediterranean Sea, which may be due to migration expansion or increased hatchling production (Tomas and Raga 2008). The vast majority of individuals stem from breeding beaches at Rancho Nuevo on the Gulf of Mexico coast of Mexico. During spring and summer, juvenile Kemp’s ridleys occur in the shallow coastal waters of the northern Gulf of Mexico from south Texas to north Florida. In the fall, most Kemp’s ridleys migrate to deeper or more southern, warmer waters and remain there through the winter (Schmid 1998). As adults, many turtles remain in the Gulf of Mexico, with only occasional occurrence in the Atlantic Ocean (NMFS et al. 2010).

Designated Critical Habitat No critical habitat has been designated for Kemp’s ridley turtles.

Recovery Goals See the 2011 Final Bi-National (U.S. and Mexico) Revised Recovery Plan for Kemp’s ridley sea turtles for complete down listing/delisting criteria for each of their respective recovery goals. The following items were identified as priorities to recover Kemp’s ridely sea turtles:

11. Protect and manage nesting and marine habitats.
12. Protect and manage populations on the nesting beaches and in the marine environment.
13. Maintain a stranding network.
14. Manage captive stocks.
15. Sustain education and partnership programs.
16. Maintain, promote awareness of and expand U.S. and Mexican laws.
17. Implement international agreements.
18. Enforce laws.

Table 17. Summary of status; Kemp’s Ridley Sea Turtle

Criteria	Description
Abundance / productivity trends	This sea turtle has declined to lowest numbers of all sea turtles. While the number of nests increased 15% annually from 1980 - 2003 at three primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos), recent declines in nest counts, decreased survival at other life stages, and updated population modeling predict this rate is not expected to continue.
Listing status	endangered
Attainment of recovery goals	criteria not yet met
Condition of PBFs	NA

9.10 Leatherback Sea Turtle

Table 18. Leatherback Sea Turtle; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Dermochelys coriacea	Leatherback sea turtle	None Designated	Endangered range wide	2013	E – 35 FR 8491	63 FR 28359 Pacific U.S. Caribbean, Atlantic and Gulf of Mexico	44 FR 17710 and 77 FR 4170

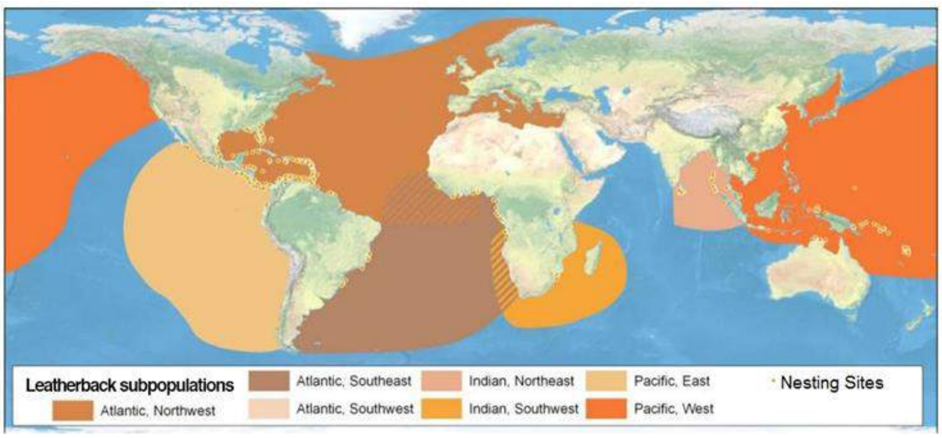

Figure 17. Leatherback Sea Turtle range

Species Description The leatherback sea turtle is unique among sea turtles for its large size, wide distribution (due to thermoregulatory systems and behavior), and lack of a hard, bony carapace. It ranges from tropical to subpolar latitudes, worldwide.

Leatherbacks are the largest living turtle, reaching lengths of six feet long, and weighing up to one ton. Leatherback sea turtles have a distinct black leathery skin covering their carapace with pinkish white skin on their belly. The species was first listed under the Endangered Species Conservation Act (35 FR 8491) and listed as endangered under the ESA since 1973.

Figure 18. Leatherback turtle. Photo: R.Tapilatu

Status The leatherback sea turtle is an endangered species whose once large nesting populations have experienced steep declines in recent decades. The primary threats to leatherback sea turtles include fisheries bycatch, harvest of nesting females, and egg harvesting. Because of these threats, once large rookeries are now functionally extinct, and there have been range-wide reductions in population abundance. Other threats include loss of nesting habitat due to development, tourism, and sand extraction. Lights on or adjacent to nesting beaches alter nesting adult behavior and are often fatal to emerging hatchlings as they are drawn to light sources and away from the sea. Plastic ingestion is common in leatherbacks and can block gastrointestinal tracts leading to death. Climate change may alter sex ratios (as temperature determines hatchling sex), range (through expansion of foraging habitat), and habitat (through the loss of nesting beaches, because of sea-level rise. The species' resilience to additional perturbation is low.

Life history Age at maturity has been difficult to ascertain, with estimates ranging from five to twenty-nine years (Avens et al. 2009; Spotila et al. 1996). Females lay up to seven clutches per season, with more than 65 eggs per clutch and eggs weighing greater than 80 grams (Reina et al. 2002; Wallace et al. 2007). The number of leatherback hatchlings that make it out of the nest on to the beach (i.e., emergent success) is approximately 50% worldwide (Eckert et al. 2012). Females nest every one to seven years. Natal homing, at least within an ocean basin, results in reproductive isolation between five broad geographic regions: eastern and western Pacific, eastern and western Atlantic, and Indian Ocean. Leatherback sea turtles migrate long, transoceanic distances between their tropical nesting beaches and the highly productive temperate waters where they forage, primarily on jellyfish and tunicates. These gelatinous prey are relatively nutrient-poor, such that leatherbacks must consume large quantities to support their body weight. Leatherbacks weigh about 33% more on their foraging grounds than at nesting, indicating that they probably catabolize fat reserves to fuel migration and subsequent reproduction (James et al. 2005; Wallace et al. 2006). Sea turtles must meet an energy threshold before returning to nesting beaches. Therefore, their remigration intervals (the time between nesting) are dependent upon foraging success and duration (Hays 2000; Price et al. 2004).

Population Dynamics

Abundance Leatherbacks are globally distributed, with nesting beaches in the Pacific, Atlantic, and Indian oceans. Detailed population structure is unknown, but is likely dependent upon nesting beach location. Based on estimates calculated from nest count data, there are between 34,000 and 94,000 adult leatherbacks in the North Atlantic (TEWG 2007). In contrast, leatherback populations in the Pacific are much lower. Overall, Pacific populations have declined from an estimated 81,000 individuals to less than 3,000 total adults and subadults (Spotila et al. 2000). Population abundance in the Indian Ocean is difficult to assess due to lack of data and inconsistent reporting. Available data from southern Mozambique show that approximately ten females nest per year from 1994 to 2004, and about 296 nests per year counted in South Africa (NMFS 2013b).

Productivity / Population Growth Rate Population growth rates for leatherback sea turtles vary by ocean basin. Counts of leatherbacks at nesting beaches in the western Pacific indicate that the subpopulation has been declining at a rate of almost six % per year since 1984 (Tapilatu et al. 2013). Leatherback subpopulations in the Atlantic Ocean, however, are showing signs of improvement. Nesting females in South Africa are increasing at an annual rate of four to 5.6%, and from nine to 13% in Florida and the U.S. Virgin Islands (TEWG 2007), believed to be a result of conservation efforts.

Genetic Diversity Analyses of mitochondrial DNA from leatherback sea turtles indicates a low level of genetic diversity, pointing to possible difficulties in the future if current population declines continue (Dutton et al. 1999). Further analysis of samples taken from individuals from rookeries in the Atlantic and Indian oceans suggest that each of the rookeries represent demographically independent populations (NMFS 2013b).

Distribution Leatherback sea turtles are distributed in oceans throughout the world. Leatherbacks occur throughout marine waters, from nearshore habitats to oceanic environments (Shoop and Kenney 1992). Movements are largely dependent upon reproductive and feeding cycles and the oceanographic features that concentrate prey, such as frontal systems, eddy features, current boundaries, and coastal retention areas (Benson et al. 2011).

Designated Critical Habitat On March 23, 1979, leatherback critical habitat was identified adjacent to Sandy Point, St. Croix, Virgin Islands from the 183 meter isobath to mean high tide level between 17° 42’12” N and 65°50’00” W (44 FR 17710). This habitat is essential for nesting, which has been increasingly threatened since 1979, when tourism increased significantly, bringing nesting habitat and people into close and frequent proximity. The designated critical habitat is within the Sandy Point National Wildlife Refuge. Leatherback nesting increased at an annual rate of 13% from 1994 to 2001; this rate has slowed according to nesting data from 2001 to 2010 (NMFS 2013b).

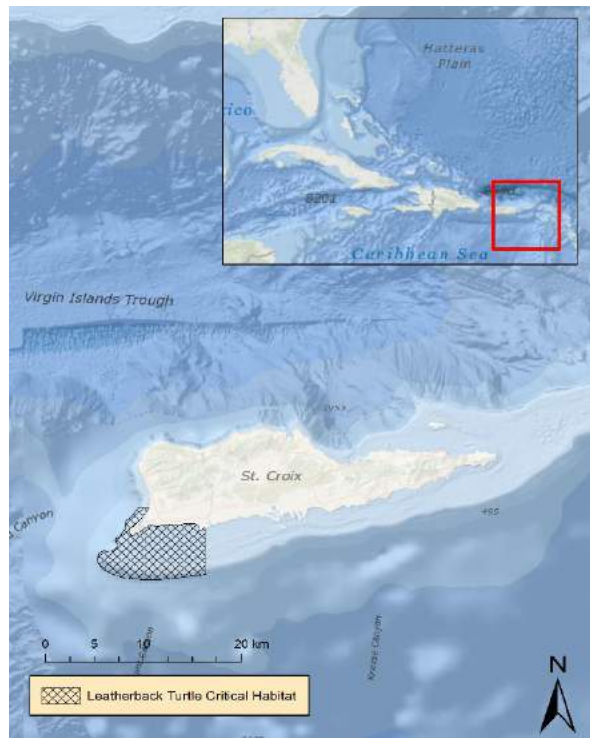

Figure 19. Map depicting leatherback sea turtle designated critical habitat in the United States Virgin Islands.

Figure 20. Map depicting leatherback sea turtle designated critical habitat along the United States Pacific Coast.

On January 20, 2012, NMFS issued a final rule to designate additional critical habitat for the leatherback sea turtle (50 CFR 226). This designation includes approximately 43,798 square kilometers stretching along the California coast from Point Arena to Point Arguello east of the 3000 m depth contour; and 64,760 square kilometers stretching from Cape Flattery, Washington to Cape Blanco, Oregon east of the 2,000 meters depth contour. The designated areas comprise approximately 108,558 square kilometers of marine habitat and include waters from the ocean surface down to a maximum depth of 80 meters. They were designated specifically because of the occurrence of prey species, primarily *scyphomedusae* of the order *Semaeostomeae* (i.e., jellyfish), of sufficient condition, distribution, diversity, abundance and density necessary to support individual as well as population growth, reproduction, and development of leatherbacks.

Recovery Goals See the 1998 and 1991 Recovery Plans for the U.S. Pacific and U.S Caribbean, Gulf of Mexico and Atlantic leatherback sea turtles for complete down listing/delisting criteria for each of their respective recovery goals. The following items were the top five recovery actions identified to support in the Leatherback Five Year Action Plan:

19. Reduce fisheries interactions
20. Improve nesting beach protection and increase reproductive output
21. International cooperation
22. Monitoring and research
23. Public engagement

Table 19. Summary of status; Leatherback Sea Turtle

Criteria	Description
Abundance / productivity trends	This species is globally distributed in the worlds oceans. The Pacific population has declined from an estimated 81,000 individuals to less than 3,000 with a continued rate of loss of approximately 6%. Atlantic population is stable and showing signs of increasing growth of between 4 - 5.6% and 9 - 13% in Florida and the U.S. Virgin Islands.
Listing status	endangered
Attainment of recovery goals	criteria not yet met

Condition of PBFs	Disease; Point and non-point pollution; Marine debris.

9.11 Loggerhead Sea Turtle, North Pacific DPS

Table 20. Loggerhead Sea Turtle, North Pacific DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Caretta caretta	Loggerhead sea turtle	North Pacific Ocean	Endangered	2009	76 FR 58868	None	None Designated

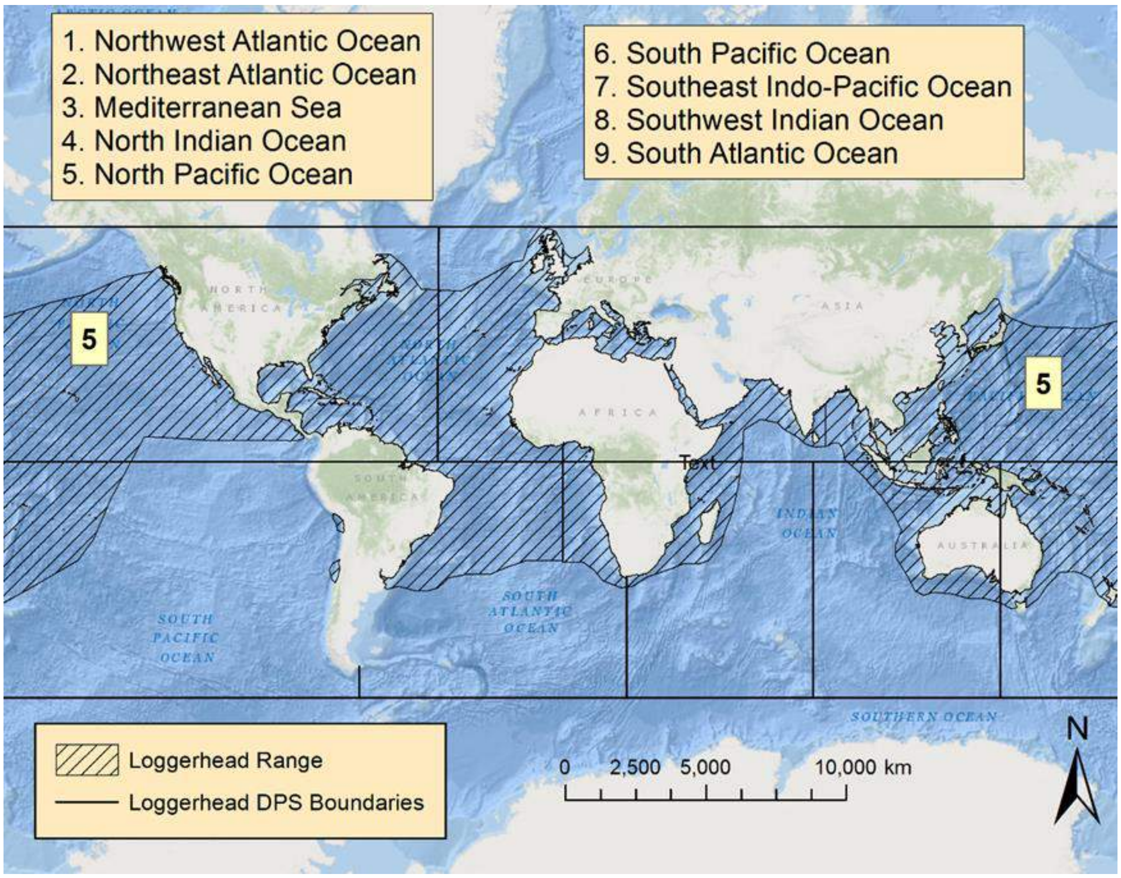

Figure 21. Loggerhead Sea Turtle, North Pacific DPS range

Species Description Loggerhead sea turtles are circumglobal, and are found in the temperate and tropical regions of the Indian, Pacific and Atlantic Oceans. North Pacific Ocean DPS loggerheads are found throughout the Pacific Ocean, north of the equator. Their range extends from the West Coast of North America to eastern Asia.

The loggerhead sea turtle is distinguished from other turtles by its reddish-brown carapace, large head and powerful jaws. The species was first listed as threatened under the Endangered Species Act in 1978 (43 FR 32800). On September 22, 2011, the NMFS designated nine DPS of loggerhead sea turtles, with the North Pacific Ocean DPS listed as endangered (75 FR 12598).

Figure 22. Loggerhead sea turtle. Photo: NOAA

Status Neritic juveniles and adults in the North Pacific Ocean DPS are at risk of mortality from coastal fisheries in Japan and Baja California, Mexico. Habitat degradation in the form of coastal development and armoring pose a threat to nesting females. Based on these threats and the relatively small population size, the Biological Review Team concluded that the North Pacific Ocean DPS is currently at risk of extinction (Conant et al. 2009).

Life history Mean age at first reproduction for female loggerhead sea turtles is thirty years. Females lay an average of three clutches per season. The annual average clutch size is 112 eggs per nest. The average remigration interval is 2.7 years. Nesting occurs on beaches, where warm, humid sand temperatures incubate the eggs. Temperature determines the sex of the turtle during the middle of the incubation period. Turtles spend the post-hatchling stage in pelagic waters. The juvenile stage is spent first in the oceanic zone and later in the neritic zone (i.e., coastal waters). Coastal waters provide important foraging habitat, inter-nesting habitat, and migratory habitat for adult loggerheads.

Population Dynamics

Abundance There is general agreement that the number of nesting females provides a useful index of the species' population size and stability at this life stage, even though there are doubts about the ability to estimate the overall population size. Adult nesting females often account for less than one% of total population numbers (Bjorndal et al. 2005).

The North Pacific Ocean DPS has a nesting population of about 2,300 nesting females (Matsuzawa 2011). Loggerhead abundance on foraging grounds off the Pacific Coast of the Baja California Peninsula, Mexico, was estimated to be 43,226 individuals (Seminoff et al. 2014).

Productivity / Population Growth Rate Overall, Gilman (2009) estimated that the number of loggerheads nesting in the Pacific has declined by 80% in the past 20 years. There was a steep (50 to 90%) decline in the annual nesting population in Japan during the last half of the twentieth century (Kamezaki et al. 2003) Since then, nesting has gradually increased, but is still considered to be depressed compared to historical numbers, and the population growth rate is negative (-0.032) (Conant et al. 2009).

Genetic Diversity Recent mitochondrial DNA analysis using longer sequences has revealed a more complex population sub-structure for the North Pacific Ocean DPS. Previously, five haplotypes were present, and now, nine haplotypes have been identified in the North Pacific Ocean DPS. This evidence supports the designation of three management units in the North Pacific Ocean DPS: 1) the Ryukyu management unit (Okinawa, Okinoerabu, and Amami), 2) Yakushima Island management unit and 3) Mainland management unit (Bousou, Enshu-nada, Shikoku, Kii and Eastern Kyushu) (Matsuzawa et al. 2016). Genetic analysis of loggerheads captured on the feeding grounds of Sanriku, Japan, found only haplotypes present in Japanese rookeries (Nishizawa et al. 2014).

Distribution Loggerheads are circumglobal, occurring throughout the temperate and tropical regions of the Atlantic, Pacific, and Indian oceans, returning to their natal region for mating and nesting. Adults and sub-adults occupy nearshore habitat. While in their oceanic phase, loggerheads undergo long migrations using ocean currents. Individuals from multiple nesting colonies can be found on a single feeding ground.

Hatchlings from Japanese nesting beaches use the North Pacific Subtropical Gyre and the Kurishio Extension to migrate to foraging grounds. Two major juvenile foraging areas have been identified in the North Pacific Basin: Central North Pacific and off of Mexico's Baja California Peninsula. Both of these feeding grounds are frequented by individuals from Japanese nesting beaches (Abecassis et al. 2013; Seminoff et al. 2014).

Designated Critical Habitat No critical habitat has been designated for the North Pacific Ocean DPS loggerhead turtle.

Recovery Goals NMFS has not prepared a Recovery Plan for the North Pacific Ocean DPS loggerhead turtle.

Table 21. Summary of status; Loggerhead Sea Turtle, North Pacific DPS

Criteria	Description
Abundance / productivity trends	Population has declined an estimated 80% in the past 20 years. While there has stabalizing, the population is considered depressed compared to historical numbers. Growth rates are negative at 0.032.
Listing status	endangered
Attainment of recovery goals	criteria not yet met
Condition of PBFs	NA

9.12 Loggerhead Sea Turtle, Northwest Atlantic DPS

Table 22. Loggerhead Sea Turtle, Northwest Atlantic DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Caretta caretta	Loggerhead sea turtle	Northwest Atlantic Ocean	Threatened	2009	76 FR 58868	2009	79 FR 39855

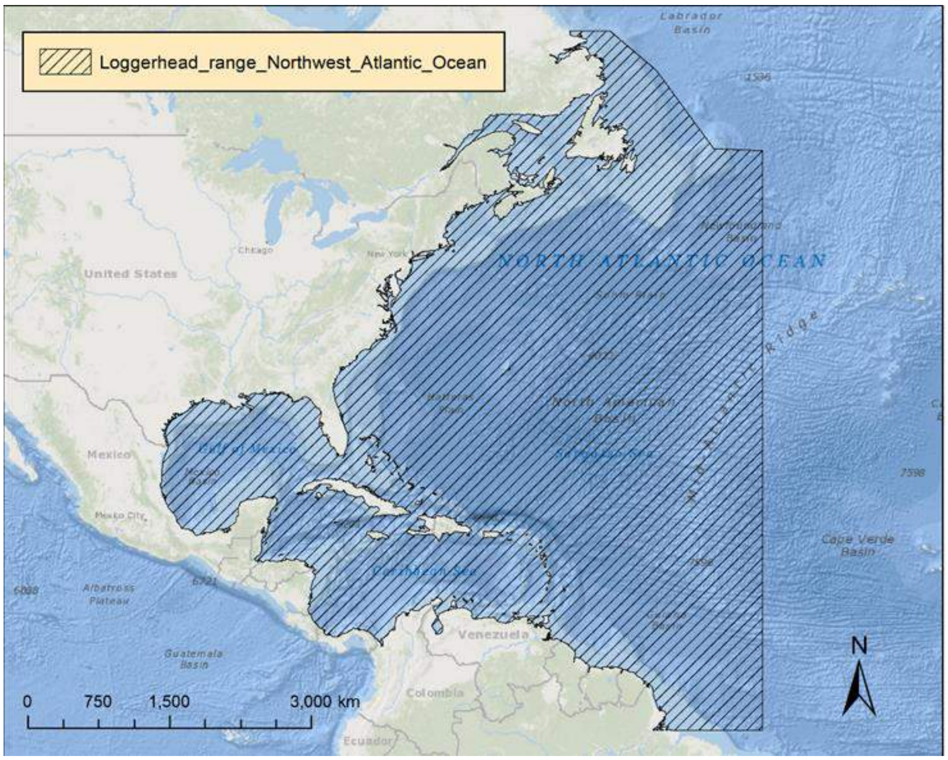

Figure 23. Loggerhead Sea Turtle, Northwest Atlantic DPS range

Species Description Loggerhead sea turtles are circumglobal, and are found in the temperate and tropical regions of the Indian, Pacific and Atlantic Oceans. Northwest Atlantic Ocean DPS loggerheads are found along eastern North America, Central America, and northern South America.

The loggerhead sea turtle is distinguished from other turtles by its reddish-brown carapace, large head and powerful jaws. The species was first listed as threatened under the Endangered Species Act in 1978 (43 FR 32800). On September 22, 2011, the NMFS designated nine DPS of loggerhead sea turtles, with the Northwest Atlantic Ocean DPS listed as threatened (75 FR 12598).

Figure 24. Loggerhead sea turtle. Photo: NOAA

Status Due to declines in nest counts at index beaches in the United States and Mexico, and continued mortality of juveniles and adults from fishery bycatch, the Northwest Atlantic Ocean DPS is at risk and likely to decline in the foreseeable future (Conant et al. 2009).

Life history Mean age at first reproduction for female loggerhead sea turtles is thirty years. Females lay an average of three clutches per season. The annual average clutch size is 112 eggs per nest. The average remigration interval is 2.7 years. Nesting occurs on beaches, where warm, humid sand temperatures incubate the eggs. Temperature determines the sex of the turtle during the middle of the incubation period. Turtles spend the post-hatchling stage in pelagic waters. The juvenile stage is spent first in the oceanic zone and later in the neritic zone (i.e., coastal waters). Coastal waters provide important foraging habitat, inter-nesting habitat, and migratory habitat for adult loggerheads.

Population Dynamics

Abundance There is general agreement that the number of nesting females provides a useful index of the species' population size and stability at this life stage, even though there are doubts about the ability to estimate the overall population size. Adult nesting females often account for less than one% of total population numbers (Bjorndal et al. 2005).

Using a stage/age demographic model, the adult female population size of the DPS is estimated at 20,000 to 40,000 females, and 53,000 to 92,000 nests annually (NMFS-SEFSC 2009). Based on genetic information, the Northwest Atlantic Ocean DPS is further categorized into five recovery units corresponding to nesting beaches. These are Northern Recovery Unit, Peninsular Florida Recovery Unit, Dry Tortugas Recovery Unit, Northern Gulf of Mexico Recovery Unit, and the Greater Caribbean Recovery Unit.

The Northern Recovery Unit, from North Carolina to northeastern Florida, and is the second largest nesting aggregation in the DPS, with an average of 5,215 nests from 1989 to 2008, and approximately 1,272 nesting females (NMFS and USFWS 2008).

The Peninsular Florida Recovery Unit hosts more than 10,000 females nesting annually, which constitutes 87% of all nesting effort in the DPS (Ehrhart et al. 2003).

The Greater Caribbean Recovery Unit encompasses nesting subpopulations in Mexico to French Guiana, the Bahamas, and the Lesser and Greater Antilles. The majority of nesting for this recovery unit occurs on the Yucatán peninsula, in Quintana Roo, Mexico, with 903 to 2,331 nests annually (Zurita et al. 2003). Other significant nesting sites are found throughout the Caribbean, and including Cuba, with approximately 250 to 300 nests annually (Ehrhart et al.

2003), and over one hundred nests annually in Cay Sal in the Bahamas (NMFS and USFWS 2008).

The Dry Tortugas Recovery Unit includes all islands west of Key West, Florida. The only available data for the nesting subpopulation on Key West comes from a census conducted from 1995 to 2004 (excluding 2002), which provided a mean of 246 nests per year, or about sixty nesting females (NMFS and USFWS 2007).

The Gulf of Mexico Recovery Unit has between one hundred to 999 nesting females annually, and a mean of 910 nests per year.

Productivity / Population Growth Rate The population growth rate for each of the four of the recovery units for the Northwest Atlantic DPS (Peninsular Florida, Northern, Northern Gulf of Mexico, and Greater Caribbean) all exhibit negative growth rates (Conant et al. 2009).

Nest counts taken at index beaches in Peninsular Florida show a significant decline in loggerhead nesting from 1989 to 2006, most likely attributed to mortality of oceanic-stage loggerheads caused by fisheries bycatch (Witherington et al. 2009). Loggerhead nesting on the Archie Carr National Wildlife Refuge (representing individuals of the Peninsular Florida subpopulation) has fluctuated over the past few decades. There was an average of 9,300 nests throughout the 1980s, with the number of nests increasing into the 1990s until it reached an all-time high in 1998, with 17,629 nests. From that point, the number of loggerhead nests at the Refuge have declined steeply to a low of 6,405 in 2007, increasing again to 15,539, still a lower number of nests than in 1998 (Bagley et al. 2013).

For the Northern recovery unit, nest counts at loggerhead nesting beaches in North Carolina, South Carolina and Georgia declined at 1.9% annually from 1983 to 2005 (NMFS and USFWS 2007).

The nesting subpopulation in the Florida panhandle has exhibited a significant declining trend from 1995 to 2005 (Conant et al. 2009; NMFS and USFWS 2007). Recent model estimates predict an overall population decline of 17% for the St. Joseph Peninsula, Florida subpopulation of the Northern Gulf of Mexico recovery unit (Lamont et al. 2014).

Genetic Diversity Based on genetic analysis of nesting subpopulations, the Northwest Atlantic Ocean DPS is further divided into five recovery units: Northern, Peninsular Florida, Dry Tortugas, Northern Gulf of Mexico, and Greater Caribbean (Conant et al. 2009). A more recent analysis using expanded mitochondrial DNA sequences revealed that rookeries from the Gulf and Atlantic coasts of Florida are genetically distinct, and that rookeries from Mexico's Caribbean coast express high haplotype diversity (Shamblin et al. 2014). Furthermore, the results suggest that the Northwest Atlantic Ocean DPS should be considered as ten management units: (1) South Carolina and Georgia, (2) central eastern Florida, (3) southeastern Florida, (4) Cay Sal, Bahamas, (5) Dry Tortugas, Florida, (6) southwestern Cuba, (7) Quintana Roo, Mexico, (8) southwestern Florida, (9) central western Florida, and (10) northwestern Florida (Shamblin et al. 2012).

Distribution Loggerhead hatchlings from the western Atlantic disperse widely, most likely using the Gulf Stream to drift throughout the Atlantic Ocean. Mitochondrial DNA evidence demonstrates that juvenile loggerheads from southern Florida nesting beaches comprise the vast majority (71 to 88%) of individuals found in foraging grounds throughout the western and eastern Atlantic: Nicaragua, Panama, Azores and Madiera, Canary Islands and Adalusia, Gulf of Mexico and Brazil (Masuda 2010).

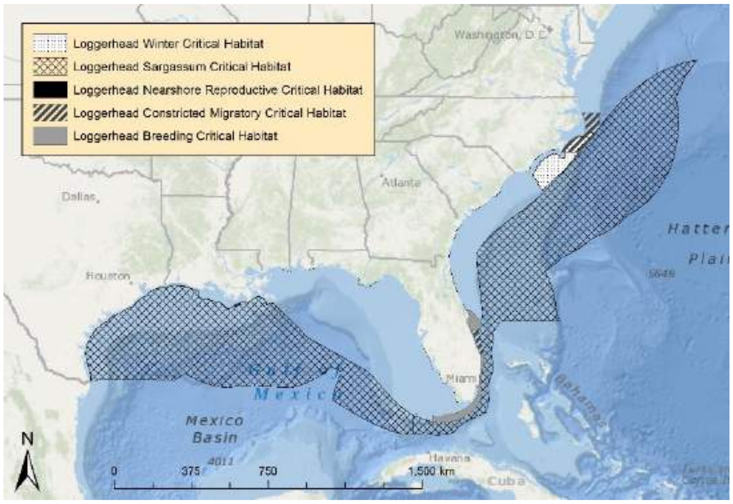

Figure 25. Map identifying designated critical habitat for the Northwest Atlantic Ocean DPS loggerhead sea turtle.

Designated Critical Habitat NMFS has designated critical habitat for the Northwest Atlantic Ocean DPS loggerhead sea turtles. On July 10, 2014, NMFS and the U.S. Fish and Wildlife Service designated critical habitat for the Northwest Atlantic Ocean DPS loggerhead sea turtles along the U.S. Atlantic and Gulf of Mexico coasts from North Carolina to Mississippi (79 FR 39856). These areas contain one or a combination of nearshore reproductive habitat, winter area, breeding areas, and migratory corridors. The critical habitat is categorized into thirty-eight occupied marine areas and 685 miles of nesting beaches. The physical or biological features and primary constituent elements identified for the different habitat types include waters adjacent to high density nesting beaches, waters with minimal obstructions and manmade structures, high densities of reproductive males and females, appropriate passage conditions for migration, conditions that support sargassum habitat, available prey, and sufficient water depth and proximity to currents to ensure offshore transport of post-hatchlings.

Recovery Goals See the 2009 Final Recovery Plan for the Northwest Atlantic Population of Loggerheads for complete down listing/delisting criteria for each of the following recovery objectives.

24. Ensure that the number of nests in each recovery unit is increasing and that this increase corresponds to an increase in the number of nesting females.
25. Ensure the in-water abundance of juveniles in both neritic and oceanic habitats is increasing and is increasing at a greater rate than strandings of similar age classes.
26. Manage sufficient nesting beach habitat to ensure successful nesting.
27. Manage sufficient feeding, migratory and internesting marine habitats to ensure successful growth and reproduction.
28. Eliminate legal harvest.
29. Implement scientifically based nest management plans.
30. Minimize nest predation.
31. Recognize and respond to mass/unusual mortality or disease events appropriately.
32. Develop and implement local, state, Federal and international legislation to ensure long-term protection of loggerheads and their terrestrial and marine habitats.
33. Minimize bycatch in domestic and international commercial and artisanal fisheries.
34. Minimize trophic changes from fishery harvest and habitat alteration.
35. Minimize marine debris ingestion and entanglement.
36. Minimize vessel strike mortality.

Table 23. Summary of status; Loggerhead Sea Turtle, Northwest Atlantic DPS

Criteria	**Description**
Abundance / productivity trends	All sub-populations are exhibiting negative growth rates. Due to declines in nest counts at index beaches in the United States and Mexico, and continued mortality of juveniles and adults from fishery bycatch, the Northwest Atlantic Ocean DPS is at risk and likely to decline in the foreseeable future.
Listing status	threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Point and non-point pollution; Marine debris.

9.13 Olive Ridley Sea Turtle, Pacific Coast Mexico Populations

Table 24. Olive Ridley Sea Turtle, Pacific Coast Mexico Populations; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Lepidochelys olivacea	Olive ridley turtle	Breeding population of the Pacific Coast of Mexico	Endangered	2014	E – 43 FR 32800	63 FR 28539	None Designated

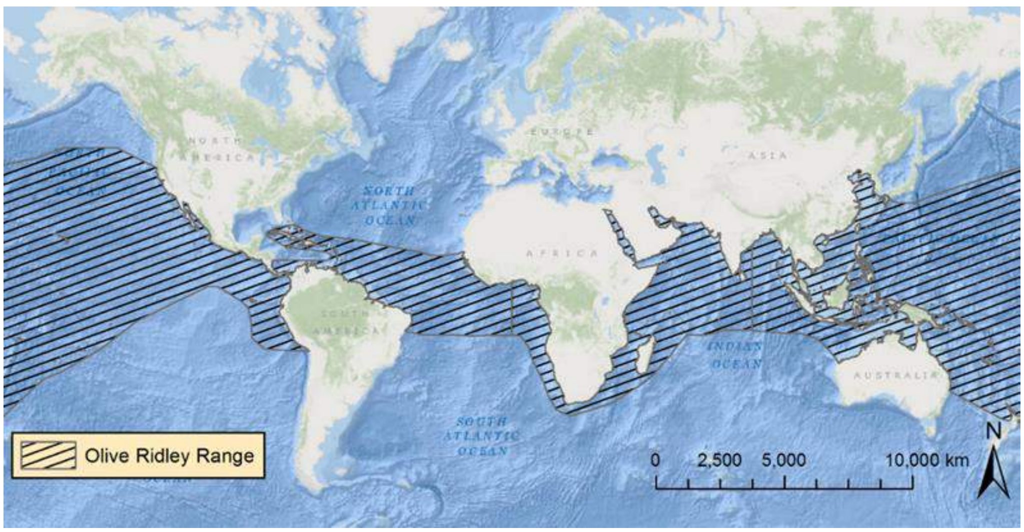

Figure 26. Olive Ridley Sea Turtle, Pacific Coast Mexico Populations range

Species Description The olive ridley sea turtle is a small, mainly pelagic, sea turtle with a circumtropical distribution.

Olive ridley sea turtles are olive or grayish-green in color, with a heart-shaped carapace. The species was listed under the ESA on July 28, 1978 (43 FR 32800). The species was separated into two listing designations: endangered for breeding populations on the Pacific coast of Mexico, and threatened wherever found except where listed as endangered (i.e., in all other areas throughout its range).

Figure 27. Olive ridley turtle. Photo: Reuven Walder

Status In the first half of the twentieth century, there was an estimated ten million olive ridleys nesting on the Pacific coast of Mexico. Olive ridleys became targeted in a fishery in Mexico and Ecuador, which severely depleted the population; there was an estimated one million olive ridleys by 1969. Olive ridley breeding populations on the Pacific coast of Mexico were listed as endangered in response to this severe population decline. Legal harvest of olive ridleys has been prohibited, although illegal harvest still occurs. The population is threatened by incidental capture in fisheries, exposure to pollutants and climate change. In spite of the severe population decline, the olive ridley breeding populations on the Pacific coast of Mexico appear to be resilient, evidenced by the increasing population.

Life history Olive ridley females mature at ten to eighteen years of age. They lay an average of two clutches per season (three to six months in duration). The annual average clutch size is one hundred to 110 eggs per nest. Olive ridleys commonly nest in successive years. Females nest in solitary or in arribadas, large aggregations coming ashore at the same time and location. The post-breeding behavior of olive ridleys in the eastern Pacific Ocean is unique in that they are nomadic, migrating across ocean basins. This contrasts with other sea turtle species, which typically migrate to a particular feeding ground after nesting. As adults, olive ridleys forage on crustaceans, fish, mollusks, and tunicates, primarily in pelagic habitats.

Population Dynamics

Abundance Olive ridley sea turtles are thought to be the most abundant species of sea turtle. Shipboard transects along the Mexico and Central American coasts between 1992 and 2006 indicate an estimated 1.39 million adults. There are six primary arribada nesting beaches in Mexico, the largest being La Escobilla, with about one million nesting females annually. There are several monitored nesting beaches where solitary nesting occurs. At Nuevo Vallarta, about 4,900 nests are laid annually.

Productivity / Population Growth Rate Based on the number of olive ridleys nesting in Mexico, populations appear to be increasing in one location (La Escobilla: from 50,000 nests in 1988 to more than one million in 2000), decreasing at Chacahua, and stable at all others. At-sea estimates of olive ridleys off of Mexico and Central America also support an increasing population trend.

Genetic Diversity Genetic studies have identified four main lineages for the olive ridley: east India, Indo-Western Pacific, Atlantic, and the eastern Pacific. Rookeries on the Pacific coasts of Costa Rica and Mexico were not genetically distinct, and fine-scale population structure was not found when solitary and arribada nesting beaches were examined. Low levels of genetic diversity among Mexican nesting sites are attributed to a population collapse caused by past overharvest.

Distribution Globally, olive ridley sea turtles can be found in tropical and subtropical waters in the Atlantic, Pacific and Indian Oceans. The range of the endangered Pacific coast breeding population extends as far south as Peru and up to California. Olive ridley sea turtles of the Pacific coast breeding colonies nest on arribada beaches at Mismaloya, Ixtapilla and La Escobilla, Mexico. Solitary nesting takes place all along the Pacific coast of Mexico.

Designated Critical Habitat No critical habitat has been designated for the olive ridley sea turtles of the breeding population of the Pacific coast of Mexico.

Recovery Goals There has not been a Recovery Plan prepared specifically for olive ridley sea turtles of the breeding populations of the Pacific coast of Mexico. The 1998 Recovery Plan was prepared for olive ridleys found in the U.S. Pacific. Olive ridley sea turtles found in the Pacific could originate from the Pacific coast of Mexico or from another nesting population. As such, the recovery goals in the 1998 Recovery Plan for the U.S Pacific olive ridley sea turtle can apply to both listed populations. See the 1998 Recovery Plan for the U.S. Pacific olive ridley sea turtles for complete down listing/delisting criteria for their recovery goals. The following items were the recovery criteria identified to consider delisting:

37. All regional stocks that use U.S. waters have been identified to source beaches based on reasonable geographic parameters
38. Foraging populations are statistically significantly increasing at several key foraging grounds within each stock region
39. All females estimated to nest annually at source beaches are either stable or increasing for over ten years
40. Management plan based on maintaining sustained populations for turtles is in effect
41. International agreements in place to protect shared stocks

Table 25. Summary of status; Olive Ridley Sea Turtle, Pacific Coast Mexico Populations

Criteria	**Description**
Abundance / productivity trends	Most abundant of all sea turtles, but some estimates predict a 50% decline in the population since the 1960's. In the Western Atlantic Ocean since 1967, there been an 80% reduction in certain nesting populations.
Listing status	endangered
Attainment of recovery goals	criteria not yet met
Condition of PBFs	NA

9.14 Olive Ridley Sea Turtle, Populations other than Pacific Coast Mexico

Table 26. Olive Ridley Sea Turtle, Populations other than Pacific Coast Mexico; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Lepidochelys olivacea	Olive ridley turtle	All other populations	Threatened	2014	T – 43 FR 32800	N/A	None Designated

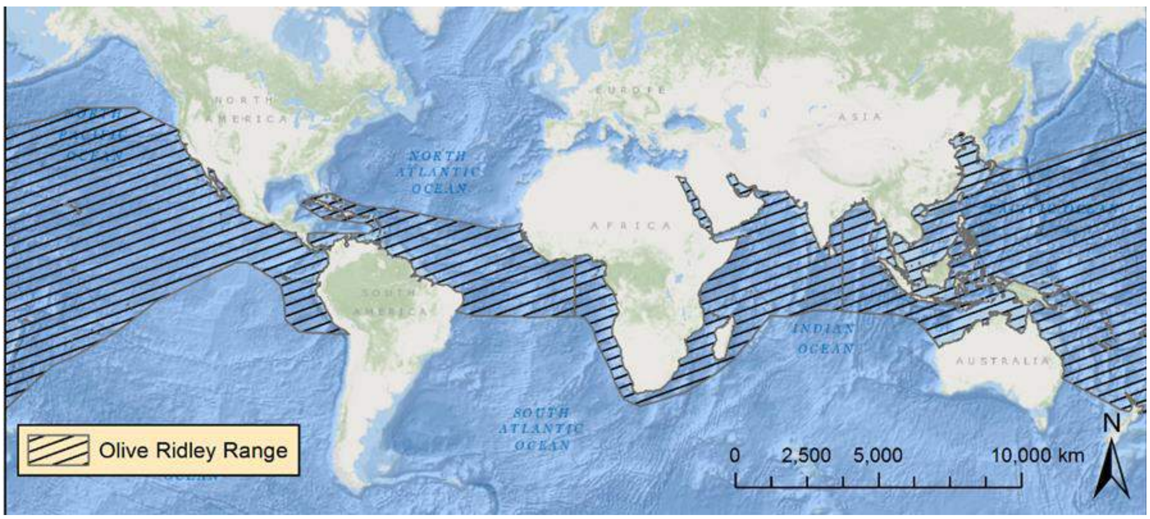

Figure 28. Olive Ridley Sea Turtle, Populations other than Pacific Coast Mexico range

Species Description The olive ridley sea turtle is a small, mainly pelagic, sea turtle with a circumtropical distribution.

Olive ridley sea turtles are olive or grayish-green in color, with a heart-shaped carapace. The species was listed under the ESA on July 28, 1978 (43 FR 32800). The species was separated into two listing designations: endangered for breeding populations on the Pacific coast of Mexico, and threatened wherever found except where listed as endangered (i.e., in all other areas throughout its range).

Figure 29. Olive ridley turtle. Photo: Reuven Walder

Status It is likely that solitary nesting locations once hosted large arribadas; since the 1960s, populations have experienced declines in abundance of 50 to 80%. Many populations continue to decline. Olive ridley sea turtles continue to be harvested as eggs and adults, legally in some areas, and illegally in others. Incidental capture in fisheries is also a major threat. The olive ridley sea turtle is the most abundant sea turtle in the world; however, several populations are declining as a result of continued harvest and fisheries bycatch. The large population size of the range-wide population, however, allows some resilience to future perturbation.

Life history Olive ridley females mature at ten to eighteen years of age. They lay an average of two clutches per season (three to six months in duration). The annual average clutch size is one hundred to 110 eggs per nest. Olive ridleys commonly nest in successive years. Females nest in solitary or in arribadas, large aggregations coming ashore at the same time and location. As adults, olive ridleys forage on crustaceans, fish, mollusks, and tunicates, primarily in pelagic habitats.

Population Dynamics

Abundance Olive ridley sea turtles are thought to be the most abundant species of sea turtle, and can be found in the Atlantic, Indian and Pacific Oceans. There is no global estimate of olive ridley abundance, and we rely on nest counts and nesting females to estimate abundance in each of the ocean basins, described below.

In the Western Atlantic, two arribada nesting beaches occur in Suriname and French Guiana. The Cayenne Peninsula in French Guiana hosts about 2,000 nests annually, while the Galibi Nature Reserve in Suriname had 335 nests in 1995. Solitary nesting also occurs elsewhere in Suriname, Guyana and French Guiana, although no abundance estimates are available. In Sergipe, Brazil, solitary nesting amounted to about 2,600 nests in 2002 and 2003.

In the Eastern Atlantic, there are no arribada nesting beaches, but solitary nesting occurs in several countries along the western coast of Africa, from Gambia to Angola. For many countries, there are no abundance estimates available. For beaches with data available (Angola, the Republic of Congo, the Democratic Republic of Congo, Equatorial Guinea and Guinea Bissau), nest counts are low, with most monitoring taking place for only a few years. The most abundant nesting beaches are Orango National Park in Guinea Bissau, which had between 170 and 620 nests from 1992 to 1994; and the Republic of Congo, which had between 300 and 600 nests annually from 2003 to 2010 (NMFS and USFWS 2014).

In the Indian Ocean, three arribada nesting beaches are found in India, amounting to 150,000-200,000 nesting females annually. Solitary nesting also occurs elsewhere in the region, in eastern Africa, Oman, India, Pakistan, and other southeast Asian countries; for many, there are no estimates available. The largest recorded solitary nesting beach is in Myanmar, when in 1999, 700 nests were counted (NMFS and USFWS 2014).

There are no known arribada nesting beaches in the western Pacific Ocean; however, some solitary nesting occurs in Australia, Brunei, Malaysia, Indonesia and Vietnam. Data are lacking for many sites. Terengganu, Malaysia had ten nests in 1998 and 1999. Alas Purwo, Indonesia, had 230 nests annually from 1993 to 1998.

In the eastern Pacific Ocean (excluding breeding populations in Mexico), there are arribada nesting beaches in Nicaragua, Costa Rica and Panama. La Flor, Nicaragua had 521,440 effective nesting females in 2008 and 2009; Chacocente, Nicaragua had 27,947 nesting females over the same period (Gago et al. 2012). Two other arribada nesting beaches are in Nicaragua, Masachapa and Pochomil, but there are no abundance estimates available. Costa Rica hosts two major arribada nesting beaches; Ostional has between 3,564 and 476,550 turtles per arribada, and Nancite has between 256 and 41,149 turtles per arribada. Panama has one arribada nesting beach, with 8,768 turtles annually.

There are several solitary nesting beaches in the East Pacific Ocean (excluding breeding populations in Mexico); however no abundance estimates are available for beaches in El Salvador, Honduras, Nicaragua, Costa Rica, Panama, Columbia and Ecuador. On Hawaii Beach in Guatemala, 1,004 females were recorded in 2005 (NMFS and USFWS 2014).

Productivity / Population Growth Rate Population growth rate and trend information for the threatened population of olive ridely sea turtles is difficult to discern, owing to its range over a large geographic area, and a lack of consistent monitoring data in all nesting areas. Below, we present the any known population trend information for olive ridley sea turtles by ocean basin (NMFS and USFWS 2014).

Nesting at arribada beaches in French Guiana appears to be increasing, while in Suriname, nesting has declined by more than 90% since 1968. Solitary nesting also occurs elsewhere in Suriname, Guyana and French Guiana; no trend data are available. Solitary nesting in Brazil appears to be increasing, with 100 nests recorded in 1989 to 1990, to 2,606 in 2002 to 2003.

In the Eastern Atlantic, trend data is not available for most solitary nesting beaches. Nest counts in the Republic of Congo decreased from 600 nests in 2003 and 2004 to less than 300 in 2009 and 2010.

The three arribada nesting beaches in India (Gahirmatha, Rushikulya, and Devi River) are considered stable over three generations. There is no trend data available for several solitary nesting beaches in the Indian Ocean. However, even for the few beaches with short-term monitoring, the nest counts are believed to represent a decline from earlier years.

There are no arribaba nesting beaches in the Western Pacific Ocean. Data are lacking or inconsistent for many solitary nesting beaches in the Western Pacific, so it is not possible to assess population trends for these sites. Nest counts at Alas Purwo, Indonesia, appear to be increasing, the nest count at Terengganu, Malaysia, is thought to be a decline from previous years.

Population trends at Nicaraguan arribaba nesting beaches are unknown or stable (La Flor). Ostional, Costa Rica arribada nesting beach is increasing, while trends Nancite, Costa Rica, and Isla Cañas, Panama, nesting beaches are declining. For most solitary nesting beaches in the East Pacific Ocean, population trends are unknown, except for Hawaii Beach, Guatemala, which is decreasing.

Genetic Diversity Genetic studies have identified four main lineages for the olive ridley: east India, Indo-Western Pacific, Atlantic, and the eastern Pacific. In the eastern Pacific, rookeries on the Pacific Coasts of Costa Rica and Mexico were not genetically distinct, and fine-scale population structure was not found when solitary and arribada nesting beaches were examined. There was no population subdivision among olive ridleys along the east India coastline. Low levels of genetic diversity among Atlantic French New Guinea and eastern Pacific Baja California nesting sites are attributed to a population collapse caused by past overharvest (NMFS and USFWS 2014).

Distribution Globally, olive ridley sea turtles can be found in tropical and subtropical waters in the Atlantic, Pacific and Indian Oceans. Major nesting arribada beaches are found in Nicaragua, Costa Rica, Panama, India and Suriname.

Designated Critical Habitat No critical habitat has been designated for the range-wide, threatened population of olive ridley turtles.

Recovery Goals There has not been a Recovery Plan prepared specifically for the range-wide, threatened population of olive ridley sea turtles. The 1998 Recovery Plan was prepared for olive ridleys found in the U.S. Pacific. Olive ridley sea turtles found in the Pacific could originate from the Pacific Coast of Mexico or from another nesting population. As such, the recovery goals in the 1998 Recovery Plan for the U.S Pacific olive ridley sea turtle can apply to both listed populations. See the 1998 Recovery Plan for the U.S. Pacific olive ridley sea turtles for complete down listing/delisting criteria for their recovery goals. The following items were the recovery criteria identified to consider delisting:

42. All regional stocks that use U.S. waters have been identified to source beaches based on reasonable geographic parameters
43. Foraging populations are statistically significantly increasing at several key foraging grounds within each stock region
44. All females estimated to nest annually at source beaches are either stable or increasing for over ten years
45. Management plan based on maintaining sustained populations for turtles is in effect
46. International agreements in place to protect shared stocks

Table 27. Summary of status; Olive Ridley Sea Turtle, Populations other than Pacific Coast Mexico

Criteria	**Description**
Abundance / productivity trends	Some nesting populations are stable or increasing, but most remain severely depressed. These populations are outside the action area.
Listing status	threatened
Attainment of recovery goals	criteria not yet met
Condition of PBFs	NA

9.15 Killer Whale, Southern Resident DPS

Table 28. Killer Whale, Southern Resident DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Orcinus orca	Killer Whale	Southern Resident	Endangered	2016	70 FR 69903	73 FR 4176	71 FR 69054

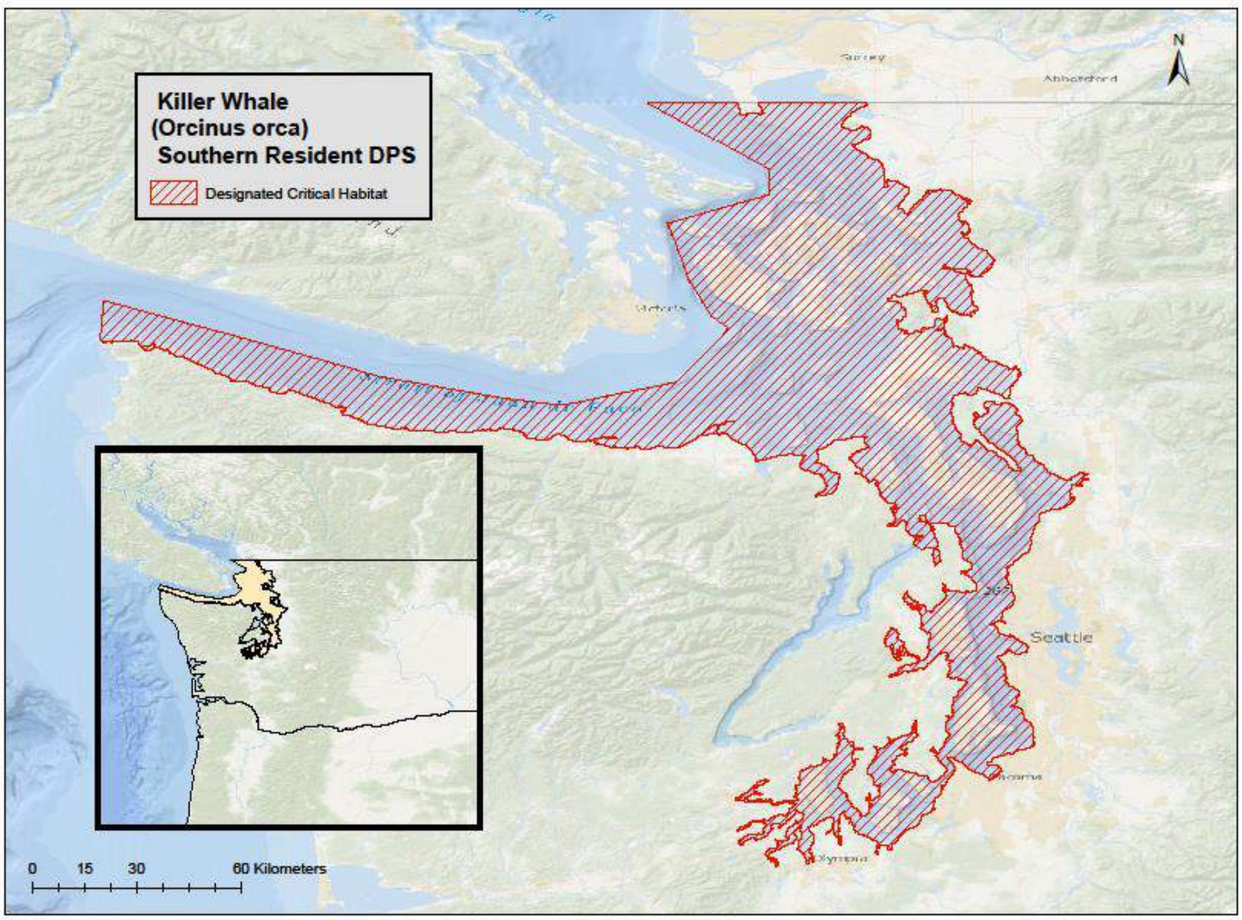

Figure 30. Killer Whale, Southern Resident DPS designated critical habitat

Species Description Killer whales are distributed worldwide, but populations are isolated by region and ecotype. Killer whales have been divided into distinct population segments on the basis of differences in genetics, ecology, morphology and behavior. The Southern Resident killer whale distinct population segment can be found along the Pacific Coast of the United States and Canada, and in the Salish Sea, Strait of Juan de Fuca and Puget Sound.

Killer whales are odontocetes and the largest delphinid species with black coloration on their dorsal side and white undersides and patches near the eyes. They also have a highly variable gray or white saddle behind the dorsal fin. The Southern Resident DPS of killer whales was listed as endangered under the ESA on November 18, 2005 (70 FR 69903).

Figure 31. Southern Resident killer whales. Photo: National Oceanic and Atmospheric Administration

Status The Southern Resident killer whale DPS was listed as endangered in 2005 in response to the population decline from 1996 to 2001, small population size, and reproductive limitations (i.e., few reproductive males and delayed calving). Since listing, there have been no signs of recovery. Current threats to its survival and recovery include: contaminants, vessel traffic, and reduction in prey availability. Chinook salmon populations have declined due to degradation of habitat, hydrology issues, harvest, and hatchery introgression; such reductions may require an increase in foraging effort. In addition, these prey contain environmental pollutants. These contaminants become concentrated at higher trophic levels and may lead to immune suppression or reproductive impairment (Wasser, 2017). The inland waters of Washington and British Columbia support a large whale watch industry, commercial shipping, and recreational boating; these activities generate underwater noise, which may mask whales' communication or interrupt foraging. The factors that originally endangered the species persist throughout its habitat: contaminants, vessel traffic, and reduced prey. The DPS's resilience to future perturbation is reduced as a result of its small population size. The recent decline, unstable population status, and population structure (e.g., few reproductive age males and non-calving adult females) continue to be causes for concern. The relatively low number of individuals (76 as of September 2017) in this population makes it difficult to resist or recover from natural spikes in mortality, including disease and fluctuations in prey availability.

Life history Southern Resident killer whales are geographically, matrilineally, and behaviorally distinct from other killer whale populations (70 FR 69903). The DPS includes three large, stable pods (J, K, and L), which occasionally interact (Parsons et al. 2009). Some mating occurs outside natal pods, during temporary associations of pods, or as a result of the temporary dispersal of males (Pilot et al. 2010, Ford et al. 2001). However, based on an updated pedigree from new genetic data, most of the offspring in recent years were sired by two fathers, meaning that less than 30 individuals make up the effective reproducing portion of the population. Because a small number of males were identified as the fathers of many offspring, a smaller number may be sufficient to support population growth than was previously thought (Ford et al. 2011, NWFSC unpublished data). In addition many offspring were the result of matings within the same pod raising questions and concerns about inbreeding effects. Research into the relationship between genetic diversity, effective breeding population size, and health is currently underway to determine how this metric can inform us about extinction risk and inform recovery (NWFSC unpublished data). Males become sexually mature at ten to seventeen years of age. Females reach maturity at twelve to sixteen years of age and produce an average of 5.4 surviving calves during a reproductive life span of approximately 25 years. Mothers and offspring maintain highly stable, life-long social bonds, and this natal relationship is the basis for a matrilineal social structure. They prey upon salmonids, especially Chinook salmon (Hanson et al. 2010, Ford et al. 2016).

Population Dynamics

Abundance The most recent abundance estimate for the Southern Resident DPS is seventy-six whales in 2017[3]. This represents a decline from just a few years ago, when in 2012, there were 85 whales. Population abundance has fluctuated over time with a maximum of approximately 100 whales in 1995(Carretta et al. 2016), with an increase between 1974 and 1993, from 76 to 93 individuals. As compared to stable or growing populations, the DPS reflects lower fecundity and has demonstrated little to no growth in recent decades (NMFS 2016).

Productivity / Population Growth Rate For the period between 1974 and the mid-90s, when the population increased from 76 to 93 animals, the population growth rate was 1.8% (Ford et al. 1994). More recent data indicate the population is now in decline (Carretta et al. 2016). Lack of prey has been identified as a significant limiting factor in the population's growth rate. NMFS 5-year review suggests a downward trend in population growth protected over the next 50 years

Genetic Diversity After thorough genetic study, the Biological Review Team concluded that Southern Resident killer whales were discrete from other killer whale groups (NMFS 2008, Parsons et al. 2013, Morin et al. 2015). Despite the fact that their ranges overlap, Southern Resident killer whales do not intermix with Northern Resident killer whales. Southern Resident killer whales consist of three pods, called J, K, and L. Low genetic diversity within a population is believed to be in part due to the matrilineal social structure (NMFS 2008, Parsons et al. 2013, Morin et al. 2015).

Distribution Southern Resident killer whales occur in the inland waterways of Puget Sound, Strait of Juan de Fuca, and Southern Georgia Strait during the spring, summer and fall. During the winter, they move to coastal waters primarily off Oregon, Washington, California, and British Columbia.

Designated Critical Habitat On November 29, 2006, NMFS designated critical habitat for the Southern Resident killer whale (71 FR 69054). The critical habitat consists of approximately 6,630 km^2 in three areas: the Summer Core Area in Haro Strait and waters around the San Juan Islands; Puget Sound; and the Strait of Juan de Fuca. It provides the following physical and biological features essential to the conservation of Southern Resident killer whales: water quality to support growth and development; prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth; and inter-area passage conditions to allow for migration, resting, and foraging.

On January 21, 2014, NMFS received a petition to revise critical habitat for SRKW, which cited recent information on the SRKW habitat use along the West Coast of the United States. The petitioner, the Center for Biological Diversity, requested that the critical habitat designation be revised and expanded to include areas of the Pacific Ocean between Cape Flattery, WA, and Point Reyes, CA, extending approximately 47 miles (76 km) offshore. NMFS published a 90-day finding on April 25, 2014 (79 FR 22933) that the petition contained substantial information to support the proposed measure and that NMFS would further consider the action and also solicited information from the public.

On February 24, 2015 NMFS issued a 12-month finding based upon a review of public comments and the available information, which described how NMFS intends to proceed with the requested

[3] http://www.orcanetwork.org/Main/index.php?categories_file=Births%20and%20Deaths; accessed 11/14/2017

revision. NMFS identified next steps that must be followed to support the development of a proposed rule, including completing data collection and analysis, identifying areas meeting the definition of critical habitat, completing a Section 4(b)(2) analysis under the ESA, and developing a proposed rule for public comment. NMFS is in the process of working through these steps and is planning to publish a proposed rule to revise SRKW critical habitat in 2017.

Recovery Goals See the 2008 Final Recovery Plan for the Southern Resident killer whale for complete down listing/delisting criteria for each of the following recovery goals:

- Prey Availability: Support salmon restoration efforts in the region including habitat, harvest and hatchery management considerations and continued use of existing NMFS authorities under the ESA and Magnuson-Stevens Fishery Conservation and Management Act to ensure an adequate prey base
- Pollution/Contamination: Clean up existing contaminated sites, minimize continuing inputs of contaminants harmful to killer whales, and monitor emerging contaminants.
- Vessel Effects: Continue with evaluation and improvement of guidelines for vessel activity near Southern Resident killer whales and evaluate the need for regulations or protected areas.
- Oil Spills: Prevent oil spills and improve response preparation to minimize effects on Southern Residents and their habitat in the event of a spill.
- Acoustic Effects: Continue agency coordination and use of existing ESA and MMPA mechanisms to minimize potential impacts from anthropogenic sound.
- Education and Outreach: Enhance public awareness, educate the public on actions they can participate in to conserve killer whales and improve reporting of Southern Resident killer whale sightings and strandings.
- Response to Sick, Stranded, Injured Killer Whales: Improve responses to live and dead killer whales to implement rescues, conduct health assessments, and determine causes of death to learn more about threats and guide overall conservation efforts.
- Transboundary and Interagency Coordination: Coordinate monitoring, research, enforcement, and complementary recovery planning with Canadian agencies, and Federal and State partners.
- Research and Monitoring: Conduct research to facilitate and enhance conservation efforts. Continue the annual census to monitor trends in the population, identify individual animals, and track demographic parameters.

Table 29. Summary of status; Killer Whale, Southern Resident DPS

Criteria	**Description**
Abundance / productivity trends	Stable to declining populations in past decade, small population size, unstable population structure
Listing status	endangered
Attainment of recovery goals	criteria not yet met

Condition of PBFs	Depleted prey throughout designated critical habitat; Point and non-point contaminants; Noise disturbance.

9.16 Steller Sea Lion, Western DPS

Table 30. Steller Sea Lion, Western DPS; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Eumetopias jubatus	Steller sea lion	Western	Endangered range wide	N/A	62 FR 24345	3/2008	58 FR 45269

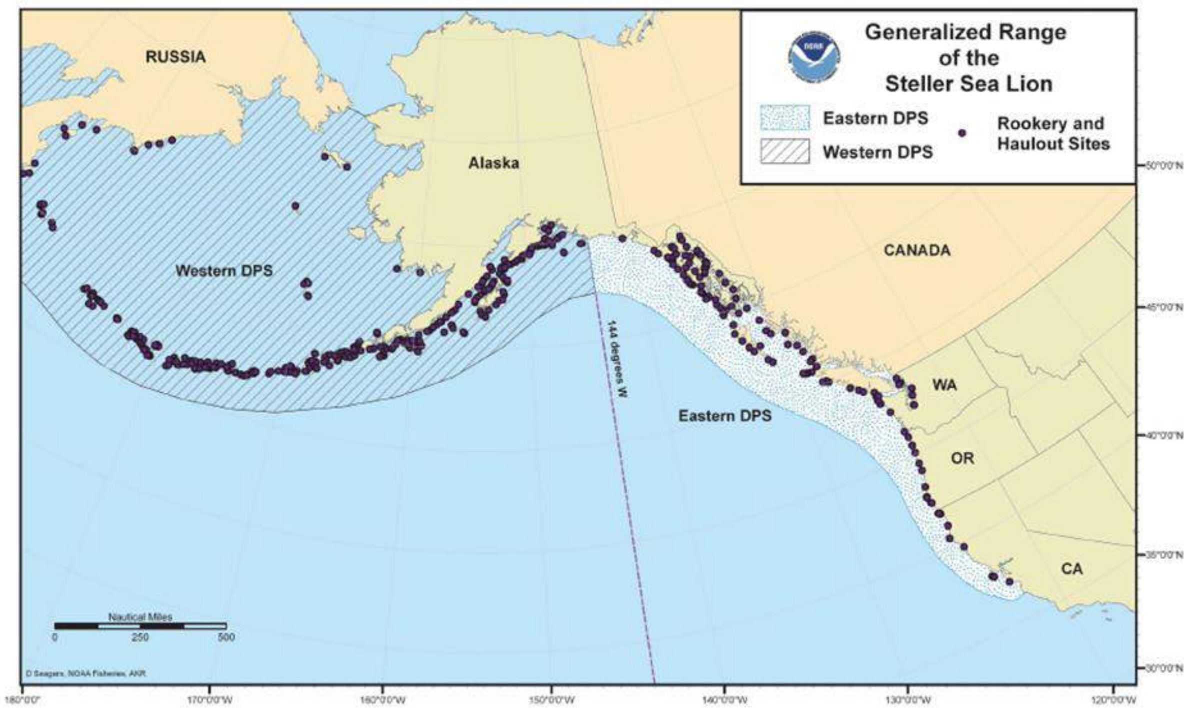

Figure 32. Steller Sea Lion, Western DPS range

Species Description The Steller sea lion ranges from Japan, through the Okhotsk and Bering Seas, to central California. It consists of two morphologically, ecologically, and behaviorally separate DPS: the Eastern, which includes sea lions in Southeast Alaska, British Columbia, Washington, Oregon and California; and the Western, which includes sea lions in all other regions of Alaska, as well as Russia and Japan.

Steller sea lions adults are light blonde to reddish brown and slightly darker on the chest and abdomen. At the time of their initial listing, Steller sea lions were considered a single population listed as threatened (55 FR 29793). On May 5, 1997, following a status review, NMFS established two DPSs of Steller sea lions, and issued a final determination to list the Western DPS as endangered under the ESA (62 FR 24345). The Eastern DPS was delisted on November 4, 2013, and the Western DPS retained its endangered status (78 FR 66139).

Figure 33. Steller sea lion. Photo: NOAA National Marine Mammal Laboratory.

Status The species was listed as threatened in 1990 because of significant declines in population sizes (55 FR 49204). At the time, the major threat to the species was thought to be reduction in prey availability. To protect and recovery the species, NMFS established the following measures: prohibition of shooting at or near sea lions; prohibition of vessel approach to within three nautical miles of specific rookeries, within 0.5 miles on land, and within sight of other listed rookeries; and restriction of incidental fisheries take to 675 sea lions annually in Alaskan waters. In 1997, the Western DPS was reclassified as endangered because it had continued to decline since its initial listing in 1990 (62 FR 24345). Despite the added protection (and an annual incidental fisheries take of twenty-six individuals), the DPS is likely still in decline (though the decline has slowed or stopped in some portions of the range). The reasons for the continued decline are unknown but may be associated with nutritional stress as a result of environmental change and competition with commercial fisheries. The DPS appears to have little resilience to future perturbations.

Life history Within the Western DPS, pupping and breeding occurs at numerous major rookeries from late May to early July. Male Steller sea lions become sexually mature at three to seven years of age. They are polygynous, competing for territories and females by age ten or eleven. Female Steller sea lion become sexually mature at three to six years of age and reproduce into their early twenties. Most females breed annually, giving birth to a single pup. Pups are usually weaned in one to two years. Females and their pups disperse from rookeries by August to October. Juveniles and adults disperse widely, especially males. Their large aquatic ranges are used for foraging, resting, and traveling. Steller sea lions forage on a wide variety of demersal, semi-demersal, and pelagic prey, including fish and cephalopods. Some prey species form large seasonal aggregations, including endangered salmon and eulachon species. Others are available year round.

Population Dynamics

Abundance As of 2015, the best estimate of abundance of the western Steller sea lion DPS in Alaska was 12,189 for pups and 37,308 for non-pups (total N_{min} = 49, 497) (Muto 2016). This represents a large decline since counts in the 1950s (N = 140,000) and 1970s (N = 110,000).

Productivity / Population Growth Rate Steller sea lion Western DPS site counts decreased 40% from 1991 to 2000, an average annual decline of 5.4%; however, counts increased three% between 2004 and 2008, the first recorded population increase since the 1970s (NMFS 2008). However, there are regional differences in population growth rate, with positive trends in the

Figure 34. Map depicting Alaskan designated critical habitat for the Western distinct population segment Steller sea lion.

eastern portion of the range, and negative trends west of Samalga Pass (~170°W) (Muto 2016). These trends indicate that overall, the Western DPS may be stable or exhibiting a slight negative trend as a whole.

Genetic Diversity Based on the results of genetic studies, the Steller sea lion population was reclassified into two DPS: western and eastern. The data which came out of these studies indicated that the two populations had been separate since the last ice age (Bickham et al. 1998). Further examination of the Steller sea lions from the Gulf of Alaska (i.e., the Western DPS) revealed a high level of haplotypic diversity, indicating that genetic diversity had been retained despite the decline in abundance (Bickham et al. 1998).

Distribution Steller sea lions are distributed mainly around the coasts to the outer continental shelf along the North Pacific Ocean rim from northern Hokkaiddo, Japan through the Kuril Islands and Okhotsk Sea, Aleutian Islands and central Bering Sea, southern coast of Alaska and south to California. The Western DPS includes Steller sea lions that reside in the central and western Gulf of Alaska, Aleutian Islands, as well as those that inhabit the coastal waters and breed in Asia (e.g., Japan and Russia).

Designated Critical Habitat In 1997, NMFS designated critical habitat for the Steller sea lion (58 FR 45269). The critical habitat includes specific rookeries, haulouts, and associated areas, as well as three foraging areas that are considered to be essential for the health, continued survival, and recovery of the species.

In Alaska, areas include major Steller sea lion rookeries, haulouts and associated terrestrial, air, and aquatic zones. Critical habitat includes a terrestrial zone extending 3,000 feet (0.9 kilometers) landward from each major rookery and haulout; it also includes air zones extending 3,000 feet (0.9 kilometers) above these terrestrial zones and aquatic zones. Aquatic zones extend 3,000 feet (0.9 kilometers) seaward from the major rookeries and haulouts east of 144°W. In addition, NMFS designated special aquatic foraging areas as critical habitat for the Steller sea lion. These areas include the Shelikof Strait (in the Gulf of Alaska), Bogoslof Island, and Seguam Pass (the latter two are in the Aleutians). These sites are located near Steller sea lion abundance centers and include important foraging areas, large concentrations of prey, and host large commercial fisheries that often interact with the species.

Although within the range of the now delisted Eastern DPS, the designated critical habitat in California and Oregon remains in effect (78 FR 66139). In California and Oregon, major Steller sea lion rookeries and associated air and aquatic zones are designated as critical habitat. Critical habitat includes an air zone extending 3,000 feet (0.9 kilometers) above rookery areas historically occupied by sea lions. Critical habitat also includes an aquatic zone extending 3,000 feet (0.9 kilometers) seaward.

Recovery Goals See the 2008 Revised Recovery Plan for the Steller sea lion for complete down listing/delisting criteria for each of the following recovery goals.

- Baseline population monitoring
- Insure adequate habitat and range for recovery
- Protect from over-utilization for commercial, recreational, scientific or educational purposes
- Protect from diseases, contaminants and predation
- Protect from other natural or anthropogenic actions and administer the recovery program

Table 31. Summary of status; Steller Sea Lion, Western DPS

Criteria	Description
Abundance / productivity trends	30% of 1950s abundance, stable to slight negative population trend, little population resilliance
Listing status	endangered
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Point and non-point contaminants/pollution; Habitat degradation; Oil and gas exploration.

9.17 Guadalupe Fur Seal

Table 32. Guadalupe Fur Seal; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Arctocephalus townsendi	Guadalupe fur seal	None	Threatened throughout its range	None	50 FR 51252	None	None Designated

Figure 35. Guadalupe Fur Seal range

Species Description Guadalupe fur seals were once found throughout Baja California, Mexico and along the California coast. Currently, the species breeds mainly on Guadalupe Island, Mexico, off the coast of Baja California. A smaller breeding colony, discovered in 1997, appears to have been established at Isla Benito del Este in the San Benito Archipelago, Baja California, Mexico (Belcher and T.E. Lee 2002).

Guadalupe fur seals are medium sized, sexually dimorphic otariids (Belcher and T.E. Lee 2002; Reeves et al. 2002). Distinguishing characteristics of the Guadalupe fur seal include the digits on their hind flippers (all of similar length), large, long foreflippers, and unique vocalizations (Reeves et al. 2002). Guadalupe fur seals are dark brown to black, with the adult males having tan or yellow hairs at the back of their mane. Guadalupe fur seals were listed as threatened under the ESA on December 16, 1985 (50 FR 51252).

Figure 36. Guadalupe fur seal. Photo: NOAA

Status A number of human activities may have contributed to the current status of this species, historic commercial hunting was likely the most devastating. Commercial sealers in the nineteenth century decimated the Guadalupe fur seal population, taking as many 8,300 fur seals from San Benito Island (Townsend 1924). The species was presumed extinct, until 1926, when a small herd was found on Guadalupe Island by commercial fishermen, who later returned and killed all that could be found. In 1954, during a survey of the island Hubbs (1956) discovered at least fourteen individuals. Although population surveys occurred on an irregular basis in subsequent years, evidence shows that the Guadalupe fur seal has been increasing ever since. Although commercial hunting occurred in the past, and has since ceased, the effects of these types of exploitations persist today. Other human activities, such as entanglements from commercial fishing gear, are ongoing and continue to affect these species. Because that over the last fifty years the population has been increasing since being severely depleted, we believe that the Guadalupe fur seal population is resilient to future perturbations.

Life history Guadalupe fur seals prefer rocky habitats and can be found in natural recesses and caves (Fleischer 1978). Female Guadalupe fur seals arrive on beaches in June, with births occurring between mid-June to July (Pierson 1978); the pupping season is generally over by late July (Fleischer 1978). Females stay with pups for seven to eight days after parturition, and then alternate between foraging trips at sea and lactation on shore; nursing lasts about eight months (Figureroa-Carranza 1994). Guadalupe fur seals feed mainly on squid species (Esperon-Rodriguez and Gallo-Reynoso 2013). Foraging trips can last between four to 24 days (average of 14 days). Tracking data show that adult females spend 75% of their time sea, and 25% at rest (Gallo-Reynoso et al. 1995).

Population Dynamics

Abundance At the time of listing, the population was estimated at 1,600 individuals, compared to approximately 30,000 before hunting began. A population was “rediscovered” in 1928 with the capture of two males on Guadalupe Island; from 1949 on, researchers reported sighting Guadalupe fur seals at Isla Cedros (near the San Benito Archipelago), and Guadalupe Island (Bartholomew Jr. 1950; Peterson et al. 1968). In 1994, the population at Guadalupe Island was estimated at 7,408 individuals (Gallo-Reynoso 1994).

Productivity / Population Growth Rate All Guadalupe fur seals represent a single population, with two known breeding colonies in Mexico, and a purported breeding colony in the United States. When the most recent stock assessment report for Guadalupe fur seals was published in 2000, the breeding colonies in Mexico were increasing; more recent evidence indicates that this trend is continuing (Aurioles-Gamboa et al. 2010; Esperon-Rodriguez and Gallo-Reynoso 2012). After compiling data from counts over thirty years, Gallo calculated that the population of Guadalupe fur seals in Mexico was increasing, with an average annual growth rate of 13.3% on Guadalupe Island (Gallo-Reynoso 1994). More recent estimates of the Guadalupe fur seal population of the San Benito Archipelago (from 1997-2007) indicates that it is increasing as well at an annual rate of 21.6% (Esperon-Rodriguez and Gallo-Reynoso 2012), and that this population is at a phase of exponential increase (Aurioles-Gamboa et al. 2010).

Genetic Diversity Bernardi et al. (1998) compared the genetic divergence in the nuclear fingerprint of samples taken from 29 Guadalupe fur seals, and found an average similarity of 0.59 of the DNA profiles. This average is typical of outbreeding populations. Although the relatively high levels of genetic variability are encouraging, it is important to note that commercial harvest still influenced the population. Later studies comparing mitochondrial DNA found in the bones of pre-exploitation Guadalupe fur seals against the extant population showed a loss of genotypes, with twenty-five genotypes in pre-harvest fur seals, and seven present today (Weber et al. 2004).

Distribution Guadalupe fur seals have been known to travel great distances, with sightings occurring thousands of kilometers away from the main breeding colonies (Aurioles-Gamboa et al. 1999). Guadalupe fur seals are infrequently observed in U.S. waters. They can be found on California's Channel Islands, with as many fifteen individuals being sighted since 1997 on San Miguel Island, including three females and reared pups.

Designated Critical Habitat No critical habitat has been designated for the Guadalupe fur seal.

Recovery Goals A Recovery Plan has not yet been prepared for Guadalupe fur seals.

Table 33. Summary of status; Guadalupe Fur Seal

Criteria	Description
Abundance / productivity trends	5% of historical abundance, increasing abundance trend, populations resiliant to future stresses
Listing status	threatened
Attainment of recovery goals	none
Condition of PBFs	NA

9.18 Hawaiian Monk Seal

Table 34. Hawaiian Monk Seal; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Neomonachus schauinslandi	Hawaiian monk seal	None	Endangered: throughout its range	2007	41 FR 51611	2007	53 FR 18988

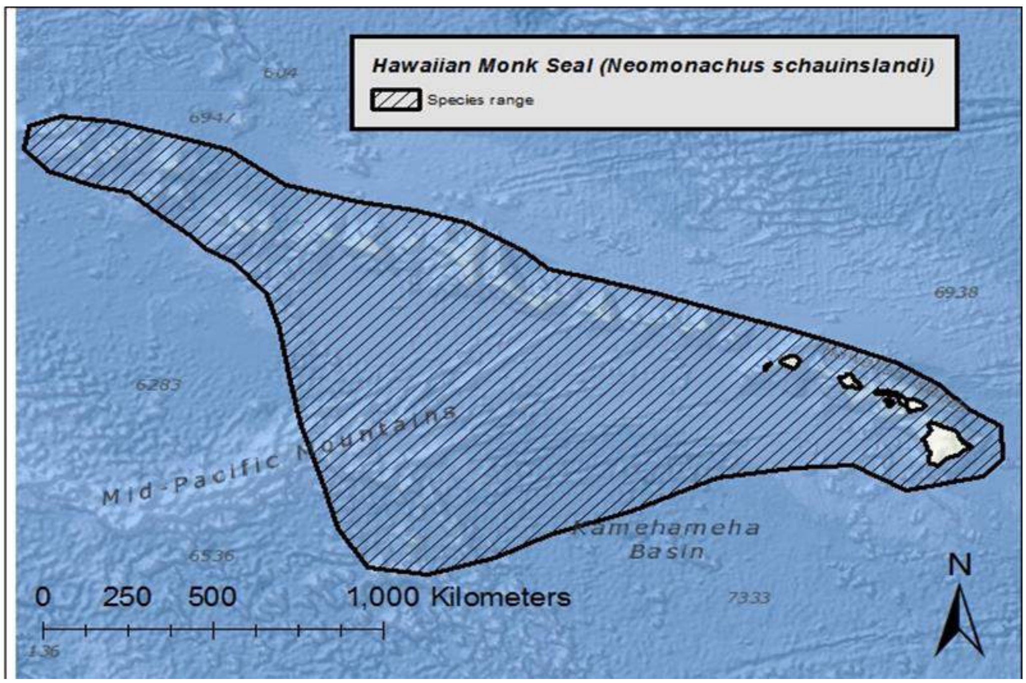

Figure 37. Hawaiian Monk Seal range

Species Description The Hawaiian monk seal is a large phocid ("true seal") that is one of the rarest marine mammals in the world. The Hawaiian monk seal inhabits the Northwestern Hawaiian Islands and Main Hawaiian Islands.

Hawaiian monk seals are silvery-grey with a lighter creamy coloration on their underside (newborns are black), they may also have light patches of red or green tinged coloration from attached algae. The Hawaiian monk seal was originally listed as endangered on November 23, 1976 (41 FR 51611).

Figure 38. Hawaiian monk seal. Photo: NOAA

Status Hawaiian monk seals were once harvested for their meat, oil, and skins, leading to extirpation in the main Hawaiian islands and near-extinction of the species by the twentieth century (Hiruki and Ragen 1992; Ragen 1999). The species partially recovered by 1960, when hundreds of seals were counted on northwestern Hawaiian islands beaches. Since then, however, the species has declined in abundance. Though the ultimate cause(s) for the decline remain unknown threats include: food limitations in northwestern Hawaiian islands, entanglement in marine debris, human interactions, loss of haul-out and pupping beaches due to erosion in northwestern Hawaiian islands, disease outbreaks, shark predation, male aggression towards females, and low genetic diversity. With only approximately 1,112 individuals remaining the species' resilience to further perturbation is low.

Life history Hawaiian monk seals can live, on average, twenty-five to thiry years. Sexual maturity in females is reached around five years of age and it is thought to be similar for males but they do not gain access to females until they are older. They have a gestation period of ten to eleven months, and calves nurse for approximately one month while the mother fasts and remains on land. After nursing, the mother abandons her pup and returns to the sea for eight to ten weeks before returning to beaches to molt. Males compete in a dominance hierarchy to gain access to females (i.e., guarding them on shore). Mating occurs at sea, however, providing opportunity for female mate choice. Monk seals are considered foraging generalist that feed primarily on benthic and demersal prey such as fish, cephalopods, and crustaceans. They forage in subphotic zones either because there areas host favorable prey items or because these areas are less accessible by competitors (Parrish et al. 2000).

Population Dynamics

Abundance The entire range of the Hawaiian monk seal is located within U.S. waters. In addition to a small but growing population found on the main Hawaiian islands there are six main breeding subpopulations in the northwestern Hawaiian islands identified as: Kure Atoll, Midway Islands, Pearl and Hermes Reef, Lisianski Island, Laysan Island, and French Frigate Shoals. The best estimate of the total population of Hawaiian monk seals is 1,112. This estimate is the sum of estimated abundance at the six main northwestern Hawaiian islands subpopulations, an extrapolation of counts at Necker and Nihoa Islands (smaller breeding sub-populations), and an estimate of minimum abundance in the main Hawaiian islands. The minimum population size for the entire species is 1,088 (781 for the six main northwestern Hawaiian islands reproductive sites, 38.3 and 89.3 for Necker and Nihoa Islands respectively, and 179 individuals in the main Hawaiian islands).

Productivity / Population Growth Rate The overall abundance of Hawaiian monk seals has declined by over 68% since 1958. Current estimates indicate a growth rate of approximately

6.5% annually for the main Hawaiian islands subpopulation (Baker et al. 2011). Likewise, sporadic beach counts at Necker and Nihoa Islands suggest a positive growth rate. The six main northwestern Hawaiian islands subpopulations continue to decline at approximately 3.4% annually.

Genetic Diversity Genetic analysis indicates the species is a single panmictic population, thus warranting a single stock designation (Schultz et al. 2011). Genetic variation among monk seals is extremely low and may reflect a long-term history at low population levels and more recent human influences (Kretzmann et al. 2001; Schultz et al. 2009). In addition to low genetic variability, studies by Kretzmann et al. (1997) suggest the species is characterized by minimal genetic differentiation among sub-populations and, perhaps some naturally occurring local inbreeding. The potential for genetic drift should have increased when seal numbers were reduced by European harvest in the nineteenth century, but any tendency for genetic divergence among sub-populations is probably mitigated by the inter-island movements of seals. Since the population is so small there is concern about long-term maintenance of genetic diversity making it quite likely that this species will remain endangered for the foreseeable future.

Distribution The Hawaiian monk seal inhabits the Northwestern Hawaiian Islands and Main Hawaiian Islands.

Designated Critical Habitat Hawaiian monk seal critical habitat was originally designated on April 30, 1986 (51 FR 16047) and was extended on May 26, 1988 (53 FR 18988). It includes all beach areas, sand spits, and islets (including all beach crest vegetation to its deepest extent inland), lagoon waters, inner reef waters, and ocean waters out to a depth of twenty fathoms (thirty-seven meters) around the northwestern Hawaiian islands breeding atolls and islands. The marine component of this habitat serves as foraging areas, while terrestrial habitat provides resting, pupping, and nursing habitat.

On September 21, 2015, NMFS published a final rule to revise critical habitat for Hawaiian monk seals (80 FR 50925), extending the current designation in the northwestern Hawaiian islands out to the 200 meter depth contour (including Kure Atoll, Midway Islands, Pearl and Hermes Reef, Lisianski Island, Laysan Island, Maro Reef, Gardner Pinnacles, French Frigate Shoals, Necker Island, and Nihoa Island). It also designates six new areas in in the main Hawaiian islands (i.e., terrestrial and marine habitat from five meters inland from the shoreline extending seaward to the 200 meter depth contour around Kaula, Niihau, Kauai, Oahu, Maui Nui, and Hawaii).

Recovery Goals See the 2007 Final Recovery Plan for the Hawaiian monk seal for complete down listing/delisting criteria for each of the four following recovery goals.

- Improve the survivorship of females, particularly juveniles, in sub-populations of the northwestern Hawaiian islands.
- Maintain the extensive field presence during the breeding season in the northwestern Hawaiian islands.
- Ensure the continued natural growth of the Hawaiian monk seal in the main Hawaiian islands by reducing threats including interactions with recreational fisheries, disturbance of mother-pup pairs, disturbance of hauled out seals, and exposure to human domestic animal diseases.

- Reduce the probability of the introduction of infectious diseases into the Hawaiian monk seal population.

Table 35. Summary of status; Hawaiian Monk Seal

Criteria	**Description**
Abundance / productivity trends	<40% of 1958 abundance, two populations have increasing trends, six populations have declining trends, very low genetic resilliance
Listing status	endangered
Attainment of recovery goals	criteria not yet met
Condition of PBFs	Limitations in food; Marine debris (entanglement); Habitat degradation.

9.19 Johnson's Seagrass

Table 36. Johnson's Seagrass; overview table

Species	Common Name	DPS	ESA Status	Recent Review Year	Listing	Recovery Plan	Critical Habitat
Halophila Johnsonii	Johnson's Seagrass	NA	Threatened	2007	63 FR 49035	2002	65 FR 17786

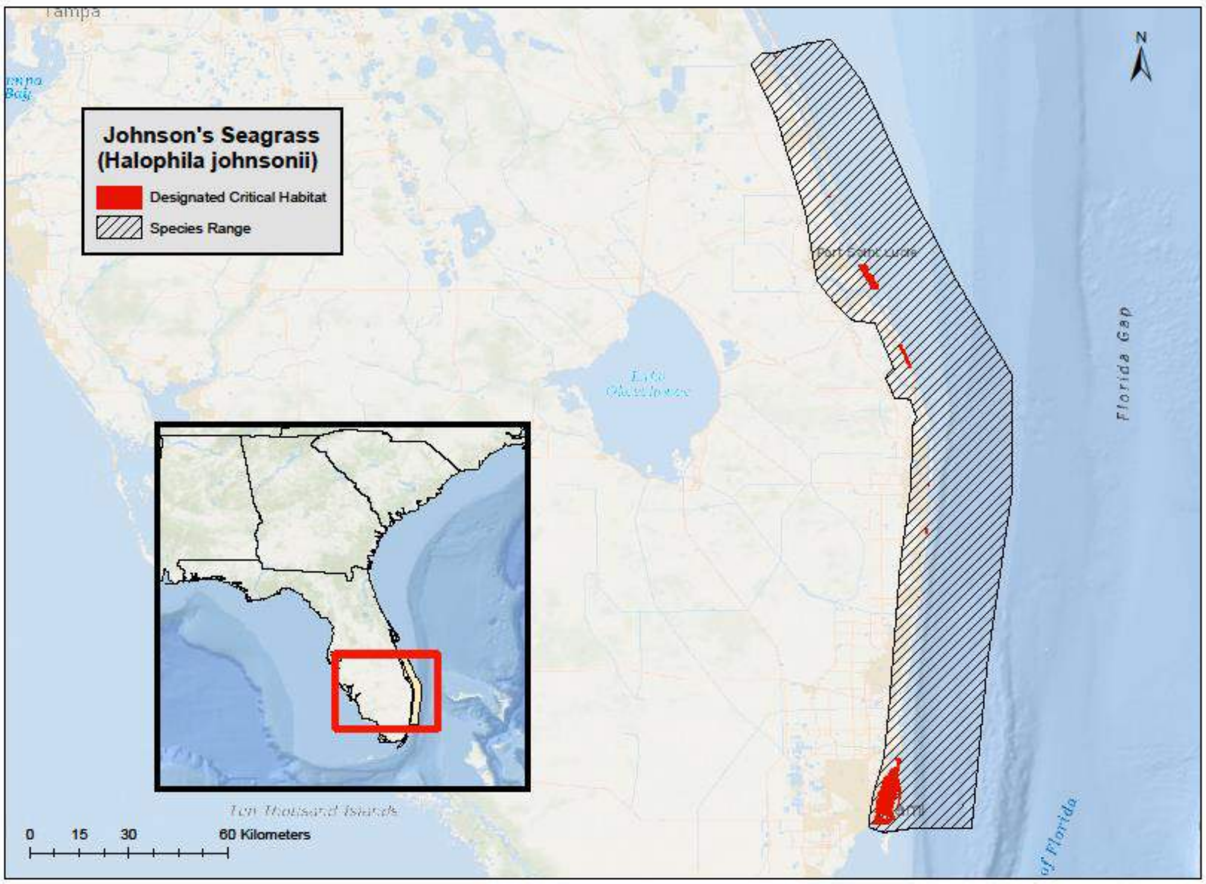

Figure 39. Johnson's Seagrass range and designated critical habitat

Species Description Johnson's seagrass is a rare species of marine plant that can be identified by its linearly shaped foliage leaves that present in pairs, smooth margins, creeping rhizomes with petioles, sessile female flowers, and long-necked fruit. It is also known for its distinct asexual reproduction, with no male flowers to be known. The species is more tolerant of salinity, temperature, and desiccation variation than other seagrasses in the area, preferring to grow in coastal lagoons in the intertidal zone rather than intermediate areas where other seagrasses thrive.

Johnson's seagrass was originally listed as threatened on September 14, 1998, becoming the first marine plant species to be listed under the ESA. The plant has a very limited distribution; found growing only in isolated patches along an approximately 200 kilometers (km) stretch of coastline between Sebastian Inlet and north Biscayne Bay in southeastern Florida.

Status Johnson's seagrass continues to be listed as threatened due to the species' vulnerability to a number of anthropogenic and natural disturbances (2002 recovery plan). It is the rarest species of its genus, exhibiting the most limited geographic distribution of any seagrass, and is also one of the least abundant species within its small geographic range. The species' dependence on substrate stability, in conjunction with its limited reproductive capacity and energy storage capacity, make it exceedingly difficult for Johnson's seagrass to survive environmental upset or repopulate lost areas. Additionally, environmental damage and habitat loss persist despite federal and state conservation efforts.

Life history The apparent absence of sexual reproduction evident among Johnson's seagrass suggests the species depends exclusively on asexual branching and clonal growth dynamics for the maintenance and distribution of its population. The species achieves vegetative growth through the division of apical meristems, which branch from horizontal rhizomes, forming leaf pairs, female flowers, and lateral branches. On average, new meristems are formed on rhizomes every 2 to 4 days (Kenworthy, 1997; Bolen, 1997). Eventually this forms high density patches that are typically widely spaced and These patches are most commonly Widely spaced patches As apical meristems produce new leaf pairs, old leaf pairs and their rhizomes senesce, die, and disintegrate.

Population Dynamics

Abundance Johnson's seagrass is the least abundant species of seagrasses within its range. It grows opportunistically in disjunct, isolated patches at depths from the intertidal zone down to depths of approximately 3-4 meters in a wide range of sediment types, salinities, and in variable water quality conditions. However, due to a its small size and minimal stored reserves. The largest known contiguous distribution of patches has been observed in Lake Worth Lagoon and is estimated to be 30 acres (Kenworthy, 1997).

Productivity / Population Growth Rate Available data for overall population rates for Johnson's seagrass are not available at this time. However, one study reports that abundance of all seagrass species has declined 16% since 1986 for the entire Indian River Lagoon complex (Pronce to Jupiter Inlet) while longer term losses are estimated to be near 50% for all seagrasses since Johnson's seagrass has immense potential for vegetative expansion. Its unique physiological attributes, clonal growth, tolerance of ranging degrees of salinity, temperature, and water quality conditions enable the species to grow in varying environments.

Genetic Diversity Research indicates Johnson's seagrass has a very low level of genetic diversity.

Distribution Found growing only in lagoons along the southeastern coastline of Florida, Johnson's seagrass has an extremely limited distribution. Its range is a 200 km stretch from Sebastian Inlet to north Biscayne Bay, Florida. Research indicates there has been no significant change in the species' overall geographical range (2007) from when it was originally listed as threatened.

Designated Critical Habitat On April 5, 2000, NMFS designated ten portions of the Indian River Lagoon and Biscayne Bay, Florida, as critical habitat within the current range of Johnson's seagrass. These portions present the following criteria: 1) populations that have persisted for 10 years, 2) persistent flowering populations, 3) northern and southern limits of the species, 4) unique genetic diversity, and 5) a documented high abundance of the Johnson's seagrass compared to other areas in the species' range.

Factors affecting the designated critical habitat of Johnson's seagrass include degraded water quality, habitat destruction, siltation due to land-use practices and algal overgrowth (nutrification).

Recovery Goals See the 2002 Final Recovery Plan for Johnson's seagrass for complete down listing/delisting criteria for each of the four following recovery goals.

- Identify and protect populations and habitat
- Initiate range-wide monitoring program
- Refine habitat requirements of *H. johnsonii*
- Conduct detailed life history studies of *H. johnsonii* to examine vegetative fragment dispersal, survival, and sexual reproduction
- Determine and implement habitat management needs and techniques
- Identify the genetic diversity and genetic structure of *H. johnsonii* across its geographic range
- Develop restoration techniques
- Formulate an educational outreach program to increase awareness of H. johnsonii and its status

CHAPTER 10

ENVIRONMENTAL BASELINE

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10 Environmental Baseline

10.1 Introduction

The environmental baseline is defined as: "past and present impacts of all Federal, State, or private actions and other human activities in an action area, the anticipated impacts of all proposed Federal projects in an action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process" (50 CFR 402.02). The key purpose of the environmental baseline is to describe the natural and anthropogenic factors influencing the status and condition of Endangered Species Act (ESA)-listed species and designated critical habitat in the action area. Since this is a consultation on what is a program with a large geographic scope, this environmental baseline focuses more generally on the status and trends of the aquatic ecosystems in the U.S. and the consequences of that status for listed resources. For the baseline land-use analysis, we relied on the 2011 National Land Cover Database (NLCD).

Activities that negatively impact water quality also threaten aquatic species. The deterioration of water quality is a contributing factor that has led to the reduction in populations of some ESA-listed aquatic species under the National Marine Fisheries' (NMFS) jurisdiction. Declines in populations of these species leave them vulnerable to a multitude of threats. Due to the cumulative effects of reduced abundance, low or highly variable growth capacity, and the loss of essential habitat, these species are less resilient to additional disturbances. In larger populations, stressors that affect only a limited number of individuals could once be tolerated by the species without resulting in population level impacts; in smaller populations, the same stressors are more likely to reduce the likelihood of survival. In addition, populations that have ongoing stressors already present in the environment are less likely to be resilient to additional stressors resulting from the action. It is with this understanding of the Environmental Baseline that we will consider the effects of the proposed action on endangered and threatened species and their designated critical habitat. The action area for this consultation covers a very large number of individual watersheds and an even larger number of specific water bodies (e.g., lakes, rivers, streams, estuaries). It is, therefore, not practicable to describe the environmental baseline and assess risk for each particular area. Accordingly, this opinion approaches the environmental baseline on a region-by-region basis (See ***Table 1***), describing the activities, conditions and stressors which adversely affect ESA-listed species and designated critical habitat. These include natural threats (e.g., parasites and disease, predation and competition, wildland fires), water quality, hydromodification projects, land use changes, dredging, mining, artificial propagation, non-native species, fisheries, vessel traffic, and climate changes. For each of these threats we start with a general overview of the problem, followed by a more focused analysis at the regional level for the species listed above, as appropriate and where such data are available.

Table 1 Regions evaluated in the environmental baseline and associated ESA-listed species under NMFS' jurisdiction

Region	Species
Pacific Islands: Hawaii, Guam, Commonwealth of the Northern Mariana	*Acropora globiceps, Acropora jacquelineae, Acropora retusa, Acropora speciosa, Euphyllia pardivisa, Isopora crateriformis, and Seriatopora aculeate,* Hawaiian monk

Islands, Pacific Remote, Island Areas, and American Samoa	seal, and the green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles
Alaskan Aleutian Islands Region	southern DPS eulachon, southern DPS green sturgeon, southern resident killer whale, leatherback sea turtle, Steller sea lion and most of the Chinook, Chum, Coho and Sockeye ESU/DPSs
Pacific Coast: Washington, Oregon, California, and Idaho	Chum salmon (2 ESUs), Chinook salmon (9 ESUs), Coho salmon (4 ESUs), Sockeye (2 ESUs), Steelhead (11 ESUs), Eulachon, Pacific smelt, Green sturgeon, Steller sea lion, Guadalupe fur seal, and the green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles
Northeast: Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland, and Virginia	Atlantic salmon, Atlantic sturgeon (3 DPS), shortnose sturgeon, and the green, hawksbill, leatherback, loggerhead, and Kemp's ridley sea turtles
Southeast: North Carolina, South Carolina, Georgia, St. Marys-Satilla, St. Johns, and East Florida Coastal basins	Atlantic sturgeon (2 DPS), shortnose sturgeon, and the green, hawksbill, leatherback, loggerhead, and Kemp's ridley sea turtles
South Florida and the U.S. Caribbean: Southern Florida Basin, Puerto Rico, U.S. Virgin Islands	Johnson's seagrass, Nassau grouper, elkhorn coral, staghorn coral, lobed star coral, boulder star coral, mountainous star coral, pillar coral, and rough cactus coral, and the green turtle, hawksbill, leatherback, loggerhead, and olive and Kemp's ridley sea turtles
Gulf of Mexico: Peace River Basin of Florida northwestward to Alabama, Mississippi, Louisiana, and Texas	Gulf sturgeon, smalltooth sawfish, and the green, hawksbill, leatherback, loggerhead, and Kemp's ridley sea turtles

Our summary of the environmental baseline complements the information provided in the Status of Species and Critical Habitats Likely to Be Adversely Affected section (Chapter 9), and provides background necessary to evaluate and interpret information presented in the Effects of the Action and Cumulative Effects sections (Chapters 11-18).

The quality of the biophysical components within aquatic ecosystems is affected by natural events as well as human activities conducted within and around coastal waters, estuarine and riparian zones, as well as those conducted more remotely in the upland portion of the watershed. Industrial activities can result in discharge of pollutants, changes in water temperature and levels of dissolved oxygen, and the addition of nutrients. In addition, forestry and agricultural practices can result in erosion, run-off of fertilizers, herbicides, insecticides or other chemicals, nutrient enrichment and alteration of water flow.

The information from the environmental baseline is treated as a "risk modifier" in the Integration and Synthesis section (Chapters 19-24). Factors which have the potential to "modify" the risk are those which are able to interact with the effects of the action. For example, elevated temperatures have been demonstrated to increase the toxicity of OP pesticides in fish (Mayer and Ellersieck, 1986; 1988; Osterauer & Kohler, 2008) and certain mixtures of cholinesterase inhibiting pesticide increase the toxicity to juvenile coho salmon (Laetz et al. 2014). While many of the factors described in this section have the potential to modify the action, and were thus considered, two of the factors present in the environmental baseline were consistently found to have a high potential to modify the risk. The two factors are: 1) elevated freshwater temperatures, and 2) pesticide environmental mixtures. Elevated temperatures may increase risk to species because adverse toxicological responses are heightened with increases in temperature. Pesticide environmental mixtures may increase risk because of additive or synergist effects. We therefore developed two key questions to guide our synthesis of the information within the environmental baseline section:

1. Are freshwater temperatures elevated?
2. Are pesticide mixtures present, or anticipated based on current land use?

We used best available information to answer these two questions for each of our species. To assess elevated temperature, we evaluated the most recent TMDL 303(d) listings to calculate the total river-kilometers of recorded temperature exceedance within each species range (e.g. ***Table 6***). Species recovery plans, status updates, and listing documents also contributed species specific information regarding documented temperature exceedances. To assess pesticide environmental mixtures we examined land use categories within each species range by performing an overlap analysis with the most recent NLCD information (NLCD, 2011) (e.g. ***Table 2***). We found the United States Geological Survey's (USGS) most recent National Water-Quality Assessment (NAWQA) report (Ryberg et al. 2014) corroborated previous reports findings of trends between concentration and use for pesticides with both agricultural and urban applications. As such, we used land use categories such as "cultivated crops", "pasture/hay", and "developed land" as proxies for areas with an increased potential for environmental mixtures. Species recovery plans, status updates, and listing documents also contributed species specific information regarding pesticide environmental mixtures.

Within the Integration and Synthesis section (Chapters 19-24) we characterize the overall magnitude of influence of the environmental baseline as either "low" or "high". This characterization includes directionality (i.e. positive influence which equates to less risk or negative influence which equates to more risk) as well as confidence. The magnitude, directionality, and confidence of the influence are determined primarily by answers provided to the two questions outlined above. We acknowledge that the magnitude, and directionality of these two factors varies on a species-by-species basis, for example the same proportion of habitat with elevated temperatures may affect two species in different ways (e.g. smalltooth sawfish occur in warmer water bays in Florida, whereas Pacific salmonids require cold water; elevated temperatures would affect these species differently). We further acknowledge that the quantitative data (e.g. 303(d), NLCD) is incomplete without considering the qualitative data often provided in recovery plans, status reports and listing documents. Therefore, we characterized magnitude and directionality with the following guidelines:

- If answers to one or both key questions are in the affirmative, and, if the extent of one or both factors are considered to be of sufficient concern for that species, then the magnitude is large and the directionality is negative;
- If both key questions are answered in the negative, and, if other baseline factors for that species (e.g. prey availability) indicate a positive baseline, then the magnitude will be small and the directionality will be positive;
- If answers to both key questions are in the negative, and, if other baseline factors for that species (e.g. prey availability) indicate a negative baseline, then the magnitude will be small and the directionality will be negative.

The three guidelines above are not exhaustive of all possible combinations of the factors examined in the baseline, rather they outline only those combinations which were encountered in this Opinion. We characterize the overall confidence in the magnitude and directionality as either "low" or "high". Confidence is determined by assessing the amount of evidence provided, as well as by further considering the species-specific implications of the two factors. For example, we found these factors for the shortnose sturgeon to have a large magnitude and negative directionality. However, the confidence was determined to be low because much of this species' life history occurs in marine habitats, which are less likely to be effected by pesticide mixtures and elevated temperatures.

The environmental baseline sections that follow are organized by region (e.g. Pacific island region). Within each region, discussions of land-use, water quality, and other components of the baseline are presented at the subregion level (hydrologic unit code 2) when applicable.

10.2 Pacific Island Region

The Pacific island region includes the Hawaiian Islands, American Samoa, Guam, and the Northern Mariana Islands (***Figure 1***).

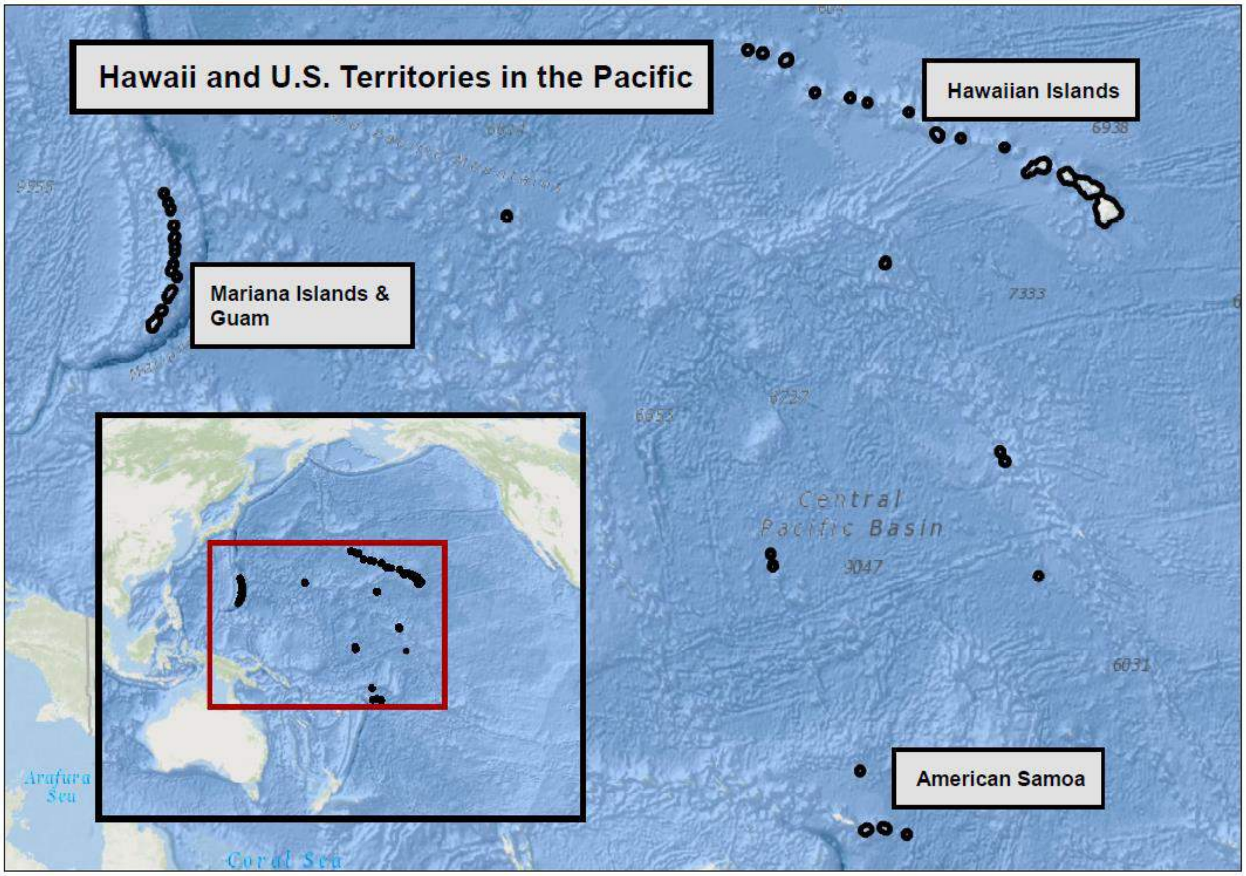

Figure 1. Hawaiian Islands and US territories in the Pacific

Thirteen of the 77 species addressed in the Opinion occur in this subregion. They are: Hawaiian monk seal, green, hawksbill, leatherback, loggerhead, and olive ridley sea turtles as well as seven coral species - Acropora globiceps, Acropora jacquelineae, Acropora retusa, Acropora speciosa, Euphyllia pardivisa, Isopora crateriformis, and Seriatopora aculeate.

10.2.1 Hawaiian Islands

10.2.1.1 Sea Turtles

Fisheries This section summarizes some fisheries with observations or reports of incidental or intentional sea turtle takes. Estimates can be made of the impacts of coastal, offshore, and distant-water fisheries on sea turtle populations in the Pacific Ocean by extrapolating data collected on fisheries with known effort that have been observed to incidentally take sea turtles. Such estimates are hampered by a lack of data on pelagic distribution of sea turtles. Estimates of total fishing effort are complicated because not all active vessels fish equivalent number of days per trip or annually; use the same number of hooks, length of net, or mesh size; or have the same carrying capacity. However, even with minimum effort estimates, substantial fishing effort occurs in the Pacific Ocean for which NMFS has minimal sea turtle bycatch information.

North Pacific Driftnet Fisheries (before December 1992). Comprehensive data are lacking, but the observer data indicate the possible magnitude of past turtle mortality. The North Pacific high-seas driftnet fisheries may have killed at least 2,500 turtles per year during the late 1980s, and the estimated total driftnet bycatch was about 9,000 turtles per year (Wetherall et al. 1993). Most mortalities observed in 1990 were loggerheads in the Japanese and Taiwanese large-mesh fisheries. Effects from historic driftnet fisheries may still be evident in sea turtle populations today. Foreign high-seas driftnet fishing in the North Pacific Ocean for squid, tuna, and billfish ended with a United Nations moratorium in December 1992 (NMFS 2011c).

Pacific Longline Fisheries. Longline fisheries represent the predominance of effort in Federal waters. Available data indicate that approximately 30,000 loggerheads and 20,000 leatherbacks were caught as bycatch by pelagic longlines throughout the Pacific in 2000, and about 2600-6000 loggerheads and 1000-3200 leatherbacks of the bycatch were mortalities (Lewison et al. 2004). A 2001 Opinion under ESA section 7 on the combined deepset tuna and shallow-set swordfish fisheries concluded that the Hawaii-based longline fisheries jeopardized the continued existence of three sea turtle species: loggerhead (Caretta caretta), leatherback (Dermochelys coriacea), and green (Chelonia mydas), but did not jeopardize the continued existence of the olive ridley sea turtle (Lepidochelys olivacea) or any ESA-listed marine mammals. This Opinion was overturned in litigation, but not before extensive changes were effected to dramatically reduce turtle bycatch and mortality, including a three-year closure of the swordfish fishery, a regulatory definition of gear and turtle take limits for the continued deep-set tuna fishery, measures for handling and release of protected species, and certified training for vessel operators. A 2004 Opinion on the region's pelagic fisheries, a 2005 Opinion on the deep-set fishery, and a 2008 Opinion on the shallow-set fishery concluded that neither fishery was likely to jeopardize the continued existence of a listed species. Litigation continues on the operation of this fishery, with challenges to NMFS policy by both industry associations and environmental groups (NMFS 2011c).

Limits on incidental take of sea turtles were established by the 2004 and 2008 Opinions, mandating immediate closure of the Hawaii-based shallow-set pelagic longline fishery for swordfish when limits are reached in a calendar year. Take limits that trigger reconsultation but not closure were also established for green and olive ridley sea turtles in the swordfish fishery (one-year limits), and for all four turtle species in the Hawaii-based deep-set pelagic longline fishery for tuna (three-year limits). Currently, there is also a cap on effort (number of sets) that applies only in the shallowset swordfish fishery, which has 100% mandatory observer coverage to monitor sea-turtle interactions (the deep-set longline fishery is known to have significantly lower bycatch of marine turtles). When the swordfish fishery bycatch of loggerhead or leatherback sea turtles reaches the take limit, the fishery is closed for the remainder of the year, which occurred in 2006 but not in 2004, 2005, or 2007–2009. Sea turtle bycatch in the deep-set longline fishery stayed under the take limit through 2011(NMFS 2011c).

The changes in fishing gear that were required to reduce sea turtle bycatch in the swordfish fishery were the result of a success story that began in the Atlantic and continued to the Pacific. Watson et al. (2005) conducted experiments in the Atlantic Ocean which showed that replacing "J" hooks with large (size 18) circle hooks and replacing squid bait with fish bait could greatly reduce both loggerhead and leatherback sea turtle bycatch in swordfish longline fishing. Both measures were required in the reopened Hawaii swordfish fishery in 2004 and were as effective as expected in reducing turtle bycatch. In addition, the average rate of shark catch in the reopened swordfish fishery was much lower than before the gear was changed, perhaps due to the elimination of the previously used type of bait, squid, which is a preferred food of blue shark (Gilman et al. 2006). The fishery has also been much more concentrated in the early part of the calendar year than it was before effort was capped in 2004. This may also have reduced blue shark catch rates, which tended to be higher later in the year. Although not required to do so, the American Samoa longline fishery has always used circle hooks of varying size, and the Hawaii deep-set longline fishery, which used tuna hooks almost exclusively prior to 2004, has greatly increased its use of circle hooks(NMFS 2011c).

Other Pacific longline fisheries may have high levels of sea turtle bycatch, although the shallow-set type of fishing for swordfish, which has the highest turtle bycatch rates, has not yet been used in American Samoa or Guam (NMFS 2011c).

Debris Ingestion of marine debris is a serious threat to sea turtles. Sea turtles can mistake debris (e.g., tar and plastic) for natural food items, which can cause death. Leatherback, loggerhead, and green sea turtles feed in areas that coincide with areal accumulation of plastics (EPA 2011)(USFWS 2008). Some types of marine debris, such as oil, may be directly or indirectly toxic. Other types of marine debris, such as discarded or derelict fishing gear, may entangle and drown sea turtles.

Contaminants Coastal runoff and river discharges carry large volumes of petrochemical and other contaminants from agricultural activities, cities, and industries into aquatic habitats. Petrochemical and other contaminants also run off vessels at sea. Sea turtles travel between nearshore and offshore habitats and may be exposed to and accumulate these contaminants during their life cycle.

Vessel Strikes Vessel collisions can result in serious injury and death. Vessel collisions may pose a threat to sea turtles in or near the action area although NMFS is unclear to what extent.

Other Federal Activities Other Federal activities, such as U.S. Navy operations and issuance of various licenses and permits by Federal agencies, may occur in the action area. Those activities may affect sea turtles, and the ESA requires section 7 consultation with NMFS for such actions.

Conservation, Management and Recovery Activities The Western Pacific Regional Fisheries Management Council, NMFS Pacific Islands Regional Office, and Southwest Fisheries Science Center are continuing to collaborate with regional and local governments around the Pacific rim, conservation and wildlife groups internationally, and the fishing industry both nationally and internationally. These parties have started to implement projects to conserve sea turtles in the Pacific in cooperation with experienced non-governmental organizations such as World Wildlife Fund - Indonesia, Kamiali Integrated Conservation Development Group of Papua New Guinea, the Sea Turtle Association of Japan, and Wildcoast in Baja, Mexico.

10.2.1.2 Hawaiian Monk Seal

Prey Limitation Prey limitation is considered to be one of the primary reasons for the decline of monk seals in the NWHI (Craig and Ragen 1999, Antonelis et al. 2006, NMFS 2006, Baker 2008, Parrish et al. 2011(NMFS, 2016 #318)). It may result in decreased pup girth at weaning, high juvenile mortality, delayed age at first parturition, low birth rate, and emaciated animals (Lowry et al. 2011). Reduced prey availability may be the result of an overall decline in ecosystem productivity as a result of environmental variability (Craig and Ragen 1999, Parrish et al. 2011).

Predation Tiger and Galapagos sharks are known to prey upon seals and are abundant in the NWHI (Dale et al. 2011a, Dale et al. 2011b). Given the decline in pup production (from 91 in 1993 to 37 in 2010), current predation rates are unsustainable (Lowry et al. 2011).

Male Aggression Multiple-male aggression, or mobbing, was at times the primary cause of adult female mortality at Laysan Island, and single male aggression is episodically a significant cause of pup mortality. Multiple-male aggression is thought to result when males significantly outnumber females (Johanos et al. 2010).

Habitat Loss The majority of monk seals reside in the NWHI, which are protected as the Papahanaumokuakea Marine National Monument, one of the largest no-take marine reserves in the world. These low-lying islands are threatened by sea level rise and natural erosion. From 1985 to 1996, approximately 35% of French Frigate Shoals pups were born at Whaleskate, a 6.8 hectacre island. In the late 1990s, the island disappeared due to natural erosion. It is possible that loss of this important pupping beach led to crowding at Trig Island, which exposed pups to increased shark predation and ultimately contributed to the decline. Climate change, and sea level rise in particular, may contribute to future habitat loss (Baker et al. 2006; NMFS, 2016 #318).

Fisheries Interactions Monk seals often become entangled or hooked in active and discarded fishing gear. Between 1982 and 2006, 48 hookings were recorded throughout the archipelago. Over the same time period, entanglement in discarded fishing gear led to at least seven deaths and 32 serious injuries in the NWHI (Lowry et al. 2011). In the MHI, at least six seals have drowned in gill nets since 1976; three of those were since 2006 (Leone 2010). Reduced prey availability, as described above, may be the result of overfishing (Craig and Ragen 1999, Parrish et al. 2011).

Human Disturbance Human disturbance of nursing and resting seals is a major concern in the MHI, where seals share the beaches with recreational beach-goers, fishermen, and pets. Volunteer groups and stranding network members try to monitor such activities and educate the public on proper viewing distances; however interactions still occur.

Climate Change. Anticipated climate change will undoubtedly influence the future abundance of monk seals. Warming sea surface temperatures and ocean acidification is likely to reduce the availability of prey (Pachauri, 2014 #319; Polovina et al. 2008). Sea level rise would reduce available beach habitat. The result may be long-term, steady decline of monk seal carrying capacity in the NWHI (Schultz et al. 2011b).

Conservation, Management and Recovery Activities The PIFSC has implemented numerous initiatives to mitigate declining abundance of the Hawaiian monk seal, including: removal of aggressive males from the population, translocation, rehabilitation, disentanglement, medical treatment, and population monitoring. These activities have met with a variety of success or failure but have definitively slowed, but not reversed, the species' decline (Harting et al. in prep.).

10.2.2 American Samoa, Mariana Islands & Guam

10.2.2.1 Sea Turtles

Direct Harvest Directed take by illegal egg and adult harvesting is identified as one of the primary threats to green and hawksbill sea turtles. Sea turtles were traditionally taken by residents of Guam for celebrations and some illegal harvesting likely continues in the form of egg collection and adult collection from both beaches and coastal waters (NMFS and USFWS 1998a; NMFS and USFWS 1998b, NMFS, 2007 #320)

Habitat Loss Habitat loss is considered a primary threat to green and hawksbill sea turtles in Guam (NMFS and USFWS 1998a; NMFS and USFWS 1998b). Beachfront development, artificial lighting, and non-native vegetation, loss or degradation of nesting habitat resulting from erosion control through beach nourishment and armoring, are serious threats affecting nesting females and hatchlings.

Fisheries Impacts At a bycatch working group meeting of the Inter-America Tropical Tuna Convention held in Kobe, Japan in 2004, a member of the Japanese delegation stated that based on preliminary data from 2000, the Japanese tuna longline fleet was estimated to take approximately 6,000 turtles, with 50% mortality. Little information on species composition was given; however, all species of Pacific sea turtles were taken (NMFS 2005).

Taiwanese have harvested sea turtles for many years for their meat, their bones for use in Chinese medicine, and eggs for profit. In Taiwan, sea turtle bycatch in fisheries occurs, although little quantitative information is available for fisheries operating in the Pacific Ocean (Cheng 2002).

In the Republic of the Marshall Islands, a purse-seine fishery for tuna and a significant longline fishery operate in the exclusive economic zone, and sea turtles have been captured in both fisheries with mortality sometimes occurring (Hay and Sablan-Zebedy 2005). McCoy (2007a) presented a summary of sea turtle interactions with longline vessels based in Majuro from observer data from 2005 to 2007. A total of 33 sea turtle interactions were documented during this period, of which six were identified as green turtles. The mortality rates recorded for these 33 interactions were high, with only five turtles identified as alive upon release (McCoy 2007a).

In Palau, a total of 18 sea turtles were captured on shallow-set longline vessels during 12 trips with observer coverage from April–December 2007. Out of the 18 interactions, two were green turtles (McCoy 2007b). One was landed onboard alive and released, the other was dead at the time of landing.

Incidental catch of turtles in Guam coastal waters by commercial fishing vessels probably also occurs (NMFS and USFWS 1998). However, no bycatch studies have been undertaken to quantify the level of incidental capture by commercial fishing operations in the Solomon Islands.

Military Activities The Department of the Navy's U.S. Pacific Fleet maintains a naval base at Guam's Apra Harbor and conducts training and testing within Apra Harbor and the water surrounding Guam as part of their Marianas Islands Testing and Training. Underwater detonations associated with military training, particularly those occurring in Apra Harbor, may affect green and hawksbill sea turtles including behavioral responses, habitat avoidance, injury (hearing threshold shifts), and death.

Debris Ingestion of marine debris can be a serious threat to sea turtles. When feeding, sea turtles can mistake debris (e.g. tar and plastic) for natural food items. Some types of marine debris may be directly or indirectly toxic to sea turtles on their migration to (and potentially within) the action area, such as oil. Turtles can become entangled in derelict gillnets, pound nets, and the lines associated with longline and trap/pot fishing gear.

Contaminants Coastal runoff and river discharges carry large volumes of petrochemical and other contaminants from agricultural activities, cities, and industries into the marine environment. Marina and dock construction, dredging, aquaculture, oil and gas exploration and extraction, increased under water noise, and boat traffic can degrade marine habitats used by sea turtles (Colburn et al. 1996, NMFS, 2007 #320).

Conservation Efforts Haggan Watch is a program started in 2005 and staffed by volunteers that monitor Guam's coast for sea turtles. Nesting sea turtles are observed to ensure nests are not poached for eggs and adults are not disturbed. Injured turtles are brought to facilities and nursed back to health before release. Airmen from the Andersen Air Force Base (AFB) in Guam have partnered with researchers from the University of Guam to monitor sea turtle nesting along the northern coast of Guam. The program removes litter from the beaches and monitors sea turtle nesting activity.

10.2.2.2 Coral species in the Pacific

Climate Change and Acidification The reefs of American Samoa are not immune to the impacts from the global phenomenon of climate change. The global mean temperature has risen by 0.76 degrees Celsius over the last 150 years, and much of that increase has occurred over the past 50 years (Solomon et al., 2007). The incidence of climate-related events to corals in American Samoa have been minimal compared to many areas around the world. Mass coral bleaching events happened in American Samoa in 1994 (Goreau and Hays, 1994), 2002, 2003 (Fenner et al., 2008), and 2015 (Fenner, personal comm.). There was mortality from some of these events; however, it was not massive. In several backreef pools on Tutuila, some corals bleach every summer, but mortality has been very minimal (Fenner and Heron, 2009). There is no evidence yet of effects of acidification on reefs in American Samoa.

Disease Coral disease outbreaks have followed some of the mass coral bleaching events in American Samoa with some mortality, though mortality has not been great. There is a diversity of coral diseases in American Samoa, but prevalence is low (Fenner et al., 2008; Aeby et al., 2009; Fenner, personal comm.). There have been a few small, localized, disease outbreaks in American Samoa in recent years (Fenner, 2013).

Fisheries Interactions Fishing pressure in the 1970s in American Samoa was reported as among the highest reported in the world (Dalzell et al., 1996). Increasing prosperity since then has led to a shift to purchasing food in stores and decreasing fishing pressures (Sabater and Carroll, 2009). Harvest on reef flats is fairly common at the lowest tides, and some other forms of fishing such as hook and line, and throw net are also carried out on reef flats at times. Walking on corals impacts them, and a small amount of walking on fragile branching *Acropora* staghorn corals occurs, breaking branches.

Land-based Contaminants Runoff from land carries nutrients from on land, including from piggeries and septic systems. In most areas, the nutrients are probably carried quickly to the ocean with sediment. However, in narrow bays such as Pago Pago Harbor and Vatia Bay, circulation is limited and water residence times are greatly increased, and so runoff nutrients accumulate in the water.

Construction Activities Construction activities have done considerable damage to some areas of the reefs around Tutuila in the past. Material has been dredged from inner reef flats in several areas to provide material to add to village land, and in the largest such project, to build over the reef flat to construct the airport runways.

Predation Crown-of-thorns starfish (COTS) eat the tissue off of coral skeletons. They are normally quite rare on reefs, but periodically they reach outbreak proportions on some reefs, and can form plagues of millions of starfish, eating the tissue and killing almost all of the corals. Outbreaks occurred on Tutuila in 1938 and 1978, with the 1978 outbreak involving millions of starfish and eating an estimated 90% or more of all corals.

10.3 Alaskan Aleutian Islands Region

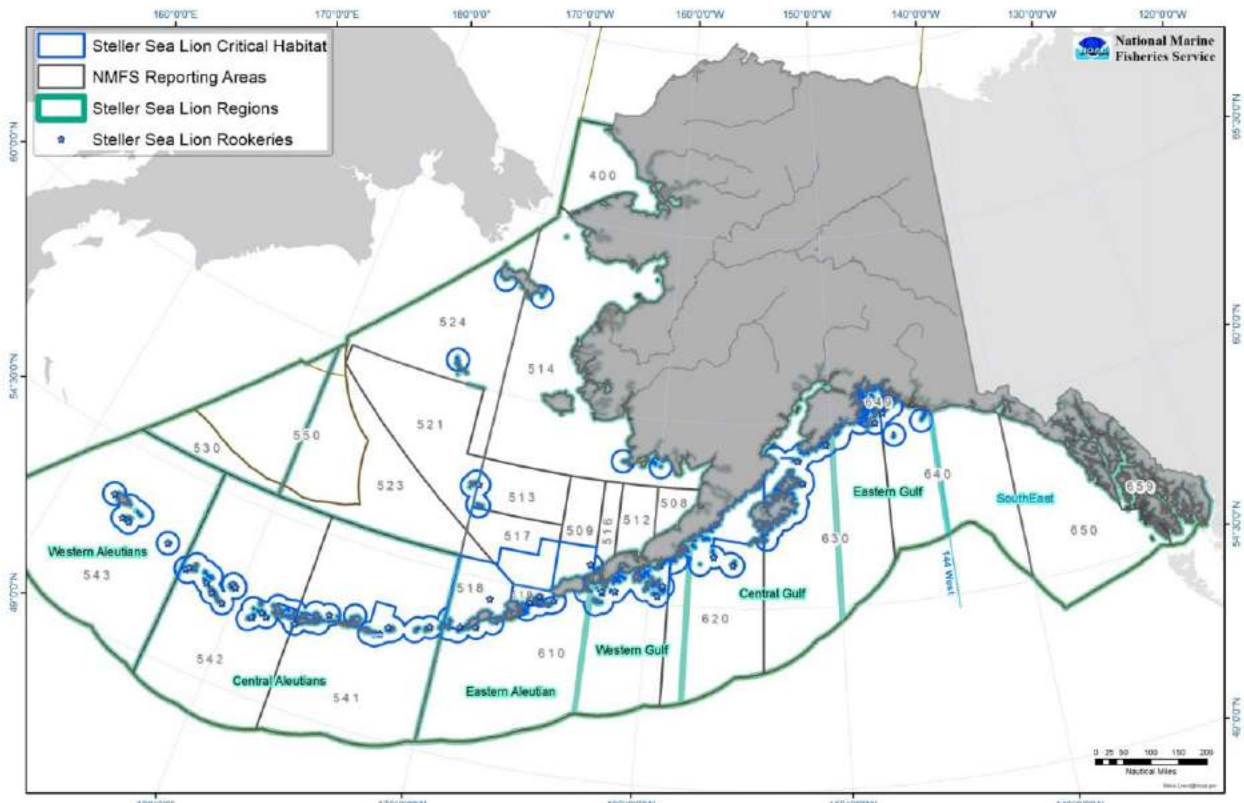

Figure 2. State of Alaska and the distribution of the Western DPS Steller sea lion.

Many of the species addressed in the Opinion spend all or some portion of their life in this subregion. They include: southern DPS eulachon, southern DPS green sturgeon, southern resident killer whale, leatherback sea turtle, Steller sea lion and most of the Chinook, Chum, Coho, Sockeye and Steelhead ESU/DPSs. The environmental baseline information presented here pertains primarily to the Steller sea lion. Baseline factors for the other species which occur in this region are described in the West Coast region narrative.

10.3.1 Steller Sea Lion

Fisheries Interactions The minimum estimated mortality rate of western Steller sea lions incidental to all U.S. commercial fisheries is 33.8 sea lions per year, based on observer data

(32.8) and stranding data (1.0) where observer data were not available. Several fisheries that are known to interact with the WDPS have not been observed making the estimated mortality a minimum estimate (Allen and Angliss 2013).

The Russian herring trawl fishery in the western Bering Sea was observed in 2002. The estimated take of Steller sea lions from observed vessels was 50 (26–74, 95% CI) with a mortality rate of 83% (Burkanov et al. 2006).

The Steller Sea Lion Recovery Plan (NMFS 2008) ranked competition with fisheries for prey as a potentially high threat to recovery of the WDPS. Substantial scientific debate surrounds the question about the impact of potential competition between fisheries and sea lions. It is generally well accepted that fisheries target several important Steller sea lion prey species (NRC 2003, NMFS, 2008 #321).

Subsistence/Native Harvest The most recent subsistence harvest data were collected by the Alaska Department of Fish and Game through 2008 and by the Ecosystem Conservation Office of the Aleut Community of St. Paul through 2009. The mean annual subsistence take from the WDPS in Alaska over the 5-year period from 2004 through 2008, combined with the mean take over the 2005–2009 period from St. Paul, was 198 Steller sea lions/year (Allen and Angliss 2013).

Disturbance Vessel traffic, sea lion research and tourism may disrupt sea lion feeding, breeding, or aspects of sea lion behavior. However, the Steller Sea Lion Recovery Plan (NMFS 2008) ranked disturbance from these sources as a low threat to the recovery of the WDPS. Disturbance from these sources are not likely affecting population dynamics in the WDPS.

Contaminants The Steller Sea Lion Recovery Plan ranked the threat of toxic substances as medium (NMFS 2008). Studies published since the completion of the Recovery Plan indicate that contaminants may pose a greater threat to the recovery of the WDPS, particularly for animals in the western portion of the WDPS, than indicated in NMFS (2008). Myers et al. (2008) analyzed organochlorine contaminant (OC) levels in blood samples from Steller sea lion pups from Russia and western Alaska. Exposure to OCs in marine mammals and other wildlife has been associated with reproductive failures (Helle et al. 1976, Reijnders 1986) population declines (Martineau et al. 1987), carcinomas (Martineau et al. 1999) (Ylitalo et al. 2005), and immune suppression (Beckmen et al. 2003, DeSwart et al. 1994, Ross et al. 1996).

Mercury is a ubiquitous environmental pollutant that bioaccumulates and biomagnifies in food webs. Mercury enters ecosystems through natural sources (e.g., volcanism) and a variety of anthropogenic activities (e.g., mining and the burning of coal) and is converted by bacteria into the more toxic methylmercury (Kenney et al. 2012). The extent to which these levels of mercury impair Steller sea lion physiology is unknown. It is theorized that pinnipeds produce higher levels of selenium than other mammals which may detoxify the mercury in Steller sea lion organs (Holmes et al. 2008).

Predation Steller sea lions in both the eastern and western stocks are eaten by killer whales (Dahlheim and White 2010, Ford et al. 1998, Heise et al. 2003, Horning and Mellish 2012, Maniscalco et al. 2007, Matkin et al. 2007, Springer et al. 2008, Williams et al. 2004). The Steller Sea Lion Recovery Plan ranked killer whale predation as a potentially high threat to the recovery of the WDPS (NMFS 2008). Steller sea lions may also be attacked by sharks, though little evidence exists to indicate that sharks prey on Steller sea lions. The Steller Sea Lion

Recovery Plan did not rank shark predation as a threat to the recovery of the WDPS (NMFS 2008).

Nutritional Stress Nutritional stress results when a species is unable to acquire adequate energy and nutrients from prey resources. Nutritional stress could result from changes in prey quality, distribution, or abundance. WDPS Steller sea lions exhibited symptoms of nutritional stress during the rapid population decline in the 1980s. In 1985, sea lions were smaller on average, slower to reach sexual maturity, and had a lower birth rate than in the 1970s (Calkins et al. 1998, Calkins and Goodwin 1988, Pitcher et al. 1998, York 1994). The Steller Sea Lion Recovery Plan (NMFS 2008) determined that nutritional stress is a leading hypothesis for the steep population decline in the 1980s.

10.4 West Coast Region

The West coastal region includes rocky coasts, estuaries, bays, sub-estuaries and city harbors. In total the west coast contains 2,200 square miles of estuaries, over 60% of which is part of three major estuarine systems: the San Francisco Estuary, Columbia River Estuary, and Puget Sound (USEPA 2015). The coastal counties of the West Coast are home to 19% of the US population, and 63% of the total population of the West Coast states. The population in these coastal counties has nearly doubled since 1970 and is currently estimated to be around 40 million people (USEPA).

Coastal Condition Assessment ***Figure 3*** shows a summary of findings from the EPA's National Coastal Condition Assessment Report for the Northeast Region (USEPA 2015). A total of 134 sites were sampled to assess approximately 2,200 square miles of West Coast coastal waters. Biological quality is rated as good in 71% of the West coast region based on the benthic index. Poor biological conditions occur in 3% of the coastal area. About 21% of the region reported missing results. Based on the water quality index, 64% of the West coast is in good condition, 26% is rated fair, and 2% is rated poor.

Based on the sediment quality index, 31% of the West coast area sampled is in good condition, 23% is in fair condition, and 27% is in poor condition (19% were reported "missing"). Compared to ecological risk-based thresholds for fish tissue contamination, 5% of the West coast is rated as good, 29% is rated fair, and 44% is rated poor. The contaminants that most often exceed the thresholds for a "poor" rating in the assessed areas of the West coast are selenium, mercury, arsenic, and, in a small proportion of the area, total PCBs.

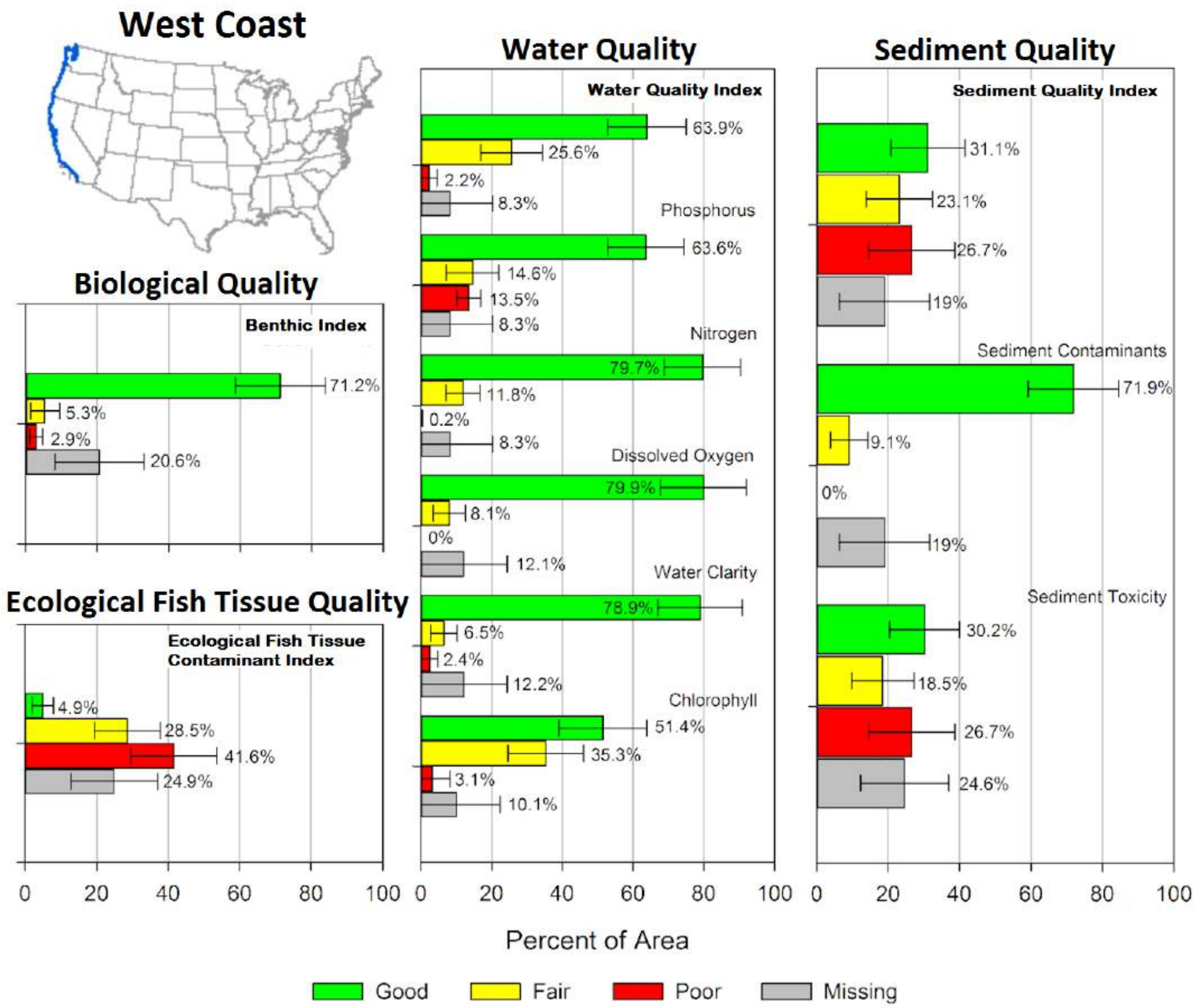

Figure 3. National Coastal Condition Assessment 2010 Report findings for the West Coast Region. Bars show the percentage of coastal area within a condition class for a given indicator (n = 134 sites sampled). Error bars represent 95% confidence levels (USEPA 2015).

10.4.1 West Coast Salmonids

10.4.1.1 Parasites and/or Disease

Most young fish are highly susceptible to disease during the first two months of life. The cumulative mortality in young animals can reach 90 to 95%. Although fish disease organisms occur naturally in the water, native fish have co-evolved with them. Fish can carry these diseases at less than lethal levels (Foott et al. 2003; Kier Associates 1991; Walker and Foott 1993). However, disease outbreaks may occur when water quality is diminished and fish are stressed from crowding and diminished flows (Guillen 2003; Spence et al. 1996). Young coho salmon or other salmonid species may become stressed and lose their resistance in higher temperatures (Spence et al. 1996). Consequently, diseased fish become more susceptible to predation and are less able to perform essential functions, such as feeding, swimming, and defending territories (McCullough 1999). Examples of parasites and disease for salmonids include whirling disease, infectious hematopoietic necrosis (IHN), sea-lice (*Lepeophtheirus salmonis*), *Henneguya salminicola*, *Ichthyopthirius multifiliis* or Ich, and Columnaris *(Flavobacterium columnare*).

Whirling disease is a parasitic infection caused by the microscopic parasite *Myxobolus cerebrali*. Infected fish continually swim in circular motions and eventually expire from exhaustion. The disease occurs in the wild and in hatcheries and results in losses to fry and fingerling salmonids, especially rainbow trout. The disease is transmitted by infected fish and fish parts and birds.

IHN is a viral disease in many wild and farmed salmonid stocks in the Pacific Northwest. This disease affects rainbow/steelhead trout, cutthroat trout (*Salmo clarki*), brown trout (*Salmo trutta*), Atlantic salmon (*Salmo salar*), and Pacific salmon including Chinook, sockeye, chum, and coho salmon. The virus is triggered by low water temperatures and is shed in the feces, urine, sexual fluids, and external mucus of salmonids. Transmission is mainly from fish to fish, primarily by direct contact and through the water.

Sea lice (e.g. *Lepeophtheirus salmonis,* various *Caligus* species) is a marine ectoparasite found in coastal waters that can also cause deadly infestations of farm-grown salmon and may affect wild salmon. *Henneguya salminicola*, a protozoan parasite, is commonly found in the flesh of salmonids, particularly in British Columbia. The fish responds by walling off the parasitic infection into a number of cysts that contain milky fluid. This fluid is an accumulation of a large number of parasites. Fish with the longest freshwater residence time as juveniles have the most noticeable infection. The order of prevalence for infection is coho followed by sockeye, Chinook, chum, and pink salmon. The *Henneguya* infestation does not appear to cause disease in the host salmon – even heavily infected fish tend to return to spawn successful.

Additionally, ich (a protozoan) and Columnaris (a bacterium) are two common fish diseases that were implicated in the massive kill of adult salmon in the Lower Klamath River in September 2002 (CDFG 2003; Guillen 2003).

10.4.1.2 Predation

Salmonids are exposed to high rates of natural predation, during freshwater rearing and migration stages, as well as during ocean migration. Salmon along the U.S. west coast are prey for marine mammals, birds, sharks, and other fishes. Concentrations of juvenile salmon in the coastal zone experience high rates of predation. In the Pacific Northwest, the increasing size of tern, seal, and sea lion populations may have reduced the survival of some salmon ESUs/DPSs. Threatened Puget Sound Chinook adults are preferred prey of endangered Southern Resident Killer Whales (Orcas).

10.4.1.3 Wildland Fire

Wildland fires that are allowed to burn naturally in riparian or upland areas may benefit or harm aquatic species, depending on the degree of departure from natural fire regimes. Although most fires are small in size, large size fires increase the chances of adverse effects on aquatic species. Large fires that burn near the shores of streams and rivers can have biologically significant short-term effects. They include increased water temperatures, ash, nutrients, pH, sediment, toxic chemicals, and loss of large woody debris (Buchwalter et al. 2004; Rinne 2004). Nevertheless, fire is also one of the dominant habitat-forming processes in mountain streams (Bisson et al. 2003). As a result, many large fires burning near streams can result in fish kills with the survivors actively moving downstream to avoid poor water quality conditions (Greswell 1999; Rinne 2004). The patchy, mosaic pattern burned by fires provides a refuge for those fish and invertebrates that leave a burning area or simply spares some fish that were in a different location at the time of the fire (USFS 2000). Small fires or fires that burn entirely in upland areas also cause ash to enter rivers and increase smoke in the atmosphere, contributing to ammonia concentrations in rivers as the smoke adsorbs into the water (Greswell 1999).

The presence of ash also has indirect effects on aquatic species depending on the amount of ash entry into the water. All ESA-listed salmonids rely on macroinvertebrates as a food source for at least a portion of their life histories. When small amounts of ash enter the water, there are usually no noticeable changes to the macroinvertebrate community or the water quality (Bowman and Minshall 2000). When significant amounts of ash are deposited into rivers, the macroinvertebrate community density and composition may be moderately to drastically reduced for a full year with long-term effects lasting 10 years or more (Buchwalter et al. 2003; Buchwalter et al. 2004; Minshall et al. 2001). Larger fires can also indirectly affect fish by altering water quality. Ash and smoke contribute to elevated ammonium, nitrate, phosphorous, potassium, and pH, which can remain elevated for up to four months after forest fires (Buchwalter et al. 2003).

10.4.1.4 Climate Variability and Climate Change

Oceanographic features of the action area may influence prey availability and habitat for Pacific salmonids. These features comprise climate regimes which may suffer regime shifts due to climate changes or other unknown influences. The action area includes important spawning and rearing grounds and physical or biological features essential to the conservation of listed Pacific salmonids - *i.e.*, water quality, prey, and passage conditions. These Pacific oceanographic conditions, climatic variability, and climate change may affect salmonids in the action area.

There is evidence that Pacific salmon abundance may have fluctuated for centuries as a consequence of dynamic oceanographic conditions (Beamish and Bouillon 1993; Beamish et al. 2009; Finney et al. 2002). Sediment cores reconstructed for 2,200-year records have shown that Northeastern Pacific fish stocks have historically been regulated by these climate regimes (Finney et al. 2002). The long-term pattern of the Aleutian Low pressure system has corresponded to the trends in salmon catch, to copepod production, and to other climate indices, indicating that climate and the marine environment may play an important role in salmon production. Pacific salmon abundance and corresponding worldwide catches tend to be large during naturally-occurring periods of strong Aleutian low pressure causing stormier winters and upwelling, positive Pacific Decadal Oscillation (PDO), and an above average Pacific circulation index (Beamish et al. 2009). A trend of an increasing Aleutian Low pressure indicates high pink and chum salmon production and low production of coho and Chinook salmon (Beamish et al. 2009). The abundance and distribution of salmon and zooplankton also relate to shifts in North Pacific atmosphere and ocean climate (Francis and Hare 1994).

Over the past century, regime shifts have occurred as a result of the North Pacific's natural climate regime. Reversals in the prevailing polarity of the PDO occurred around 1925, 1947, 1977, and 1989 (Hare and Mantua. 2000; Mantua et al. 1997). The reversals in 1947 and 1977 correspond to dramatic shifts in salmon production regimes in the North Pacific Ocean (Mantua et al. 1997). During the pre-1977 climate regime, the productivity of salmon populations from the Snake River exceeded expectations (residuals were positive) when values of the PDO were negative (Levin 2003). During the post-1977 regime when ocean productivity was generally lower (residuals were negative), the PDO was negative (Levin 2003).

A smaller, less pervasive regime shift occurred in 1989 (Hare and Mantua. 2000). Beamish *et al.*(2000) analyzed this shift and found a decrease in marine survival of coho salmon in Puget Sound and off the coast of California to Washington. Trends in coho salmon survival were linked over the southern area of their distribution in the Northeast Pacific to a common climatic event. The Aleutian Low Pressure Index and the April flows from the Fraser River also changed abruptly about this time (Beamish et al. 2000).

The Intergovernmental Panel on Climate Change (IPCC) has high confidence that some hydrological systems have been affected through increased runoff and earlier spring peak discharge in glacier- and snow-fed rivers and through effects on thermal structure and water quality of warming rivers and lakes (Pachauri et al. 2014). Oceanographic models project a weakening of the thermohaline circulation resulting in a reduction of heat transport into high latitudes of Europe, an increase in the mass of the Antarctic ice sheet, and a decrease in the Greenland ice sheet (IPCC 2001).

Carbon dioxide emissions are also predicted to have major environmental impacts along the west coast of North America during the 21st century and beyond (Climate Impacts Group (CIG) 2004; IPCC 2001). Eleven of the past 12 years (1995 - 2006) rank among the 12 warmest years in the instrumental record of global surface temperature since 1850 (IPCC 2007). The IPCC predicts that, for the next two decades, a warming of about 0.2ºC per decade will occur for a range of predicted carbon dioxide emissions scenarios (IPCC 2007). This warming trend continues in both water and air. Global average sea level has risen since 1961 at an average rate of 1.8 mm/year and since 1993 at 3.1 mm/year, with contributions from thermal expansion, melting glaciers and ice caps, and the polar ice sheets (IPCC 2007).

Poor environmental conditions for salmon survival and growth may be more prevalent with projected warming increases and ocean acidification. Increasing climate temperatures can influence smolt development which is limited by time and temperature (McCormick et al. 2009). Food availability and water temperature may affect proper maturation and smoltification and feeding behavior (Mangel 1994). Climate change may also have profound effects on seawater entry and marine performance of anadromous fish, including increased salinity intrusion in estuaries due to higher sea levels, as well as a projected decrease of seawater pH (Orr et al. 2005). There is evidence that Chinook salmon survival in the Pacific during climate anomalies and El Nino events changes as a result of a shift from predation- to competition-based mortality in response to declines in predator and prey abundances and increases in pink salmon abundance (Ruggerone and Goetz 2004). If climate change leads to an overall decrease in the availability of food, then returning fish will likely be smaller (Mangel 1994). Finally, future climatic warming could lead to alterations of river temperature regimes, which could further reduce available fish habitat (Yates et al. 2008).

Although the impacts of global climate change are less clear in the ocean environment, early modeling efforts suggest that increased temperatures will likely decrease ocean mixing (i.e. increase ocean stratification). This stratification coincides with relatively poor ocean habitat for most Pacific Northwest salmon populations (Climate Impacts Group (CIG) 2004; IPCC 2001).

We expect changing weather and oceanographic conditions may affect prey availability, temperature and water flow in habitat conditions, and growth for all 28 ESUs/DPSs. Consequently, we expect the long-term survival and reproductive success for listed salmonids to be negatively affected by global climate change.

In addition to changes in hydrological regimes that will affect salmon, climate change will affect agriculture as rainfall and temperature patterns shift. Some crops currently well-suited for particular regions may instead be grown in alternate locations. Agricultural pest pressures are also likely to change over time. Both the shifts in crop location and pest pressure are likely to change pesticide use patterns.

10.4.1.5 Baseline Pesticide Detections in Aquatic Environment

The USGS NAWQA program assessed trends in pesticide concentration at 59 sites across the US for three overlapping periods: 1992-2001, 1997-2006, and 2001-2010. Trends in reported agriculture use intensity were assessed for the same periods at 57 sites (Ryberg et al. 2014). The report found widespread agreement between trends in concentration and use for agricultural pesticides. Additionally, the report found that trends between concentration and use for pesticides with both agricultural and urban use could be explained by taking into consideration concentration trends in urban streams (Ryberg et al. 2014).

Pesticide concentrations were detected at concentrations which exceeded aquatic-life benchmarks in many rivers and streams throughout the 20-year sampling period (Stone et al. 2014). In the most recent decade sampled (2002 – 2011), 61% of streams and rivers which drain agricultural watersheds contained pesticides at concentrations which exceeded thresholds. In Addition, 46% of mixed-land and 90% of urban streams were found to have pesticides in exceedance of aquatic-life benchmarks. According to (Stone et al. 2014) a number of important pesticides were not included in the sampling protocol and thus the potential for adverse effect is likely greater than is suggested by the percent of streams with exceedances.

When pesticides are released into the environment, they frequently end up as contaminants in aquatic environments. Depending on their physical properties some are rapidly transformed via chemical, photochemical, and biologically mediated reactions into other compounds, known as degradates. These degradates may become as prevalent as the parent pesticides depending on their rate of formation and their relative persistence.

Another dimension of pesticides and their degradates in the aquatic environment is their simultaneous occurrence as mixtures (Gilliom et al. 2006). Mixtures result from the use of different pesticides for multiple purposes within a watershed or groundwater recharge area. Pesticides generally occur more often in natural waterbodies as mixtures than as individual compounds.

Mixtures of pesticides were detected more often in streams than in ground water and at relatively similar frequencies in streams draining areas of agricultural, urban, and mixed land use. More than 90% of the time, water from streams in these developed land use settings had detections of two or more pesticides or degradates. About 70% and 20% of the time, streams had five or more and 10 or more pesticides or degradates, respectively (Gilliom et al. 2006). Fish exposed to multiple pesticides at once may also experience additive and synergistic effects. If the effects on a biological endpoint from concurrent exposure to multiple pesticides can be predicted by adding the potency of the pesticides involved, the effects are said to be additive. If, however, the response to a mixture leads to a greater than expected effect on the endpoint, and the pesticides within the mixture enhance the toxicity of one another, the effects are characterized as synergistic. These effects are of particular concern when the pesticides share a mode of action. NAWQA analysis of all detections indicates that more than 6,000 unique mixtures of 5 pesticides were detected in agricultural streams (Gilliom et al. 2006). The number of unique mixtures varied with land use.

During the years 2012-2014 the USEPA and USGS conducted an assessment of targeted-chemical composition and cumulative biochemical activity of water samples collected from streams across the United States. Eight of the 10 most-frequently detected anthropogenic organics were pesticides with frequencies ranging 66-84% of all sites, and chlorpyrifos was one of these eight pesticides most commonly detected (Bradley et al. 2017).

Pollution originating from a discrete location such as a pipe discharge or wastewater treatment outfall is known as a point source. Point sources of pollution require a National Pollutant Discharge Elimination System (NPDES) permit. These permits are issued for aquaculture, concentrated animal feeding operations, industrial wastewater treatment plants, biosolids (sewer/sludge), pre-treatment and stormwater overflows. The Environmental Protection Agency (EPA) administers the NPDES permit program and states certify that NPDES permit holders comply with state water quality standards. Nonpoint source discharges do not originate from discrete points; thus, nonpoint sources are difficult to identify, quantify, and are not regulated. Examples of nonpoint source pollution include, but are not limited to, urban runoff from impervious surfaces, areas of fertilizer and pesticide application, sedimentation, and manure.

According to EPA's database of NPDES permits, about 243 NPDES individual permits are co-located with listed Pacific salmonids in California. Collectively, the total number of EPA-recorded NPDES permits in Idaho, Oregon, and Washington, that are co-located with listed Pacific salmonids is 1,978.

On November 27, 2006, EPA issued a final rule which exempted pesticides from the NPDES permit process, provided that application was approved under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The NPDES permits, then, do not include any point source application of pesticides to waterways in accordance with FIFRA labels. On January 7, 2009, the Sixth Circuit Court of Appeals vacated this rule (National Cotton Council v. EPA, 553 F.3d 927 (6th Cir. 2009)). The result of the vacatur, according to the Sixth Circuit, is that "discharges of pesticide pollutants are subject to the NPDES permitting program" under the CWA. In response, EPA has developed a Pesticide General Permit through the NPDES permitting program to regulate such discharges. Baseline Water Temperature – Clean Water Act.

Elevated temperature is considered a pollutant in most states with approved Water Quality Standards under the federal Clean Water Act (CWA) of 1972. Under the authority of the CWA, states periodically prepare a list of all surface waters in the state for which beneficial uses are impaired by pollutants including drinking, recreation, aquatic habitat, and industrial uses. This process is in accordance with section 303(d) of the CWA. Estuaries, lakes, and streams listed under 303(d) are those that are considered impaired or threatened by pollution. They are water quality limited, do not meet state surface water quality standards, and are not expected to improve within the next two years.

Each state has unique 303(d) listing criteria and processes. Generally a water body is listed separately for each standard it exceeds, so it may appear on the list more than once. If a water body is not on the 303(d) list, it is not necessarily contaminant-free; rather it may not have been tested. Therefore, the 303(d) list is a minimum list for the each state regarding polluted water bodies by parameter.

After states develop their lists of impaired waters, they are required to prioritize and submit their lists to EPA for review and approval. Each state establishes a priority ranking for such waters, considering the severity of the pollution and the uses to be made of such waters. States are expected to identify high priority waters targeted for Total Maximum Daily Load (TMDL) development within two years of the 303(d) listing process.

Temperature is significant for the health of aquatic life. Water temperatures affect the distribution, health, and survival of native cold-blooded salmonids in the Pacific Northwest and elsewhere. These fish will experience adverse health effects when exposed to temperatures outside their optimal range. For listed Pacific salmonids, water temperature tolerance varies between species and life stages. Optimal temperatures for rearing salmonids range from 10ºC to 16ºC. In general, the increased exposure to stressful water temperatures and the reduction of suitable habitat caused by drought conditions reduce the abundance of salmon. Warm temperatures can reduce fecundity, reduce egg survival, retard growth of fry and smolts, reduce rearing densities, increase susceptibility to disease, decrease the ability of young salmon and trout to compete with other species for food, and to avoid predation (McCullough 1999; Spence et al. 1996). Migrating adult salmonids and upstream migration can be delayed by excessively warm stream temperatures. Excessive stream temperatures may also negatively affect incubating and rearing salmonids (Gregory and Bisson 1997).

Sublethal temperatures (above 24ºC) could be detrimental to salmon by increasing susceptibility to disease (Colgrove and Wood 1966) or elevating metabolic demand (Brett 1995). Substantial research demonstrates that many fish diseases become more virulent at temperatures over 15.6ºC (McCullough 1999). Due to the sensitivity of salmonids to temperature, states have established lower temperature thresholds for salmonid habitat as part of their water quality standards.

10.4.1.6 Baseline Habitat Condition

As noted in the status of the species section, the riparian zones for many of the Evolutionarily Significant Units (ESUs)/Distinct Population Segments (DPSs) are degraded. Riparian zones are the areas of land adjacent to rivers and streams. These systems serve as the interface between the aquatic and terrestrial environments. Riparian vegetation is characterized by emergent aquatic plants and species that thrive on close proximity to water, such as willows. This vegetation maintains a healthy river system by reducing erosion, stabilizing main channels, and providing shade. Leaf litter that enters the river becomes an important source of nutrients for invertebrates (Bisson and Bilby 2001). Riparian zones are also the major source of large woody debris (LWD). When trees fall and enter the water, they become an important part of the ecosystem. The LWD alters the flow, creating the pools of slower moving water preferred by salmon (Bilby et al. 2001). While not necessary for pool formation, LWD is associated with around 80% of pools in northern California, Washington, and the Idaho pan-handle (Bilby and Bisson 2001).

Bilby and Bisson (2001) discuss several studies that associate increased LWD with increased pools, and both pools and LWD with salmonid productivity. Their review also includes documented decreases in salmonid productivity following the removal of LWD. Other benefits of LWD include deeper pools, increased sediment retention, and channel stabilization.

Floodplains are relatively flat areas adjacent to streams and rivers that stretch from the banks of the channel to the base of the enclosing valley walls. They allow for the lateral movement of the main channel and provide storage for floodwaters during periods of high flow. The floodplain includes the floodway, which consists of the stream channel, and adjacent areas that actively carry flood flows downstream; and the flood fringe, which are areas that are inundated, but which do not experience a strong current. Water stored in the floodplain is later released during periods of low flow. This process ensures adequate flows for salmonids during the summer months, and reduces the possibility of high-energy flood events destroying salmonid redds (Smith 2005).

Periodic flooding of these areas creates habitat used by salmonids. Thus, floodplain areas vary in depth and widths and may be intermittent or seasonal. Storms also wash sediment and LWD into the main stem river, often resulting in blockages. These blockages may force the water to take an alternate path and result in the formation of side channels and sloughs (Benda et al. 2001). Side channels and sloughs are important spawning and rearing habitat for salmonids. The degree to which these off-channel habitats are linked to the main channel via surface water connections is referred to as connectivity (PNERC 2002). As river height increases with heavier flows, more side channels form and connectivity increases. Juvenile salmonids migrate to and rear in these channels for a certain period of time before swimming out to the open sea.

Healthy riparian habitat and floodplain connectivity are vital for supporting a salmonid population. Chinook salmon and steelhead have life history strategies that rely on floodplains during their juvenile life stages. Chum salmon use adjacent floodplain areas for spawning. Soon after their emergence, chum salmon use the riverine system to rapidly reach the estuary where they mature, rear, and migrate to the ocean. Coho salmon use the floodplain landscape extensively for rearing. Estuarine floodplains can provide value to juveniles of all species once they reach the salt water interface.

Once floodplain areas have been disturbed, it can take decades for their recovery (Smith 2005). Consequently, most land use practices cause some degree of impairment. Development leads to construction of levees and dikes, which isolate the mainstem river from the floodplain. Agricultural development and grazing in riparian areas also significantly change the landscape. Riparian areas managed for logging, or logged in the past, are often impaired by a change in species composition. Most areas in the northwest were historically dominated by conifers. Logging results in recruitment of deciduous trees, decreasing the quality of LWD in the rivers. Deciduous trees have smaller diameters than conifers; they decompose faster and are more likely to be displaced (Smith 2005).

Without a properly functioning riparian zone, salmonids contend with a number of limiting factors. They face reductions in quantity and quality of both off-channel and pool habitats. Also, when seasonal flows are not moderated, both higher and lower flow conditions exist. Higher flows can displace fish and destroy redds, while lower flows cut off access to parts of their habitat. Finally, decreased vegetation limits the available shade and cover, exposing individuals to higher temperatures and increased predation.

10.4.1.7 Baseline Pesticide Consultations

NMFS has consulted with EPA on the registration of several pesticides. NMFS (NMFS 2008b) determined that current use of chlorpyrifos, diazinon, and malathion is likely to jeopardize the continued existence of 27 listed salmonid ESUs/DPSs.[1] NMFS (NMFS 2009a) further determined that current use of carbaryl and carbofuran is likely to jeopardize the continued

[1] The Fourth Circuit Court of Appeals remanded this Opinion on February 21, 2013. The Opinion was remanded to address the issues raised by the Court. Those issues are addressed in this Opinion.

existence of 22 ESUs/DPSs; and the current use of methomyl is likely to jeopardize the continued existence of 18 ESUs/DPSs of listed salmonids. NMFS also published conclusions regarding the registration of 12 different a.i.s (NMFS 2010). NMFS concluded that pesticide products containing azinphos methyl, disulfoton, fenamiphos, methamidophos, or methyl parathion are not likely to jeopardize the continuing existence of any listed Pacific Salmon or destroy or adversely modify designated critical habitat. NMFS also concluded that the effects of products containing bensulide, dimethoate, ethoprop, methidathion, naled, phorate, or phosmet are likely to jeopardize the continued existence of some listed Pacific Salmonids and to destroy or adversely modify designated habitat of some listed salmonids. NMFS issued a biological opinion on the effects of four herbicides and two fungicides (NMFS 2011a). NMFS concluded that products containing 2,4-D are likely to jeopardize the existence of all listed salmonids, and adversely modify or destroy the critical habitat of some ESU / DPSs. Products containing chlorothalonil or diuron were also likely to adversely modify or destroy critical habitat, but not likely to jeopardize listed salmonids. NMFS also concluded that products containing captan, linuron, or triclopyr BEE do not jeopardize the continued existence of any ESUs/DPSs of listed Pacific salmonids or adversely modify designated critical habitat. Most recently in 2012, NMFS completed two additional opinions covering four more pesticides. In May, 2012 NMFS issued an opinion on oryzalin, pendimethalin, and trifluralin concluding each of these chemicals are likely to jeopardize the continued existence of some listed Pacific salmonids, and adversely modify designated critical habitat of some listed salmonids (NMFS 2012). In July 2012, NMFS issued an opinion on thiobencarb, an herbicide authorized for use only on rice. California is the only state within the range of listed Pacific salmonids that has approved the use of thiobencarb and is the only state among the action area states that grows rice. The thiobencarb opinion focused on three listed Pacific salmon ESUs/DPSs in California's Central Valley where rice is grown. NMFS concluded EPAs registration of thiobencarb would harm listed species, but not jeopardize the continued existence of these three species and would not adversely modify their designated critical habitat. In 2013, NMFS issued an opinion on the effects of three pesticides: diflubenzuron, fenbutatin oxide, and propargite. NMFS concluded that products containing diflubenzuron, fenbutatin oxide, and propargite are likely to jeopardize the existence of many listed salmonids, and adversely modify or destroy the critical habitat of many ESU / DPSs.

10.4.2 Southern Resident Killer Whale

Natural Mortality As apex predators, sources of natural mortality in SR killer whales are likely limited. Possible sources can still include disease and parasitism. While disease is not known to limit any killer whale population and no epidemics are known in the SR killer whale DPS, killer whales may be vulnerable to disease outbreaks given their distribution patterns and strong social networks (Altizer et al. 2003, Guimaraes Jr. et al. 2007). A variety of pathogens have been identified in killer whales, and there are other pathogens in sympatric marine mammal species that could be transmittable to killer whales (Gaydos et al. 2004).

Climate Change Climatic variability and change may be affecting SR killer whales in the action area; however, the effects of climate change on any marine species are not definitively known. Gaps in information on species movements and distribution, the difficulty involved with studying highly mobile marine mammals, as well as insufficient historical information and long-term data sets on habitat and distribution all complicate any potential conclusions on the effects of climate change for such species (Kintisch 2006, Simmonds and Isaac 2007). Possible effects of climatic variability for marine species include the following: alteration of ecological community composition and structure, possibly resulting in species relocating from areas they currently use in response to changes in oceanic conditions; changes to migration patterns or community structure; changes to species abundance; increased susceptibility to disease and contaminants; alterations to prey composition and availability; and altered timing of breeding (Macleod et al. 2005, Robinson et al. 2005, Kintisch 2006, McMahon and Hays 2006). Such changes could affect growth, reproductive success and survival, and therefore would have consequences for the recovery of marine mammal species (Robinson et al. 2005, Learmonth et al. 2006, Cotte and Guinet 2007).

Prey Availability SR killer whales predominantly prey upon salmonids, particularly Chinook salmon. Maintaining a robust prey resource is essential to SR killer whale recovery; the U.S. recovery goal of 2.3% annual growth over 28 years would imply a 75% increase in energetic requirements (Williams et al. 2011b). Limited prey availability can have detrimental effects for SR killer whales, including requiring the whales to spend more time and energy foraging, possibly causing negative effects on reproductive rates and morality. Inadequate prey is a source of stress for SR killer whales, and a comparatively greater one than vessel traffic (Ayres et al. 2012). Nutritional stress has also been thought to be a contributing factor to slower growth rates in SR killer whales (Fearnbach et al. 2011). Prey availability is also a possible influencing factor in the interconnectivity of SR killer whale social network (Foster et al. 2012).

Pollution and Contaminants Persistent organic pollutants (POPs) is a collective term for environmental contaminants like dioxins, furans, PCBs, PBDEs, dichlorodiphenyltrichloroethane (DDT), hexachlorocyclohexanes (HCHs), and hexachlorobenzenes (HCBs). These chemicals are used (or have previously been used) in pesticides, industrial manufacturing, and pharmaceutical production, to name a few applications. The relative contribution of any one source in contaminating killer whales with POPs is poorly understood (NMFS 2008). As a long-lived, top marine predator, SR killer whales bioaccumulate POPs in their tissues and blubber, potentially leading to numerous adverse health effects such as skeletal deformity, reproductive dysfunction, impaired immune function, and enzyme disruption (Krahn et al. 2009). Levels of contaminants in wild individuals are much higher than those found in captive killer whales (Bennett et al. 2009). Numerous factors can affect concentrations of POPs in marine mammals, such as age, sex and birth order, diet, and habitat use (Mongillo et al. 2012). In marine mammals, POP contaminant load for males increases with age, whereas females pass on contaminants to offspring during pregnancy and lactation (Addison and Brodie 1987, Borrell et al. 1995). POPs can be transferred from mothers to juveniles at a time when their bodies are undergoing rapid development, putting juveniles at risk for immune and endocrine system dysfunction later in life (Krahn et al. 2009).

Oil Spills Exposure to petroleum hydrocarbons released into the environment via oil spills and other discharge sources represents a serious and potentially catastrophic risk for SR killer whales. The substantial volume of shipping traffic and the presence of refineries in the action area creates the risk of a catastrophic oil spill that could affect SR killer whales and their prey. Due to its proximity to Alaska’s crude oil supply, Puget Sound is one of the leading petroleum refining centers in the United States, with about 15 billion gallons of crude oil and refined petroleum products transported through it annually in 2005; this amount increased to about 22 billion gallons in 2010 (Puget Sound Action Team 2005; Puget Sound Partnership 2011).

Vessel Strikes Ship strikes of SR killer whales do occur and can result in serious injury and mortality. Scheffer and Slipp (1948) noted several collisions between killer whales and boats, but gave no information on effects to the whales from these encounters. One killer whale mortality from a ship strike was reported for Washington and British Columbia from 1960-1990 (Baird 2001). More recently, in British Columbia, there were 10 known killer whale ship strikes from 1995- 2007, two of them fatal, and with one individual struck and died the following year (Williams and O'Hara 2010).

Vessel Presence and Whale Watching Several studies have specifically examined the effects of whale watching on marine mammals, and investigators have observed a variety of short-term responses from animals, ranging from no apparent response to changes in vocalizations, duration of time spend at the surface, swimming speed, swimming angle or direction, respiration rate, dive time, feeding behavior, and social behavior (NMFS 2008). Responses appear to be dependent on factors such as vessel proximity, speed, and direction, as well as the number of vessels in the vicinity (see 76 FR 20870 for a review). In 2005, a commercial whale watching vessel struck a SR killer whale, inflicting a minor injury, which subsequently healed (NMFS 2008).

Noise Transportation, including commercial and recreational vessel traffic, airplanes and helicopters, all contribute to sound in the ocean (NRC 2003). The military uses sound to test the construction of new vessels, as well as for naval operations. In some areas where oil and gas production takes place, noise originates from the drilling and production platforms, tankers, vessel and aircraft support, seismic surveys, and the explosive removal of platforms (NRC 2003).

Researchers have described behavioral responses from marine mammals due to these noises, which included cessation of feeding, resting, or social interactions. Many contend that anthropogenic sources of noise have increased ambient noise levels in the ocean over the last 50 years (NRC 1994, Richardson et al. 1995, NRC 2000, 2003, 2005). Much of this increase is due to increased shipping as ships become more numerous and of larger tonnage (NRC 2003).

Anthropogenic sound can drown out the clicks, calls, and whistles killer whales use to communicate with one another during foraging and the echolocation signals used to navigate (Bain and Dahlheim 1994, Gordon and Moscrop 1996, Erbe 2002, Williams et al. 2002a, Williams et al. 2002b, NMFS 2008, Holt et al. 2009). Killer whales have a wide frequency range of hearing (from 1-100 kHz) (Szymanski et al. 1999), and although large vessels emit predominantly low frequency sound, studies report broadband noise from large cargo ships with significant levels above 2 kHz, and thus may interfere with important biological functions of killer whales (Holt 2008, NMFS 2008).

Scientific Research SR killer whales have been the subject of scientific research activities in the action area, as authorized by NMFS permits. After the listing of SR killer whales as endangered under the ESA, NMFS issued three new scientific research permits, amended three existing permits and renewed one additional permit to authorize a variety of research activities targeting these whales (NMFS 2006). In subsequent years, additional research permits have authorized take of SR killer whales. No mortalities or serious injuries are authorized for SR killer whales under these permits.

Conservation and Management Efforts In 2011, NMFS established regulations prohibiting vessels from approaching killer whales within 200 yds (189.2 m) and from parking in the path of whales when in inland waters of Washington State (76 FR 20870). Certain exceptions to these regulations apply, such as to government vessels engaged in official business, cargo vessels in shipping lanes, fishing vessels actively fishing, and vessel maneuvers necessary for safety reasons.

10.4.3 Pacific Northwest Subregion

The Pacific Northwest subregion includes all of Washington and parts of California, Idaho, Montana, Nevada, Oregon, Utah, and Wyoming. The subregion totals roughly 700,000 km^2 of which about 600,000 km^2 is classified as undeveloped, 30,000 km^2 is classified as developed and about 70,000 km^2 is classified as agriculture (***Figure 4***).

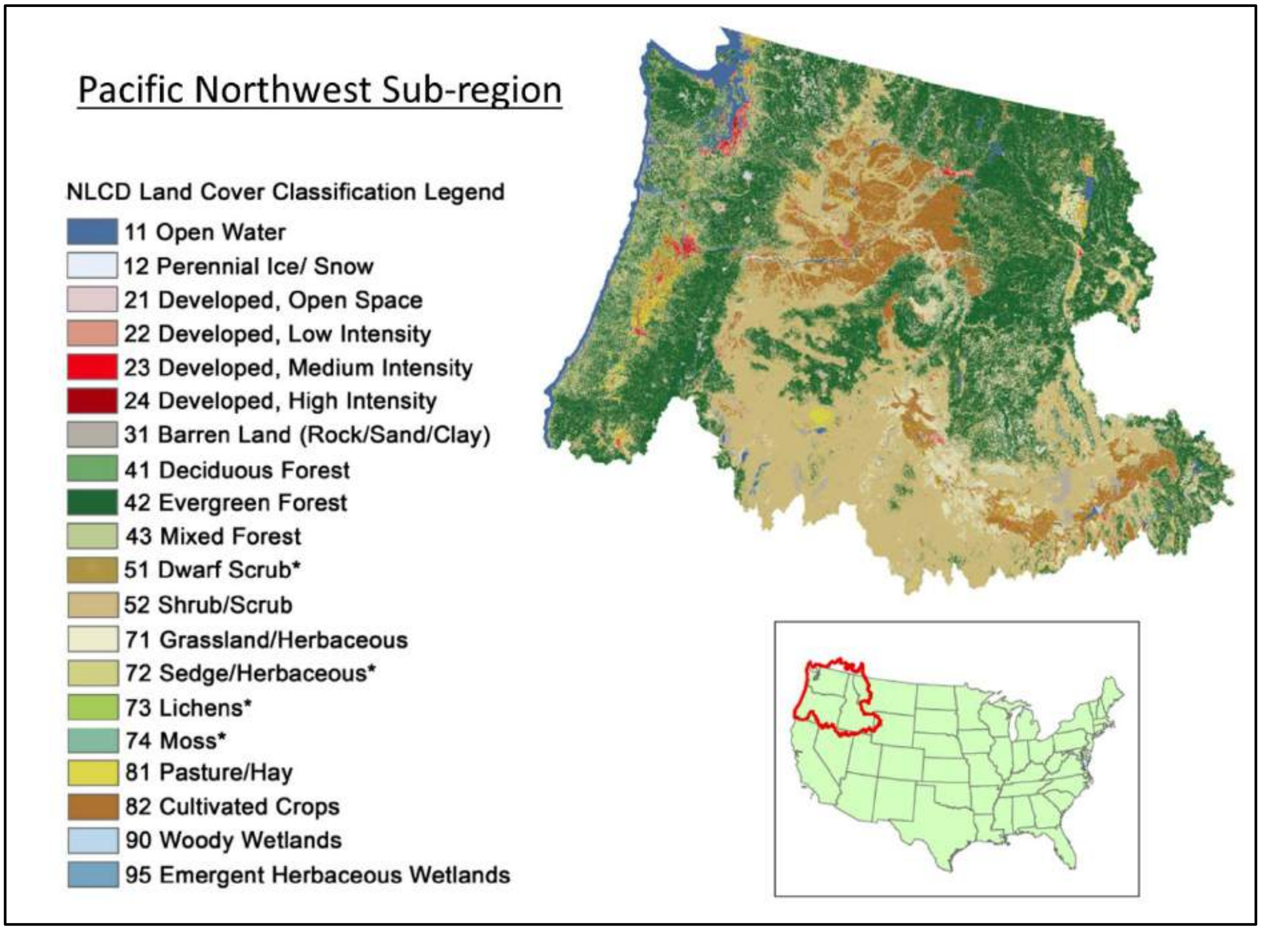

Figure 4. Landuse in the Pacific Northwest sub-region. Data from the NLCD 2011 (www.mrlc.gov).

Twenty-six of the 77 species addressed in the Opinion occur in this subregion. They are: bococcio rockfish, yelloweye rockfish, green sturgeon Southern DPS, chinook salmon (ESUs: Snake River spring/summer-run, Snake River fall-run, Puget Sound, Upper Columbia River spring-run, Lower Columbia River,and Upper Willamette River), chum salmon (ESUs: Columbia River, and Hood Canal summer-run), coho salmon (ESUs: Oregon coast, Southern Oregon/Northern California coast, Lower Columbia River), sockeye salmon (ESUs: Ozette Lake, and Snake River), steelhead (DPSs: Upper Columbia River, Upper Willamette River, Middle Columbia River, Lower Columbia River, Snake River basin, Puget Sound), southern DPS eulachon, southern resident killer whale, leatherback sea turtle, and the North Pacific Ocean loggerhead sea turtle. ***Table 2, Table 3, Table 4***, and ***Table 5*** show the types and areas of land use within each of the species' ranges.

Table 2. Area of land use categories within Pacific Northwest subregion selected Chinook salmon ranges in km . The total area for each category is given in bold. Land cover was determined via the NLCD 2011. Land cover class definitions are available at: http://www.mrlc.gov/nlcd_definitions.php

Land Cover	Chinook salmon					
NLCD Sub category	Snake River spring/ summer	Snake River fall	Puget Sound	Upper Columbia River spring	Lower Columbia River	Upper Willamette River
Water	**1,813**	**1,694**	**807**	**1,814**	**747**	**651**
Open Water	1,780	1,694	534	1,802	717	651
Perennial Ice/Snow	33	0	273	12	30	-
Developed Land	**2,643**	**1,719**	**4,883**	**2,343**	**2,161**	**2,259**
Open Space	1,009	674	1,528	742	807	653
Low Intensity	571	478	1,524	691	581	744
Medium Intensity	322	300	766	386	330	461
High Intensity	119	117	303	133	138	194
Barren Land	622	150	762	392	305	208
Undeveloped Land	**72,964**	**14,730**	**20,204**	**19,657**	**15,330**	**14,396**
Deciduous Forest	335	319	1,024	318	616	305
Evergreen Forest	38,727	4,277	12,395	6,789	9,584	9,242
Mixed Forest	444	429	2,210	435	968	711
Shrub/Scrub	18,996	5,637	2,917	9,463	2,788	2,471
Grassland/Herbaceous	13,771	3,587	966	2,032	718	983
Woody Wetlands	371	270	502	362	436	465
Emergent Wetlands	320	210	191	257	218	220
Agriculture	**8,761**	**4,552**	**1,395**	**3,892**	**1,076**	**4,744**
Pasture/Hay	789	372	1,140	710	745	2,968
Cultivated Crops	7,971	4,180	255	3,183	330	1,776
TOTAL (inc. open water)	**86,180**	**22,696**	**27,289**	**27,706**	**19,314**	**22,051**
TOTAL (w/o open water)	**84,367**	**21,001**	**26,482**	**25,892**	**18,567**	**21,400**

Table 3. Area of land use categories within Pacific Northwest subregion selected fish and sea turtle species ranges in km . The total area for each category is given in bold. Land cover was determined via the NLCD 2011. Land cover class definitions are available at: http://www.mrlc.gov/nlcd_definitions.php

Land Cover						
NLCD Sub category	Bocaccio rockfish	Yelloweye rockfish	Eulachon	Leatherback sea turtle	Loggerhead sea turtle – North	Southern Resident Killer Whale*

					Pacific Ocean	
Water	**2,820**	**2,820**	**18,208**	**109,586**	**27,044**	**6,451**
Open Water	2,816	2,816	18,204	109,582	27,040	6,451
Perennial Ice/Snow	4	4	4	4	4	-
Developed Land	**2,747**	**2,747**	**5,164**	**35,294**	**8,305**	**554**
Open Space	753	753	1,789	11,630	2,350	109
Low Intensity	896	896	1,199	9,176	1,786	93
Medium Intensity	513	513	696	6,945	2,114	24
High Intensity	222	222	262	2,911	788	8
Barren Land	364	364	1,218	4,633	1,267	319
Undeveloped Land	**5,229**	**5,229**	**21,328**	**93,945**	**22,137**	**1,065**
Deciduous Forest	504	504	1,094	7,058	703	69
Evergreen Forest	2,631	2,631	11,095	17,220	9,050	569
Mixed Forest	770	770	2,642	5,310	2,629	144
Shrub/Scrub	583	583	2,975	11,795	4,536	43
Grassland/Herbaceous	335	335	1,889	9,935	3,349	56
Woody Wetlands	212	212	826	19,500	674	20
Emergent Wetlands	194	194	807	23,127	1,196	163
Agriculture	**687**	**687**	**1,683**	**16,985**	**1,896**	**122**
Pasture/Hay	543	543	1,110	6,378	820	117
Cultivated Crops	144	144	573	10,607	1,076	6
TOTAL (inc. open water)	**11,484**	**11,484**	**46,382**	**255,811**	**59,381**	**8,191**
TOTAL (w/o open water)	**8,663**	**8,663**	**28,175**	**146,225**	**32,337**	**1,740**
**Southern resident killer whale landuse overlap values are based on the designated critical habitat.*						

Table 4. Area of land use categories within Pacific Northwest subregion selected chum, coho and sockeye species' ranges in km². The total area for each category is given in bold. Land cover was determined via the NLCD 2011. Land cover class definitions are available at: http://www.mrlc.gov/nlcd_definitions.php

Land Cover	Chum salmon		Coho salmon			Sockeye salmon	
NLCD Sub category	Columbia River	Hood Canal summer-run	Oregon Coast	Southern Oregon/ Northern California	Lower Columbia River	Ozette Lake	Snake River
Water	**691**	**57**	**193**	**1,657**	**745**	**30**	**1,699**

Open Water	687	13	193	1,646	715	30	1,682
Perennial Ice/Snow	4	44	0	12	30	-	17
Developed Land	**1,894**	**369**	**1,676**	**2,063**	**2,139**	**4**	**1,685**
Open Space	668	130	1,106	1,394	795	1	622
Low Intensity	541	78	168	235	574	0	478
Medium Intensity	334	23	61	114	329	0	297
High Intensity	137	7	24	31	137	-	116
Barren Land	213	131	317	289	304	3	172
Undeveloped Land	**8,629**	**3,053**	**25,050**	**43,886**	**14,938**	**198**	**18,880**
Deciduous Forest	522	99	334	1,041	611	4	304
Evergreen Forest	4,116	2,096	13,762	27,973	9,311	138	6,955
Mixed Forest	836	185	3,774	2,425	962	3	426
Shrub/Scrub	1,912	431	4,991	9,490	2,703	30	7,155
Grassland/Herbaceous	672	168	1,619	2,710	702	13	3,527
Woody Wetlands	363	55	305	155	430	9	286
Emergent Wetlands	210	19	265	92	218	1	226
Agriculture	**1,069**	**80**	**919**	**1,228**	**1,071**	**-**	**3,833**
Pasture/Hay	694	79	857	761	742	-	501
Cultivated Crops	375	2	61	467	330	-	3,332
TOTAL (inc. open water)	**12,283**	**3,558**	**27,838**	**48,834**	**18,893**	**232**	**26,097**
TOTAL (w/o open water)	**11,592**	**3,502**	**27,645**	**47,177**	**18,148**	**202**	**24,399**

Table 5. Area of land use categories within Pacific Northwest subregion selected steelhead species' ranges in km . The total area for each category is given in bold. Land cover was determined via the NLCD 2011. Land cover class definitions are available at: http://www.mrlc.gov/nlcd_definitions.php

Land Cover	Steelhead salmon DPS					
NLCD Sub category	Upper Columbia River	Upper Willamette River	Middle Columbia River	Lower Columbia River	Snake River Basin	Puget Sound
Water	**768**	**704**	**1,633**	**1,191**	**1,813**	**597**
Open Water	12	-	1,616	1,160	1,780	392
Perennial Ice/Snow	756	704	17	30	33	205
Developed Land	**1,959**	**2,076**	**3,566**	**2,070**	**2,643**	**4,836**
Open Space	701	832	1,677	734	1,009	1,517
Low Intensity	389	514	969	574	571	1,521
Medium Intensity	134	209	444	330	322	777
High Intensity	418	174	144	137	119	302
Barren Land	318	347	331	295	622	719
Undeveloped Land	**20,658**	**11,476**	**64,159**	**13,939**	**72,964**	**18,912**
Deciduous Forest	7,138	4,483	341	572	335	1,005
Evergreen Forest	436	1,104	19,856	8,840	38,727	11,202
Mixed Forest	9,901	2,019	451	809	444	2,210
Shrub/Scrub	2,087	845	39,441	2,446	18,996	2,859
Grassland/Herbaceous	830	2,804	3,015	630	13,771	970
Woody Wetlands	266	220	505	427	371	506
Emergent Wetlands	1	1	550	215	320	161
Agriculture	**3,868**	**2,361**	**13,797**	**1,061**	**8,761**	**1,345**
Pasture/Hay	3,495	1,908	1,155	732	789	1,094
Cultivated Crops	373	453	12,643	329	7,971	251
TOTAL (inc. open water)	**27,254**	**16,617**	**83,155**	**18,260**	**86,180**	**25,690**
TOTAL (w/o open water)	**26,485**	**15,913**	**81,522**	**17,069**	**84,367**	**25,094**

Baseline Water Temperature Temperature is significant for the health of aquatic life. Water temperatures affect the distribution, health, and survival of native cold-blooded salmonids in the Pacific Northwest and elsewhere. These fish will experience adverse health effects when exposed to temperatures outside their optimal range. For listed Pacific salmonids, water temperature tolerance varies between species and life stages. Optimal temperatures for rearing salmonids range from 10ºC to 16ºC. In general, the increased exposure to stressful water temperatures and the reduction of suitable habitat caused by drought conditions reduce the abundance of salmon. Warm temperatures can reduce fecundity, reduce egg survival, retard growth of fry and smolts, reduce rearing densities, increase susceptibility to disease, decrease the ability of young salmon and trout to compete with other species for food, and to avoid predation (McCullough 1999; Spence et al. 1996). Migrating adult salmonids and upstream migration can be delayed by excessively warm stream temperatures. Excessive stream temperatures may also negatively affect incubating and rearing salmonids (Gregory and Bisson 1997). ***Figure 5*** depicts waterbodies with 303(d) temperature exceedances within the Pacific Northwest subregion.

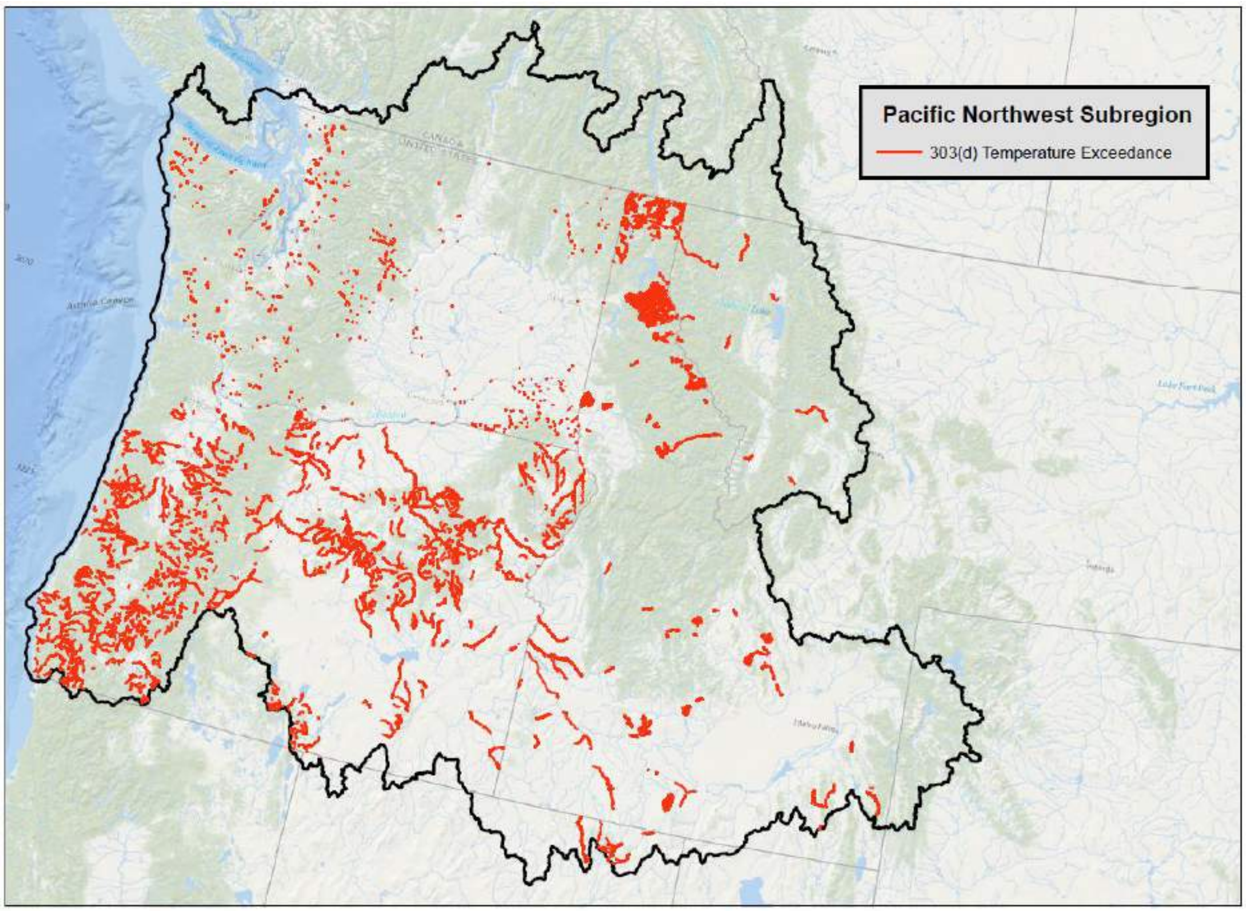

Figure 5. 303(d) temperature exceedances within the Pacific Northwest subregion. Data downloaded from USEPA ATTAINS website; "303(d) May 1, 2015 National Extract layer".

We used GIS layers made publically available through USEPA's Assessment and Total Maximum Daily Load Tracking and Implementation System (ATTAINS) to determine the number of km on the 303(d) list for exceeding temperature thresholds within the boundaries of those species which utilize freshwater habitats (***Table 6***). Because the 303(d) list is limited to the subset of rivers tested, the chart values should be regarded as lower-end estimates. While some ESU/DPS ranges do not contain any 303(d) rivers listed for temperature, others show considerable overlap. These comparisons demonstrate the relative significance of elevated temperature among ESUs/DPSs. Increased water temperature may result from wastewater discharge, decreased water flow, minimal shading by riparian areas, and climatic variation.

Table 6. Number of kilometers of river, stream and estuaries included in ATTAINS 303(d) lists due to temperature that are located within selected Pacific Northwest species (ESU/DPS) ranges. Data were taken from USEPA ATTAINS website: May 1, 2015 National Extract.

Species	River-kilometers of recorded temperature exceedance 303(d)
Chinook, Snake River spring/summer-run ESU	1,378
Chinook, Snake River fall-run ESU	395
Chinook, Puget Sound ESU	269
Chinook, Upper Columbia River spring-run ESU	310
Chinook, Lower Columbia River ESU	286
Chinook, Upper Willamette River ESU	1,516
Chum, Columbia River ESU	302
Chum, Hood Canal summer-run ESU	45
Coho, Oregon Coast ESU	2,498
Coho, Southern Oregon/Northern California coasts ESU	5,509
Coho, Lower Columbia River ESU	281
Sockeye, Ozette Lake ESU	2
Sockeye, Snake River ESU	305
Steelhead, Upper Columbia River DPS	312
Steelhead, Upper Willamette River DPS	944
Steelhead, Middle Columbia River DPS	3,509
Steelhead, Lower Columbia River DPS	276
Steelhead, Snake River Basin DPS	1,378
Steelhead, Puget Sound DPS	267
Eulachon, Southern DPS	2,077

Pesticide Reduction Programs The Idaho State Department of Agriculture has published a BMP guide for pesticide use. The BMPs include eight "core" voluntary measures that will prevent pesticides from leaching into soil and groundwater. These measures include applying pest-specific controls, being aware of the depth to ground water, and developing an Irrigation Water Management Plan.

Oregon has PURS legislation that requires all agricultural uses of registered pesticides be reported. In this case "agricultural" use includes applications to parks, golf courses, and most livestock uses. Oregon requires reporting if application is part of a business, for a government agency, or in a public place. However, the Governor of Oregon has suspended the PURS program until January 2013 due to budget shortages.

Oregon has also implemented a voluntary program. The Pesticide Stewardship Partnerships (PSP) program began in 1999 through the Oregon Department of Environmental Quality. The PSP's goal is to involve growers and other stakeholders in water quality management at a local level. Effectiveness monitoring is used to provide feedback on the success of mitigation measures. As of 2006, there were six pilot PSPs planned or in place. Early results from the first PSPs in the Columbia Gorge Hood River and in Mill Creek demonstrate reductions in chlorpyrifos and diazinon levels and detection frequencies. DEQ's pilot programs suggest that PSPs can help reduce contamination of surface waters.

Oregon is in the process of developing a Pesticide Management Plan for Water Quality Protection, as required under FIFRA. This plan describes how government agencies and stakeholders will collaboratively reduce pesticides in Oregon water supplies. The PSP program is a component of this plan, and will provide information on the effectiveness of mitigation measures.

Washington State has a Surface Water Monitoring Program that looks at pesticide concentrations in some salmonid bearing streams and rivers. The program was initiated in 2003 and now monitors four areas. Three of these were chosen due to high overlap with agriculture: the Skagit-Samish watershed, the Lower Yakima Watershed, and the Wenatchee and Entiat watersheds. The final area, in the Cedar-Sammamish watershed, is an urban location, intended to look at runoff in a non-agriculture setting. It was chosen due to detection of pesticides coincident with pre-spawning mortality in coho salmon. The Surface Water Monitoring program is relatively new and will continue to add watersheds and testing for additional pesticides over time.

Washington State also has a voluntary program that assists growers in addressing water rights issues within a watershed. Several watersheds have elected to participate, forming Comprehensive Irrigation District Management Plans (CIDMPs). The CIDMP is a collaborative process between government and landowners and growers; the parties determine how they will ensure growers get the necessary volume of water while also guarding water quality. This structure allows for greater flexibility in implementing mitigation measures to comply with both the CWA and the ESA.

The Columbia Gorge Fruit Growers Association is a non-profit organization dedicated to the needs of growers in the mid-Columbia area. The association brings together over 440 growers and 20 shippers of fruit from Oregon and Washington. It has issued a BMP handbook for OPs, including information on alternative methods of pest control. The mid-Columbia area is of particular concern, as many orchards are in close proximity to streams.

Stewardship Partners is a non-profit organization in Washington State that works to build partnerships between landowners, government, and non-profit organizations. In large part, its work focuses on helping landowners to restore fish and wildlife habitat while maintaining the economic viability of their farmland. Projects include restoring riparian areas, reestablishing floodplain connectivity, and removing blocks to fish passage. Another current project is to promote rain gardens as a method of reducing surface water runoff from developed areas. Rain gardens mimic natural hydrology, allowing water to collect and infiltrate the soil.

Stewardship Partners also collaborates with the Oregon-based Salmon-Safe certification program (www.salmonsafe.org). Salmon-Safe is an independent eco-label recognizing organizations who have adopted conservation practices that help restore native salmon habitat in Pacific Northwest, California, and British Columbia. These practices protect water quality, fish and wildlife habitat, and overall watershed health. While the program began with a focus on agriculture, it has since expanded to include industrial and urban sites as well. The certification process includes pesticide restrictions. Salmon-Safe has produced a list of "high risk" pesticides which, if used, would prevent a site from becoming certified. If a grower wants an exception, they must provide written documentation that demonstrates a clear need for use of the pesticide, that no safer alternatives exist, and that the method of application (such as timing, location, and amount used) represents a negligible risk to water quality and fish habitat. Over 300 farms, 250 vineyards, and 240 parks currently have the Salmon-Safe certification. Salmon-Safe has also worked with over 20 corporate / industrial sites and is beginning programs that focus on golf courses and nurseries.

Ranching and Agriculture Ranching, agriculture, and related services in the Pacific Northwest employ more than nine times the national average [19% of the households within the basin (NRC 2004)]. Ranching practices have led to increased soil erosion and sediment loads within adjacent tributaries. The worst of these effects may have occurred in the late 1800s and early 1900s from deliberate burning to increase grass production (NRC 2004). Several measures are currently in place to reduce the impacts of grazing. Measures include restricted grazing in degraded areas, reduced grazing allotments, and lowered stocking rates. Today, the agricultural industry impacts water quality within the basin. Agriculture is second only to the large-scale influences of hydromodification projects regarding power generation and irrigation. Water quality impacts from agricultural activities include alteration of the natural temperature regime, insecticide and herbicide contamination, and increased suspended sediments. During general agricultural operations, pesticides are applied on a variety of crops for pest control. These pesticides may contaminate surface water via runoff especially after rain events following application. Agricultural uses of the a.i.s assessed in this Opinion are discussed in the *Description of the Proposed Action*.

Water Diversions for Agriculture Agriculture and ranching increased steadily within the Columbia River basin from the mid- to late-1800s. By the early 1900s, agricultural opportunities began increasing at a much more rapid pace with the creation of more irrigation canals and the passage of the Reclamation Act of 1902 (NRC 2004). Today, agriculture represents the largest water user within the basin (>90%).

Roughly 6% of the annual flow from the Columbia River is diverted for the irrigation of 7.3 million acres of croplands within the basin. The vast majority of these agricultural lands are located along the lower Columbia River, the Willamette, Yakima, Hood, and Snake rivers, and the Columbia Plateau (Hinck et al. 2004).

The impacts of these water diversions include an increase nutrient load, sediments (from bank erosion), and temperature. Flow management and climate changes have further decreased the delivery of suspended particulate matter and fine sediment to the estuary. The conditions of the habitat (shade, woody debris, over-hanging vegetation) whereby salmonids are constrained by low flows also may make fish more or less vulnerable to predation, elevated temperatures, crowding, and disease. Water flow effects on salmonids may seriously impact adult migration and water quality conditions for spawning and rearing salmonids. High temperature may also result from the loss of vegetation along streams that used to shade the water and from new land uses (buildings and pavement) whereby rainfall picks up heat before it enters into an adjacent stream. Runoff inputs from multiple land use may further pollute receiving waters inhabited by fish or along fish migratory corridors.

Analysis of surface and ground water contaminants were conducted for a number of basins within the Pacific Northwest Region by the NAWQA program. The USGS has a number of fixed water quality sampling sites throughout various tributaries of the Columbia River. Many of the water quality sampling sites have been in place for decades. Water volumes, crop rotation patterns, crop type, and basin location are some of the variables that influence the distribution and frequency of pesticides within a tributary. Detection frequencies for a particular pesticide can vary widely. In addition to current use-chemicals, legacy chemicals continue to pose a serious problem to water quality and fish communities despite their ban in the 1970s and 1980s (Hinck et al. 2004).

Fish and macroinvertebrate communities exhibit an almost linear decline in condition as the level of agriculture intensity increases within a basin (Cuffney et al. 1997; Fuhrer et al. 2004). A study conducted in the late 1990s examined 11 species of fish, including anadromous and resident fish collected throughout the basin, for a suite of 132 contaminants. They included 51 semi-volatile chemicals, 26 pesticides, 18 metals, 7 PCBs, 20 dioxins, and 10 furans. Sampled fish tissues revealed PCBs, metals, chlorinated dioxins and furans (products of wood pulp bleaching operations), and other contaminants.

NAWQA Analysis: Yakima River Basin

The regional NAWQA summary presented here represents data collected during the period 1992-2001. USGS data from 2002-2011 is provided at the national-level (Ryberg et al. 2014) and is summarized in section 10.4.1.5.

The Yakima River Basin is one of the most agriculturally productive areas in the U.S. (Fuhrer et al. 2004). Croplands within the Yakima Basin account for about 16% of the total basin area of which 77% is irrigated. The extensive irrigation-water delivery and drainage system in the Yakima River Basin greatly controls water quality conditions and aquatic health in agricultural streams, drains, and the Yakima River (Fuhrer et al. 2004). From 1999 to 2000, the USGS conducted a NAWQA study in the Yakima River Basin. Fuhrer *et al.* (2004) reported that nitrate and orthophosphate were the dominant forms of nitrogen and phosphorus found in the Yakima River and its agricultural tributaries. Arsenic, a known human carcinogen, was also detected in agricultural drains at elevated concentrations.

The USGS also detected 76 pesticide compounds in the Yakima River Basin. They include 38 herbicides, 17 insecticides (such as carbaryl, diazinon, and malathion), 15 breakdown products, and 6 others (Fuhrer et al. 2004). In agricultural drainages, insecticides were detected in 80% of samples and herbicides were present in 91%. They were also detected in mixed landuse streams – 71% and 90 %, respectively. The most frequently detected pesticides were 2,4-D, terbacil, azinphos methyl, atrazine, carbaryl, and deethylatrazine. Generally, compounds were detected in tributaries more often than in the Yakima River itself.

Ninety-one percent of the samples collected from the small agricultural watersheds contained at least two pesticides or pesticide breakdown products. Samples contained a median of 8 and a maximum of 26 chemicals (Fuhrer et al. 2004). The herbicide 2,4-D, occurred most often in the mixtures, along with azinphos methyl, the most heavily applied pesticide, and atrazine, one of the most aquatic mobile pesticides (Fuhrer et al. 2004). The most frequently detected pesticides in the Yakima River Basin are total DDTs, dichloro-diphenyl-dichloroethane (DDD), and dieldrin (Fuhrer et al. 2004; Johnson and Newman 1983; Joy 2002; Joy and Madrone 2002). Nevertheless, concentrations of total DDT in water have decreased since 1991. These reductions are attributed to erosion-controlling best management practices (BMPs).

Another study conducted by the USGS between May 1999 and January 2000 in the surface waters of Yakima Basin detected 25 pesticide compounds (Ebbert and Embry 2001). Atrazine was the most widely detected herbicide and azinphos methyl was the most widely detected insecticide. Other detected compounds include simazine, terbacil, trifluralin; deethylatrazine, carbaryl, diazinon, malathion, and DDE.

NAWQA Analysis: Central Columbia Plateau

The regional NAWQA summary presented here represents data collected during the period 1992-2001. USGS data from 2002-2011 is provided at the national-level (Ryberg et al. 2014) and is summarized in section 10.4.1.5.

The Central Columbia Plateau is a prominent apple growing region. The USGS sampled 31 surface-water sites representing agricultural land use, with different crops, irrigation methods, and other agricultural practices for pesticides in Idaho and Washington from 1992 - 1995 (Williamson et al. 1998). Pesticides were detected in samples from all sites, except for the Palouse River at Laird Park (a headwaters site in a forested area). Many pesticides were detected in surface water at very low concentrations. Concentrations of six pesticides exceeded freshwater-chronic criteria for the protection of aquatic life in one or more surface-water samples. They include the herbicide triallate and five insecticides (azinphos methyl, chlorpyrifos, diazinon, *gamma*-HCH, and parathion).

Detections at four sites were high, ranging from 12 to 45 pesticides. The two sites with the highest detection frequencies are in the Quincy-Pasco subunit, where irrigation and high chemical use combine to increase transport of pesticides to surface waters. Pesticide detection frequencies at sites in the dryland farming (non-irrigated) areas of the North-Central and Palouse subunits are below the national median for NAWQA sites. All four sites had at least one pesticide concentration that exceeded a water-quality standard or guideline.

Concentrations of organochlorine pesticides and PCBs are higher than the national median (50^{th} percentile) at seven of 11 sites; four sites were in the upper 25% of all NAWQA sites. Although most of these compounds have been banned, they still persist in the environment. Elevated concentrations were observed in dryland farming areas and irrigated areas.

NAWQA Analysis: Williamette Basin

The regional NAWQA summary presented here represents data collected during the period 1992-2001. USGS data from 2002-2011 is provided at the national-level (Ryberg et al. 2014) and is summarized in section 10.4.1.5.

From 1991 to 1995, the USGS also sampled surface waters in the Willamette Basin, Oregon. Wentz *et al.* (1998) reported that 50 pesticides and pesticide degradates of the 86 were detected in streams. Atrazine, simazine, metolachlor, deethylatrazine, diuron, and diazinon were detected in more than one-half of stream samples (Wentz et al. 1998). The highest pesticide concentrations generally occurred in streams draining predominately agricultural land. Forty-nine pesticides were detected in streams draining predominantly agricultural land. About 25 pesticides were detected in streams draining mostly urban areas.

NAWQA Analysis: Lower Clackamas River Basin

The regional NAWQA summary presented here represents data collected during the period 1992-2001. USGS data from 2002-2011 is provided at the national-level (Ryberg et al. 2014) and is summarized in section 10.4.1.5.

Carpenter *et al.* (2008) summarized four different studies that monitored pesticide levels in the lower Clackamas River from 2000 to 2005. Water samples were collected from sites in the lower mainstem Clackamas River, its tributaries, and in pre- and post-treatment drinking-water. In all, 63 pesticide compounds (33 herbicides, 15 insecticides, 6 fungicides, and 9 degradates) were detected in samples collected during storm and nonstorm conditions. Fifty-seven pesticides or degradates were detected in the tributaries (mostly during storms), whereas fewer compounds (26) were detected in samples of source water from the lower mainstem Clackamas River, with fewest (15) occurring in drinking water. The two most commonly detected pesticides were the triazine herbicide simazine and atrazine, which occurred in about one- half of samples. The a.i. in common household herbicides Roundup (glyphosate) and Cross bow (triclopyr and 2,4-D) were frequently detected together.

NAWQA Analysis: Upper Snake River Basin

The regional NAWQA summary presented here represents data collected during the period 1992-2001. USGS data from 2002-2011 is provided at the national-level (Ryberg et al. 2014) and is summarized in section 10.4.1.5.

The USGS conducted a water quality study from 1992 - 1995 in the upper Snake River basin, Idaho and Wyoming (Clark et al. 1998). This basin does not overlap with any of the 28 ESU/DPSs, though it does feed into the migratory corridor of all Snake River species, and eventually into the Columbia River. In basin wide stream sampling in May and June 1994, Eptam, atrazine (and desethylatrazine), metolachlor, and alachlor were the most commonly detected pesticides. These compounds accounted for 75% of all detections. Seventeen different pesticides were detected downstream from American Falls Reservoir.

Hood River Basin

The Hood River Basin ranks fourth in the state of Oregon in total agricultural pesticide usage (Jenkins et al. 2004). The land in Hood River basin is used to grow five crops: alfalfa, apples, cherries, grapes, and pears. About 61 a.i.s, totaling 1.1 million lbs, are applied annually to roughly 21,000 acres. Of the top nine, three are carbamates and three are organophosphate insecticides (***Table 7***).

Table 7. Summarized detection information from (Carpenter et al. 2008).

Active Ingredient	Class	Lbs applied
Oil	-	624,392
Lime Sulfur	-	121,703
Mancozeb	Carbamate	86,872
Sulfur	-	60,552
Ziram	Carbamate	45,965
Azinphos methyl	Organophosphate	22,294

Metam-Sodium	Carbamate	17,114
Phosmet	Organophosphate	15,919
Chlorpyrifos	Organophosphate	14,833

The Hood River basin contains approximately 400 miles of perennial stream channel, of which an estimated 100 miles is accessible to anadromous fish. These channels are important rearing and spawning habitat for salmonids, making pesticide drift a major concern for the area.

NAWQA Analysis: Puget Sound Basin

The regional NAWQA summary presented here represents data collected during the period 1992-2001. USGS data from 2002-2011 is provided at the national-level (Ryberg et al. 2014) and is summarized in section 10.4.1.5.

The USGS sampled waters in the Puget Sound Basin between 1996 and 1998. Ebbert et al. (2000) reported that 26 of 47 analyzed pesticides were detected. A total of 74 manmade organic chemicals were detected in streams and rivers, with different mixtures of chemicals linked to agricultural and urban settings NAWQA results reported that the herbicides atrazine, prometon, simazine and tebuthiuron were the most frequently detected herbicides in surface and ground water (Bortleson and Ebbert 2000). Herbicides were the most common type of pesticide found in an agricultural stream (Fishtrap Creek) and the only type of pesticide found in shallow ground water underlying agricultural land (Bortleson and Ebbert 2000). The most commonly detected VOC in the agricultural land use study area was associated with the application of fumigants to soils prior to planting (Bortleson and Ebbert 2000). One or more fumigant-related compounds (1,2-dichloropropane, 1,2,2-trichloropropane, and 1,2,3-trichloropropane) were detected in over half of the samples. Insecticides, in addition to herbicides, were detected frequently in urban streams (Bortleson and Ebbert 2000). Sampled urban streams showed the highest detection rate for the three insecticides: carbaryl, diazinon, and malathion. No insecticides were found in shallow ground water below urban residential land (Bortleson and Ebbert 2000).

Urban and Industrial Development The largest urban area in the Columbia River basin is the greater Portland metropolitan area, located at the mouth of the Willamette River. Portland's population exceeds 500,000 (Hinck et al. 2004). Although the basin's land cover is about 8% of the U.S. total land mass, its human population is one-third the national average (about 1.2% of the U.S. population) (Hinck et al. 2004).

Discharges from sewage treatment plants, paper manufacturing, and chemical and metal production represent the top three permitted sources of contaminants within the lower Columbia River basin according to discharge volumes and concentrations (Rosetta and Borys 1996). Rosetta and Borys (1996) review of 1993 data indicate that 52% of the point source waste water discharge volume is from sewage treatment plants, 39% from paper and allied products, 5% from chemical and allied products, and 3% from primary metals. However, the paper and allied products industry are the primary sources of the suspended sediment load (71%). Additionally, 26% of the point source waste water discharge volume comes from sewage treatment plants and 1% is from the chemical and allied products industry. Nonpoint source discharges (urban stormwater runoff) account for significant pollutant loading to the lower basin, including most organics and over half of the metals. Although rural nonpoint sources contributions were not calculated, Rosetta and Borys (1996) surmised that in some areas and for some contaminants, rural areas may contribute a large portion of the nonpoint source discharge. This is particularly true for pesticide contamination in the upper river basin where agriculture is the predominant land use.

Water quality has been reduced by phosphorus loads and decreased water clarity, primarily along the lower and middle sections of the Columbia River Estuary. Although sediment quality is generally very good, benthic indices have not been established within the estuary. Fish tissue contaminant loads (PCBs, DDT, DDD, DDE, and mercury) are high and present a persistent and long lasting effect on estuary biology. Health advisories have been recently issued for people eating fish in the area that contain high levels of dioxins, PCBs, and pesticides.

In the 1930s, all of western Washington contained about 15.5 million acres of “harvestable” forestland. By 2004, the total acreage was nearly half that originally surveyed (PSAT 2007). Forest cover in Puget Sound alone was about 5.4 million acres in the early 1990s. About a decade later, the region had lost another 200,000 acres of forest cover with some watersheds losing more than half the total forested acreage. The most intensive loss of forest cover occurred in the Urban Growth Boundary, which encompasses specific parts of the Puget Lowland. In this area, forest cover declined by 11% between 1991 and 1999 (Ruckelshaus and McClure 2007). Projected land cover changes indicate that trends are likely to continue over the next several decades with population changes (Ruckelshaus and McClure 2007). Coniferous forests are also projected to decline at an alarming rate as urban uses increase.

According to the 2001 State of the Sound report (PSAT 2007), impervious surfaces covered 3.3% of the region, with 7.3% of lowland areas (below 1,000 ft elevation) covered by impervious surfaces. From 1991 to 2001, the amount of impervious surfaces increased 10.4% region wide. Consequently, changes in rainfall delivery to streams alter stream flow regimes. Peak flows are increased and subsequent base flows are decreased and alter in-stream habitat. Stream channels are widened and deepened and riparian vegetation is typically removed which can cause increases in water temperature and will reduce the amounts of woody debris and organic matter to the stream system.

Pollutants carried into streams from urban runoff include pesticides, heavy metals, PCBs, polybrominated diphenyl ethers (PBDEs) compounds, PAHs, nutrients (phosphorus and nitrogen), and sediment (***Table 8***). Other ions generally elevated in urban streams include calcium, sodium, potassium, magnesium, and chloride ions where sodium chloride is used as the principal road deicing salt (Paul and Meyer 2001). The combined effect of increased concentrations of ions in streams is the elevated conductivity observed in most urban streams.

Table 8. Examples of Water Quality Contaminants in Residential and Urban Areas.

Contaminant groups	Select constituents	Select example(s)	Source and Use Information
Fertilizers	Nutrients	Phosphorus Nitrogen	lawns, golf courses, urban landscaping
Heavy Metals	Pb, Zn, Cr, Cu, Cd, Ni, Hg, Mg	Cu	brake pad dust, highway and parking lot runoff, rooftops
Pesticides including- Insecticides (I) Herbicides (H) Fungicides (F) Wood Treatment chemicals (WT) Legacy Pesticides (LP) Other ingredients in pesticide formulations (OI)	Organophosphates (I) Carbamates (I) Organochlorines (I) Pyrethroids (I) Triazines (H) Chloroacetanilides (H) Chlorophenoxy acids (H) Triazoles (F) Copper containing fungicides (F) Organochlorines (LP) Surfactants/adjuvants (OI)	Chlorpyrifos (I) Diazinon (I) Carbaryl (I) Atrazine (H) Esfenvalerate (I) Creosote (WT) DDT (LP) Copper sulfate (F) Metalaxyl (F) Nonylphenol (OI)	golf courses, right of ways, lawn and plant care products, pilings, bulkheads, fences
Pharmaceuticals and personal care products	Natural and synthetic hormones soaps and detergents	Ethinyl estradiol Nonylphenol	hospitals, dental facilities, residences, municipal and industrial waste water discharges
Polyaromatic hydrocarbons (PAHs)	Tricyclic PAHs	Phenanthrene	fossil fuel combustion, oil and gasoline leaks, highway runoff, creosote-treated wood
Industrial chemicals	PCBs PBDEs Dioxins	Penta-PBDE	utility infrastructure, flame retardants, electronic equipment

Many other metals have been found in elevated concentrations in urban stream sediments including arsenic, iron, boron, cobalt, silver, strontium, rubidium, antimony, scandium, molybdenum, lithium, and tin (Wheeler et al. 2005). The concentration, storage, and transport of metals in urban streams are connected to particulate organic matter content and sediment characteristics. Organic matter has a high binding capacity for metals and both bed and suspended sediments with high organic matter content frequently exhibit 50 - 7,500 times higher concentrations of zinc, lead, chromium, copper, mercury, and cadmium than sediments with lower organic matter content.

Although urban areas occupy only 2% of the Pacific Northwest land base, the impacts of urbanization on aquatic ecosystems are severe and long lasting (Spence et al. 1996). O'Neill *et al.* (2006) found that Chinook salmon returning to Puget Sound had significantly higher concentrations of PCBs and PBDEs compared to other Pacific coast salmon populations. Furthermore, Chinook salmon that resided in Puget Sound in the winter rather than migrate to the Pacific Ocean (residents) had the highest concentrations of persistent organic pollutants (POPs), followed by Puget Sound fish populations believed to be more ocean-reared. Fall-run Chinook salmon from Puget Sound have a more localized marine distribution in Puget Sound and the Georgia Basin than other populations of Chinook salmon from the west coast of North America. This ESU is more contaminated with PCBs (2 to 6 times) and PBDEs (5 to 17 times). O'Neill *et al.* (2006) concluded that regional body burdens of contaminants in Pacific salmon, and Chinook salmon in particular, could contribute to the higher levels of contaminants in federally-listed endangered southern resident killer whales.

Endocrine disrupting compounds are chemicals that mimic natural hormones, inhibit the action of hormones and/or alter normal regulatory functions of the immune, nervous and endocrine systems and can be discharged with treated effluent (King County 2002). Endocrine disruption has been attributed to DDT and other organochlorine pesticides, dioxins, PAHs, alkylphenolic compounds, phthalate plasticizers, naturally occurring compounds, synthetic hormones and metals. Natural mammalian hormones such as 17β-estradiol are also classified as endocrine disruptors. Both natural and synthetic mammalian hormones are excreted through the urine and are known to be present in wastewater discharges.

Jobling *et al.* (1995) reported that 10 chemicals known to occur in sewage effluent interacted with the fish estrogen receptor by reducing binding of 17β-estradiol to its receptor, stimulating transcriptional activity of the estrogen receptor or inhibiting transcription activity. Binding of the 10 chemicals with the fish endocrine receptor indicates that the chemicals could be endocrine disruptors and forms the basis of concern about WWTP effluent and fish endocrine disruption.

Fish communities are impacted by urbanization (Wheeler et al. 2005). Urban stream fish communities have lower overall abundance, diversity, taxa richness and are dominated by pollution tolerant species. Lead content in fish tissue is higher in urban areas. Furthermore, the proximity of urban streams to humans increases the risk of non-native species introduction and establishment. Thirty-nine non-native species were collected in Puget Sound during the 1998 Puget Sound Expedition Rapid Assessment Survey (Brennan et al. 2004). Lake Washington, located within a highly urban area, has 15 non-native species identified (Ajawani 1956).

PAH compounds also have distinct and specific effects on fish at early life history stages (Incardona et al. 2004). PAHs tend to adsorb to organic or inorganic matter in sediments, where they can be trapped in long-term reservoirs (Johnson et al. 2002). Only a portion of sediment-adsorbed PAHs are readily bioavailable to marine organisms, but there is substantial uptake of these compounds by resident benthic fish through the diet, through exposure to contaminated water in the benthic boundary layer, and through direct contact with sediment. Benthic invertebrate prey are a particularly important source of PAH exposure for marine fishes, as PAHs are bioaccumulated in many invertebrate species (Meador et al. 1995; Varanasi et al. 1989; Varanasi et al. 1992).

PAHs and their metabolites in invertebrate prey can be passed on to consuming fish species, PAHs are metabolized extensively in vertebrates, including fishes (Johnson et al. 2002). Although PAHs do not bioaccumulate in vertebrate tissues, PAHs cause a variety of deleterious effects in exposed animals. Some PAHs are known to be immunotoxic and to have adverse effects on reproduction and development. Studies show that PAHs exhibit many of the same toxic effects in fish as they do in mammals (Johnson et al. 2002).

Habitat Modification This section briefly describes how anthropogenic land use has altered aquatic habitat conditions for salmonids in the Pacific Northwest Region. Basin wide, critical ecological connectivity (mainstem to tributaries and riparian floodplains) has been disconnected by dams and associated activities such as floodplain deforestation and urbanization. Dams have flooded historical spawning and rearing habitat with the creation of massive water storage reservoirs. More than 55% of the Columbia River Basin that was accessible to salmon and steelhead before 1939 has been blocked by large dams (NWPPC 1986). Construction of the Grand Coulee Dam blocked 1,000 miles (1,609 km) of habitat from migrating salmon and steelhead (Wydoski and Whitney 1979). Similarly, over one third (2,000 km) of coho salmon habitat is no longer accessible (Good et al. 2005). The mainstem habitats of the lower Columbia and Willamette rivers have been reduced primarily to a single channel. As a result, floodplain area is reduced, off-channel habitat features have been eliminated or disconnected from the main channel, and the amount of LWD in the mainstem has been reduced. Remaining areas are affected by flow fluctuations associated with reservoir management for power generation, flood control, and irrigation. Overbank flow events, important to habitat diversity, have become rare as a result of controlling peak flows and associated revetments. Portions of the basin are also subject to impacts from cattle grazing and irrigation withdrawals. Consequently, estuary dynamics have changed substantially.

Habitat loss has fragmented habitat and human density increase has created additional loads of pollutants and contaminants within the Columbia River Estuary (Anderson et al. 2007). About 77% of swamps, 57% of marshes, and over 20% of tree cover have been lost to development and industry. Twenty four threatened and endangered species occur in the estuary, some of which are recovering while others (*i.e.*, Chinook salmon) are not.

Stream habitat degradation in Columbia Central Plateau is relatively high (Williamson et al. 1998). In the most recent NAWQA survey, a total of 16 sites were evaluated - all of which showed signs of degradation (Williamson et al. 1998). Streams in this area have an average of 20% canopy cover and 70% bank erosion. These factors have severely affected the quality of habitat available to salmonids. The Palouse subunit of the Lower Snake River exceeds temperature levels for the protection of aquatic life (Williamson et al. 1998).

The Willamette Basin Valley has been dramatically changed by modern settlement. The complexity of the mainstem river and extent of riparian forest have both been reduced by 80% (PNERC 2002). About 75% of what was formerly prairie and 60% of what was wetland have been converted to agricultural purposes. These actions, combined with urban development, extensive (96 miles) bank stabilization, and in-river and nearshore gravel mining, have resulted in a loss of floodplain connectivity and off-channel habitat (PNERC 2002).

Much of the estuarine wetlands in Puget Sound have been heavily modified, primarily from agricultural land conversion and urban development (NRC 1996). Although most estuarine wetland losses result from conversions to agricultural land by ditching, draining, or diking, these wetlands also experience increasing effects from industrial and urban causes. By 1980, an estimated 27,180 acres of intertidal or shore wetlands had been lost at 11 deltas in Puget Sound (Bortleson et al. 1980). Tidal wetlands in Puget Sound amount to roughly 18% of their historical extent (Collins and Sheikh 2005). Coastal marshes close to seaports and population centers have been especially vulnerable to conversion with losses of 50 - 90%. By 1980, an estimated 27,180 acres of intertidal or shore wetlands had been lost at 11 deltas in Puget Sound (Bortleson et al. 1980). More recently, tidal wetlands in Puget Sound amount to about 17 - 19% of their historical extent (Collins and Sheikh 2005). Coastal marshes close to seaports and population centers have been especially vulnerable to conversion with losses of 50 - 90% common for individual estuaries. Salmon use freshwater and estuarine wetlands for physiological transition to and from salt water and rearing habitat. The land conversions and losses of Pacific Northwest wetlands constitute a major impact. Salmon use marine nearshore areas for rearing and migration, with juveniles using shallow shoreline habitats (Brennan et al. 2004).

About 800 miles of Puget Sound's shorelines are hardened or dredged (PSAT 2004; Ruckelshaus and McClure 2007). The area most intensely modified is the urban corridor (eastern shores of Puget Sound from Mukilteo to Tacoma). Here, nearly 80% of the shoreline has been altered, mostly from shoreline armoring associated with the Burlington Northern Railroad tracks (Ruckelshaus and McClure 2007). Levee development within the rivers and their deltas has isolated significant portions of former floodplain habitat that was historically used by salmon and trout during rising flood waters.

Urbanization has caused direct loss of riparian vegetation and soils and has significantly altered hydrologic and erosion rates. Watershed development and associated urbanization throughout the Puget Sound, Hood Canal, and Strait of Juan de Fuca regions have increased sedimentation, raised water temperatures, decreased LWD recruitment, decreased gravel recruitment, reduced river pools and spawning areas, and dredged and filled estuarine rearing areas (Bishop and Morgan 1996 in (NMFS 2008a)). Large areas of the lower rivers have been channelized and diked for flood control and to protect agricultural, industrial, and residential development.

The principal factor for decline of Puget Sound steelhead is the destruction, modification, and curtailment of its habitat and range. Barriers to fish passage and adverse effects on water quality and quantity resulting from dams, the loss of wetland and riparian habitats, and agricultural and urban development activities have contributed and continue to contribute to the loss and degradation of steelhead habitats in Puget Sound (NMFS 2008a).

More than 100 years of industrial pollution and urban development have affected water quality and sediments in Puget Sound. Many different kinds of activities and substances release contamination into Puget Sound and the contributing waters. According to the State of the Sound Report (PSAT 2007) in 2004, more than 1,400 fresh and marine waters in the region were listed as "impaired." Almost two-thirds of these water bodies were listed as impaired due to contaminants, such as toxics, pathogens, and low dissolved oxygen or high temperatures, and less than one-third had established cleanup plans. More than 5,000 acres of submerged lands (primarily in urban areas; 1% of the study area) are contaminated with high levels of toxic substances, including polybrominated diphenyl ethers (PBDEs; flame retardants), and roughly one-third (180,000 acres) of submerged lands within Puget Sound are considered moderately contaminated. In 2005 the Puget Sound Action Team (PSAT) identified the primary pollutants of concern in Puget Sound and their sources listed below in ***Table 9***.

Table 9. Pollutants of Concern in Puget Sound (PSAT 2005).

Pollutant	Sources
Heavy Metals: Pb, Hg, Cu, and others	vehicles, batteries, paints, dyes, stormwater runoff, spills, pipes.
Organic Compounds: Polycyclic aromatic hydrocarbons (PAHs)	Burning of petroleum, coal, oil spills, leaking underground fuel tanks, creosote, asphalt.
Polychlorinated biphenyls (PCBs)	Solvents electrical coolants and lubricants, pesticides, herbicides, treated wood.
Dioxins, Furans	Byproducts of industrial processes.
Dichloro-diphenyl-trichloroethane (DDTs)	Chlorinated pesticides.
Phthalates	Plastic materials, soaps, and other personal care products. Many of these compounds are in wastewater from sewage treatment plants.
Polybrominated diphenyl ethers (PBDEs)	PBDEs are added to a wide range of textiles and plastics as a flame retardant. They easily leach from these materials and have been found throughout the environment and in human breast milk.

While much of the coastal region is forested, it has still been impacted by land use practices. Less than 3% of the Oregon coastal forest is old growth conifers (Gregory 2000). The lack of mature conifers indicates high levels of habitat modification. As such, overall salmonid habitat quality is poor, though it varies by watershed. The amount of remaining high quality habitat ranges from 0% in the Sixes to 74% in the Siltcoos (ODFW 2005). Approximately 14% of freshwater winter habitat available to juvenile coho is of high quality. Much of the winter habitat is unsuitable due to high temperatures. For example, 77% of coho salmon habitat in the Umpqua basin exceeds temperature standards.

Reduction in stream complexity is the most significant limiting factor in the Oregon coastal region. An analysis of the Oregon coastal range determined the primary and secondary life cycle bottlenecks for the 21 populations of coastal coho salmon (Nicholas et al. 2005). Nicholas *et al.* (2005) determined that stream complexity is either the primary (13) or secondary (7) bottleneck for every population. Stream complexity has been reduced through past practices such as splash damming, removing riparian vegetation, removing LWD, diking tidelands, filling floodplains, and channelizing rivers.

Habitat loss through wetland fills is also a significant factor. ***Table 10*** summarizes the change in area of tidal wetlands for several Oregon estuaries (Good 2000).

Table 10. Change in total area (acres2) of tidal wetlands in Oregon (tidal marshes and swamps) due to filling and diking between 1870 and 1970 (Good 2000).

Estuary	Diked or Filled Tidal Wetland	Percent of 1870 Habitat Lost
Necanicum	15	10
Nehalem	1,571	75
Tillamook	3,274	79
Netarts	16	7
Sand Lake	9	2
Nestucca	2,160	91
Salmon	313	57
Siletz	401	59
Yaquina	1,493	71
Alsea	665	59
Siuslaw	1,256	63
Umpqua	1,218	50
Coos Bay	3,360	66
Coquille	4,600	94
Rogue	30	41
Chetco	5	56
Total	20,386	72%

The only listed salmonid population in coastal Washington is the Ozette Lake sockeye. The range of this ESU is small, including only one lake (31 km^2) and 71 km of stream. Like the Oregon Coastal drainages, the Ozette Lake area has been heavily managed for logging. Logging resulted in road building and the removal of LWD, which affected the nearshore ecosystem (NMFS Salmon Recovery Division 2008). LWD along the shore offered both shelter from predators and a barrier to encroaching vegetation (NMFS Salmon Recovery Division 2008). Aerial photograph analysis shows near-shore vegetation has increased significantly over the past 50 years (Ritchie 2005). Further, there is strong evidence that water levels in Ozette Lake have dropped between 1.5 and 3.3 ft from historic levels [Herrera 2005 *in* (NMFS Salmon Recovery Division 2008)]. The impact of this water level drop is unknown. Possible effects include increased desiccation of sockeye redds and loss of spawning habitat. Loss of LWD has also contributed to an increase in silt deposition, which impairs the quality and quantity of spawning habitat. Very little is known about the relative health of the Ozette Lake tributaries and their impact on the sockeye salmon population.

Habitat Restoration Since 2000, land management practices included improving access by replacing culverts and fish habitat restoration activities at Federal Energy Regulatory Commission (FERC)-licensed dams. Habitat restoration in the upper (reducing excess sediment loads) and lower Grays River watersheds may benefit the Grays River chum salmon population as it has a sub-yearling juvenile life history type and rears in such habitats. Short-term daily flow fluctuations at Bonneville Dam sometimes create a barrier (*i.e.*, entrapment on shallow sand flats) for fry moving into the mainstem rearing and migration corridor. Some chum fry have been stranded on shallow water flats on Pierce Island from daily flow fluctuations. Coho salmon are likely to be affected by flow and sediment delivery changes in the Columbia River plume. Steelhead may be affected by flow and sediment delivery changes in the plume (Casillas 1999).

In 2000, NOAA Fisheries completed consultation on issuance of a 50-year incidental take permit to the State of Washington for its Washington State Forest Practices Habitat Conservation Plan (HCP). The HCP is expected to improve habitat conditions on state forest lands within the action area. Improvements include removing barriers to migration, restoring hydrologic processes, increasing the number of large trees in riparian zones, improving stream bank integrity, and reducing fine sediment inputs (NMFS 2008c).

Positive changes in water quality in the Puget Sound region are evident. One of the most notable improvements was the elimination of sewage effluent to Lake Washington in the mid-1960s. This significantly reduced problems within the lake from phosphorus pollution and triggered a concomitant reduction in cyanobacteria (Ruckelshaus and McClure 2007). Even so, as the population and industry has risen in the region a number of new and legacy pollutants are of concern.

Mining Mining has a long history in Washington. In 2004, the state was ranked 13th nationally in total nonfuel mineral production value and 17th in coal production (NMA 2007; Palmisano et al. 1993). Metal mining for all metals (zinc, copper, lead, silver, and gold) peaked between 1940 and 1970 (Palmisano et al. 1993). Today, construction sand and gravel, Portland cement, and crushed stone are the predominant materials mined. Where sand and gravel is mined from riverbeds (gravel bars and floodplains) it may result in changes in channel elevations and patterns, instream sediment loads, and seriously alter instream habitat. In some cases, instream or floodplain mining has resulted in large scale river avulsions. The effect of mining in a stream or reach depends upon the rate of harvest and the natural rate of replenishment, as well as flood and precipitation conditions during or after the mining operations.

Most of the mining in the Columbia River basin is focused on minerals such as phosphate, limestone, dolomite, perlite, or metals such as gold, silver, copper, iron, and zinc. Mining in the region is conducted in a variety of methods and places within the basin. Alluvial or glacial deposits are often mined for gold or aggregate. Ores are often excavated from the hard bedrocks of the Idaho batholiths. Eleven percent of the nation's output of gold has come from mining operations in Washington, Montana, and Idaho. More than half of the nation's silver output has come from a few select silver deposits.

Many of the streams and river reaches in the Columbia River basin are impaired from mining. Several abandoned and former mining sites are also designated as superfund cleanup areas (Anderson et al. 2007; Stanford et al. 2005). According to the U.S. Bureau of Mines, there are about 14,000 inactive or abandoned mines within the Columbia River Basin. Of these, nearly

200 pose a potential hazard to the environment [Quigley, 1997 *in* (Hinck et al. 2004)]. Contaminants detected in the water include lead and other trace metals.

Oregon is ranked 35th nationally in total nonfuel mineral production value in 2004. In that same year, Washington was ranked 13th nationally in total nonfuel mineral production value and 17th in coal production (NMA 2007; Palmisano et al. 1993). Metal mining for all metals (*e.g.*, zinc, copper, lead, silver, and gold) peaked in Washington between 1940 and 1970 (Palmisano et al. 1993). Today, construction sand, gravel, Portland cement, and crushed stone are the predominant materials mined in both Oregon and Washington. Where sand and gravel is mined from riverbeds (gravel bars and floodplains) changes in channel elevations and patterns, and also changes in instream sediment loads, may result and alter instream habitat. In some cases, instream or floodplain mining has resulted in large scale river avulsions. The effect of mining in a stream or reach depends upon the rate of harvest and the natural rate of replenishment. Additionally, the severity of the effects is influenced by flood and precipitation conditions during or after the mining operations.

Hydromodification Projects More than 400 dams exist in the Columbia River basin, ranging from mega dams that store large amounts of water to small diversion dams for irrigation. Every major tributary of the Columbia River except the Salmon River is totally or partially regulated by dams and diversions. More than 150 dams are major hydroelectric projects. Of these, 18 dams are located on the mainstem Columbia River and its major tributary, the Snake River. The FCRPS encompasses the operations of 14 major dams and reservoirs on the Columbia and Snake rivers. These dams and reservoirs operate as a coordinated system. The Corps operates 9 of 10 major federal projects on the Columbia and Snake rivers, and the Dworshak, Libby and Albeni Falls dams. The BOR operates the Grand Coulee and Hungry Horse dams. These federal projects are a major source of power in the region. These same projects provide flood control, navigation, recreation, fish and wildlife, municipal and industrial water supply, and irrigation benefits.

BOR has operated irrigation projects within the basin since 1904. The irrigation system delivers water to about 2.9 million acres of agricultural lands. About 1.1 million acres of land are irrigated using water delivered by two structures, the Columbia River Project (Grand Coulee Dam) and the Yakima Project. The Grand Coulee Dam delivers water for the irrigation of over 670,000 acres of croplands and the Yakima Project delivers water to nearly 500,000 acres of croplands (Bouldin et al. 2007).

The Bonneville Power Administration (Corps et al.), an agency of the U.S. Department of Energy, wholesales electric power produced at 31 federal dams (67% of its production) and non-hydropower facilities in the Columbia-Snake Basin. The BPA sells about half the electric power consumed in the Pacific Northwest. The federal dams were developed over a 37-year period starting in 1938 with Bonneville Dam and Grand Coulee in 1941, and ending with construction of Libby Dam in 1973 and Lower Granite Dam in 1975.

Development of the Pacific Northwest regional hydroelectric power system, dating to the early 20th century, has had profound effects on the ecosystems of the Columbia River Basin (ISG 1996). These effects have been especially adverse to the survival of anadromous salmonids. The construction of the FCRPS modified migratory habitat of adult and juvenile salmonids. In many cases, the FCRPS presented a complete barrier to habitat access for salmonids. Approximately 80% of historical spawning and rearing habitat of Snake River fall-run Chinook salmon is now inaccessible due to dams. The Snake River spring/summer run has been limited to the Salmon, Grande Ronde, Imnaha, and Tuscanon rivers. Damming has cut off access to the majority of Snake River Chinook salmon spawning habitat. The Sunbeam Dam on the Salmon River is believed to have limited the range of Snake River sockeye salmon as well.

Both upstream and downstream migrating fish are impeded by the dams. Additionally, a substantial number of juvenile salmonids are killed and injured during downstream migrations. Physical injury and direct mortality occurs as juveniles pass through turbines, bypasses, and spillways. Indirect effects of passage through all routes may include disorientation, stress, delay in passage, exposure to high concentrations of dissolved gases, warm water, and increased predation. Non-federal hydropower facilities on Columbia River tributaries have also partially or completely blocked higher elevation spawning.

Qualitatively, several hydromodification projects have improved the productivity of naturally produced SR Fall-run Chinook salmon. Improvements include flow augmentation to enhance water flows through the lower Snake and Columbia Rivers [USBR 1998 *in* (NMFS 2008c)]; providing stable outflows at Hells Canyon Dam during the fall Chinook salmon spawning season and maintaining these flows as minimums throughout the incubation period to enhance survival of incubating fall-run Chinook salmon; and reduced summer temperatures and enhanced summer flow in the lower Snake River [see (Corps et al. 2007), *Appendix 1 in* (NMFS 2008c)]. Providing suitable water temperatures for over-summer rearing within the Snake River reservoirs allows the expression of productive "yearling" life history strategy that was previously unavailable to SR Fall-run Chinook salmon.

The mainstem FCRPS corridor has also improved safe passage through the hydrosystem for juvenile steelhead and yearling Chinook salmon with the construction and operation of surface bypass routes at Lower Granite, Ice Harbor, and Bonneville dams and other configuration improvements (Corps et al. 2007).

For salmon, with a stream-type juvenile life history, projects that have protected or restored riparian areas and breached or lowered dikes and levees in the tidally influenced zone of the estuary have improved the function of the juvenile migration corridor. The FCRPS action agencies recently implemented 18 estuary habitat projects that removed passage barriers. These activities provide fish access to good quality habitat.

The Corps *et al.* (2007) estimated that hydropower configuration and operational improvements implemented from 2000 to 2006 have resulted in an 11.3% increase in survival for yearling juvenile LCR Chinook salmon from populations that pass Bonneville Dam. Improvements during this period included the installation of a corner collector at Powerhouse II (PH2) and the partial installation of minimum gap runners at Powerhouse 1 (PH1) and of structures that improve fish guidance efficiency at PH2. Spill operations have been improved and PH2 is used as the first priority powerhouse for power production because bypass survival is higher than at PH1. Additionally, drawing water towards PH2 moves fish toward the corner collector. The bypass system screen was removed from PH1 because tests showed that turbine survival was higher than through the bypass system at that location.

More than 20 dams occur within the Puget Sound region's rivers and overlap with the distribution of salmonids. A number of basins contain water withdrawal projects or small impoundments that can impede migrating salmon. The resultant impact of these and land use changes (forest cover loss and impervious surface increases) has been a significant modification in the seasonal flow patterns of area rivers and streams, and the volume and quality of water delivered to Puget Sound waters. Several rivers have been modified by other means including levees and revetments, bank hardening for erosion control, and agriculture uses. Since the first dike on the Skagit River delta was built in 1863 for agricultural development (Ruckelshaus and McClure 2007), other basins like the Snohomish River are diked and have active drainage systems to drain water after high flows that top the dikes. Dams were also built on the Cedar, Nisqually, White, Elwha, Skokomish, Skagit, and several other rivers in the early 1900s to supply urban areas with water, prevent downstream flooding, allow for floodplain activities (like agriculture or development), and to power local timber mills (Ruckelshaus and McClure 2007).

Over the next few years, however, a highly publicized and long discussed dam removal project is expected to begin in the Elwha River. The removal of two dams in the Elwha River, a short but formerly very productive salmon river, is expected to open up more than 70 miles of high quality salmon habitat (Ruckelshaus and McClure 2007; Wunderlich et al. 1994). Estimates suggest that nearly 400,000 salmon could begin using the basin within 30 years after the dams are removed (PSAT 2007).

In 1990, only one-third of the water withdrawn in the Pacific Northwest was returned to the streams and lakes (NRC 1996). Water that returns to a stream from an agricultural irrigation is often substantially degraded. Problems associated with return flows include increased water temperature, which can alter patterns of adult and smolt migration; increased toxicant concentrations associated with pesticides and fertilizers; increased salinity; increased pathogen populations; decreased dissolved oxygen concentration; and increased sedimentation (NRC 1996). Water-level fluctuations and flow alterations due to water storage and withdrawal can affect substrate availability and quality, temperature, and other habitat requirements of salmon. Indirect effects include reduction of food sources; loss of spawning, rearing, and adult habitat; increased susceptibility of juveniles to predation; delay in adult spawning migration; increased egg and alevin mortalities; stranding of fry; and delays in downstream migration of smolts (NRC 1996).

Compared to other areas in the greater Northwest Region, the coastal region has fewer dams and several rivers remain free flowing (*e.g.*, Clearwater River). The Umpqua River is fragmented by 64 dams, the fewest number of dams on any large river basin in Oregon (Carter and Resh 2005). According to Palmisano *et al.* (1993) dams in the coastal streams of Washington permanently block only about 30 miles of salmon habitat. In the past, temporary splash dams were constructed throughout the region to transport logs out of mountainous reaches. The general practice involved building a temporary dam in the creek adjacent to the area being logged, and filling the pond with logs. When the dam broke the floodwater would carry the logs to downstream reaches where they could be rafted and moved to market or downstream mills. Thousands of splash dams were constructed across the Northwest in the late 1800s and early 1900s. While the dams typically only temporarily blocked salmon habitat, in some cases dams remained long enough to wipe out entire salmon runs. The effects of the channel scouring and loss of channel complexity resulted in the long-term loss of salmon habitat (NRC 1996).

Artificial Propagation There are several artificial propagation programs for salmon production within the Columbia River Basin. These programs were instituted under federal law to lessen the effects of lost natural salmon production within the basin from the dams. Federal, state, and tribal managers operate the hatcheries. For more than 100 years, hatcheries in the Pacific Northwest have been used to produce fish for harvest and replace natural production lost to dam construction. Hatcheries have only minimally been used to protect and rebuild naturally produced salmonid populations (*e.g.*, Redfish Lake sockeye salmon). In 1987, 95% of the coho salmon, 70% of the spring Chinook salmon, 80% of the summer Chinook salmon, 50% of the fall-run Chinook salmon, and 70% of the steelhead returning to the Columbia River Basin originated in hatcheries (CBFWA 1990). More recent estimates suggest that almost half of the total number of smolts produced in the basin come from hatcheries (Beechie et al. 2005).

The impact of artificial propagation on the total production of Pacific salmon and steelhead has been extensive (Hard et al. 1992). Hatchery practices, among other factors, are a contributing factor to the 90% reduction in natural coho salmon runs in the lower Columbia River over the past 30 years (Flagg et al. 1995). Past hatchery and stocking practices have resulted in the transplantation of salmon and steelhead from non-native basins. The impacts of these hatchery practices are largely unknown. Adverse effects of these practices likely included: loss of genetic variability within and among populations (Busack 1990; Hard et al. 1992; Reisenbichler 1997; Riggs 1990), disease transfer, increased competition for food, habitat, or mates, increased predation, altered migration, and the displacement of natural fish (Fresh 1997; Hard et al. 1992; Steward and Bjornn 1990). Species with extended freshwater residence may face higher risk of domestication, predation, or altered migration than species that spend only a brief time in freshwater (Hard et al. 1992). Nonetheless, artificial propagation may also contribute to the conservation of listed salmon and steelhead. However, it is unclear whether or how much artificial propagation during the recovery process will compromise the distinctiveness of natural populations (Hard et al. 1992).

The states of Oregon and Washington and other fisheries co-managers are engaged in a substantial review of hatchery management practices through the Hatchery Scientific Review Group (HSRG). The HSRG was established and funded by Congress to provide an independent review of current hatchery program in the Columbia River Basin. The HSRG has completed its work on Lower Columbia River populations and provided its recommendations. A general conclusion is that the current production programs are inconsistent with practices that reduce impacts on naturally-spawning populations, and will have to be modified to reduce adverse effects on key natural populations identified in the Interim Recovery Plan. The adverse effects are caused by hatchery-origin adults spawning with natural-origin fish or competing with natural-origin fish for spawning sites (NMFS 2008c). Oregon and Washington initiated a comprehensive program of hatchery and associated harvest reforms (ODFW 2007; Washington Department of Fish and Wildlife (WDFW) 2005). The program is designed to achieve HSRG objectives related to controlling the number of hatchery-origin fish on the spawning grounds and in the hatchery broodstock.

Coho salmon hatchery programs in the lower Columbia have been tasked to compensate for impacts of fisheries. However, hatchery programs in the LCR have not operated specifically to conserve LCR coho salmon. These programs threaten the viability of natural populations. The long-term domestication of hatchery fish has eroded the fitness of these fish in the wild and has reduced the productivity of wild stocks where significant numbers of hatchery fish spawn with wild fish. Large numbers of hatchery fish have also contributed to more intensive mixed stock fisheries. These programs largely overexploited wild populations weakened by habitat degradation. Most LCR coho salmon populations have been heavily influenced by hatchery production over the years.

The artificial propagation of late-returning Chinook salmon is widespread throughout Puget Sound (Good et al. 2005). Summer/fall Chinook salmon transfers between watersheds within and outside the region have been commonplace throughout this century. Therefore, the purity of naturally spawning stocks varies from river to river. Nearly 2 billion Chinook salmon have been released into Puget Sound tributaries since the 1950s. The vast majority of these have been derived from local late-returning adults.

Returns to hatcheries have accounted for 57% of the total spawning escapement. However, the hatchery contribution to spawner escapement is probably much higher than that due to hatchery-derived strays on the spawning grounds. The genetic similarity between Green River late-returning Chinook salmon and several other late-returning Chinook salmon in Puget Sound suggests that there may have been a significant and lasting effect from some hatchery transplants (Marshall et al. 1995).

Overall, the use of Green River stock throughout much of the extensive hatchery network in this ESU may reduce the genetic diversity and fitness of naturally spawning populations (Good et al. 2005).

Commercial, Recreational and Subsistence Fishing Despite regulated fishing programs for salmonids, listed salmonids are also caught as bycatch. There are several approaches under the ESA to address tribal and state take of ESA-listed species that may occur as a result of harvest activities. section 10 of the ESA provides for permits to operate fishery harvest programs. ESA section 4(d) rules provide exemptions from take for resource, harvest, and hatchery management plans. Furthermore, there are several treaties that have reserved the right of fishing to tribes in the North West Region.

Management of salmon fisheries in the Columbia River Basin is a cooperative process involving federal, state, and tribal representatives. The Pacific Fishery Management Council sets annual fisheries in federal waters from three to 200 miles off the coasts of Washington, Oregon, and California. Salmon and steelhead fisheries in the Columbia River and its tributaries are co-managed by the states of Washington, Oregon, Idaho, four treaty tribes, and other tribes that traditionally have fished in those waters. A federal court oversees Columbia River harvest management through the U.S. v. Oregon proceedings. Inland fisheries are those in waters within state boundaries, including those extending out three miles from the coasts. The states of Oregon, Idaho, and Washington issue salmon fishing licenses for these areas.

Fisheries in the Columbia River basin are managed within the winter/spring, summer, and fall seasons. There are Treaty Indian and non-Treaty fisheries which are managed subject to state and tribal regulation, consistent with provisions of a U.S. v. Oregon 2008 agreement. The winter/spring season extends from January 1 to June 15. Commercial, recreational, and ceremonial subsistence fisheries target primarily upriver spring Chinook stocks and spring Chinook salmon that return to the Willamette and lower Columbia River tributaries. Some steelhead are also caught incidentally in these fisheries. The summer season extends from June 16 to July 31. Commercial, recreational, and ceremonial and subsistence fisheries are managed primarily to provide harvest opportunity directed at unlisted UCR summer Chinook salmon. Summer fisheries are constrained primarily by the available opportunity for UCR summer Chinook salmon, and by specific harvest rate limits for SR sockeye salmon and harvest rate limits on steelhead in non-Treaty fisheries. Fall season fisheries begin on August 1 and end on December 31. Commercial, recreational, and ceremonial and subsistence fisheries target primarily harvestable hatchery and natural origin fall Chinook and coho salmon. Fall season fisheries are constrained by specific ESA related harvest rate limits for listed SR fall Chinook salmon, and SR steelhead.

Treaty Indian fisheries are managed subject to the regulation of the Columbia River Treaty Tribes. They include all mainstem Columbia River fisheries between Bonneville Dam and McNary Dam, and any fishery impacts from tribal fishing that occurs below Bonneville Dam. Tribal fisheries within specified tributaries to the Columbia River are included.

Non-Treaty fisheries are managed under the jurisdiction of the states. These include mainstem Columbia River commercial and recreational salmonid fisheries at the river mouth of Bonneville Damn, designated off channel Select Area fisheries, mainstem recreational fisheries between Bonneville Dam and McNary Dam, recreational fisheries between McNary Dam and Highway 305 Bridge in Pasco, Washington, recreational and Wanapum tribal spring Chinook fisheries from McNary Dam to Priest Rapids Dam, and recreational spring Chinook fisheries in the Snake River upstream to Lower Granite Dam.

Archeological records indicate that indigenous people caught salmon in the Columbia River more than 7,000 years ago. One of the most well-known tribal fishing sites within the basin was located near Celilo Falls, an area in the lower river that has been occupied by Dalles Dam since 1957. Salmon fishing increased with better fishing methods and preservation techniques, such as drying and smoking. Salmon harvest substantially increased in the mid-1800s with canning techniques. Harvest techniques also changed over time, from early use of hand-held spears and dip nets, to riverboats using seines and gill nets. Harvest techniques eventually transitioned to large ocean-going vessels with trolling gear and nets and the harvest of Columbia River salmon and steelhead from California to Alaska (Beechie et al. 2005).

During the mid-1800s, an estimated 10 to 16 million adult salmon of all species entered the Columbia River each year. Large annual harvests of returning adult salmon during the late 1800s ranging from 20 million to 40 million lbs of salmon and steelhead significantly reduced population productivity (Beechie et al. 2005). The largest known harvest of Chinook salmon occurred in 1883 when Columbia River canneries processed 43 million lbs of salmon (Lichatowich 1999). Commercial landings declined steadily from the 1920s to a low in 1993. At that time, just over one million lbs of Chinook salmon were harvested (Beechie et al. 2005).

Harvested and spawning adults reached 2.8 million in the early 2000s, of which almost half are hatchery produced (Beechie et al. 2005). Most of the fish caught in the river are steelhead and spring/summer run Chinook salmon. Ocean harvest consists largely of coho and fall-run Chinook salmon. Most ocean catches are made north of Cape Falcon, Oregon. Over the past five years, the number of spring and fall salmon commercially harvested in tribal fisheries has averaged between 25,000 and 110,000 fish (Beechie et al. 2005). Recreational catch in both ocean and in-river fisheries varies from 140,000 to 150,000 individuals (Beechie et al. 2005).

Non-Indian fisheries in the lower Columbia River are limited to a harvest rate of 1%. Treaty Indian fisheries are limited to a harvest rate of 5 to 7%, depending on the run size of upriver Snake River sockeye stocks. Actual harvest rates over the last 10 years have ranged from 0 to 0.9%, and 2.8 to 6.1%, respectively [see TAC 2008, Table 15 *in* (NMFS 2008c)].

Columbia River chum salmon are not caught incidentally in tribal fisheries above Bonneville Dam. However, Columbia River chum salmon are incidentally caught occasionally in non-Indian fall season fisheries below Bonneville Dam. There are no fisheries in the Columbia River that target hatchery or natural-origin chum salmon. The species' later fall return timing make them vulnerable to relatively little potential harvest in fisheries that target Chinook salmon and coho salmon. CR chum salmon rarely take the sport gear used to target other species. Incidental catch of chum amounts to a few tens of fish per year (TAC 2008). The harvest rate of CR chum salmon in proposed state fisheries in the lower river is estimated to be 1.6% per year and is less than 5%.

LCR coho salmon are harvested in the ocean and in the Columbia River and tributary freshwater fisheries of Oregon and Washington. Incidental take of coho salmon prior to the 1990s fluctuated from approximately 60 to 90%. However, this number has been reduced since its listing to 15 to 25% (LCFRB 2004). The exploitation of hatchery coho salmon has remained approximately 50% through the use of selective fisheries.

LCR steelhead are harvested in Columbia River and tributary freshwater fisheries of Oregon and Washington. Fishery impacts of LCR steelhead have been limited to less than 10% since implementation of mark-selective fisheries during the 1980s. Recent harvest rates on UCR steelhead in non-Treaty and treaty Indian fisheries ranged from 1% to 2%, and 4.1% to 12.4%, respectively (NMFS 2008c).

Despite regulated fishing programs for salmonids, listed salmonids are also caught as bycatch. There are several approaches under the ESA to address tribal and state take of ESA-listed species that may occur as a result of harvest activities. Section 10 of the ESA provides for permits to operate fishery harvest programs. ESA section 4(d) rules provide exemptions from take for resource, harvest, and hatchery management plans. Furthermore, there are several treaties that have reserved the right of fishing to tribes in the North West Region.

Management of salmon fisheries in the Puget Sound Region is a cooperative process involving federal, state, tribal, and Canadian representatives. The Pacific Fishery Management Council sets annual fisheries in federal waters from three to 200 miles off the coasts of Washington, Oregon, and California. The annual North of Falcon process sets salmon fishing seasons in waters such as Puget Sound, Willapa Bay, Grays Harbor, and Washington State rivers. Inland fisheries are those in waters within state boundaries, including those extending out three miles from the coasts. The states of Oregon, Idaho, and Washington issue salmon fishing licenses for these areas. Adult salmon returning to Washington migrate through both U.S. and Canadian waters and are harvested by fishermen from both countries. The 1985 Pacific Salmon Treaty helps fulfill conservation goals for all members and is implemented by the eight-member bilateral Pacific Salmon Commission. The Commission does not regulate salmon fisheries, but provides regulatory advice.

Most of the commercial landings in the region are groundfish, Dungeness crab, shrimp, and salmon. Many of the same species are sought by Tribal fisheries and by charter and recreational anglers. Nets and trolling are used in commercial and Tribal fisheries. Recreational anglers typically use hook and line, and may fish from boat, river bank, or docks.

Harvest impacts on Puget Sound Chinook salmon populations average 75% in the earliest five years of data availability and have dropped to an average of 44% in the most recent five-year period (Good et al. 2005). Populations in Puget Sound have not experienced the strong increases in numbers seen in the late 1990s in many other ESUs. Although more populations have increased than decreased since the last BRT assessment, after adjusting for changes in harvest rates, trends in productivity are less favorable. Most populations are relatively small, and recent abundance within the ESU is only a small fraction of estimated historic run size.

Despite regulated fishing programs for salmonids, listed salmonids are also caught as bycatch. There are several approaches under the ESA to address tribal and state take of ESA-listed species that may occur as a result of harvest activities. Section 10 of the ESA provides for permits to operate fishery harvest programs. ESA section 4(d) rules provide exemptions from take for resource, harvest, and hatchery management plans.

Management of salmon fisheries in the Washington-Oregon-Northern California drainage is a cooperative process involving federal, state, and tribal representatives. The Pacific Fishery Management Council sets annual fisheries in federal waters from three to 200 miles off the coasts of Washington, Oregon, and California. Inland fisheries are those within state boundaries, including those extending out three miles from state coastlines. The states of Oregon, Idaho, California and Washington issue salmon fishing licenses for these areas.

Most commercial landings in the region are groundfish, Dungeness crab, shrimp, and salmon. Many of the same species are sought by Tribal fisheries, as well as by charter, and recreational anglers. Nets and trolling are used in commercial and Tribal fisheries. Recreational anglers typically use hook and line and may fish from boat, river bank, or docks.

Non-native Species Many non-native species have been introduced to the Columbia River Basin since the 1880s. At least 81 non-native species have currently been identified, composing one-fifth of all species in some areas. New non-native species are discovered in the basin regularly; a new aquatic invertebrate is discovered approximately every 5 months (Sytsma et al. 2004). It is clear that the introduction of non-native species has changed the environment, though whether these changes will impact salmonid populations is uncertain (Sytsma et al. 2004).

10.4.4 California Subregion

The California subregion includes parts of California, Nevada, and Oregon. The subregion totals roughly 430,000 km^2 of which about 320,000 km^2 is classified as undeveloped, 50,000 km^2 is classified as developed and about 50,000 km^2 is classified as agriculture (***Figure 6***).

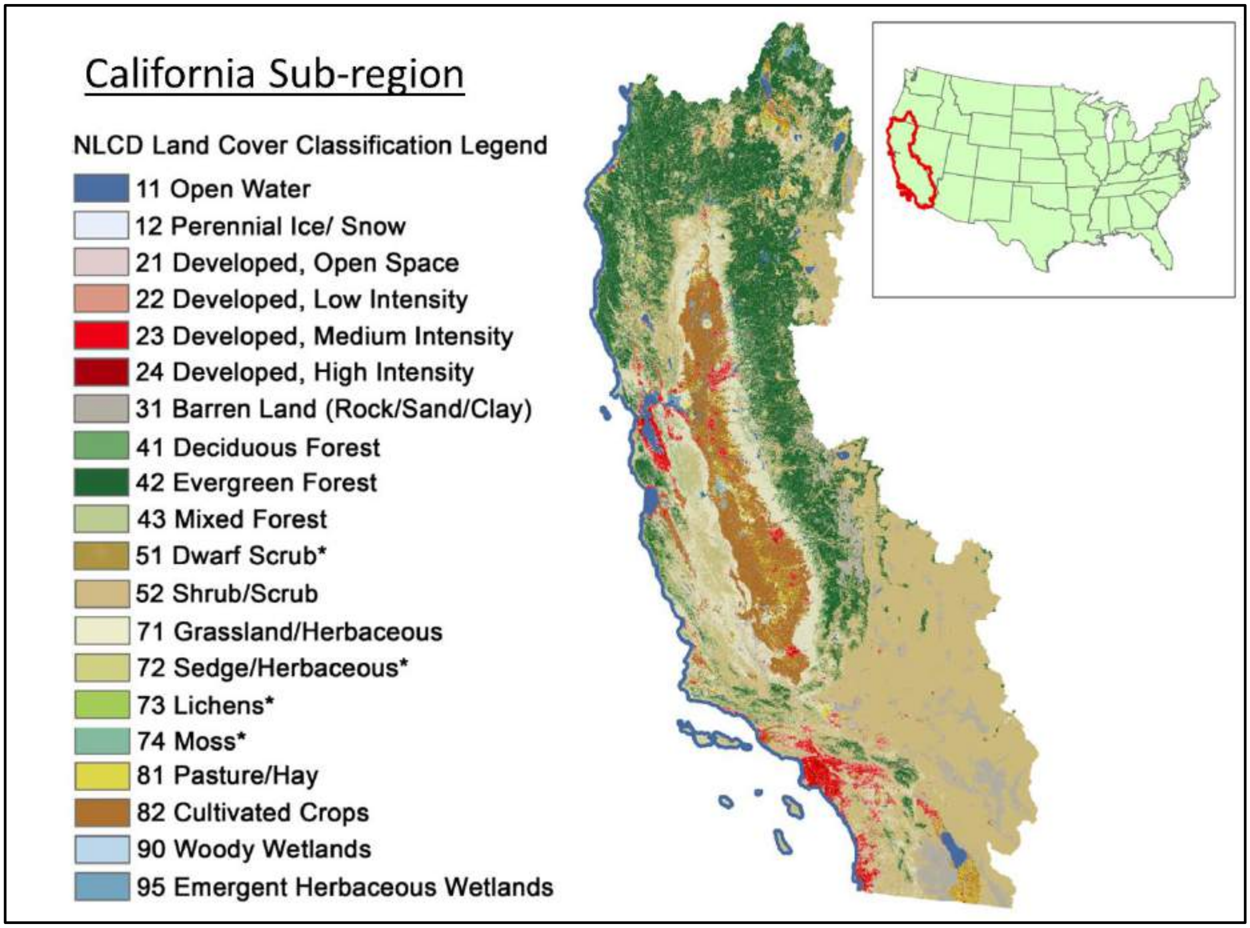

Figure 6. Landuse in the California sub-region. Data from the NLCD 2011 (www.mrlc.gov).

Twenty-two of the 77 species addressed in the Opinion occur in this subregion. They are: chinook salmon (ESUs: Central Valley spring-run, California coastal, Sacramento River winter-run), coho salmon (ESUs: southern Oregon/northern California coastal, central California coast), steelhead salmon (DPSs: northern California, south-central California coast, central California coast, California Central Valley, southern California), southern DPS eulachon, southern DPS green sturgeon, gulf grouper, southern resident killer whale, Guadalupe fur seal, leatherback sea turtle, North Pacific Ocean loggerhead sea turtle, hawksbill sea turtle, olive Ridley sea turtle, East Pacific green sea turtle, black abalone, and white abalone. ***Table 11*** and ***Table 12*** show the types and areas of land use within each of the species' ranges.

Table 11. Area of land use categories within California subregion selected salmonid ranges in km . The total area for each category is given in bold. Land cover was determined via the NLCD 2011. Land cover class definitions are available at: http://www.mrlc.gov/nlcd_definitions.php

Land Cover	Chinook			Coho	Steelhead	
NLCD Sub category	Central Valley spring	California Coastal	Sacramento River winter	Central California Coast	Northern California	South-Central California Coast
Water	**493**	**2,684**	**1,751**	**4,800**	**2,558**	**2,198**
Open Water	493	2,684	1,751	4,800	2,558	2,198
Perennial Ice/Snow	-	-	-	-	-	-
Developed Land	**5,119**	**1,166**	**2,426**	**3,579**	**779**	**1,734**
Open Space	2,105	793	757	1,285	590	945
Low Intensity	1,126	143	546	804	55	263
Medium Intensity	1,246	112	734	1,088	38	200
High Intensity	345	20	266	340	6	36
Barren Land	296	97	122	62	90	290
Undeveloped Land	**23,064**	**18,468**	**5,226**	**11,905**	**15,758**	**12,919**
Deciduous Forest	900	826	113	235	744	1
Evergreen Forest	4,349	10,258	648	5,340	9,411	1,516
Mixed Forest	427	1,494	196	1,539	1,132	1,468
Shrub/Scrub	3,815	3,757	632	1,997	2,906	4,109
Grassland/Herbaceous	12,557	1,998	2,765	2,495	1,442	5,633
Woody Wetlands	288	77	129	72	67	92
Emergent Wetlands	729	59	743	228	56	102
Agriculture	**19,298**	**476**	**5,759**	**573**	**233**	**1,546**
Pasture/Hay	2,598	243	641	63	218	217
Cultivated Crops	16,700	233	5,118	510	16	1,329
TOTAL (inc. open water)	**47,975**	**22,795**	**15,162**	**20,857**	**19,328**	**18,398**
TOTAL (w/o open water)	**47,482**	**20,110**	**13,411**	**16,057**	**16,770**	**16,200**

Table 12. Area of land use categories within California subregion selected steelhead, sturgeon, sea turtle ranges in km . The total area for each category is given in bold. Land cover was determined via the NLCD 2011. Land cover class definitions are available at: http://www.mrlc.gov/nlcd_definitions.php

Land Cover	Steelhead DPS			Sturgeon	Sea Turtle
NLCD Sub category	Central California Coast	California Central Valley	Southern California	Green Sturgeon Southern DPS	East Pacific Green Sea Turtle
Water	**3,463**	**2,075**	**3,131**	**15,444**	**13,958**
Open Water	3,463	2,075	3,131	15,439	13,958
Perennial Ice/Snow	-	-	-	5	-
Developed Land	**3,570**	**7,021**	**6,396**	**12,892**	**5,003**
Open Space	1,140	2,732	1,667	3,882	1,393
Low Intensity	848	1,509	1,433	3,169	1,036
Medium Intensity	1,165	1,756	2,390	3,505	1,750
High Intensity	363	549	810	1,289	638
Barren Land	54	475	96	1,048	187
Undeveloped Land	**8,599**	**30,130**	**10,826**	**32,525**	**11,069**
Deciduous Forest	163	954	1	1,187	119
Evergreen Forest	2,346	4,478	892	11,878	3,395
Mixed Forest	1,412	1,147	909	3,887	1,165
Shrub/Scrub	1,598	5,719	6,742	5,998	3,079
Grassland/Herbaceous	2,608	16,291	2,101	7,020	2,586
Woody Wetlands	41	318	95	1,013	128
Emergent Wetlands	430	1,223	86	1,542	598
Agriculture	**622**	**21,417**	**1,025**	**9,351**	**1,217**
Pasture/Hay	73	2,869	160	1,751	302
Cultivated Crops	548	18,548	865	7,600	914
TOTAL (inc. open water)	**16,253**	**60,643**	**21,379**	**70,213**	**31,247**
TOTAL (w/o open water)	**12,790**	**58,568**	**18,247**	**54,769**	**17,289**

Baseline Water Temperature Temperature is significant for the health of aquatic life. Water temperatures affect the distribution, health, and survival of native cold-blooded salmonids in the Pacific Northwest and elsewhere. These fish will experience adverse health effects when exposed to temperatures outside their optimal range. For listed Pacific salmonids, water temperature tolerance varies between species and life stages. Optimal temperatures for rearing salmonids range from 10ºC to 16ºC. In general, the increased exposure to stressful water temperatures and the reduction of suitable habitat caused by drought conditions reduce the abundance of salmon. Warm temperatures can reduce fecundity, reduce egg survival, retard growth of fry and smolts, reduce rearing densities, increase susceptibility to disease, decrease the ability of young salmon and trout to compete with other species for food, and to avoid predation (McCullough 1999; Spence et al. 1996). Migrating adult salmonids and upstream migration can be delayed by excessively warm stream temperatures. Excessive stream temperatures may also negatively affect incubating and rearing salmonids (Gregory and Bisson 1997). ***Figure 7*** depicts waterbodies with 303(d) temperature exceedances within the California subregion.

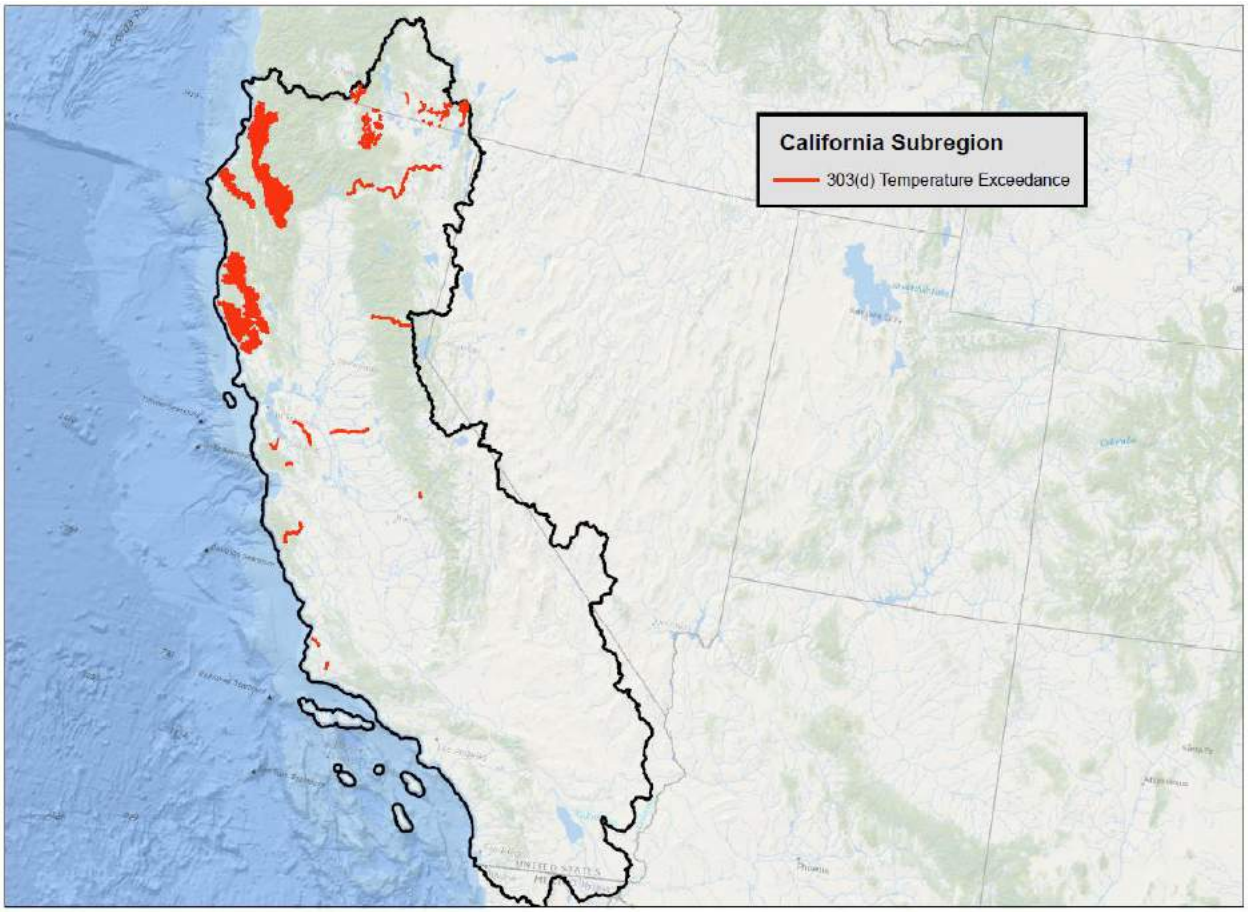

Figure 7. 303(d) temperature exceedances within the California subregion. Data downloaded from USEPA ATTAINS website; "303(d) May 1, 2015 National Extract layer".

We used GIS layers made publically available through USEPA's Assessment and Total Maximum Daily Load Tracking and Implementation System (ATTAINS) to determine the number of km on the 303(d) list for exceeding temperature thresholds within the boundaries of those species which utilize freshwater habitats (***Table 13***). Because the 303(d) list is limited to the subset of rivers tested, the chart values should be regarded as lower-end estimates. While some ESU/DPS ranges do not contain any 303(d) rivers listed for temperature, others show considerable overlap. These comparisons demonstrate the relative significance of elevated temperature among ESUs/DPSs. Increased water temperature may result from wastewater discharge, decreased water flow, minimal shading by riparian areas, and climatic variation.

Table 13. Number of kilometers of river, stream and estuaries included in ATTAINS 303(d) lists due to temperature that are located within selected California subregion species (ESU/DPS) ranges. Data were taken from USEPA ATTAINS website: May 1, 2015 National Extract.

Species	Kilometers of recorded temperature exceedance
Chinook, Central Valley spring-run ESU	92
Chinook, California Coastal ESU	4,467
Chinook, Sacramento River winter-run ESU	No exceedances recorded[2]
Coho, Central California Coast ESU	3,272
Steelhead, Northern California DPS	3,100
Steelhead, South-Central California Coast DPS	84
Steelhead, Central California Coast DPS	1,397
Steelhead, California Central Valley DPS	92
Steelhead, Southern California DPS	29
Green Sturgeon, Southern DPS	881

Pesticide Reduction Programs When using these three a.i.s, growers must adhere to the court-ordered injunctive relief, requiring buffers of 20 yards for ground application and 100 yards for any aerial application. These measures are mandatory in all four states, pending completion of consultation.

California State Code does not include specific limitations on pesticide application aside from human health protections. It only includes statements advising that applicators are required to follow all federal, state, and local regulations.

Additionally, pesticide reduction programs already exist in California to minimize levels of the above a.i.s into the aquatic environment. Monitoring of water resources is handled by the California Environmental Protection Agency's Regional Water Boards. Each Regional Board makes water quality decisions for its region including setting standards and determining waste discharge requirements. The Central Valley Regional Water Quality Control Board (CVRWQCB) addresses issues in the Sacramento and San Joaquin River Basins. These river basins are characterized by crop land, specifically orchards, which historically rely heavily on organophosphates for pest control.

In 2003, the CVRWQCB adopted the Irrigated Lands Waiver Program (ILWP). Participation was required for all growers with irrigated lands that discharge waste which may degrade water quality. However, the ILWP allowed growers to select one of three methods for regulatory coverage (Markle et al. 2005). These options included: 1) join a Coalition Group approved by the CVRWQCB, 2) file for an Individual Discharger Conditional Waiver, and 3) comply with zero discharge regulation (Markle et al. 2005). Many growers opted to join a Coalition as the other options were more costly. Coalition Groups were charged with completing two reports – a Watershed Evaluation Report and a Monitoring and Reporting Plan. The Watershed Evaluation Report included information on crop patterns and pesticide/nutrient use, as well as mitigation

[2] While temperature exceedances are not recorded in the 303(d) list they are anticipated within this species range.

measures that would prevent orchard runoff from impairing water quality. Similar programs are in development in other agricultural areas of California.

As a part of the Waiver program, the Central Valley Coalitions undertook monitoring of "agriculture dominated waterways". Some of the monitored waterways are small agricultural streams and sloughs that carry farm drainage to larger waterways. The coalition was also required to develop a management plan to address exceedance of State water quality standards. Currently, the Coalitions monitor toxicity to test organisms, stream parameters (*e.g.*, flow, temperature, etc.), nutrient levels, and pesticides used in the region, including diazinon and chlorpyrifos. Diazinon exceedances within the Sacramento and Feather Rivers resulted in the development of a TMDL. The Coalitions were charged with developing and implementing management and monitoring plans to address the TMDL and reduce diazinon runoff.

The Coalition for Urban/Rural Environmental Stewardship (CURES) is a non-profit organization that was founded in 1997 to support educational efforts for agricultural and urban communities focusing on the proper and judicious use of pest control products. CURES educates growers on methods to decrease pesticide surface water contamination in the Sacramento River Basin. The organization has developed best-practice literature for pesticide use in both urban and agricultural settings (www.curesworks.org). CURES also works with California's Watershed Coalitions to standardize their Watershed Evaluation Reports and to keep the Coalitions informed. The organization has worked with local organizations, such as the California Dried Plum Board and the Almond Board of California, to address concerns about diazinon, pyrethroids, and sulfur. The CURES site discusses alternatives to organophosphate dormant spray applications. It lists pyrethroids and carbaryl as alternatives, but cautions that these compounds may impact non-target organisms. The CURES literature does not specifically address the a.i.s discussed in this Opinion.

California also has PURS legislation whereby all agricultural uses of registered pesticides must be reported. In this case "agricultural" use includes applications to parks, golf courses, and most livestock uses.

In 2006, CDPR put limitations on dormant spray application of most insecticides in orchards, in part to adequately protect aquatic life in the Central Valley region. While the legislation was prompted by diazinon and chlorpyrifos exceedances, these limitations also apply to other organophosphates, pyrethroids, and carbamates.

The CDPR publishes voluntary interim measures for mitigating the potential impacts of pesticide usage to listed species. These measures are available online as county bulletins (http://www.cdpr.ca.gov/docs/endspec/colist.htm).

Habitat Modification The Central Valley area, including San Francisco Bay and the Sacramento and San Joaquin River Basins, has been drastically changed by development. Salmonid habitat has been reduced to 300 miles from historic estimates of 6,000 miles (CDFG 1993). In the San Joaquin Basin alone, the historic floodplain covered 1.5 million acres with 2 million acres of riparian vegetation (CDFG 1993). Roughly 5% of the Sacramento River Basin's riparian forests remain. Impacts of development include loss of LWD, increased bank erosion and bed scour, changes in sediment loadings, elevated stream temperature, and decreased base flow. Thus, lower quantity and quality of LWD and modified hydrology reduce and degrade salmonid rearing habitat.

The Klamath Basin in Northern California has been heavily modified as well. Water diversions have reduced spring flows to 10% of historical rates in the Shasta River, and dams block access to 22% of historical salmonid habitat. The Scott and Trinity Rivers have similar histories. Agricultural development has reduced riparian cover and diverted water for irrigation (NRC 2003). Riparian habitat has decreased due to extensive logging and grazing. Dams and water diversions are also common. These physical changes resulted in water temperatures too high to sustain salmonid populations. The Salmon River, however, is comparatively pristine; some reaches are designated as Wild and Scenic Rivers. The main cause of riparian loss in the Salmon River basin is likely wild fires – the effects of which have been exacerbated by salvage logging (NRC 2003).

Mining Famous for the gold rush of the mid-1800s, California has a long history of mining. Extraction methods such as suction dredging, hydraulic mining, and strip mining may cause water pollution problems. In 2004, California ranked top in the nation for non-fuel mineral production with 8.23% of total production (NMA 2007). Today, gold, silver, and iron ore comprise only 1% of the production value. Primary minerals include construction sand, gravel, cement, boron, and crushed stone. California is the only state to produce boron, rare-earth metals, and asbestos (NMA 2007).

California contains approximately 1,500 abandoned mines. Roughly 1% of these mines are suspected of discharging metal-rich waters into the basins. The Iron Metal Mine in the Sacramento Basin releases more than 1,100 lbs of copper and more than 770 lbs of zinc to the Keswick Reservoir below Shasta Dam. The Iron Metal Mine also released elevated levels of lead (Cain et al. 2000 in Carter and Resh 2005). Metal contamination reduces the biological productivity within a basin. Metal contamination can result in fish kills at high levels or sublethal effects at low levels. Sublethal effects include a reduction in feeding, overall activity levels, and growth. The Sacramento Basin and the San Francisco Bay watershed are two of the most heavily impacted basins within the state from mining activities. The basin drains some of the most productive mineral deposits in the region. Methyl mercury contamination within San Francisco Bay, the result of 19^{th} century mining practices using mercury to amalgamate gold in the Sierra Nevada Mountains, remains a persistent problem today. Based on sediment cores, pre-mining concentrations were about five times lower than concentrations detected within San Francisco Bay today (Conaway et al. 2003).

Hydromodification Projects Several of the rivers within California have been modified by dams, water diversions, drainage systems for agriculture and drinking water, and some of the most drastic channelization projects in the nation. There are about 1,400 dams within the State of California, more than 5,000 miles of levees, and more than 140 aqueducts (Mount 1995). In general, the southern basins have a warmer and drier climate and the more northern, coastal-influenced basins are cooler and wetter. About 75% of the runoff occurs in basins in the northern half of California, while 80% of the water demand is in the southern half. Two water diversion projects meet these demands—the federal Central Valley Project (CVP) and the California State Water Project (CSWP). The CVP is one of the world's largest water storage and transport systems. The CVP has more than 20 reservoirs and delivers about 7 million acre-ft per year to southern California. The CSWP has 20 major reservoirs and holds nearly 6 million acre-ft of water. The CSWP delivers about 3 million acre-ft of water for human use. Together, both diversions irrigate about 4 million acres of farmland and deliver drinking water to roughly 22 million residents.

Both the Sacramento and San Joaquin rivers are heavily modified, each with hundreds of dams. The Rogue, Russian, and Santa Ana rivers each have more than 50 dams, and the Eel, Salinas, and the Klamath Rivers have between 14 and 24 dams each. The Santa Margarita is considered one of the last free flowing rivers in coastal southern California with nine dams occurring in its watershed. All major tributaries of the San Joaquin River are impounded at least once and most have multiple dams or diversions. The Stanislaus River, a tributary of the San Joaquin River, has over 40 dams. As a result, the hydrograph of the San Joaquin River is seriously altered from its natural state. Alteration of the temperature and sediment transport regimes had profound influences on the biological community within the basin. These modifications generally result in a reduction of suitable habitat for native species and frequent increases in suitable habitat for non-native species. The Friant Dam on the San Joaquin River is attributed with the extirpation of spring-run Chinook salmon within the basin. A run of the spring-run Chinook salmon once produced about 300,000 to 500,000 fish (Carter and Resh 2005).

Artificial Propagation Anadromous fish hatcheries have existed in California since establishment of the McCloud River hatchery in 1872. There are nine state hatcheries: the Iron Gate (Klamath River), Mad River, Trinity (Trinity River), Feather (Feather River), Warm Springs (Russian River), Nimbus (American River), Mokelumne (Mokelumne River), and Merced (Merced River). The California Department of Fish and Game (CDFG) also manages artificial production programs on the Noyo and Eel rivers. The Coleman National Fish Hatchery, located on Battle Creek in the upper Sacramento River, is a federal hatchery operated by the USFWS. The USFWS also operates an artificial propagation program for Sacramento River winter run Chinook salmon.

Of these, the Feather River, Nimbus, Mokelumne, and Merced River facilities comprise the Central Valley Hatcheries. Over the last 10 years, the Central Valley Hatcheries have released over 30 million young salmon. State and the federal (Coleman) hatcheries work together to meet overall goals. State hatcheries are expected to release 18.6 million smolts in 2008 and Coleman is aiming for more than 12 million. There has been no significant change in hatchery practices over the year that would adversely affect the current year class of fish. A new program marking 25% of the 32 million Sacramento River Fall-run Chinook smolts may provide data on hatchery fish contributions to the fisheries in the near future.

Commercial and Recreational Fishing The region is home to many commercial fisheries. The largest in terms of total California landings in 2006 were northern anchovy, Pacific sardine, Chinook salmon, sablefish, Dover sole, Pacific whiting, squid, red sea urchin, and Dungeness crab (CDFG 2007). Red abalone is also harvested.

Despite regulated fishing programs for salmonids, listed salmonids are also caught as bycatch. There are several approaches under the ESA to address tribal and state take of ESA-listed species that may occur as a result of harvest activities. Section 10 of the ESA provides for permits to operate fishery harvest programs. ESA section 4(d) rules provide exemptions from take for resource, harvest, and hatchery management plans.

Management of salmon fisheries in the Southwest Coast Region is a cooperative process involving federal, state, and tribal representatives. The Pacific Fishery Management Council sets annual fisheries in federal waters from three to 200 miles off the coasts of Washington, Oregon, and California. Inland fisheries are those within state boundaries, including those extending out three miles from state coastlines. The states of Oregon, Idaho, California, and Washington issue salmon fishing licenses for inland fisheries. The California Fish and Game Commission (CFGC) establish the salmon seasons and issues permits for all California waters and the Oregon Department of Fish and Game sets the salmon seasons and issues permits for all Oregon waters.

In 2008, there was an unprecedented collapse of the Sacramento River fall-run Chinook salmon that led to complete closure of the commercial and sport Chinook fisheries in California and in Oregon south of Cape Falcon. U.S. Department of Commerce Secretary Gary Locke released a 2008 West Coast salmon disaster declaration for California and Oregon in response to poor salmon returns to the Sacramento River, which led to federal management reducing commercial salmon fishing off southern Oregon and California to near zero. Secretary Locke also released $53.1 million in disaster funds to aid affected fishing communities.

Non-native Species Plants and animals that are introduced into habitats where they do not naturally occur are called non-native species. They are also known as non-indigenous, exotic, introduced, or invasive species, and have been known to affect ecosystems. Non-native species are introduced through infested stock for aquaculture and fishery enhancement, through ballast water discharge and from the pet and recreational fishing industries (http://biology.usgs.gov/s+t/noframe/x191.htm.). The Aquatic Nuisance Species Task Force suggests that it is inevitable that cultured species will eventually escape confinement and enter U.S. waterways. Non-native species were cited as a contributing cause in the extinction of 27 species and 13 subspecies of North American fishes over the past 100 years (Miller et al. 1989). Wilcove, Rothstein *et al.* (1998) note that 25% of ESA-listed fish are threatened by non-native species. By competing with native species for food and habitat as well as preying on them, non-native species can reduce or eliminate populations of native species.

Surveys performed by CDFG state that at least 607 non-native species are found in California coastal waterways (Foss et al. 2007). The majority of these species are representatives of four phyla: annelids (33%), arthropods (22%), chordates (13%), and mollusks (10%). Non-native chordate species are primarily fish and tunicates which inhabit fresh and brackish water habitats such as the Sacramento-San Joaquin Delta (Foss et al. 2007). The California Aquatic Invasive Species Management Plan includes goals and strategies for reducing the introduction rate of new invasive species as well as removing those with established populations.

Withering Syndrome (applicable to abalone) Withering syndrome is the primary ongoing threat to black abalone populations in the action area. First detected on Santa Cruz Island in 1986 (*Haaker et al. 1992*), the disease has spread throughout all of the Channel Islands and the Southern California coast as far north as Rancho Marino, south of Point Piedras Blancas in San Luis Obispo County (*Tissot 2007; VanBlaricom et al. 2009; Neuman et al. In press*). The disease has resulted in mass mortalities of black abalone throughout Southern California and continues to threaten populations as it moves progressively northward along the mainland California coast. Most populations affected by withering syndrome have been extirpated or remain at low densities and have not exhibited successful recruitment.

NAWQA Analysis: Santa Ana Basin

The regional NAWQA summary presented here represents data collected during the period 1992-2001. USGS data from 2002-2011 is provided at the national-level (Ryberg et al. 2014) and is summarized in section 10.4.1.5.

The Santa Ana watershed is the most heavily populated study site out of more than 50 assessment sites studied across the nation by the NAWQA Program. According to Belitz *et al.* (2004), treated wastewater effluent is the primary source of baseflow to the Santa Ana River. Secondary sources that influence peak river flows include stormwater runoff from urban, agricultural, and undeveloped lands (Belitz et al. 2004). Stormwater and agricultural runoff frequently contain pesticides, fertilizers, sediments, nutrients, pathogenic bacteria, and other chemical pollutants to waterways and degrade water quality. The above inputs have resulted in elevated concentrations of nitrates and pesticides in surface waters of the basin. Nitrates and pesticides were more frequently detected here than in other national NAWQA sites (Belitz et al. 2004). Additionally, Belitz *et al.* (2004) found that pesticides and volatile organic compounds (VOCs) were frequently detected in surface and ground water in the Santa Ana Basin.

Of the 103 pesticides and degradates routinely analyzed for in surface and ground water, 58 were detected. Pesticides included diuron, diazinon, carbaryl, chlorpyrifos, lindane, malathion, and chlorothalonil. Diuron was detected in 92% of urban samples – a rate much higher than the national frequency of 25 % (Belitz et al. 2004). Of the 85 VOCs routinely analyzed for, 49 were detected. VOCs included methyl *tert*-butyl ether (MTBE), chloroform, and trichloroethylene (TCE). Organochlorine compounds were also detected in bed sediment and fish tissue. Organochlorine concentrations were also higher at urban sites than at undeveloped sites in the Santa Ana Basin. Organochlorine compounds include DDT and its breakdown product diphenyl dicloroethylene (DDE), and chlordane. Other contaminants detected at high levels included trace elements such as lead, zinc, and arsenic. According to Belitz *et al.* (2004), the biological community in the basin is heavily altered as a result from these pollutants.

NAWQA Analysis: San Joaquin-Tulare Basin

The regional NAWQA summary presented here represents data collected during the period 1992-2001. USGS data from 2002-2011 is provided at the national-level (Ryberg et al. 2014) and is summarized in section 10.4.1.5.

A study was conducted by the USGS in the mid-1990s on water quality within the San Joaquin-Tulare basins. Concentrations of dissolved pesticides in this study unit were among the highest of all NAWQA sites nationwide. The USGS detected 49 of the 83 pesticides it tested for in the mainstem and three subbasins. Pesticides were detected in all but one of the 143 samples. The most common detections were of the herbicides simazine, dacthal, metolachlor, and EPTC (Eptam), and the insecticides diazinon and chlorpyrifos. Twenty-two pesticides were detected in over 20% of the samples (Dubrovsky et al. 1998). Further, many samples contained mixtures of at least 7 pesticides, with a maximum of 22 different compounds. Diuron was detected in all three subbasins, despite land use differences.

Organochlorine insecticides in bed sediment and tissues of fish or clams were also detected. They include DDT and toxaphene. Levels at some sites were among the highest in the nation. Concentrations of trace elements in bed sediment generally were higher than concentrations found in other NAWQA study units (Dubrovsky et al. 1998).

NAWQA Analysis: Sacramento River Basin

The regional NAWQA summary presented here represents data collected during the period 1992-2001. USGS data from 2002-2011 is provided at the national-level (Ryberg et al. 2014) and is summarized in section 10.4.1.5.

Another study conducted by the USGS from 1996 - 1998 within the Sacramento River Basin compared the pesticides in surface waters at four specific sites – urban, agricultural, and two integration sites (Domagalski 2000). Pesticides included thiobencarb, carbofuran, molinate, simazine, metolachlor, dacthal, chlorpyrifos, carbaryl, and diazinon – as well as the three a.i.'s assessed in this Opinion. Land use differences between sites are reflected in pesticide detections. Thiobencarb was detected in 90.5 % of agricultural samples, but only 3.3% of urban samples (Domagalski 2000). This finding is unsurprising as rice is the dominant crop within the agricultural basin. Some pesticides were detected at concentrations higher than criteria for the protection of aquatic life in the smaller streams, but were diluted to safer levels in the mainstem river. Intensive agricultural activities also impact water chemistry. In the Salinas River and in areas with intense agriculture use, water hardness, alkalinity, nutrients, and conductivity are also high.

10.5 Northeast Region

The Northeast coastal region includes rocky coasts, drowned river valleys, estuaries, salt marshes, and city harbors. The Northeast is the most populous coastal region in the U.S. In 2010, the region was home to 54.2 million people, representing about a third of the nation's total coastal population (USEPA 2015). The population in this area has increased by 10 million residents (~ 23%) since 1970. The coast from Cape Cod to the Chesapeake Bay consists of larger watersheds that are drained by major riverine systems that empty into relatively shallow and poorly flushed estuaries. These estuaries are more susceptible to the pressures of a highly populated and industrialized coastal region.

National Coastal Condition Assessment ***Figure 8*** shows a summary of findings from the EPA's National Coastal Condition Assessment Report for the Northeast Region (USEPA 2015). A total of 238 sites were sampled to assess approximately 10,700 square miles of Northeast coastal waters. Biological quality is rated as good in 62% of the Northeast coast region based on the benthic index. Poor biological conditions occur in 27% of the coastal area. About 11% of the region reported missing results, due primarily to difficulties in collecting benthic samples along the rocky coast north of Cape Cod. Based on the water quality index, 44% of the Northeast coast is in good condition, 49% is rated fair, and 6% is rated poor.

Based on the sediment quality index, 60% of the Northeast coastal area sampled is in good condition, 20% is in fair condition, and 9% is in poor condition (11% were reported "missing"). Compared to ecological risk-based thresholds for fish tissue contamination, less than 1% of the Northeast coast is rated as good, 27% is rated fair, and 33% is rated poor. Researchers were unable to evaluate fish tissue for 39% of the region, including almost the entire Acadian Province, because target species were not caught for analysis. The contaminants that most often exceed the thresholds for a "poor" rating in the assessed areas of the Northeast coast are selenium, mercury, arsenic, and, in a small proportion of the area, total PCBs.

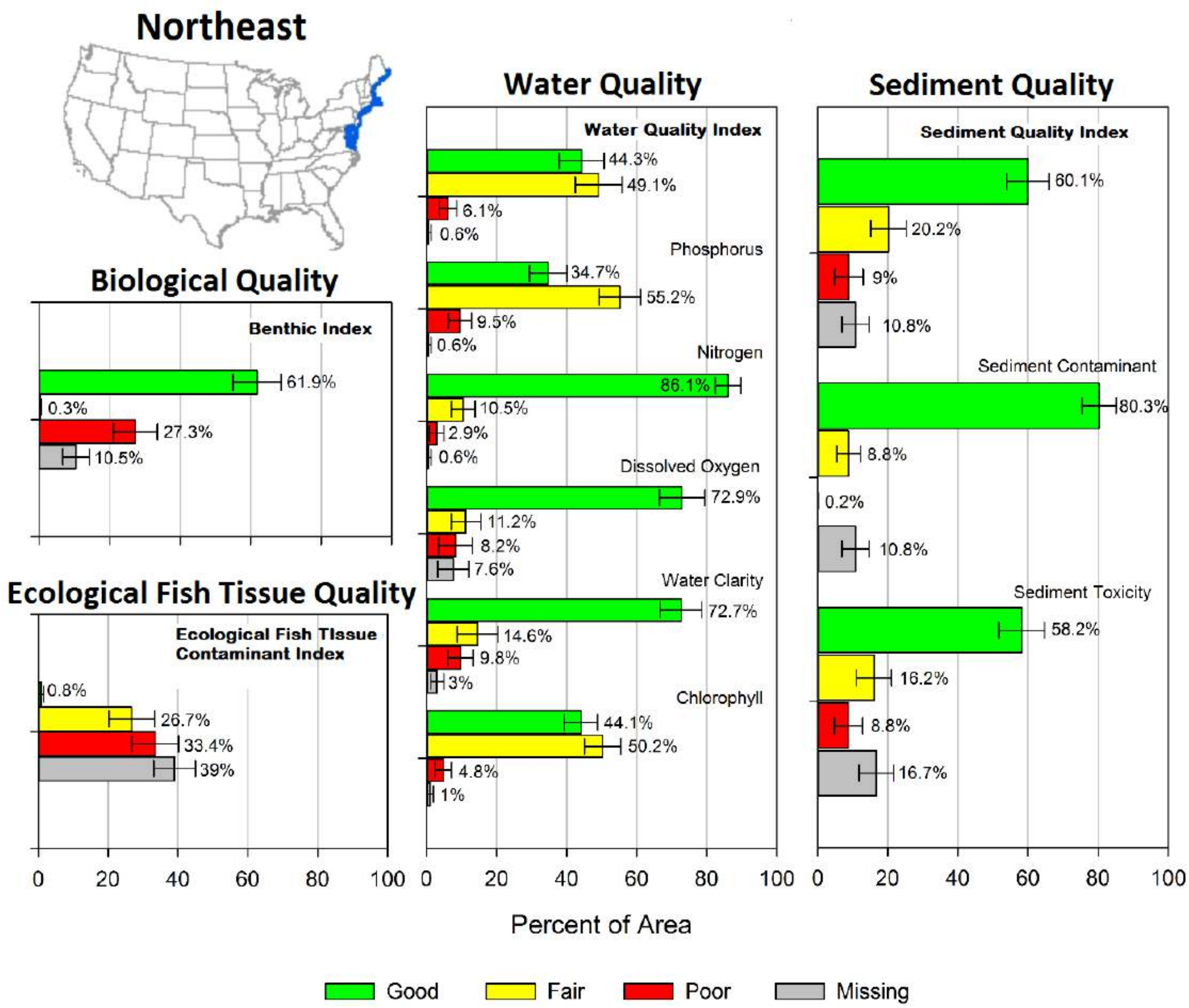

Figure 8. National Coastal Condition Assessment 2010 Report findings for the Northeast Region. Bars show the percentage of coastal area within a condition class for a given indicator (n = 238 sites sampled). Error bars represent 95% confidence levels (USEPA 2015).

NMFS reviewed current water quality 303(d) and 305(b) data from EPA's Assessment and Total Maximum Daily Load Tracking and Implementation System (ATTAINS). Specifically NMFS collected spatial data for assessed and impaired waters extracted by EPA in May and June of 2015, respectively. The data were subsettted to focus on those impairments within subwatersheds of the coastal management zone and subwatersheds containing NMFS jurisdictional critical habitat designated under the ESA. For the Northeast, assessment data are available for waters within 1,499 subwatersheds of interest for this opinion. Just over 1000 are within the Coastal Management Zone. The remaining non-coastal subwatersheds contain inland waters used by the anadromous species Atlantic and shortnose sturgeon and Atlantic Salmon. The extent of assessed waters include 32,321 kilometers of rivers and streams and 2,145 square kilometers within lakes, bays, and estuaries. About two thirds of these assessed waters are classified as impaired. The top five impairments are pathogens, organic oxygen depletion due to organic enrichment, nutrients, PCBs, and pesticides. None of the subwatersheds containing designated critical habitat for North

Atlantic Right whale or Atlantic salmon have waters are impaired by pesticides. The northeast pesticide impairments occur in subwatersheds containing proposed designated critical habitat for Atlantic sturgeon and in subwatersheds containing waters occupied by Atlantic and shortnose sturgeon. Pesticides impairments occur along 678 km of rivers and streams and in 5.6 square km of estuary waters in subwatersheds used by shortnose sturgeon. About 440 km of rivers and streams and 3 square kilometers of lotic waters in subwatersheds used by Atlantic sturgeon are impaired by pesticides. This includes 183 km of rivers and streams and 2.5 square km of waters in subwatersheds containing proposed designated critical habitat for this species. Many of the impairments are related to legacy pesticides (e.g., DDT and metabolites, chlordane, lindane), but currently registered pesticides such as naphthalene are also listed. Over half of northeastern impaired waters (65%) do not have an identified source for the stressors causing impairments. Where stressor sources are identified, the most important contributors are urban runoff, municipal discharges, atmospheric deposition, and agriculture.

10.5.1 New England Subregion

The New England subregion includes all of Maine, New Hampshire and Rhode Island and parts of Connecticut, Massachusetts, New York, and Vermont. The subregion totals roughly 160,000 km2 of which about 130,000 km^2 is classified as undeveloped, 15,000 km^2 is classified as developed and about 7,000 km^2 is classified as agriculture (***Figure 9)***.

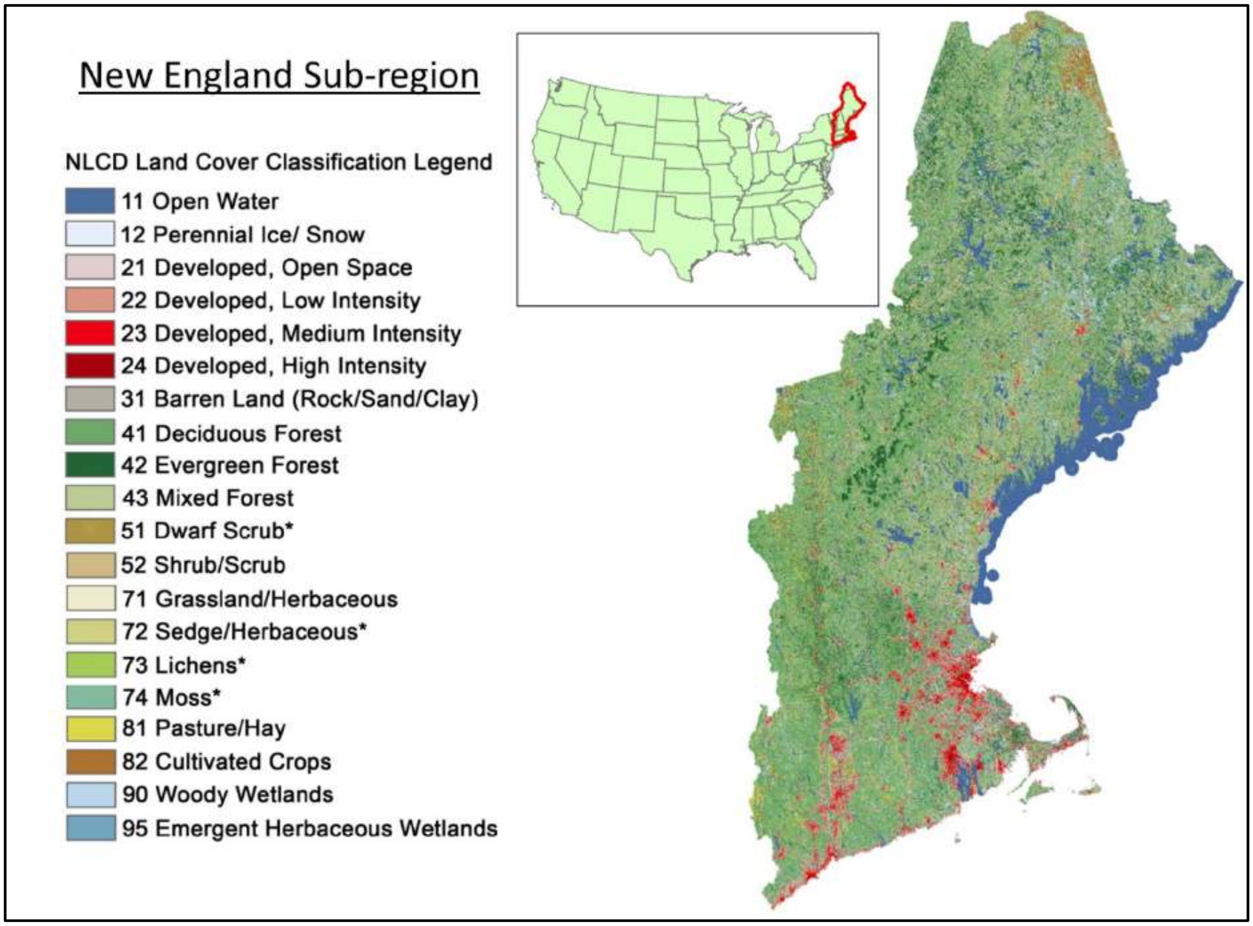

Figure 9. Landuse in the New England subregion. Data from the NLCD 2011 (www.mrlc.gov).

Nine of the 77 species addressed in the Opinion occur in this subregion. They are: hawksbill sea turtle, north Atlantic green sea turtle, leatherback sea turtle, kemp's ridley sea turtle, northwest Atlantic Ocean loggerhead sea turtle, Atlantic salmon, shortnose sturgeon, Gulf of Maine Atlantic sturgeon, and the New York bight Atlantic sturgeon. ***Table 14*** show the types and areas of land use within selected species' ranges.

Table 14. Area of land use categories within Atlantic salmon and Atlantic sturgeon species ranges in km . The total area for each category is given in bold. Land cover was determined via the NLCD 2011. Land cover class definitions are available at: http://www.mrlc.gov/nlcd_definitions.php

Land Cover NLCD Sub category	Atlantic Salmon	Atlantic Sturgeon, Gulf of Maine DPS	Atlantic Sturgeon, New York Bight DPS
Water	**828**	**10,258**	**11,893**
Open Water	828	10,258	11,893
Perennial Ice/Snow	-	-	-
Developed Land	**545**	**6,942**	**24,584**
Open Space	238	2,700	10,768
Low Intensity	140	1,999	6,707
Medium Intensity	49	1,367	4,614
High Intensity	15	457	1,932
Barren Land	104	419	563
Undeveloped Land	**4,514**	**46,884**	**60,439**
Deciduous Forest	573	10,424	36,592
Evergreen Forest	1,380	10,488	5,043
Mixed Forest	1,278	15,037	5,747
Shrub/Scrub	290	2,423	1,623
Grassland/Herbaceous	132	560	610
Woody Wetlands	628	6,589	8,667
Emergent Wetlands	232	1,363	2,157
Agriculture	**207**	**2,671**	**13,009**
Pasture/Hay	132	1,795	7,405
Cultivated Crops	74	876	5,604
TOTAL (inc. open water)	**6,093**	**66,755**	**109,925**
TOTAL (w/o open water)	**5,266**	**56,497**	**98,032**

Baseline Water Temperature Temperature is significant for the health of aquatic life. Water temperatures affect the distribution, health, and survival of native cold-blooded salmonids in the Pacific Northwest and elsewhere. These fish will experience adverse health effects when exposed to temperatures outside their optimal range. For listed Pacific salmonids, water temperature tolerance varies between species and life stages. Optimal temperatures for rearing salmonids range from 10ºC to 16ºC. In general, the increased exposure to stressful water temperatures and the reduction of suitable habitat caused by drought conditions reduce the abundance of salmon. Warm temperatures can reduce fecundity, reduce egg survival, retard growth of fry and smolts, reduce rearing densities, increase susceptibility to disease, decrease the ability of young salmon and trout to compete with other species for food, and to avoid predation (McCullough 1999; Spence et al. 1996). Migrating adult salmonids and upstream migration can be delayed by excessively warm stream temperatures. Excessive stream temperatures may also negatively affect incubating and rearing salmonids (Gregory and Bisson 1997). ***Figure 10*** depicts waterbodies with 303(d) temperature exceedances within the New England subregion.

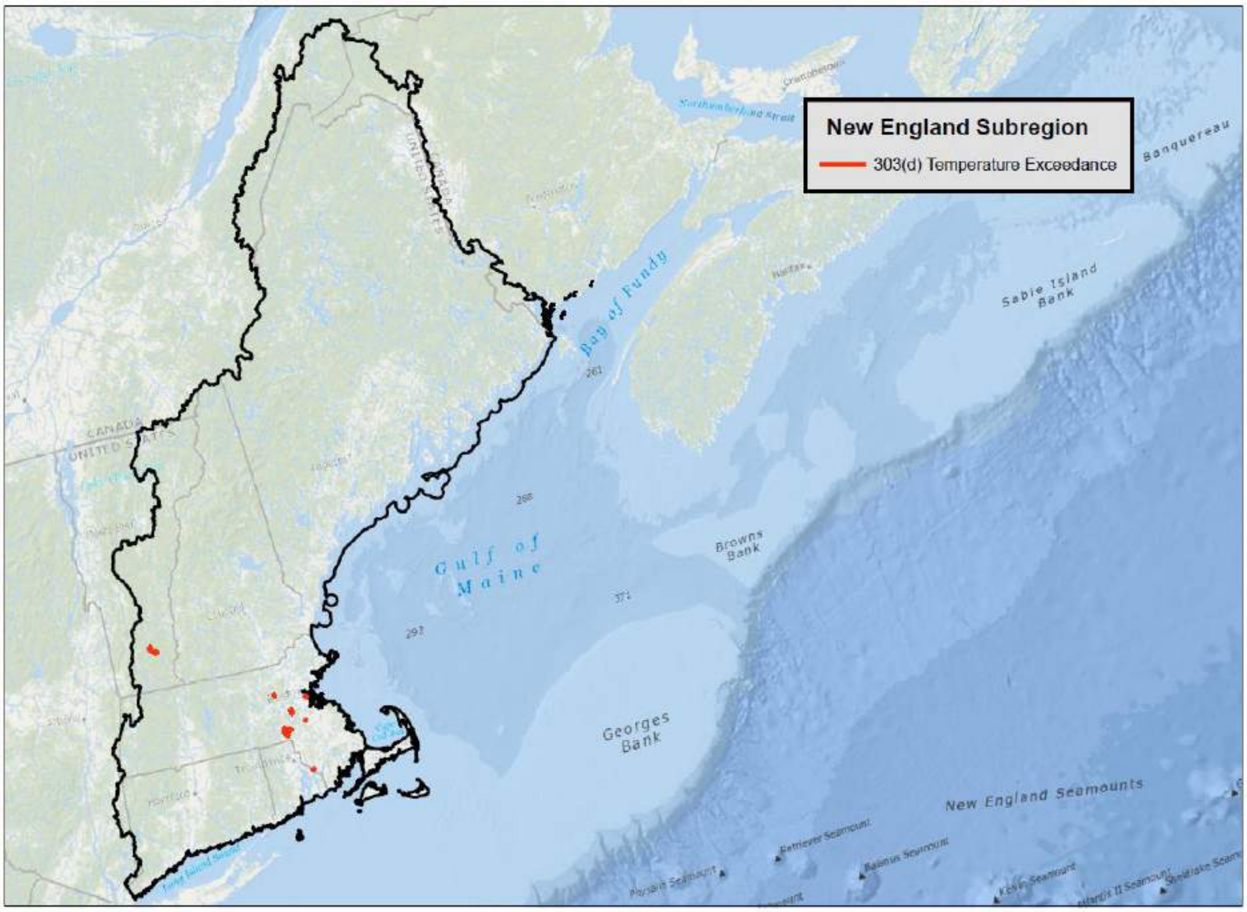

Figure 10. 303(d) temperature exceedances within the New England subregion. Data downloaded from USEPA ATTAINS website; "303(d) May 1, 2015 National Extract layer".

We used GIS layers made publically available through USEPA's Assessment and Total Maximum Daily Load Tracking and Implementation System (ATTAINS) to determine the number of km on the 303(d) list for exceeding temperature thresholds within the boundaries of those species which utilize freshwater habitats (***Table 15***). Because the 303(d) list is limited to the subset of rivers tested, the chart values should be regarded as lower-end estimates. While some ESU/DPS ranges do not contain any 303(d) rivers listed for temperature, others show considerable overlap. These comparisons demonstrate the relative significance of elevated temperature among ESUs/DPSs. Increased water temperature may result from wastewater discharge, decreased water flow, minimal shading by riparian areas, and climatic variation.

Table 15. Number of kilometers of river, stream and estuaries included in ATTAINS 303(d) lists due to temperature that are located within selected New England subregion species (ESU/DPS) ranges. Data were taken from USEPA ATTAINS website: May 1, 2015 National Extract.

Species	Kilometers of recorded temperature exceedance
Atlantic salmon, Gulf of Maine DPS (marine habitats only)	No exceedances recorded
Atlantic sturgeon, Gulf of Maine DPS	16
Atlantic sturgeon, New York Bight DPS	675

10.5.2 Mid-Atlantic subregion

The mid-Atlantic subregion includes all of Delaware and New Jersey and the District of Columbia, and parts of Connecticut, Maryland, Massachusetts, New York, Pennsylvania, Vermont, Virginia, and West Virginia. The subregion totals roughly 300,000 km^2 of which about 170,000 km^2 is classified as undeveloped, 40,000 km^2 is classified as developed and about 60,000 km^2 is classified as agriculture (***Figure 11***).

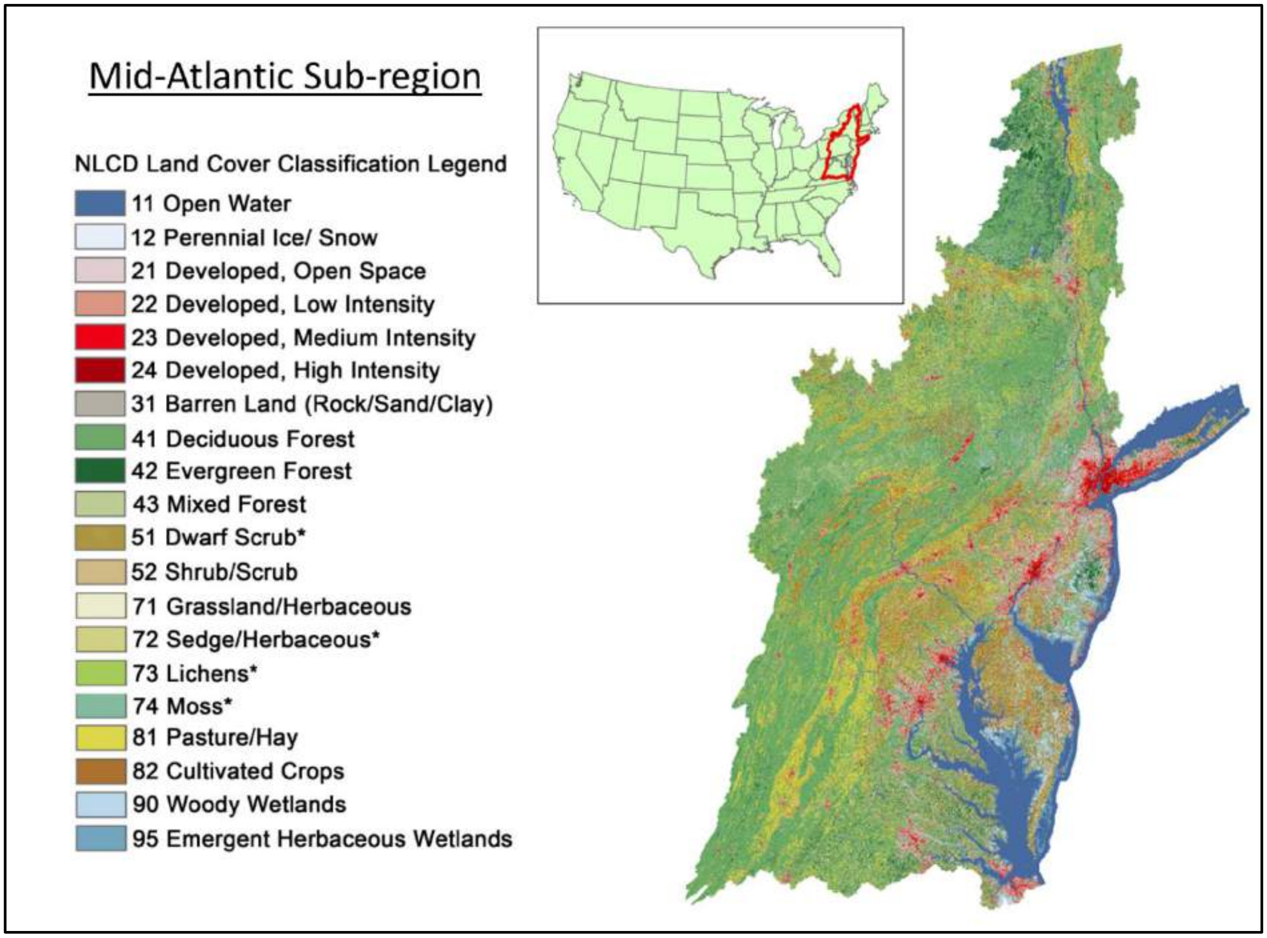

Figure 11. Landuse in the Mid-Atlantic subregion. Data from the NLCD 2011 (www.mrlc.gov).

Eight of the 77 species addressed in the Opinion occur in this subregion. They are: hawksbill sea turtle, north Atlantic green sea turtle, leatherback sea turtle, kemp's ridley sea turtle, northwest Atlantic Ocean loggerhead sea turtle, shortnose sturgeon, Atlantic sturgeon (DPSs: New York bight, Chesapeake Bay). ***Table 16*** shows the types and areas of land use within selected species' ranges. Note that not all species known to occur in this region are discussed in this section. Species not discussed here are discussed in the other regional reviews.

Table 16. Area of land use categories within selected sturgeon and sea turtle ranges in km . The total area for each category is given in bold. Land cover was determined via the NLCD 2011. Land cover class definitions are available at: http://www.mrlc.gov/nlcd_definitions.php

Land Cover				

NLCD Sub category	Shortnose Sturgeon	Atlantic Sturgeon, Chesapeake Bay DPS	Loggerhead Sea turtle, NW Atlantic Ocean DPS	Green Sea Turtle, North Atlantic DPS
Water	**34,604**	**13,444**	**82,542**	**82,542**
Open Water	34,604	13,444	82,542	82,542
Perennial Ice/Snow	-	-	-	-
Developed Land	**14,887**	**9,661**	**26,990**	**26,990**
Open Space	6,608	5,114	9,280	9,280
Low Intensity	3,990	2,589	7,390	7,390
Medium Intensity	2,401	1,275	4,831	4,831
High Intensity	1,135	472	2,123	2,123
Barren Land	753	212	3,366	3,366
Undeveloped Land	**56,731**	**26,187**	**71,809**	**71,809**
Deciduous Forest	10,374	9,982	6,355	6,355
Evergreen Forest	11,944	3,465	8,170	8,170
Mixed Forest	3,617	1,711	2,681	2,681
Shrub/Scrub	4,978	2,181	7,259	7,259
Grassland/Herbaceous	2,149	490	6,586	6,586
Woody Wetlands	17,720	6,438	18,827	18,827
Emergent Wetlands	5,949	1,918	21,931	21,931
Agriculture	**12,272**	**12,384**	**15,089**	**15,089**
Pasture/Hay	3,772	3,810	5,558	5,558
Cultivated Crops	8,500	8,574	9,531	9,531
TOTAL (inc. open water)	**118,494**	**61,676**	**196,429**	**196,429**
TOTAL (w/o open water)	**83,890**	**48,232**	**113,888**	**113,888**

Baseline Water Temperature. Temperature is significant for the health of aquatic life (e.g. water temperatures affect the distribution, health, and survival of native cold-blooded salmonids in the Pacific Northwest). ***Figure 12*** depicts waterbodies with 303(d) temperature exceedances within the New England subregion.

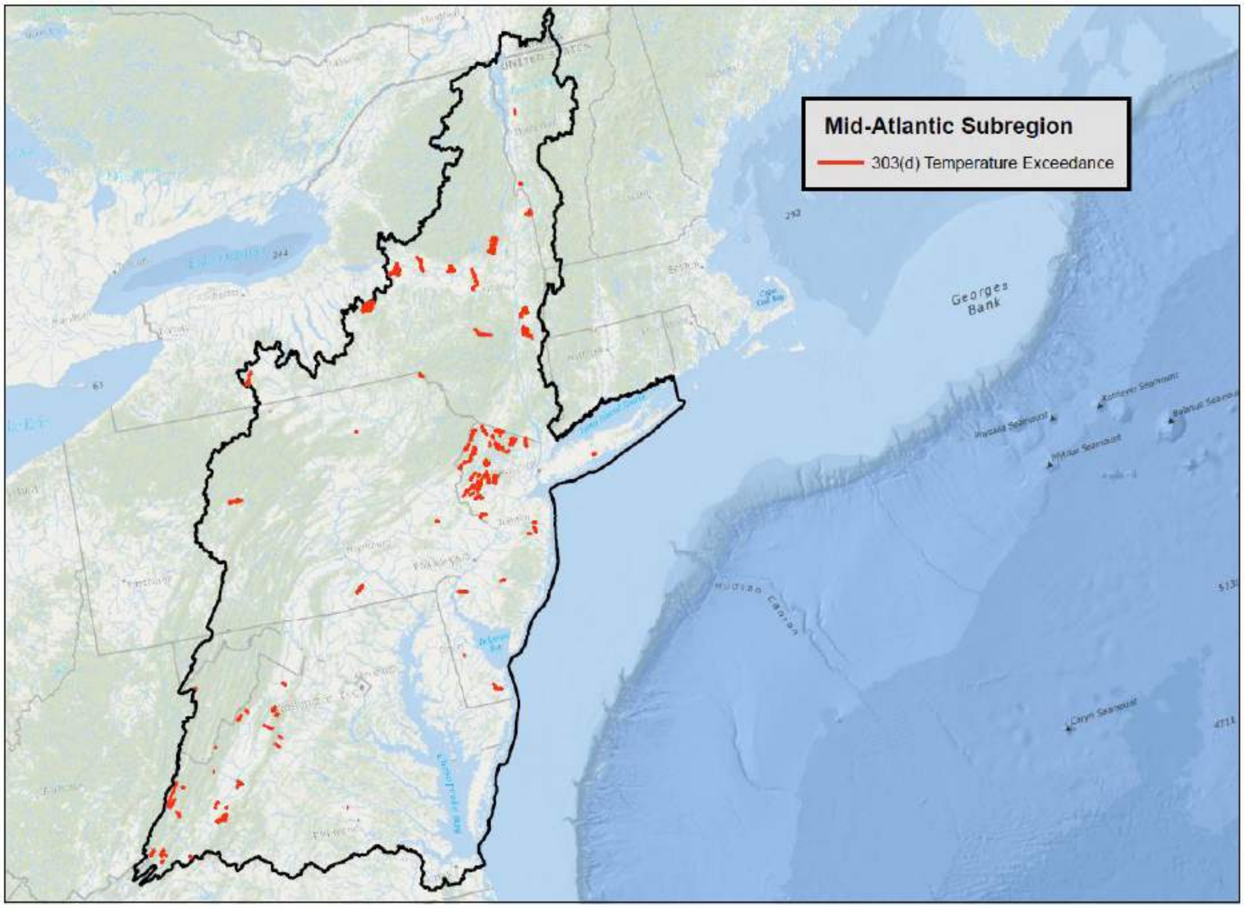

Figure 12. 303(d) temperature exceedances within the Mid-Atlantic subregion. Data downloaded from USEPA ATTAINS website; "303(d) May 1, 2015 National Extract layer".

We used GIS layers made publically available through USEPA's Assessment and Total Maximum Daily Load Tracking and Implementation System (ATTAINS) to determine the number of km on the 303(d) list for exceeding temperature thresholds within the boundaries of those species which utilize freshwater habitats (***Table 17***). Because the 303(d) list is limited to the subset of rivers tested, the chart values should be regarded as lower-end estimates. While some ESU/DPS ranges do not contain any 303(d) rivers listed for temperature, others show considerable overlap. These comparisons demonstrate the relative significance of elevated temperature among ESUs/DPSs. Increased water temperature may result from wastewater discharge, decreased water flow, minimal shading by riparian areas, and climatic variation.

Table 17. Number of kilometers of river, stream and estuaries included in ATTAINS 303(d) lists due to temperature that are located within selected Mid-Atlantic subregion species (ESU/DPS) ranges. Data were taken from USEPA ATTAINS website: May 1, 2015 National Extract.

Species	Kilometers of recorded temperature exceedance
Shortnose Sturgeon	55
Atlantic Sturgeon, Chesapeake Bay DPS	16

10.5.3 Factors Affecting Sturgeon throughout the U.S. East Coast

Dams and Diversions Dams are used to impound water for water resource projects such as hydropower generation, irrigation, navigation, flood control, industrial and municipal water supply, and recreation. Most modern reservoirs are designed for two or more of these purposes (Baxter 1977). Dams can have profound effects on diadromous fishes by fragmenting populations, eliminating or impeding access to historic habitat, modifying free-flowing rivers to reservoirs and altering downstream flows and water temperatures. Direct physical damage and mortality can occur to diadromous fishes that migrate through the turbines of traditional hydropower facilities or as they attempt to move upstream using passage devices.

Perhaps the biggest impact dams have on sturgeon is the loss of upriver spawning and rearing habitat. Migrations of sturgeon in rivers without barriers are wideranging with total distances sometimes exceeding 200 km or more depending on the river system (Kynard 1997). The construction of dams has blocked upriver passage for the majority of sturgeon populations. Dams have restricted spawning activities to areas below the impoundment, often in close proximity to the dam (Kynard 1997, Cooke and Leach 2004, Duncan et al. 2004).

Flow The suitability of riverine habitat for sturgeon spawning and rearing depends on annual fluctuations in flow, which can be greatly altered or reduced by the presence and operation of dams (Jager et al. 2001, Cooke et al. 2004). Effects on spawning and rearing may be most dramatic in hydropower facilities that operate in peaking mode (Auer 1996b, Secor et al. 2002). Daily peaking operations store water above the dam when demand is low and release water for electricity generation when demand is high, creating substantial, daily fluctuations in flow and temperature regimes. Kynard et al. (2012), have documented that flow fluctuations for hydroelectric power generation affected access to spawning habitat and possibly deterred spawning of shortnose sturgeon on the Connecticut River.

Dredging Many rivers and estuaries are periodically dredged for flood control or to support commercial shipping and recreational boating. Dredging also aids in construction of infrastructure and in marine mining. Dredging may have significant impacts on aquatic ecosystems including the direct removal/burial of organisms; turbidity/siltation effects; contaminant resuspension; noise/disturbance; alterations to hydrodynamic regime and physical habitat and actual loss of riparian habitat (Chytalo 1996, Winger et al. 2000).

The impacts of dredging operations on sturgeon are often difficult to assess. Hydraulic dredges can lethally take sturgeon by entraining sturgeon in dredge drag arms and impeller pumps (NMFS 1998). Mechanical dredges have also been documented to lethally take shortnose sturgeon (Dickerson 2006). In addition to direct effects, indirect effects from either mechanical or hydraulic dredging include destruction of benthic feeding areas, disruption of spawning migrations, and deposition of resuspended fine sediments in spawning habitat (NMFS 1998).

Dickerson (2006) summarized observed takes of sturgeon from dredging activities conducted by the ACOE; overall 24 sturgeon (11 shortnose sturgeon, 11 Atlantic sturgeon and 2 Gulf sturgeon) were observed during the years of 1990-2005 (***Table 17***). Of the 24 sturgeon observed, 15 (62.5%) were reported as dead. Dickerson (2006) noted that the largest take of sturgeon species was observed in the Delaware (n=6) and Kennebec (n=6) rivers. To reduce the impacts of dredging on sturgeon, NMFS imposes seasonal restrictions through ESA Section 7 consultations.

Blasting and Pile Driving Bridge demolition and other projects require blasting with powerful explosives. Fishes are particularly susceptible to the effects of underwater explosions and are killed over a greater range than other organisms (Lewis 1996). Unless appropriate precautions are made to mitigate the potentially harmful effects of shock wave transmission, internal damage and/or death may result (NMFS 1998). Additionally, in-water pile driving for bridge construction has resulted in high underwater sound pressures that have proved lethal to fishes (Reyff 2008). The impacts from pile driving vary with the methods used and the species tested.

Water Quality and Contaminants The quality of water in river/estuary systems is affected by human activities conducted directly in the riparian zone and those conducted upland. Industrial activities can result in discharges of pollutants, changes in water temperature and levels of DO, and the addition of nutrients. In addition, forestry and agricultural practices can result in erosion, run-off of fertilizers, herbicides, insecticides or other chemicals, nutrient enrichment and alteration of water flow. Coastal and riparian areas are also heavily impacted by real estate development and urbanization that result in storm water discharges, non-point source pollution, and erosion. The water quality over the range of sturgeon varies by watershed.

Life history characteristics of shortnose sturgeon (i.e., long lifespan, extended residence in estuarine habitats, benthic foraging) predispose the species to long-term and repeated exposure to environmental contamination and potential bioaccumulation of heavy metals and other toxicants (Dadswell 1979, NMFS 1998). However, there has been little work on the effects of contaminants on sturgeon to date.

Chemicals and metals such as chlordane, dichlorodiphenyl dichloroethylene (DDE), DDT, dieldrin, PCBs, cadmium, mercury, and selenium settle to the river bottom and are later consumed by benthic feeders, such as macroinvertebrates, and then work their way higher into the food web (e.g., to sturgeon). Some of these compounds may affect physiological processes and impede a fish's ability to withstand stress, while simultaneously increasing the stress of the surrounding environment by reducing DO, altering pH, and altering other physical properties of the water body. Shortnose sturgeon collected from the Delaware and Kennebec Rivers had total toxicity equivalent concentrations of polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), PCBs, DDE, aluminum, cadmium, and copper above adverse effect concentration levels reported in the literature (ERC Inc. 2002, 2003). Six individuals collected from the Hudson River have been tested over the past 37 years; most carried very high burden load of PCBs, or one of its derivatives (see River Summaries section – Hudson River).

Dioxin and furans were detected in ovarian tissue collected from shortnose sturgeon caught in the Sampit River/Winyah Bay system, SC. Results indicated four out of seven individuals analyzed contained tetrachlorodibenzo-*p*-dioxin (TCDD) concentrations greater than 50 pg/g (parts-per-trillion), a level which can adversely affect the development of sturgeon fry (J. Iliff, NOAA, Silver Spring, MD, pers. comm.).

Heavy metals and organochlorine compounds accumulate in sturgeon tissue, but the long-term effects are not known (Ruelle and Henry 1992, Ruelle and Keenlyne 1993). Elevated levels of contaminants, including chlorinated hydrocarbons, in several other fish species are associated with reproductive impairment (Cameron et al. 1992, Longwell et al. 1992, Hammerschmidt et al. 2002, Giesy et al. 1986, Mac and Edsall 1991, Matta et al. 1997, Billsson et al. 1998), reduced survival of larval fishes (Berlin et al. 1981, Giesy et al. 1986), delayed maturity (Jorgensen et al.

2004) and posterior malformations (Billsson et al. 1998). Pesticide exposure in fishes may affect anti-predator and homing behavior, reproductive function, physiological development, and swimming speed and distance (Beauvais et al. 2000, Scholz et al. 2000, Moore and Waring 2001, Waring and Moore 2004).

Sensitivity to environmental contaminants also varies across life stage. Early life stages of fishes appear to be more susceptible to environmental and pollutant stress than older life stages (Rosenthal and Alderdice 1976). Dwyer et al. (2005) compared relative sensitivities of common surrogate species used in contaminant studies to 17 listed species including shortnose and Atlantic sturgeon during a 96-hour acute water exposure to carbaryl, copper, 4-nonphenol, pentachlorophenal (PCP) and permethrin using early life stages with mortality as the endpoint. Atlantic and shortnose sturgeon were ranked the two most sensitive species of the 17 tested (Dwyer et al. 2005). Additionally, a study examining the effects of coal tar, a byproduct of the process of destructive distillation of bituminous coal, indicated that components of coal tar are toxic to shortnose sturgeon embryos and larvae in whole sediment flow-through and coal tar elutrtraite static renewal (Kocan et al. 1993).

Climate Change Rising sea level may result in the salt wedge moving upstream, possibly affecting the survival of drifting larvae and YOY sturgeon that are sensitive to elevated salinity. Similarly, for river systems with dams, YOY may experience a habitat squeeze between a shifting (upriver) salt wedge and a dam causing loss of available habitat for this life stage.

The increased rainfall predicted by some models in some areas may increase runoff and scour spawning areas and flooding events could cause temporary water quality issues. Rising temperatures predicted for all of the U.S. will likely exacerbate existing water quality problems with DO and temperature. While this occurs primarily in rivers in the southeast U.S. and the Chesapeake Bay, it may start to occur more commonly in the northern rivers. One might expect range extensions to shift northward (i.e. into the St. Lawrence River, Canada) while truncating the southern distribution.

Increased droughts (and water withdrawal for human use) predicted by some models in some areas may cause loss of habitat including loss of access to spawning habitat. Drought conditions in the spring may also expose eggs and larvae in rearing habitats. If a river becomes too dry all sturgeon life stages, including adults, may become susceptible to strandings. Low flow and drought conditions are also expected to cause additional water quality issues.

Any of the conditions associated with climate change are likely to disrupt river ecology causing shifts in community structure and the type and abundance of prey. Additionally, cues for spawning migration and spawning could occur earlier in the season causing a mismatch in prey that are currently available to developing sturgeon in rearing habitat.

10.6 Southeast Region

The extent of the Southeast coastal region along the Carolinas, Georgia, and Florida encompasses about 4,500 square miles and includes salt marshes, barrier islands, tidal rivers, coastal lagoons, bays and sounds with busy ports and resort areas. Between 1980 and 2006, the coastal counties of the Southeast Coast region showed the largest rate of population increase of any coastal region in the conterminous U.S. The population grew from 7.15 million to 12.8 million people, a 79% increase, and continues to grow with over 15 million people living in the region as of 2010.

According to the EPA 2015 coastal condition assessment, benthic communities of southeastern coastal waters are in good condition in 77% of waters in the Southeast Coast region (***Figure 13***). 10% of coastal waters are in fair condition and 12% are in poor condition. Overall 21% of waters are in good condition with respect to nutrient indicators. The nutrient phosphorous and chlorophyll a, which in excess, affects water clarity and dissolved oxygen levels are the primary causes for 69% of waters found to be in fair condition and nine percent of coastal waters in poor condition. Sediment contaminants and toxicity of those contaminants in sediment indicate 65% of substrate in coastal waters are in good condition, 30% are rated as in fair condition, and four percent are in poor condition. Finally, contaminants in fish tissues identified problems (i.e., poor condition index) due to selenium, mercury and arsenic in 57% of waters and the remaining waters listed as in fair condition. In a few instances, DDT was a driving factor in the condition index.

Using EPA's ATTAINS database NMFS determined that, where identified, urban runoff and municipal and industrial discharges were the most commonly identified sources of stressors causing impairments. For the Southeast, assessment data are available for waters within 794 subwatersheds of interest for this opinion. Coastal Management Zone included 571 of these subwatersheds. The remaining non-coastal subwatersheds contain inland waters used by the anadromous species Atlantic and shortnose sturgeon. The extent of assessed waters include 8,846 kilometers of rivers and streams and 480 square kilometers within lakes, bays, and estuaries. About 85% of assessed rivers and streams are classified as impaired while one third of the lakes, bays and estuaries are impaired. The top five causes of aquatic impairments are nutrients, metals (other than mercury), organic enrichment/oxygen depletion, pathogens, and mercury. The pesticide toxaphene was identified as a causal agent in one waterbody, the Back River, a coastal stream draining to St. Simons Sound in Georgia.

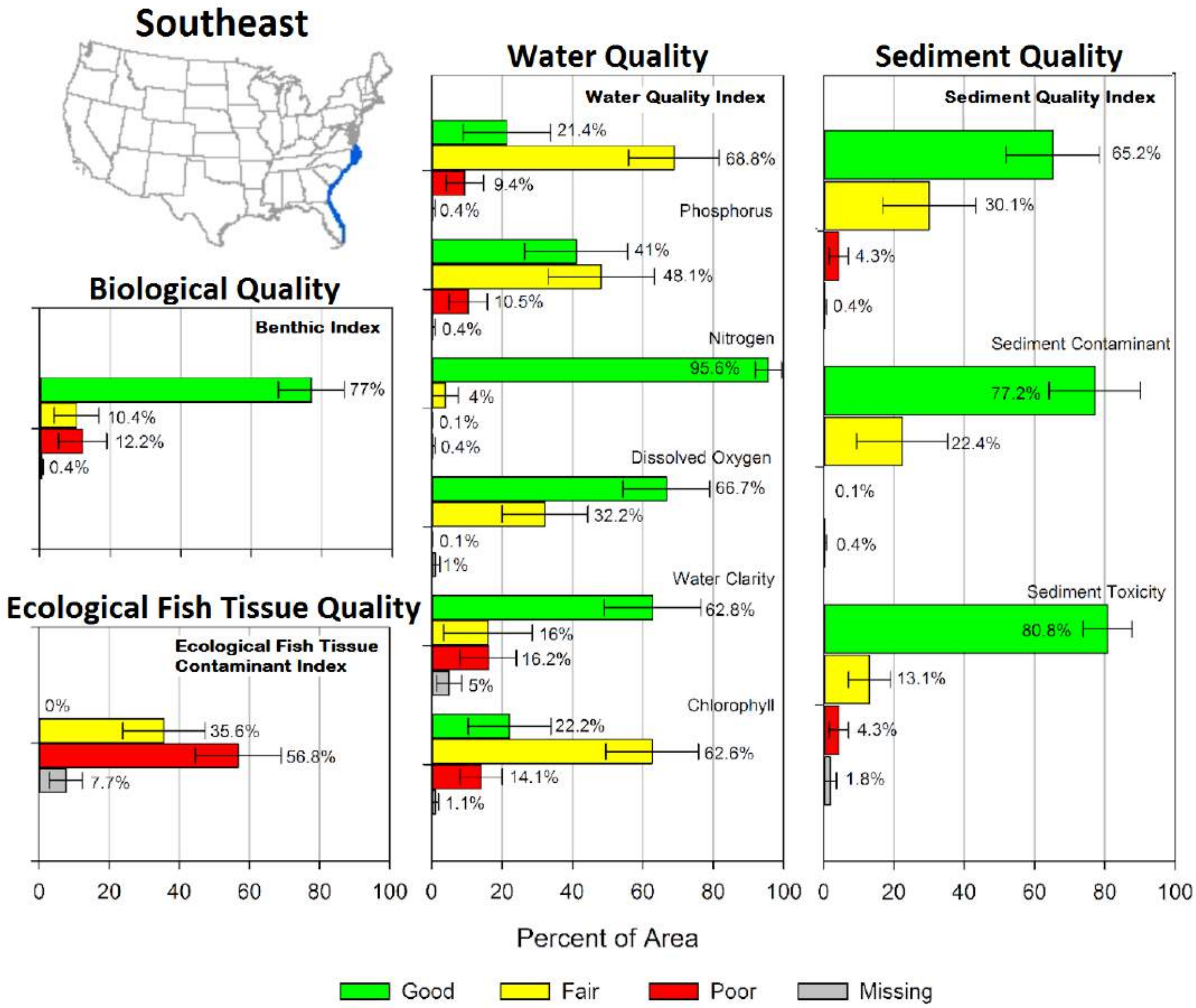

Figure 13 National Coastal Condition Assessment 2010 Report findings for the Southeast Region. Bars show the percentage of coastal area within a condition class for a given indicator (n = 87 sites sampled). Error bars represent 95% confidence levels (USEPA 2015).

10.6.1 South Atlantic – Gulf subregion

The South Atlantic-Gulf subregion includes all of Florida and South Carolina, and parts of Alabama, Georgia, Louisiana, Mississippi, North Carolina, Tennessee, and Virginia. The subregion totals roughly 700,000 km^2 of which about 470,000 km^2 is classified as undeveloped, 73,000 km^2 is classified as developed and about 118,000 km^2 is classified as agriculture (***Figure 14***).

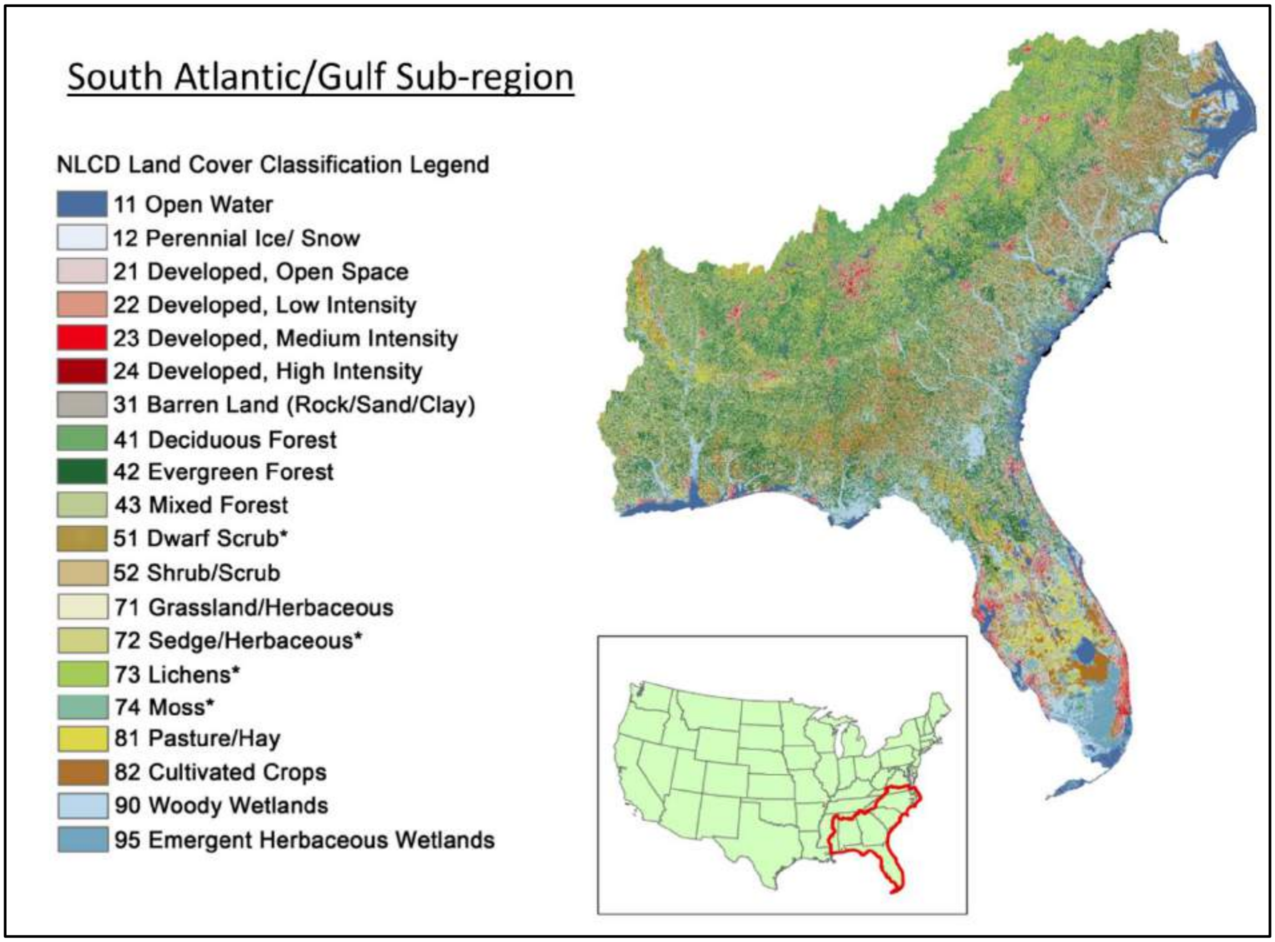

Figure 14. Landuse in the South Atlantic/Gulf subregion. Data from the NLCD 2011 (www.mrlc.gov).

Nineteen of the 77 species addressed in the Opinion occur in this subregion. They are: hawksbill sea turtle, north Atlantic green sea turtle, leatherback sea turtle, kemp’s ridley sea turtle, northwest Atlantic Ocean loggerhead sea turtle, shortnose sturgeon, Atlantic sturgeon (DPSs: Carolina, South Atlantic), gulf sturgeon, smalltooth sawfish, Nassau grouper, staghorn coral, elkhorn coral, pillar coral, lobed star coral, mountainous star coral, rough cactus coral, boulder star coral, and Johnson’s seagrass. ***Table 18*** and ***Table 19*** show the types and areas of land use within selected species’ ranges.

Table 18. Area of land use categories within selected sturgeon and sea turtle species ranges in km . The total area for each category is given in bold. Land cover was determined via the NLCD 2011. Land cover class definitions are available at: http://www.mrlc.gov/nlcd_definitions.php

Land Cover				
NLCD Sub category	Hawksbill Sea Turtle	Kemp's Ridley Sea Turtle	Atlantic Sturgeon, Carolina DPS	Atlantic Sturgeon, South Atlantic DPS
Water	**75,099**	**75,099**	**11,386**	**5,180**
Open Water	75,099	75,099	11,386	5,180
Perennial Ice/Snow	-	-	-	-
Developed Land	**25,892**	**25,892**	**10,951**	**8,290**
Open Space	8,909	8,909	6,158	4,989
Low Intensity	7,116	7,116	2,716	1,952
Medium Intensity	4,642	4,642	957	611
High Intensity	2,032	2,032	298	231
Barren Land	3,192	3,192	821	506
Undeveloped Land	**66,752**	**66,752**	**73,413**	**77,820**
Deciduous Forest	5,676	5,676	6,803	5,464
Evergreen Forest	6,696	6,696	18,335	25,427
Mixed Forest	1,308	1,308	2,208	1,751
Shrub/Scrub	6,982	6,982	9,624	11,231
Grassland/Herbaceous	6,447	6,447	5,263	6,122
Woody Wetlands	18,072	18,072	27,353	22,667
Emergent Wetlands	21,571	21,571	3,826	5,160
Agriculture	**14,846**	**14,846**	**24,476**	**11,560**
Pasture/Hay	5,372	5,372	4,537	4,752
Cultivated Crops	9,474	9,474	19,938	6,808
TOTAL (inc. open water)	**182,590**	**182,590**	**120,225**	**102,850**
TOTAL (w/o open water)	**107,490**	**107,490**	**108,840**	**97,670**

Table 19. Area of land use categories within selected south Atlantic/Gulf species ranges in km . The total area for each category is given in bold. Land cover was determined via the NLCD 2011. Land cover class definitions are available at: http://www.mrlc.gov/nlcd_definitions.php

Land Cover NLCD Sub category	Smalltooth Sawfish	Gulf Sturgeon	Florida Coast Coral Species*	Johnson's Seagrass
Water	**8,528**	**12,332**	**1,806**	**864**
Open Water	8,528	12,332	1,806	864
Perennial Ice/Snow	-	-	-	-
Developed Land	**8,975**	**3,404**	**740**	**2,837**
Open Space	3,112	1,549	161	887
Low Intensity	3,212	944	269	1,049
Medium Intensity	1,789	410	221	646
High Intensity	573	152	77	225
Barren Land	288	348	12	30
Undeveloped Land	**19,119**	**15,307**	**1,062**	**1,405**
Deciduous Forest	21	32	1	1
Evergreen Forest	2,155	3,669	22	69
Mixed Forest	64	145	0	2
Shrub/Scrub	1,079	1,954	7	47
Grassland/Herbaceous	328	621	5	31
Woody Wetlands	8,747	6,290	397	758
Emergent Wetlands	6,727	2,596	631	497
Agriculture	**1,336**	**898**	**13**	**728**
Pasture/Hay	558	469	7	217
Cultivated Crops	778	429	6	512
TOTAL (inc. open water)	**37,958**	**31,940**	**3,622**	**5,834**
TOTAL (w/o open water)	**29,430**	**19,609**	**1,815**	**4,970**

**The range of seven of the 14 species of coral addressed in this Opinion have overlap with the Florida coast, they are: staghorn, elkhorn, pillar, lobed star, mountainous star, rough cactus, and boulder star.*

10.7 South Florida and the U.S. Caribbean Region

The South Florida and US Caribbean Region includes southern Florida, Puerto Rico and the US Virgin Islands (***Figure 15***).

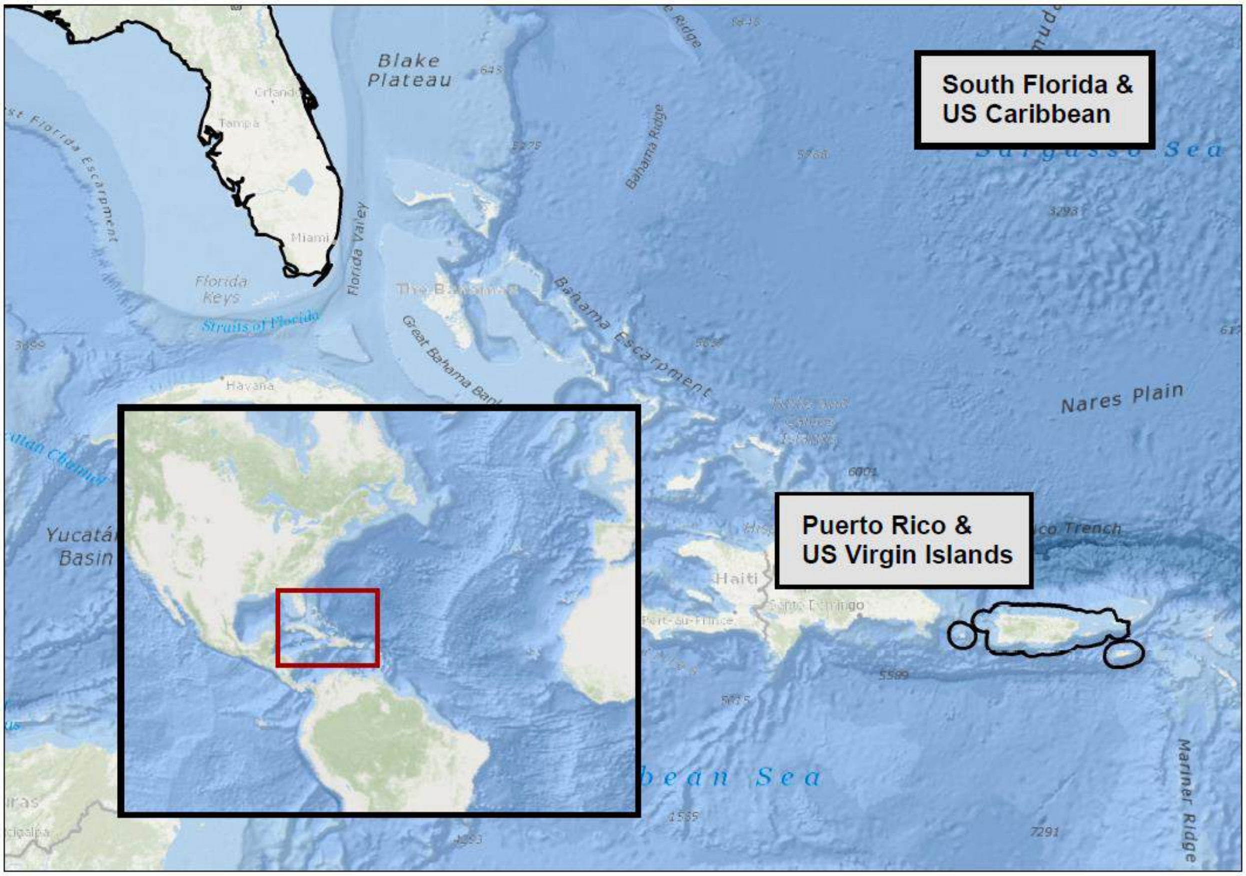

Figure 15. Southern Florida and US Territories in the Caribbean

Fifteen of the 77 species addressed in the Opinion occur in this subregion. They are: hawksbill sea turtle, north Atlantic green sea turtle, leatherback sea turtle, kemp's ridley sea turtle, northwest Atlantic Ocean loggerhead sea turtle, smalltooth sawfish, Nassau grouper, staghorn coral, elkhorn coral, pillar coral, lobed star coral, mountainous star coral, rough cactus coral, boulder star coral, and Johnson's seagrass.

10.7.1 Sea Turtles in Caribbean

Harvest and Poaching According to The Convention on International Trade in Endangered Species of Wild Fauna and Florida (CITES), In 1999, TRAFFIC North America provided a report of the past and current status of exploitation and trade of sea turtles in the Caribbean, focusing on northern Caribbean Islands, including Puerto Rico and USVI. The following excerpt from their summary describes status of trade in Puerto Rico through 1999: "Despite protective legislation in Puerto Rico and the USVI, there has remained an unquantifiable but persistent demand for sea turtle products, especially meat and eggs. While most of the take is likely to be opportunistic or incidental, some people fish specifically for turtles by hand, using nets, and harpoons. Female turtles are sometimes killed on nesting beaches for their eggs and meat, and nests are poached on several beaches around the island".

Fisheries Interactions Threatened and endangered sea turtles are adversely affected by several types of fishing gears that have been used within the action area for decades. Gillnet, hook-and-line gear (i.e., longlines and vertical line), and pot fisheries have all been documented as interacting with sea turtles. Available information suggests sea turtles can be captured in any of these gear types when the operation of the gear overlaps with the distribution of sea turtles, but gillnets are believed to have the most frequent interactions. In addition to active fishing gear, lost and abandoned gear may be especially deadly. For all fisheries within the action area for which there is a federal FMP, impacts have been evaluated under section 7. However, the majority of fishable waters that are within the action area occur within commonwealth and territorial waters and are not subject to FMPs and section 7 consultation.

Vessel Traffic Commercial and recreational vessel can adversely affect sea turtles through propeller and vessel strikes. Many records of vessel interactions have been documented within the action area. Vessel strikes can result in direct injury or death through collision (concussive) impacts or propeller wounds.

Marine Debris and Pollution Marine debris, including abandoned, lost, or otherwise discarded fishing gear (ALDFG) can pose a serious threat to sea turtles in the action area. Sea turtles have been found to ingest a wide variety of abiotic debris items such as plastics. ALDFG can kill sea turtles via entanglement, ingestion, or ghost fishing as lost gear continues to function undetected. Anthropogenic sources of marine pollution, while difficult to attribute to a specific federal, state, local or private action, may indirectly affect sea turtles in the action area. Sources of pollutants include atmospheric loading of pollutants such as PCBs and stormwater runoff from coastal towns and cities into rivers and canals emptying into bays and the ocean (e.g., Mississippi River). There are some studies on organic contaminants and trace metal accumulation in green and leatherback sea turtles from other regions which indicate bioaccumulation can occur (e.g., Aguirre et al. 1994, Caurant et al. 1999, Corsolini et al. 2000).

Dredging and Beach Renourishment The construction and maintenance of federal navigation channels has also been identified as a potential source of turtle mortality. Hopper dredges, which are frequently used in ocean bar channels and sometimes in harbor channels and offshore borrow areas, move relatively rapidly (compared to sea turtle swimming speeds) and can entrain and kill sea turtles, presumably as the drag arm of the moving dredge overtakes the slower moving sea turtle.

Conservation Actions Since 1981 leatherback sea turtle nesting has been protected and monitored at the USFWS Sandy Point National Wildlife Refuge in St. Croix using saturation tagging protocols. Another program, The Sea Turtle Program of Puerto Rico, is a multi-agency collaboration between DNER together with several NGO's and other agencies (Sea Grant-UPR, Rio Piedras-UPR, Mayaguez-UPR, Chelonia, WIDECAST, and FWS). The main goal is to: educate, investigate, recuperate and protect the species.

10.7.2 Corals in Caribbean

Fisheries Longline gear has been documented as interacting with corals. Available information suggests hooks and lines from other types of hook-and- line gear can become entangled in reefs, resulting in breakage and abrasion of corals but impacts are expected to be minor. Traps have been found to be the most damaging. A study of the trap fishery in the USVI found that, while most fishers deployed traps in seagrass or algae, sand, or coral rubble, a few fishers targeted corals (Sheridan et al. 2006), resulting in habitat impacts.

For decades, participants in the U.S. Caribbean reef fish fishery (both in the EEZ and USVI and Puerto Rico waters) have targeted species of all trophic levels. Amendments implemented in the past have altered gear construction and usage, closed seasons and areas, changed fishery management units, implemented size limits, placed prohibitions on the use of some fishing practices, and the harvest of some species (e.g., Nassau and goliath grouper). However, the FMP has never set catch quotas.

The spiny lobster fishery in waters around Puerto Rico and the USVI occurs with pots and traps, and hand-harvest. Due to the predominance of fishable habitat in state waters, it is assumed that most of the commercial harvest occurs in state waters, but fishery statistics do not allow accurate separation of harvest in the EEZ from harvest in state waters (Matos-Caraballo 2002).

Vessel Traffic Commercial and recreational vessel traffic can adversely affect listed corals through propeller scarring, propeller wash, and accidental groundings. In 1988, anchor damage from the 440-foot cruise ship Wind Spirit destroyed a 300-yd2 area of coral reef in Francis Bay, St. John, in one of the worst documented cases of anchor impacts within the Virgin Islands National Park (Drayton et al. 2004, Allen 1992).

Coastal Development Anthropogenic sources of marine pollution, while difficult to attribute to a specific federal, state, local, or private action, may indirectly affect corals in the action area. Sources of pollutants in the action area include atmospheric loading of pollutants such as PCBs, storm water runoff from coastal towns, and runoff into rivers that empty into bays and groundwater. The pathological effects of oil spills have been documented in laboratory and field studies of corals, although effects depend on the species' tolerance and level of exposure (Hoff2001). Following a crude oil spill in Las Minas Bay, Panama, short-term mortality to corals was documented, and long-term sublethal impacts to reproduction and growth were documented to last five years or more (Guzman et al. 1994).

Natural Disturbance Hurricanes and large coastal storms can also significantly harm Caribbean corals. Due to their branching morphologies, they are especially susceptible to breakage from extreme wave action and storm surges. Historically, large storms potentially resulted in asexual reproductive events, if the fragments encountered suitable substrate, attached, and grew into new colonies. However, recently, the amount of suitable substrate has been significantly reduced; therefore, many fragments created by storms die.

Disease In contrast to the rapid decline of the acroporids in the late 1970s primarily from white-band disease (Aronson et al. 2003), decline in Orbicella colonies does not generally occur from a single disease or bleaching event. Instead, partial mortality causes fragments colonies resulting in a shift in size-frequency distributions (Edmunds 2015). According to (Hoegh-Guldberg 2010), bleaching events have steadily increased in frequency since the 1980s. The 1998 and 2005 warm-water bleaching events significantly reduced Orbicella populations throughout the western Atlantic region (Miller et al. 2006; Wilkinson and Hodgson 1999; Wilkinson and Souter 2008). The 2005 event was especially severe because bleaching was closely followed by white plague (Miller et al. 2006; Wilkinson and Souter 2008). Warm-water bleaching coupled with the continued reappearance of white-band disease has also limited recovery of western Atlantic Acropora spp. in recent decades (Aronson et al. 2003).

Ocean Acidification Ocean acidification, as a result of increased atmospheric carbon dioxide, can interfere with numerous biological processes in corals including: fertilization, larval development, settlement success, and secretion of skeletons (Albright et al. 2010). In addition to global warming, acidification poses another significant threat to oceans because many major biological functions respond negatively to increased acidity of seawater. Photosynthesis, respiration rates, growth rates, calcification rates, reproduction, and recruitment may be negatively impacted with increased ocean acidity (Royal Society of London 2005). Kroeker et al. (2010) review of 139 studies quantifying ocean acidification effects determined that the effects were variable depending on species, but effects were generally negative, with calcification being one of the most sensitive processes.

10.7.3 Nassau Grouper

Fishing Effects Two different aspects of fishing effect Nassau grouper stocks, fishing effort throughout the non-spawning months and fishing effort directed at spawning aggregations or migratory access to spawning aggregations. Nassau grouper are fished commercially and recreationally throughout the year by handline, longline, fish traps, spear guns, and gillnets (NMFS General Canvas Landing System). Aggregations are mainly exploited by handlines or by fish traps, although gillnets were being used in Mexico in the early to mid-1990s (Aguilar-Perera 2004). Prior to regulations prohibiting the harvest and possession, the U.S. Virgin Islands and Puerto Rico's reef fisheries commonly took Nassau groupers at aggregation sites (SAFMC 1990, CFMC 1993).

Habitat Loss During its various life history stages, the Nassau grouper uses many different communities or habitat types within the coral reef ecosystem. The increase in urban, industrial, and tourist developments throughout the species' range impacts coastal mangroves, seagrass beds, estuaries, and live coral (Mahon 1990). Loss of juvenile habitat, such as macroalgae, seagrass beds, and mangrove channels is likely to negatively affect recruitment rates. As shown in the Bahamas (Dahlgren and Eggleston 2001), habitat preferences or selection may be key to early survival and subsequent population size and loss of those preferred coral-algal settlement habitats may pose a threat to grouper populations (Kaufman and Romero 2011). Poor water quality is a threat to both corals and macroalgae in nearshore areas. Increased sedimentation resulting from poor land development practices adds turbidity and pollutants into nearshore habitats and can change water flow patterns in creeks, where newly settled juveniles may be found. Dredging operations are also capable of destroying macroalgal beds that may be used as grouper nursery areas.

Suitable habitat for the Nassau grouper is also likely to be in decline (Semmens et al. 2008a, Lotze et al. 2006). Of the 20,000 km of coral reef estimated for the Caribbean in the mid-1990s, 29% was estimated to be under high risk of degradation from human activities, 32% is at medium risk and 39% is at low risk (Bryant et al. 1998). A decade ago, Gardner and coworkers (2003) documented basin-wide losses of hard coral cover from about 50% to about 10%. With no indications of recovery of scleractinian coral cover, it is likely that many Caribbean reefs will continue to loose three-dimensional structure through uncompensated bioerosion and increases in macroalgal cover (McClanahan et al. 2002).

Climate Change Nassau grouper have been found across a range of temperatures with the only implication being that spawning occurs when sea surface temperatures are approximately 25°C. If sea surface temperatures rise, the geographic range of the species may shift in response to any changes. One of the other potential effects of climate change could relate to the loss of structural habitat in the coral reef ecosystems (Munday et al. 2008).

10.7.4 Other baseline factors affecting multiple species

Sedimentation Currently the Port of Miami is being dredged to accommodate larger freighters. Among sediment impacts assessed, the most severe is for a sedimentation assessment site located 200 m north of the dredged channel. This assessment characterized 81% of the points surveyed as 'sediment over hardbottom' compared to 1% at the corresponding reference site. Sediment is a significant stressor for corals. Puerto Rico waters have been burdened by sediment due to a legacy of deforestation in the 1950's to support sugarcane agriculture which endured into the 1980s (Marinez and Lugo 2008). Increasing urban expansion and associated construction activities, in some cases construction converting agricultural land to a built environment, contribute to these sediment loads. Sediment favors competition by macroalga and reduces the availability of suitable colonizing substrate, smothers new recruits, attenuates light penetration and therefor symbiont photosynthesis, and reduces fertilization (Humphrey et al. 2008; Jokiel et al. 2014; Jones et al. 2015). There can be substantial natural variability in turbidity/suspended sediment among coral reef environments due to tides, storms, and river input and sediment tolerance varies among coral species (Anthony et al. 2004; Erftemeijer et al. 2012; Harmelin-Vivien 1994; Jouon et al. 2008; Orpin et al. 2004; Storlazzi et al. 2004) Certain morphologies are prone to collect more sediment from the water column than the coral species is able to clear (Hubbard, 1972; Bak, 1976; Dodge, 1977; Rogers, 1990; Stafford-Smith, 1993).

Climate Change Temperature records between 1878 and 2012 for Florida Keys coral reef habitats indicate an increase of 0.8ºC in the last century (Kuffner et al. 2015). Aquatic species, especially marine species, already experience stress related to the impacts of rising temperature. Corals, in particular, demonstrate extreme sensitivity to even small temperature increases. When sea temperatures increase beyond a coral's limit, the coral "bleaches" by expelling the symbiotic organisms that not only give coral its color, but provide food for the coral through their photosynthetic capabilities. Acropora and Orbicella species have low tolerance to temperature extremes (Colella et al. 2012; Mendes and Woodley 2002; Porter et al. 1982), are susceptible to diseases (Aronson et al. 2003; Miller et al. 2006), and succumb readily to pests (Williams et al. 2014).

Conservation Efforts The Florida Keys National Marine Sanctuary is a nearly three thousand square mile reserve protecting more than six thousand species in an area that had been exploited and significantly altered over the past century. By designating this area as a reserve, management efforts can work towards returning these waters to ecologically improved conditions. Commercial and recreational fishing, coastal development, harmful algal blooms, vessel traffic and groundings, and invasive species still pressure the ecosystem. While management strategies appear to have improved some ecological services (e.g., recovering fish spawning aggregations), the general findings of the 2011 status and trends assessment indicates some challenges to recovery with respect to habitat and biodiversity losses and pressures from human activity (e.g., bycatch) and non-indigenous species. The comparatively poor condition of selected key resources makes prospects for recovery uncertain {Office of National Marine Sanctuaries, 2011 #5051}.

Non-indigenous Species The lionfish, originally from the indo-pacific is a particularly harmful non-indigenous species in Florida's waters and in the Caribbean. Lionfish are a major predator on commercial and sport fish species and the herbivorous fish species that are important to controling algal growth on coral reefs (Albins and Hixon 2013; Cote et al. 2013; Lesser and Slattery 2011). Their presence in reef systems has been associated with severe declines in fish abundance (Albins and Hixon 2008). Initial observations in the mid-1980's are attributed to aquarium releases. They are established in coastal waters from North Carolina to South America. Lionfish have invaded the Loxahatchee estuary (i.e., Jupiter Inlet on the Atlantic coast of Florida). Over 200 young-of-year individuals ranging from 23 to 185 mm were collected over a one-year survey period. They were primarily associated with man-made structures and associated debris along the shoreline as far as 5.5 km inland (Jud et al. 2011).

Contaminants Water quality assessment data from ATTAINS for Puerto Rico and the U.S. Virgin Islands indicate that the top impairment cause along coastlines and in marine waters is excess turbidity, with 375 km of coastline and 140 km^2 of near coastal waters impaired. Pesticides are not included among impairment causes for South Florida waters or the Caribbean. The attains database contains 2014 assessment data for these waters identify pathogens, metals other than mercury, organic enrichment/oxygen depletion, turbidity, and temperature as the top 5 causes of impairments in bays and estuaries. EPA has since approved more recent water quality monitoring results from Puerto Rico and the U.S. Virgin Islands. The top five causes of impairments in Puerto Rico are listed as low dissolved oxygen, turbidity, cyanide, pathogens, and copper. Sources contributing these pollutants to waters include onsite waste water systems, urban runoff, livestock and agriculture, and collection system failures {USEPA, 2017 #5052}. Impairment causes in the U.S. Virgin Islands include turbidity, low dissolved oxygen, pathogens, and pH. The sources of these pollutants were not identified in the assessment documentation {USEPA, 2017 #5053}. NMFS relied on Florida's 2016 verified impaired waters list to identify impairments for South Florida (http://www.dep.state.fl.us/water/watersheds/assessment/a-lists.htm). In these waters, mercury in fish tissue was the dominant impairment, identified in 90% of impaired estuary and near coastal waters.

10.8 Gulf of Mexico Region

Unique coastal ecosystems in the Gulf Coast include hypersaline lagoons, coral reefs, and mangrove forests. More than half of the coastal wetlands in the conterminous United States occur along the Gulf Coast. Like most areas, population density along the Gulf Coast has increased (USEPA 2015). The coastal areas of the Gulf of Mexico includes over 750 estuaries over 10 thousand square miles.

Figure 16 shows a summary of findings from the EPA's National Coastal Condition Assessment Report for the Gulf Coast (USEPA 2015). A total of 240 sites were sampled. Based on the water quality index, 16% of the coast is in good condition, 58% are rated fair, and 24% are rated poor. Poor water quality is attributed to nutrient-related impairments, including chlorphyll a, nitrogen, and phosphorous. Sediment contaminants and toxicity of those contaminants in sediment indicate 54% of substrate in coastal waters are in good condition, 17% are rated as in fair condition, and 25% are in poor condition. Finally, contaminants in fish tissues identified problems (i.e., poor condition index) due to selenium, mercury and arsenic in 69% of waters and the remaining waters listed as in fair condition.

Using EPA's ATTAINS database NMFS determined that, where identified, urban runoff and municipal and industrial discharges were the most commonly identified sources of stressors causing impairments in the Gulf Coast Region. For the Southeast, assessment data are available for waters within 507 subwatersheds of interest for this opinion. Coastal Management Zone included 433 of these subwatersheds. The remaining non-coastal subwatersheds contain inland waters used by the anadromous Gulf sturgeon. The extent of assessed waters include 11,614 kilometers of rivers and streams and 723 square kilometers within lakes, bays, and estuaries. About 55% of assessed rivers and streams are classified as impaired while just over 40% of the lakes, bays and estuaries are impaired. The top five causes of aquatic impairments are pathogens, organic enrichment/oxygen depletion, turbidity, mercury, and nutrients. The legacy pesticide DDT metabolite DDE were reported as causal agents for two different waters. Six km of the Aroyo Colorado Tidal reach are impaired by DDE and 1.3 km of the Alabama River is impaired by DDT.

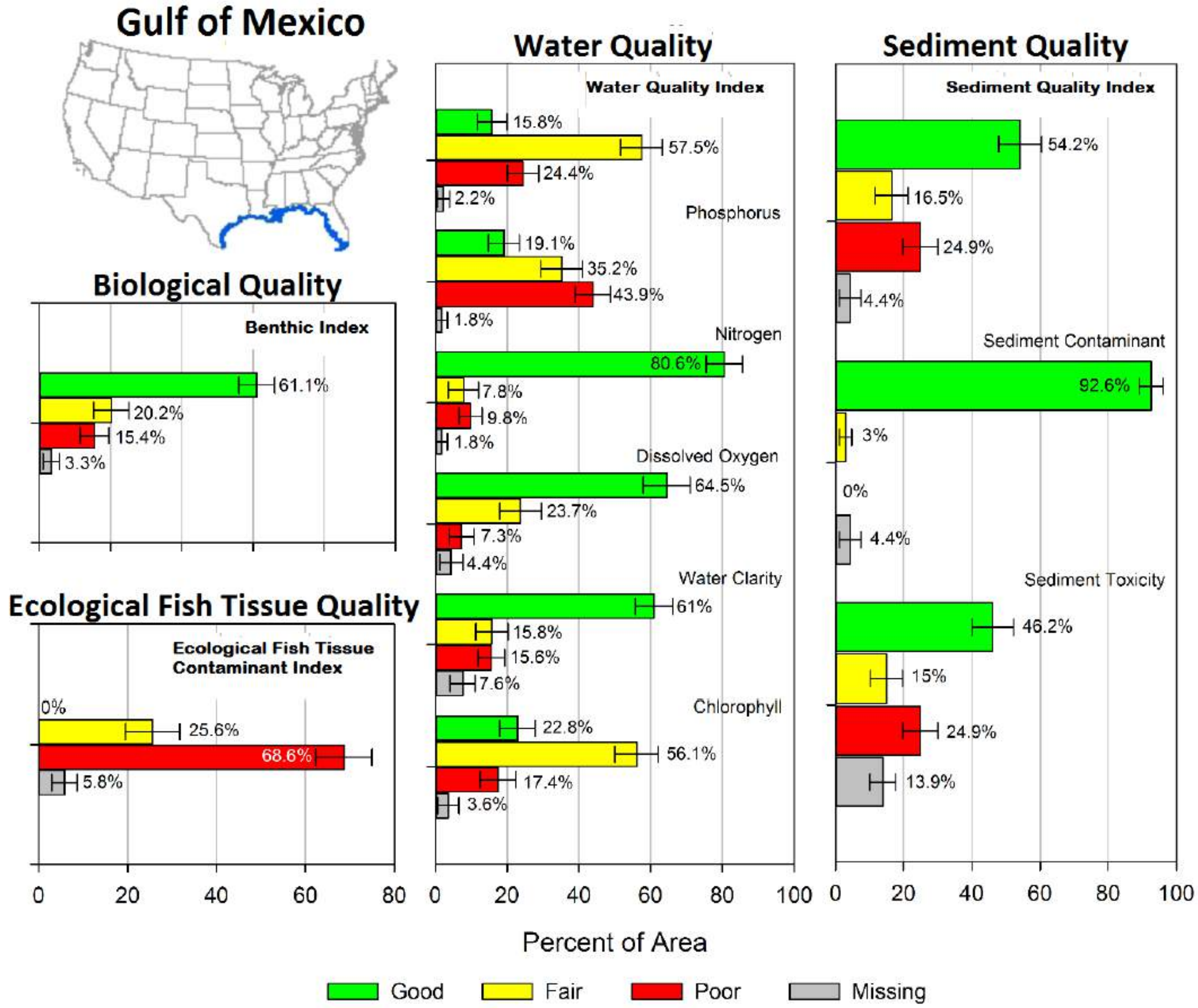

Figure 16 National Coastal Condition Assessment 2010 Report findings for the Gulf Coast. Bars show the percentage of coastal area within a condition class for a given indicator (n = 240 sites sampled). Error bars represent 95% confidence levels (USEPA 2015)

Florida's karst geology makes it particularly vulnerable to subsidence, the gradual caving in or sinking of an area of land, and sea level rise. Expansion of inland tidal marshes replacing lowland coastal forests over the last 120 years was demonstrated along the Big Bend of Florida (Raabe and Stumpf 2016). In the past, many of Florida's wetlands were drained for agriculture, logging, and urban development, and numerous rivers were channelized for navigation. The modifications were most intense in south Florida, where, beginning in the 1920s, canals and levees were built to control flooding and to drain wetlands. These modifications resulted in the loss of much of the original Everglades wetlands from Lake Okeechobee south.

Contaminants Arsenic has recently arisen as the pollutant of concern. The Tampa Bay Tributaries, Withlacoochee, Sarasota–Peace–Myakka, and Ocklawaha Basins have had the highest number of water systems reporting samples with elevated arsenic. The basins with the highest number of wells with exceedances for the two-year period associated with the Tampa

Bay Tributaries, Suwannee, Withlacoochee, and Springs Coast Basins. Arsenic in ground water may be naturally occurring, of anthropogenic origin due to human-induced geochemical changes, or a true contaminant released as a result of human activities. The prevalence of elevated arsenic detections in the southwest Florida basins and the Suwannee Basin may be due to the chemical makeup of the aquifer in these areas. In addition to this natural source, potential anthropogenic sources include arsenic-based pesticides applied to cotton fields; citrus groves; road, railroad, and power line rights-of way; golf courses; and cattle-dipping vats, which were in use in Florida until 1961 (McKinnon et al. 2011). In recent years, the use of arsenical pesticides has significantly decreased, and as of 2013 its use is restricted only to monosodium methanearsonate on cotton fields, golf courses, sod farms, and highway rights-of-way (78 CFR 59). However, residues from past use, when bound to soil particles, do not readily dissipate. Higher numbers of reported exceedances may be considered an artifact of the change in the EPA arsenic standard for ground water, which was reduced from 50 to 10 μg/L in 2001, and was fully implemented in 2006.

Fishery Bycatch Bycatch, when fishing operations discard fish or interact with non-target species, is the primary reason for the decline and, ultimately, the listing of smalltooth sawfish as endangered in 2003 (NMFS 2009). The long, toothed rostrum of the smalltooth sawfish causes this species to be particularly vulnerable to entanglement in fishing nets. Historical reports of smalltooth sawfish caught in otter trawls, trammel nets, and seine nets were relatively common in Florida and other areas in the Gulf of Mexico (NMFS 2009b). Bigelow and Schroeder (1953), who described smalltooth sawfish as “plentiful in Florida waters,” noted they were of “considerable concern to fishermen as nuisances because of the damage they do to drift- and turtle nets, to seines, and to shrimp trawls in which they often become entangled and because of the difficulty of disentangling them without being injured by their saws.” Smalltooth sawfish bycatch in shrimp trawl operations declined rapidly in the second half of the 20th century due to population decline. In Louisiana shrimp trawl landings, which were reported as high as 34,900 pounds in 1949, dropped to zero landings recorded after 1978 (Simpfendorfer 2002). In Florida, smalltooth sawfish have only occasionally been recorded in shrimp trawl landing since the 1990’s (NMFS 2009b). Smalltooth sawfish are also caught incidentally in shark drift gillnet and shark bottom longline fisheries, although interactions with these fisheries are considered relatively rare. An estimated 61 smalltooth sawfish were captured in the Atlantic and Gulf of Mexico shark bottom longline fishery from 2005-2006 (NMFS 2011b). Smalltooth sawfish are also caught incidentally by recreational anglers, particularly within the Everglades National Park. However, such interactions are considered very rare and the impacts to the species associated with post-release mortality are probably small (NMFS 2009b).

Harmful Algal Blooms The Gulf of Mexico, in particular waters along Florida's coast are susceptible to harmful algal blooms (HABs). Florida monitors for HABs in fresh, estuarine, and marine waters. Blooms can occur any time of year in Florida, due to its subtropical climate. The HABs are caused by a suite of unique taxa that can bloom under particular physical, chemical, and biological conditions. The drivers of some HABs are well understood, while the drivers of other HABs, such as the red tide organism *Karenia brevis*, are still unclear. While HABs can occur naturally, they are frequently associated with elevated nutrient concentrations. HABs may produce toxins that contaminate shellfish or finfish, making them unsuitable for human consumption. They can also affect plant and animal communities. The Gulf of Mexico Alliance, a partnership between Alabama, Florida, Louisiana, Mississippi, and Texas, is working to increase regional collaboration to enhance the Gulf's ecological and economic health. Reducing the effects of HABs is one of its water quality priorities.

Freshwater cyanobacteria (or blue-green algae) blooms have received increased attention in recent years because of their potential to produce toxins that can harm humans, livestock, domestic animals, fish, and wildlife. While blooms of cyanobacteria can occur naturally, they are frequently associated with elevated nutrient concentrations, slow-moving water, and warm temperatures. Cyanotoxins are bioactive compounds naturally produced by some species of cyanobacteria that can damage the liver (hepatotoxins), nervous system (neurotoxins), and skin (dermatotoxins) of humans and other animals. Potentially toxigenic cyanobacteria have been found statewide in Florida's rivers, streams, lakes, and estuaries. There are also concerns that freshwater cyanotoxins can be transported into coastal systems. The results of the Cyanobacteria Survey Project (1999–2001), managed by the Harmful Algal Bloom Task Force at the FFWCC (FWCC) Fish and Wildlife Research Institute, indicated that the taxa *Microcystis aeruginosa, Anabaena* spp., and *Cylindrospermopsis raciborskii* were dominant, while species with the genera *Aphanizomenon, Planktothrix, Oscillatoria*, and *Lyngbya* were also observed statewide but not as frequently. Cyanotoxins (microcystins, saxitoxin [STX], cylindrospermopsins, and anatoxin) were also found statewide (Williams et al. 2007). Other cyanobacteria of concern in Florida are reported in (Abbott et al. 2009).

More than 50 marine and estuarine HAB species occur in Florida and have the potential to affect public health, water quality, living resources, ecosystems, and the economy. Any bloom can degrade water quality because decomposing and respiring cells reduce or deplete oxygen, produce nitrogenous byproducts, and form toxic sulfides. Declining water quality can lead to animal mortality or chronic diseases, species avoidance of an area, and reduced feeding. Such sublethal, chronic effects on habitats can have far-reaching impacts on animal and plant communities. *Karenia brevis*, sometimes mixed with related *Karenia* species, causes red tides that are an ongoing threat to human and environmental health in the U.S. Gulf of Mexico. Blooms occur annually on the west coast of Florida and less frequently in the Panhandle and east coast. *Karenia brevis* produces brevetoxins that can kill fish and other marine vertebrates, including manatees, sea turtles, and seabirds. Blooms of the STX-producing dinoflagellate *Pyrodinium bahamense* have been linked to the bioaccumulation of the neurotoxin STX in puffer fish and more than 20 cases of saxitoxin puffer fish poisoning in Florida {Landsberg, 2006 #932}. While these blooms raise serious concerns about the ecology of affected ecosystems, there have not been any wide-scale animal mortality events attributed to STXs in Florida. As a tropical species, *P. bahamense* has seldom bloomed north of Tampa Bay on the west coast or north of the Indian River Lagoon on the east coast. Blooms are generally limited to May through October (Phlips et al. 2006). In Florida, *Pyrodinium* is most prevalent in flow-restricted lagoons and bays with long water residence times and salinities between 10 and 30 practical salinity units. The latter conditions competitively favor *Pyrodinium* because of its slow growth rates and euryhaline character (Phlips et al. 2006). Blooms also appear to be accentuated during periods of elevated rainfall and nutrient loads to lagoons (Phlips et al. 2010), suggesting a link between coastal eutrophication and the intensity and frequency of blooms. However, discharges of naturally tannic waters from wetlands during high-rainfall events can also produce favorable conditions for this organism. These observations also point to the potential role of future climate trends in defining the dynamics of HAB species in Florida (Phlips et al. 2010).

Other bloom-forming marine species can be divided into two categories: toxin-producing species and taxa that form blooms associated with other problems, such as low oxygen concentrations, physical damage to organisms, and general loss of habitat. Potential toxin-producing planktonic marine HAB species include the diatom group *Pseudo-nitzschia* spp.; the dinoflagellates *Alexandrium monilatum, Takayama pulchella, K. mikimotoi, K. selliformis, Karlodinium veneficum, Prorocentrum minimum, P. rhathymum*, and *Cochlodinium polykrikoides*; and the prymnesiophytes *Prymnesium* spp. and *Chrysochromulina* spp., and the raphidophyte *Chattonella* sp. (Abbott et al. 2009). Many of these species are associated with fish or shellfish kills in various ecosystems around the world (Landsberg 2002). Additionally, benthic cyanobacteria and macroalgae blooms have been observed on Florida's coral reefs and have been associated with mortality and disease events involving various organisms (Lapointe et al. 2004; Paul et al. 2005; Richardson et al. 2007).

Although many HAB species have been observed at bloom levels in Florida (Phlips et al. 2011), uncertainty remains over the relative toxicity of the specific strains. In addition to ichthyotoxic HAB species that directly cause fish kills, the list of HAB species linked to hypoxia or other density-related issues (e.g., allelopathy, physical damage to gills of fish) is extensive and includes almost any species that reaches exceptionally high biomass. Examples include the widespread bloom-forming planktonic dinoflagellate *Akashiwo sanguinea*, in the Indian River Lagoon and the St. Lucie Estuary, and the cyanobacterium *Synechococcus* in Florida Bay (Phlips et al. 2011; Phlips et al. 1999). Many fish kills, particularly those occurring in the early morning hours, are due to low DO levels in the water associated with the algal blooms and are not necessarily the result of toxins.

Another important issue associated with HABs is the loss or alteration of overall habitat quality. Prolonged and intense coastal eutrophication can result in domination by a select few species, resulting in a loss of diversity and alteration of food web structure and function. For example, during major *Pyrodinium* blooms, 80% to 90% of total phytoplankton biomass is attributable solely to this species (Phlips et al. 2006). Similar domination by a single species occurs in benthic ecosystems, where massive blooms of green and red macroalgae have periodically over-run some shallow habitats of the Florida coast (Lapointe and Bedford 2007).

10.8.1 Lower Mississippi & Texas Gulf Subregions

The lower Mississippi subregion includes parts of Arkansas, Kentucky, Louisiana, Mississippi, Missouri, and Tennessee. The subregion totals roughly 300,000 km^2 of which about 150,000 km^2 is classified as undeveloped, 20,000 km^2 is classified as developed and about 100,000 km^2 is classified as agriculture. The Texas Gulf subregion includes parts of Louisiana, New Mexico, and Texas. The subregion totals roughly 470,000 km^2 of which about 300,000 km^2 is classified as undeveloped, 40,000 km^2 is classified as developed and about 110,000 km^2 is classified as agriculture (***Table 18***).

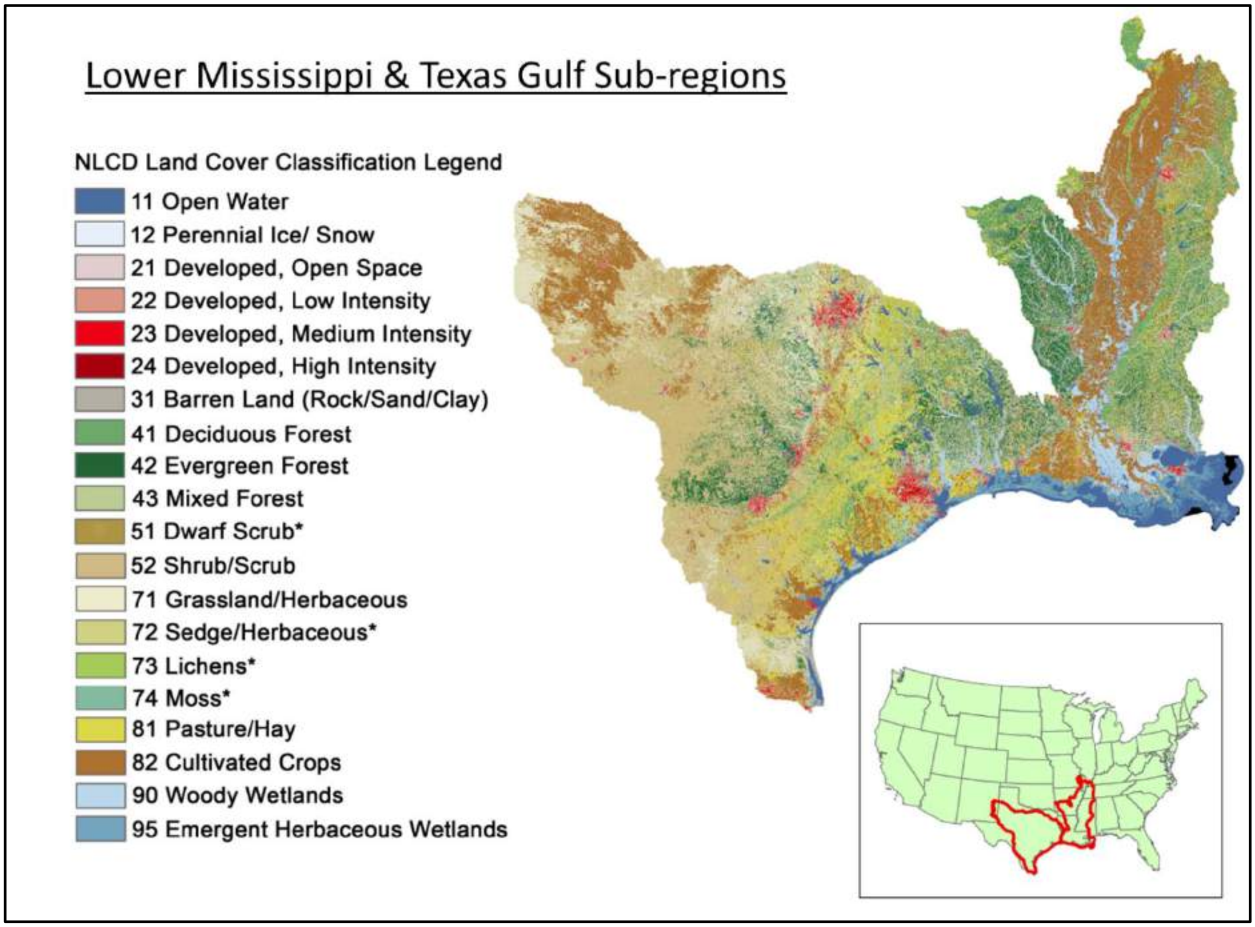

Figure 17. Landuse in the South Atlantic/Gulf subregion. Data from the NLCD 2011 (www.mrlc.gov).

Six of the 77 species addressed in the Opinion occur in these subregions. They are: hawksbill sea turtle, north Atlantic green sea turtle, leatherback sea turtle, kemp's ridley sea turtle, northwest Atlantic Ocean loggerhead sea turtle, Gulf sturgeon (baseline factors for these species are discussed earlier in the section).

CHAPTER 11

EFFECTS OF THE ACTION – INTRODUCTION

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11 Effects of the Action

Our analysis of the effects of the action to threatened and endangered species includes three primary components which are integrated into the risk analysis: exposure analysis, response analysis, and species life-history considerations. Destruction or adverse modification of designated critical habitat is analyzed separately and predicated on whether adverse changes to physical or biological features affect the conservation value of designated critical habitat.

Section 7 regulations define "effects of the action" as the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 C.F.R. §402.02). Indirect effects are those that are caused by the proposed action and are later in time, but are reasonably certain to occur. This effects analyses section is organized following the stressor, exposure, response, risk assessment framework.

The jeopardy analysis relies upon the statute and the regulatory definition of "to jeopardize the continued existence of a listed species," which is "to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 C.F.R. §402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

The destruction and adverse modification analysis considers whether the action produces "a direct or indirect alteration that appreciably diminished the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features." 50 C.F.R. 402.02. This analysis also relies on the statutory provisions.

11.1 Stressors Associated with the Proposed Action

For this consultation, the Environmental Protection Agency's (EPA's) proposed action encompasses all approved product labels containing the active ingredients chlorpyrifos, diazinon, and malathion. The potential stressors we expect to result from the proposed action include chlorpyrifos, diazinon, and malathion; other ingredients of these product formulations (including "inert" ingredients and other active ingredients); label recommended tank mixtures (including other pesticide formulations and adjuvants); and toxic metabolites and degradates of product formulation ingredients. An abiotic stressor (e.g. temperature) that is present in the habitat of listed species may influence response of the species to stressors associated with the proposed action.

11.2 Mitigation to Minimize or Avoid Exposure

Mitigation has not been proposed beyond the restrictions described in product labeling that would minimize or avoid exposure of ESA-listed species to the potential stressors of the action.

11.3 Exposure Analysis

In this section we describe the methods used to characterize pesticide exposure to listed species. The procedures rely on models that identify potential interactions of pesticides with listed species and quantify the magnitude of exposure based on how the pesticides and the listed species behave in the environment. We begin with a description of the development of aquatic habitat bins, linking physical characteristics that define aquatic habitats used by listed species with modeling parameters used to predict exposure. Next we identify the models used by EPA to derive exposure estimates for different routes of exposure including contact with contaminated surface or pore water, dietary exposure, or dermal exposure.

11.3.1 Aquatic habitat bins

The National Research Council Committee of the National Academy of Sciences recommended that fate and transport models be used to estimate time-varying and space-varying pesticide concentrations in generic habitats relevant to listed species (NRC NAS 2013). Physical characteristics of aquatic habitats, including depth, width, and flow rate affect the environmental concentrations and dissipation patterns of pesticides. A generic habitat defines these physical parameters and uses them to derive Estimated Environmental Concentrations (EECs). The 2-meter deep, static "Farm Pond" that is routinely used by EPA in screening level assessments is an example of a generic habitat. Defining generic habitats to represent all listed species is a challenge given the diversity in the habitats they occupy. Ultimately, the Services identified 10 habitat "bins," a number EPA felt could feasibly be evaluated given the scope of the analysis (***Table 1***). The generic habitats included one aquatic-associated terrestrial habitat, three static freshwater habitats of varying volume, three flowing water habitats of variable volume and flow rates, and three marine/estuarine habitats representative of nearshore tidal, nearshore subtidal, and offshore habitats. EPA utilized these bins to develop EEC for listed species that rely on aquatic habitats (EPA 2017 a, b, c).

Table 1. Generic aquatic habitats parameters for exposure modeling

Generic Habitat Bins	Depth (meters)	Width (meters)	Length (meters)	Flow (m^3/second)
1 – Aquatic-associated terrestrial habitats	NA	NA	NA	NA
2- low-flow	0.1	2	length of field[1]	0.001
3- Moderate-flow	1	8	length of field	1
4- High-flow	2	40	length of field	100
5 – Low-volume	0.1	1	1	0
6- Moderate-volume	1	10	10	0
7- High-volume	2	100	100	0
8- Intertidal nearshore	0.5	50	Length of field	NA
9- Subtidal nearshore	5	200	Length of field	NA
10- Offshore marine	200	300	Length of field	NA

[1]length of field – The habitat being evaluated is the reach or segment that abuts or is immediately adjacent to the treated field. The habitat is assumed to run the entire length of the treated area.

The Services identified the bin(s) representative of habitats utilized by each listed species. A single species may occur in a range of habitats represented by multiple bins. The BE's identify each of the species bin assignments (EPA 2017 a, b, c). Bin 1 represents habitats in the terrestrial-aquatic transition zone, such as riparian habitats, dunes, beaches, and rocky shorelines. Examples of species that utilize these habitats include sea turtles for nesting, and pinnipeds for nesting and lounging. These species may be exposed to pesticides in either the terrestrial or aquatic environment. For example, black abalone and Johnson's sea grass, occupy intertidal habitats and remain in the intertidal zone during periods of low tide when their habitats are dewatered. These species can be exposed to pesticides present in the surface water during periods of inundation, or be exposed directly to spray drift during periods of low tide.

Flowing water habitats represented by bins 2, 3, and 4 vary considerably in depth, width, and velocity, which influence both initial concentration and rates of dissipation. These bins are defined by differing flow rates that are products of velocity (influenced by the gradient and other factors) and habitat volume (width and depth). Flow rates vary temporally and spatially in these habitats and are influenced by several factors. For example, bends in the shoreline, shoreline roughness, and organic debris can create back currents or eddies that can concentrate allocthonous inputs. Dams and other water control structures would also significantly influence flow. Some small streams and channels are intermittent and can become static and temporally cut off from connections with surface water flows during dry seasons. Low flow habitats may also occur on the margins of higher flow systems (e.g. floodplain habitats associated with higher flowing rivers).

Bin 2 is intended to represent habitats with flow rates occurring of 0.001-1 m^3/second including springs, seeps, brooks, small streams, and a variety of floodplain habitats (oxbows, side channels, alcoves, etc.). Examples of listed species that utilize habitats fitting the characteristics of bin 2 include the Pacific eulachon and several salmonid species. During spawning migration, Pacific eulachon migrate upstream through shoreline habitats during low hydrograph periods at depths of 0.1-1 m. While there are different habitat preferences among the species, listed Pacific salmonids utilize lower flow habitats in some phase of their lifecycle for activities such as spawning, rearing, or migration. Bin 3 flow rates are representative of small to large streams (1-100 m3/second) and bin 4 definitions (larger volumes and flow rates exceeding 100 m3/second) correspond with larger riverine habitats. These habitats are used by listed anadromous species during spawning migrations (e.g. salmonids, sturgeons, and eulachon). Smalltooth sawfish ascend inland river systems and juveniles have been found in streams and canals consistent with bin 3 and bin 4 parameters. Additionally, juvenile green turtles shelter and forage in coastal streams and rivers.

Bins 5, 6, and 7 represent freshwater habitats that are relatively static, where flow is less likely to substantially influence the rate of pesticide dissipation. Examples of bin 5 habitats (volumes <100 m^3) include vernal pools, small ponds, floodplain habitats that are cut off from main channel flows, and seasonal wetlands. Salmonid juveniles use a variety of small volume floodplain habitats to forage, over-winter, and shelter from larger predators such as backwater areas and off-channel ponds that are relatively static and may temporarily loose connection to the main stream channel. Bin 6 volumes (100 – 20,000 m^3) correspond with many ponds, vernal pools, wetlands, and small shallow lakes and Bin 7 represents larger volume habitats (>20,000 m^3) such as lakes, impoundments, and reservoirs. Impoundments are frequently encountered by anadromous fish during spawning migrations of adults and out-migrations of juveniles. Ponds and lakes are also utilized by salmonids for rearing, particularly juvenile sockeye salmon which rear in lakes for one to three years.

Bins 8, 9, and 10 were designed to characterize marine habitats. Marine habitats are generally defined by water depth and distance from shoreline. The nearshore, or neritic zone is the relatively shallow area that extends from the coastlines to the edge of the continental shelf at depths of approximately 200m. Nearshore habitats are subdivided into the intertidal zone (Bin 8, the area between shoreline and mean low tide mark), and the subtidal zone (Bin 9, nearshore habitats that extend from the mean low tide mark to the continental shelf and are generally submerged). Bin 10 is intended to represent the deep offshore habitats (>200m in depth) that extend beyond the continental shelf. Depths within the intertidal zone are variable between locations but generally range from 0 to <10 m. Depth within the intertidal habitat depends on the tidal cycle and tidal range. Surface waters can persist during low tides and may be used by listed species. For example black abalone may be found in tide pools and salmonids may use distributary channels exposed during low tide periods. Depth in the subtidal habitats range from 0 – approximately 200m. Listed corals occur primarily in the subtidal zone. Southern resident killer whale and beluga whale also utilize nearshore habitats, as do all listed sea turtles, pinnipeds, and anadromous fish, and several listed marine fish (e.g. rockfish, grouper, and sawfish). Offshore habitats are used by all listed cetaceans and sea turtles and are also used by anadromous fish (e.g. salmonids, sturgeon), marine fish (e.g. hammerhead sharks), and pinnipeds (e.g. Hawaiian monk seal).

11.3.2 EPA derived EECs and exposure estimates

11.3.2.1 Surface water and pore water

EPA derived estimates of pesticides in surface waters and benthic sediment pore water by incorporating the bin parameters discussed into exposure models (***Table 1***). Combinations of several fate and transport models including the Pesticide Root Zone Model (PRZM5), the Variable Volume Water Model (VVWM), and AgDrift (version 2.2.1) were used to estimate concentrations in aquatic habitats of variable sizes and flow rates representative of habitats used by listed species (EPA 2017 a, b, c). The methodology utilized inputs consistent with application requirements specified on product labels. Additionally, inputs representing application site characteristics (e.g. meteorological conditions) were selected at the HUC2 regional scale to generate geographically-specific EECs (EPA 2017 a, b, c). The Pesticide in Flooded Applications Model (PFAM, version 1.09) and PRZM5/VVM were used to derive EECs in aquatic habitats for flooded agricultural applications (e.g. cranberry).

11.3.2.2 Dietary

While contact with contaminated surface water is considered the primary route of exposure in fish because pesticides are readily transported through gills, the dietary route of exposure may be of greater significance in sea turtles and marine mammals. Dietary exposure in sea turtles and marine mammals was evaluated by considering aquatic surface water EEC and bioconcentration factors associated dietary items (EPA 2017 a, b, c). Dietary exposure was not evaluated for other species because toxicity data for this route of exposure was not available.

11.3.2.3 Dermal

Dermal exposures from spray deposition directly onto animals was evaluated in pinnipeds due to potential exposure in terrestrial environments using the dermal interception model (EPA 2017 a, b, c). This model assumes only the upper half of the animal is exposed to spray deposition that results from either ground or aerial spray applications of pesticides. We did not evaluate dermal exposure in other species as they either do not occur in terrestrial habitats or they are under the jurisdiction of USFWS when they do (e.g. sea turtle).

11.4 Response Analysis

11.4.1 EPA-Reported Response Information

We relied on the available response information for the stressors of the action reported by EPA in the Biological Evaluations (BEs; EPA 2017 a, b, c). Chlorpyrifos, diazinon, and malathion are organophosphate (OP) pesticides that share a similar mechanism of toxic action in animals. They "act by inhibiting cholinesterase activity, thereby preventing the natural breakdown of various cholines and ultimately causing the neuromuscular system to seize. This may lead to a series of various effects, which may culminate in death (EPA 2017 a, b, c)." Effects observed in animals include both lethal and sublethal responses. Incidents of acute poisoning in animals from the use of these pesticides are prevalent. Chlorpyrifos, diazinon, and malathion also show varying degrees of toxicity in plants. However, the mechanism of toxicity in plants is not understood. The effects of the three OPs "have been studied extensively in many taxa, particularly in fish and aquatic and terrestrial invertebrates. Studies include acute and chronic laboratory studies with either technical or formulated chlorpyrifos, and include both registrant-submitted and open literature studies (EPA 2017 a, b, c)." EPA evaluated effects to individual fitness of listed species using response data organized under assessment endpoints for different taxa groups (e.g. aquatic invertebrates, fish, reptiles, and mammals).

11.4.1.1 Lethality

Dose-response information from laboratory toxicity studies including median lethal concentrations (LC_{50}s), median lethal doses (LD_{50}s), slopes of dose response curves, and species sensitivity distributions (SSDs) showing variability in response among tested species.

A summary of reported lethality incidents is included in EPA's incident database. Section 6(a)(2) of the Federal Insecticide, Fungicide and Rodenticide Act requires pesticide product registrants to report adverse effects information, such as incident data involving fish and wildlife. Criteria require reporting of large-scale incidents. For example, pesticide registrants are required to report the following (40 CFR part 159):

- Fish – Affected 1,000 or more individuals of a schooling species or 50 or more individuals of a non-schooling species.
- Birds- Affected 200 or more individuals of a flocking species, or 50 or more individuals of a songbird species, or 5 or more individuals of a predatory species.
- Mammals, reptiles, amphibians- Affected 50 or more individuals of a relatively common or herding species or 5 or more individuals of a rare or solitary species.

11.4.1.2 Growth

Thresholds for statistically significant impacts to growth at different concentrations (i.e. the Lowest Observed Effect Concentration (LOEC) and No Observed Effect Concentration (NOEC)), and the magnitude of effects observed.

11.4.1.3 Reproduction

Thresholds for statistically significant effects to reproduction (NOECs/LOECs) from laboratory toxicity tests and the magnitude of reproductive effects observed.

11.4.1.4 Behavior
Observed magnitude of effect and/or thresholds for statistically significant effects to behaviors (NOECs/LOECs) that could increase individual mortality, or decrease growth or reproduction (e.g. locomotion, feeding, reproductive behavior, predator avoidance, ability to migrate).

11.4.1.5 Sensory function
Observed magnitude of effect and/or thresholds for statistically significant effects (NOECs/LOECs) associated with impaired sensory function that could increase individual mortality, or decrease growth or reproduction (e.g. impacts that could impact predator avoidance, prey detection, homing ability).

11.4.1.6 AChE inhibition
Dose-response information on levels of AChE-inhibition observed at different test concentrations and in different tissues (e.g. blood, brain).

Where EPA found these assessment endpoint supported risk hypotheses of impacts to individual fitness, the risk hypothesis was incorporated into our analysis of effects at the population and species level. For example, EPA determined pesticide exposure in Southern Resident Killer Whale (SRKW) would not result in direct toxicity to SRKS; therefore, we did not formulate risk hypotheses that direct toxicity would contribute to population level effects. However, since EPA determined that the pesticides are likely to adversely affect SRKW due to potential reductions in prey resources, we evaluate the risk hypothesis that use of pesticides is sufficient to reduce SRKW abundance via reduction in prey.

11.4.2 Abiotic Stressors
Other factors, such as temperature and bacterial/viral prevalence, in the environment may enhance the susceptibility of listed species to chlorpyrifos, malathion, or diazinon. Here, we reviewed the EPA-submitted information as well as the scientific literature regarding the potential influence of abiotic stressors, namely elevated temperature and pathogens, on the toxicity of the three a.i.s. Experimental results from several studies indicated a robust relationship whereby increases in temperature increased OP toxicity in fish (Mayer and Ellersieck, 1986; 1988; Osterauer & Kohler, 2008). We found a substantive dataset that supports this line of evidence for several cold-water fish species including salmonids. For example, as water temperature increases, salmonid LC50s decrease (i.e., more fish died at elevated temperatures) (Laetz et al., 2014). We also reviewed studies showing increases in toxicity to aquatic invertebrates at elevated temperatures (e.g., Lydy et al., 1999). We expect elevated temperatures across the freshwater habitats of listed cold-water fish to co-occur with the three a.i.s. As shown in the Environmental Baseline, many listed cold-water fish reside in watersheds listed on State 303(d) lists as impaired due to temperature exceedances. We expect that cold-water fish and their prey exposed to both elevated temperature and the three insecticides in the environment will be adversely affected at relatively lower concentrations compared to exposures to the three insecticides at non-elevated temperatures in laboratory and field assays.

We also located studies that establish a relationship between pathogen exposure and enhanced OP toxicity. Dietrich et al. (2013) found that salmon displayed greater toxicity to malathion when also exposed to a common bacterial pathogen. Likewise, chlorpyrifos toxicity increased in Chinook salmon concurrently exposed to a viral pathogen (Eder et al., 2007).

In aggregate, these data support the hypothesis that elevated temperatures and/or exposure to pathogens will increase the toxicity of the three a.i.s. While we cannot quantify the degree to which elevated temperature or pathogen exposure may increase toxicity, we will treat exposure to these stressors qualitatively as a factor expected to increase the risk of malathion, diazinon and chlorpyrifos to cold-water fish.

11.5 Species Groupings

Important life history characteristics, primary routes of exposure, and risk hypotheses for pesticide impacts to listed species are presented for 7 taxa groupings of threatened and endangered species under NOAA Fisheries jurisdiction.

11.5.1 Anadromous Fish

11.5.1.1 Important Life history considerations

Anadromous fish are born in freshwater and spend a portion of their life cycle in in marine habitats. Generalized life history characteristics for listed anadromous fish are described in ***Table 2***.

Table 2. General life histories of anadromous fish

Species (number of listed ESUs or DPSs[1])	General Life History Descriptions		
	Spawning Migration	Spawning Habitat	Juvenile Rearing and Migration
Atlantic salmon (1)	After two to three years in the ocean mature adults return to their natal rivers to spawn. Atlantic salmon are iteroparous[2]	Coastal riverine habitats that consists of gravel and rubble in areas of moving water	Juveniles rear in rivers for one to three years before undergoing smoltification and migrating to the ocean. Atlantic salmon leave Maine rivers in the spring and reach Newfoundland and Labrador by mid-summer. They spend their first winter at sea south of Greenland. After the first winter at sea, a small percentage return to Maine while the majority spend a second year at sea, feeding off the southwest or, to a much lesser extent, the southeast coast of Greenland. Some Maine salmon are also found in waters along the Labrador coast. Preferred prey: fish, invertebrates
Chum (2)	Mature adults (usually three to four years old) enter rivers as early as July, with arrival on the spawning grounds occurring from September to January. Chum salmon are semelparous[3]	Generally spawn from just above tidewater in the lower reaches of mainstem rivers, tributary stream, or side channels to 100 km upstream.	The alevin life stage primarily resides just below the gravel surface until they approach or reach the fry stage. Immediately after leaving the gravel, swim-up fry migrate downstream to estuarine areas. They reside in estuaries near the shoreline for one or more weeks before migrating for extended distances, usually in a narrow band along the Pacific Ocean's coast. Preferred prey: fish, invertebrates

Species (number of listed ESUs or DPSs[1])	General Life History Descriptions		
	Spawning Migration	Spawning Habitat	Juvenile Rearing and Migration
Chinook (9)	Mature adults (usually three to five years old) enter rivers (spring through fall, depending on run). Adults migrate and spawn in river reaches extending from above the tidewater inland hundreds of miles from the Pacific. Migrating adults typically follow the thalweg. Chinook salmon migrate and spawn in four distinct runs (spring, fall, summer, and winter). Chinook salmon are semelparous.	Generally spawn in the middle and upper reaches of main stem rivers and larger tributary streams.	The alevin life stage primarily resides just below the gravel surface until they approach or reach the fry stage. Immediately after leaving the gravel, fry distribute to floodplain habitats that provide refuge from fast currents and predators. Juveniles exhibit two general life history types: Ocean-type fish migrate to sea in their first year, usually within six months of hatching. Ocean-type juveniles may rear in the estuary for extended periods. Stream-type fish migrate to the sea in the spring of their second year. Preferred prey: fish, invertebrates
Coho (4)	Mature adults (usually two to four years old) enter the rivers in the fall. The timing varies depending on location and other variables. Coho salmon are semelparous.	Spawn throughout smaller coastal tributaries, usually penetrating to the upper reaches to spawn. Spawning takes place from October to March.	Following emergence, fry move to shallow areas near stream banks. As fry grow they distribute up and downstream and establish territories in small streams, lakes, and off-channel ponds and other floodplain habitats. Here they rear for 12-18 months. In the spring of their second year juveniles rapidly migrate to sea. Initially, they remain in nearshore waters of the estuary close to the natal stream following downstream migration. Preferred prey: fish, invertebrates
Sockeye (2)	Mature adults (usually four to five years old) begin entering rivers from May to October. Sockeye are semelparous.	Spawn along lakeshores where springs occur and in outlet or inlet streams to lakes.	The alevin life stage primarily resides just below the gravel surface until they approach or reach the fry stage. Immediately after leaving the gravel, swim-up fry migrate to nursery lakes or intermediate feeding areas such as floodplain habitats along the banks of rivers. Populations that migrate directly to nursery lakes typically occupy shallow beach areas of the lake's littoral zone; a few cm in depth. As they grow larger they disperse into deeper habitats. Juveniles usually reside in the lakes for one to three years before migrating to off shore habitats in the ocean. Some are residual, and complete their entire lifecycle in freshwater. Preferred prey: fish, invertebrates

Species (number of listed ESUs or DPSs[1])	General Life History Descriptions		
	Spawning Migration	Spawning Habitat	Juvenile Rearing and Migration
Steelhead (11)	Mature adults (typically three to five years old) may enter rivers any month of the year, and spawn in late winter or spring. Migrating adults typically follow the thalweg. Steelhead are iteroparous.	Usually spawn in fine gravel in a riffle above a pool.	The alevin life stage primarily resides just below the gravel surface until they approach or reach the fry stage. Immediately after leaving the gravel, swim-up fry usually inhabit shallow water along banks of stream or floodplain habitats on streams margins. Steelhead rear in a wide variety of freshwater habitats, generally for two to three years, but up to six or seven years is possible. They smolt and migrate to sea in the spring. Preferred prey: fish, invertebrates
Eulachon (1)	Mature adults enter the estuary and move up river to spawn from early November to end of May. Historical peak of the spawning run is February – March. When in the river, adults migrate along the margins in shallow water. Upriver migration can take place in very shallow water between several inches to a few feet. Adults tend to move up with a dropping hydrograph. Adults may be in the river for up to 3 weeks.	Eggs are broadcast spawned over sandy substrate in mainstem and tributary rivers. Sand adheres to the eggs and carried downriver in the current.	The eggs may incubate 21 – 30 days depending on temperature. Larvae (4 – 5 mm) are passively transported downstream and free float with tides and current as they absorb their yolk and develop the ability to swim. First feeding for most individuals likely occurs in estuaries where they may reside for several weeks. When they begin to feed on plankton they rapidly grow in the estuary. They enter the ocean and move out to deeper water (typically <300m, although may be seen at depths up to 600m over the shelf and stay there until they become sexually mature (2 – 4 years, up to 8). Preferred prey: plankton

Species	General Life History Descriptions		
(number of listed ESUs or DPSs[1])	Spawning Migration	Spawning Habitat	Juvenile Rearing and Migration
Green sturgeon (1)	Spawning adults return to the river every 3 to 4 years to spawn. Southern DPS spawn in the Sacramento and Feather Rivers, and possibly the Yuba River. They enter the San Francisco Bay estuary February through April and transit through in about a week before entering into the river to migrate up to spawning grounds. Spawners reside in upper river up to 6 months. Post spawning adults return after 6-9 months to the marine environment, rapidly moving to marine waters. Adults can migrate as far north as the north end of Vancouver Island, B.C. Sturgeon are iteroparous.	Spawning takes place from April to early July below the lowest dam in the Sacramento and Feather rivers in 5 – 15 meter deep pools.	Larvae redistribute from hatching areas approximately 18 – 35 days post hatch with a peak in dispersion between 23 and 24 days post hatch. Juveniles are estimated to spend 3 – 18 months in the river and 6 – 18 months in the estuary based on studies of early life stage tolerance to saltwater. While in the river juveniles may use shallow flood plain habitat. They enter the ocean at around 1 ½-3 year-olds (at about 12 inches length). Both adults and sub-adults are bottom-dwellers found in nearshore areas down to about 100 m depth. Pre-adults and non-spawning adults will enter coastal estuaries in the summer months with upwelling events and feed in shallow flats. One study demonstrated a mean residence time of 43 days (n=17) in the Sacramento Estuary. Preferred prey: Larvae are likely opportunistic feeders on benthic invertebrates. Sub-adults and adults eat a variety of benthic crustaceans, mollusks, and fish.

Species (number of listed ESUs or DPSs[1])	General Life History Descriptions		
	Spawning Migration	Spawning Habitat	Juvenile Rearing and Migration
Shortnose sturgeon (1)	Spawning begins in freshwater from late winter/early spring (southern rivers) to mid to late-spring (northern rivers). Spawning migration is characterized by rapid, directed and often extensive upstream movement. Shortnose sturgeon usually leave the spawning grounds soon after spawning. Age of first spawning in males occurs 1 to 2 years after maturity, but among females is delayed for up to 5 years. Approximate age of a female at first spawning is 15 years in the St. John River, 11 years in the Hudson and Delaware Rivers, ranges from 7 to 14 years in the South Carolina rivers, and 6 years or less in the Altahama River in Georgia. Generally, females spawn every three years, although males may spawn every year.	Freshwater habitats in coastal rivers along the east coast of North America.	Movement patterns in shortnose sturgeon vary with fish size and home river location. Juvenile shortnose sturgeon generally move upstream in spring and summer and move back downstream in fall and winter; however, these movements usually occur in the region above the saltwater/freshwater interface. Adult shortnose sturgeon exhibit freshwater amphidromy (i.e., adults spawn in freshwater but regularly enter saltwater habitats during their life) in some rivers in the northern part of their range but are generally estuarine anadromous in southern rivers. This species prefers nearshore marine, estuarine, and riverine habitats of large river systems. They do not make long distance offshore migrations. Female sturgeon can live up to 67 years, but males seldom exceed 30 years of age. Thus, the ratio of females to males among young adults is 1:1, but changes to 4:1 for fish larger than 3 feet (90 cm). Preferred prey: invertebrates including crustaceans, mollusks, and insects.
Atlantic sturgeon (5)	Spawning migration begins in marine or estuarine habitats where adults spend most of their lives. They migrate upriver in spring, beginning in February-March in the south, April-May in the mid-Atlantic. In some areas, a small spawning migration may also occur in the fall. Atlantic sturgeon spawning intervals range from 1 to 5 years for males and 2 to 5 years for females. Following spawning, males may remain in the river or lower estuary until the fall; females typically exit the rivers within four to six weeks.	Spawning occurs in flowing water between the salt front and fall line of large rivers. They spawn in moderately flowing water (46-76 cm/s) in deep parts of large rivers. Sturgeon eggs are deposited on bottom substrate, usually on hard surfaces (e.g., cobble).	Larvae migrate downstream and use benthic structure (especially gravel matrices) as refuges. Juveniles usually reside in brackish estuarine waters for months to years. When they reach a size of about 30-36 inches (76-92 cm) they move into nearshore coastal waters. Subadults and adults live in coastal waters and estuaries when not spawning, generally in shallow (10-50 m depth) nearshore areas dominated by gravel and sand substrates. Long distance migrations away from spawning rivers are common. Preferred prey: Benthic invertebrates

Species	General Life History Descriptions		
(number of listed ESUs or DPSs[1])	Spawning Migration	Spawning Habitat	Juvenile Rearing and Migration
Gulf sturgeon (1)	Gulf sturgeon initiate movement from marine and estuarine habitats and into their natal rivers between February and April.	Spawning occurs in freshwater rivers, ideally comprised of clean substrates of rock and rubble.	Gulf sturgeon generally remain in their natal river for the first two or three years of their life cycle before migrating to estuarine and marine habitats where they spend the majority of their life. Preferred prey: Benthic invertebrates

1 Evolutionarily Significant Unit (ESU), Distinct Population Segment (DPS)
2 spawn only once
3 may spawn more than once

11.5.1.2 Primary Route of exposure

Anadromous fish are likely to be exposed to pesticides that are deposited in surface waters through runoff and drift transport pathways. Exposure from contact with contaminated surface water will be evaluated. Quantitative estimates of exposure are evaluated using surface water concentration estimates derived by EPA for generic aquatic habitats (bins 2-7; EPA Biological Evaluations 2017).

11.5.1.3 Risk Hypotheses

We constructed the following risk hypotheses for chlorpyrifos, diazinon, and malathion considering the available exposure, response, and life history information referenced above.

11.5.1.3.1 Atlantic salmon

NOAA Fisheries and the U.S. Fish and Wildlife Service (USFWS) share jurisdiction for the recovery of Atlantic salmon. USFWS evaluates the effects of this action on the species during its freshwater residency. In this biological opinion (Opinion) we evaluate effects of the action in marine and estuarine habitats. Consequently, we do not include risk hypotheses for freshwater reproductive and rearing activities. The risk hypotheses we constructed include:

1. Exposure to the pesticides is sufficient to reduce adult and juvenile abundance via acute lethality.
2. Exposure to the pesticide is sufficient to reduce ChE activity; the identified mechanism of toxicity.
3. Exposure to the pesticide is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.

11.5.1.3.2 Pacific Salmonids (chum, chinook, coho, sockeye, steelhead)

Adult:

1. Exposure to the pesticide is sufficient to reduce adult abundance via acute lethality.
2. Exposure to the pesticide is sufficient to reduce adult productivity via impairments to reproduction.

3. Exposure to the pesticide is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.
4. Exposure to the pesticide is sufficient to reduce ChE activity; the identified mechanism of toxicity.

Juvenile:

1. Exposure to the pesticide is sufficient to reduce juvenile abundance via acute lethality.
2. Exposure to the pesticide is sufficient to reduce abundance via impacts to growth (direct toxicity).
3. Exposure to the pesticide is sufficient to reduce Juvenile abundance via reduction in prey availability.
4. Exposure to the pesticide is sufficient to reduce ChE activity; the identified mechanism of toxicity.
5. Exposure to the pesticide is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.

11.5.1.3.3 Pacific eulachon

1. Exposure to the pesticide is sufficient to reduce juvenile and adult abundance via acute lethality
2. Exposure to the pesticide is sufficient to reduce juvenile abundance via reduction in prey availability
3. Exposure to the pesticide is sufficient to reduce juvenile and adult abundance and adult productivity via impairments to ecologically significant behaviors
4. Exposure to the pesticide is sufficient to reduce ChE activity; the identified mechanism of toxicity
5. Exposure to the pesticide is sufficient to reduce juvenile abundance via impacts to growth
6. Exposure to the pesticide is sufficient to reduce adult productivity via impairments to reproduction

11.5.1.3.4 Green sturgeon

Juvenile rearing by green sturgeon is confined to a relatively small portion of the total range of species. Therefore, we evaluated separate risk hypotheses for juvenile rearing and the adult/sub-adult life stages.

Adult/sub-adult:

1. Exposure to the pesticide is sufficient to reduce adult and sub-adult abundance via acute lethality.
2. Exposure to the pesticide is sufficient to reduce adult and sub-adult abundance via reduction in prey availability.
3. Exposure to the pesticide is sufficient to reduce ChE activity; the identified mechanism of toxicity.
4. Exposure to the pesticide is sufficient to reduce adult and sub-adult abundance and adult productivity via impairments to ecologically significant behaviors.
5. Exposure to the pesticide is sufficient to reduce adult productivity via impairments to reproduction.

Juvenile freshwater/estuarine rearing:

1. Exposure to the pesticide is sufficient to reduce juvenile abundance via acute lethality.
2. Exposure to the pesticide is sufficient to reduce juvenile abundance via reduction in prey availability.
3. Exposure to the pesticide is sufficient to reduce ChE activity; the identified mechanism of toxicity.
4. Exposure to the pesticide is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.
5. Exposure to the pesticide is sufficient to reduce juvenile abundance via impacts to growth.

11.5.1.3.5 Shortnose sturgeon and Atlantic sturgeon

1. Exposure to the pesticide is sufficient to reduce adult and juvenile abundance via acute lethality.
2. Exposure to the pesticide is sufficient to reduce adult and juvenile abundance via reduction in prey availability.
3. Exposure to the pesticide is sufficient to reduce ChE activity; the identified mechanism of toxicity.
4. Exposure to the pesticide is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.
5. Exposure to the pesticide is sufficient to reduce adult productivity via impairments to reproduction.
6. Exposure to the pesticide is sufficient to reduce abundance via impacts to growth.

11.5.1.3.6 Gulf sturgeon

NOAA Fisheries and USFWS share jurisdiction for the recovery of Gulf sturgeon. USFWS evaluates the effects of this action on the species during its freshwater residency. In this Opinion we evaluate effects of the action in marine and estuarine habitats. Consequently, we do not include risk hypotheses associated with freshwater exposures. The risk hypotheses we constructed include:

1. Exposure to the pesticide is sufficient to reduce adult and juvenile abundance via acute lethality.
2. Exposure to the pesticide is sufficient to reduce adult and juvenile abundance via reduction in prey availability.
3. Exposure to the pesticide is sufficient to reduce ChE activity; the identified mechanism of toxicity.
4. Exposure to the pesticide is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.
5. Exposure to the pesticide is sufficient to reduce adult productivity via impairments to reproduction.
6. Exposure to the pesticide is sufficient to reduce abundance via impacts to growth.

11.5.2 Marine Fish

11.5.2.1 Important Life history considerations

Marine fish use marine and estuarine habitats (***Table 3***). Smalltooth sawfish are categorized as a marine fish but they also utilize riverine habitats.

Table 3. General life histories of marine fish

Species	General Life History Descriptions		
	Reproduction	Adult life stage	Early life stages
Yelloweye rockfish and Baccaccio	Fertilization occurs internally in Rockfish. Rockfish give birth to live larval young that are passively dispersed in surface waters.	Rockfish are long-lived (50-100 years). They become reproductively mature at ~4-6 years of age. Adults are associated with kelp beds, rocky reefs, pinnacles, and sharp drop-offs and are most common at depths of 50-250 meters. They are opportunistic feeders. Preferred prey: fish and invertebrates	Larval young are passively dispersed in surface waters and can be distributed from the nearshore (including intertidal zone) to several hundred miles offshore. They remain in larval form for approximately 3 months. Juveniles and subadults are more common in shallower water than adults and are associated with reefs, kelp canopies, and artificial structures such as piers and jetties. Preferred prey: Larvae - diatoms, dinoflagellates, tintinnids, and cladocerans; Juveniles- copepods and euphausiids
Gulf grouper	Once a year, gulf grouper aggregate for reproduction (typically during a full moon in May). Spawning aggregations occur at rocky reefs and seamounts in depths from 20 to 35 meters. They are protogynous hermaphroditic, so they mature as females and later transition into males. The older, larger males are preferentially selected for at harvest, which has skewed sex ratios.	Gulf grouper can live to approximately 50 years of age. They predominately use rocky reefs, seamounts, and kelp beds of depths from five to 30 meters and deeper (30 to 45 meters). Preferred prey: fish and invertebrates	Juvenile grouper use shallow, coastal habitats (e.g. sargassum beds, seagrass areas, mangroves, and estuaries) during their first two years of life. Preferred prey: fish and invertebrates

Species	General Life History Descriptions		
	Reproduction	Adult life stage	Early life stages
Nassau grouper	Reproduction occurs during annual aggregations involving dozens to thousands of fish that collectively spawn. Fish travel long distances to arrive at aggregation sites for spawning. Annual spawning occurs at specific times, spread out over a spawning season that lasts several months each year (May-July). Spawning habitat are relatively close to shore (≥50 meters) and near deep drop-offs at depths of 6 – 60 meters)	Male and female Nassau grouper typically mature at about 4-5 years of age and can live up to approximately 30 years of age. Adult grouper are considered reef fish that utilize the fore reef and reef crest habitats. They can be found from the shoreline to depths of 130 meters. They are a top predator of the reef ecosystem. Preferred diet: fish and invertebrates	As eggs and larvae they are planktonic. Juveniles are found in nearshore shallow waters in macro algal and seagrass habitats. They shift to progressively deeper habitats with increasing size and maturation into predominantly reef habitats. Preferred diet: fish and invertebrates
Smalltooth sawfish	Smalltooth sawfish are ovoviviparous (live-born young from internal eggs). They are reported to live approximately 25-30 years and prima	It is uncertain where breeding and birthing activities occur (fresh or marine habitats). Adult sawfish can be found in shallow coastal, marine, and riverine areas.	Smalltooth sawfish stay in nursery habitats for about 1-2 years. Nursery habitats are located close to the shoreline in very shallow water (<3 feet). It is believed that sawfish stay close to the shoreline, moving in and out with the tide to avoid contact with bull sharks and other predators. Juveniles can be found in sheltered bays, on shallow banks, and in estuaries or river mouths. They are often associated with shallow habitats adjacent to mangrove stands. They will ascend inland river systems and manmade canals. Preferred prey: finned fish

11.5.2.2 Primary Route of exposure

Marine fish are likely to be exposed to pesticides that are deposited in surface waters through runoff and drift transport pathways. Exposure from contact with contaminated surface water will be evaluated. Quantitative estimates of exposure are evaluated using surface water concentration estimates derived by EPA for generic aquatic habitats. Because reliable methods were unavailable to estimate concentrations in the marine habitats relevant to these species (bin 8, 9, and 10), flowing freshwater bins were used as surrogates (bin 2 and 3). Additionally, we used the large static habitat (bin 7) as a surrogate for nearshore habitats such as estuaries under slack tide conditions.

11.5.2.3 Risk Hypotheses

We constructed the following risk hypotheses for chlorpyrifos, diazinon, and malathion considering the available exposure, response, and life history information referenced above.

11.5.2.3.1 Yelloweye rockfish and Bocaccio

Adult rockfish utilize habitats >50 meters deep that are unlikely to achieve concentrations necessary predicted to cause toxic responses. Therefore, risk hypotheses were constructed for the larval and juvenile life stages of rockfish which can occur in relatively shallow nearshore habitats.

1. Exposure to the pesticide is sufficient to reduce larval and juvenile abundance via acute lethality.
2. Exposure to the pesticide is sufficient to reduce larval and juvenile abundance via impacts to growth.
3. Exposure to the pesticide is sufficient to reduce larval and juvenile abundance via reduction in prey availability.
4. Exposure to the pesticide is sufficient to reduce ChE activity; the identified mechanism of toxicity.
5. Exposure to the pesticide is sufficient to reduce larval and juvenile abundance via impairments to ecologically significant behaviors.

11.5.2.3.2 Gulf grouper and Nassau grouper

Adults:

1. Exposure to the pesticide is sufficient to reduce adult abundance via acute lethality.
2. Exposure to the pesticide is sufficient to reduce adult productivity via impairments to reproduction.
3. Exposure to the pesticide is sufficient to reduce ChE activity; the identified mechanism of toxicity.
4. Exposure to the pesticide is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.

Juveniles:

1. Exposure to the pesticide is sufficient to reduce juvenile abundance via acute lethality.
2. Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impacts to growth.
3. Exposure to the pesticide is sufficient to reduce juvenile abundance via reduction in prey availability.
4. Exposure to the pesticide is sufficient to reduce ChE activity; the identified mechanism of toxicity.
5. Exposure to the pesticide is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.

11.5.2.3.3 Smalltooth sawfish

Juvenile and adult female sawfish utilize nursery habitats that represent a relatively small portion of the total range of species. Therefore, we evaluated separate risk hypotheses for juvenile rearing/adult female use of nursery habitats and adult use of other habitats throughout the full species range.

Adult (full range):

1. Exposure to the pesticide is sufficient to reduce adult abundance via acute lethality.
2. Exposure to the pesticide is sufficient to reduce adult abundance via reduction in prey availability.
3. Exposure to the pesticide is sufficient to reduce ChE activity; the identified mechanism of toxicity.
4. Exposure to the pesticide is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.
5. Exposure to the pesticide is sufficient to reduce adult productivity via impairments to reproduction.

Juvenile and adult females in nursery habitats:

1. Exposure to the pesticide is sufficient to reduce juvenile abundance via acute lethality.
2. Exposure to the pesticide is sufficient to reduce juvenile abundance via reduction in prey availability.
3. Exposure to the pesticide is sufficient to reduce ChE activity; the identified mechanism of toxicity.
4. Exposure to the pesticide is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.
5. Exposure to the pesticide is sufficient to reduce female productivity via impairments to reproduction.
6. Exposure to the pesticide is sufficient to reduce abundance via impacts to growth.

11.5.3 Marine Invertebrates

11.5.3.1 Important Life history considerations

Listed marine invertebrates with distributions in the United States and U.S. territories include 2 species of abalone and 14 species of reef building corals. The primary route of exposure in these organisms is assumed to be contact with contaminated surface water. While dietary exposure to pesticide is also possible, toxicity studies to assess the dietary route of exposure in these organisms are generally absent. Black abalone and white abalone have similar life histories but occur in different habitats (***Table 4***).

Table 4. General life histories of abalone

Species	General Life History Descriptions of Abalone		
	Reproduction	Development	Habitat and diet
Black abalone and White abalone	Black abalone broadcast spawn in late spring and summer. White abalone spawn in late winter to early spring. Eggs and sperm are released into the water during a synchronized event. Sex ratios are typically one to one. Fecundity in abalone can be affected by the availability of food, sea water temperature, disease, and local environmental conditions. A minimum density of spawners is essential for successful broadcast spawning. Because abalone are subject to the Allee effect, they are especially vulnerable to population collapse at low densities.	Fertilized eggs first sink to the bottom then hatch into free-swimming larvae within 24 hours. Larvae swim upwards in the water column initially, but only a short distance before settling to the bottom as the shell develops. Settlement marks the end of the larval phase and the beginning of the juvenile stage. The short duration of the free swimming larval phase of abalone (4 – 15 days) suggests dispersal is limited. Abalone larvae settle and metamorphose into juvenile abalone primarily on crustose coralline. Newly settled abalone graze on the cuticle and epithelial contents of coralline algae. Juveniles remain in coralline habitats until they reach about 6 mm (0.24 in.) in shell length.	Black abalone are an intertidal species that feed on giant kelp and other macro-algae. They can be exposed for several hours in tide pools and on exposed rocks at low tide. White abalone are a subtidal species that occurs at depths of 8 – 60 meters and generally occur more than one mile offshore. Post-larval and early juvenile abalone feed mainly on bacteria, benthic diatoms, and single-celled algae that form surface films on rocky substrate. Juvenile abalone begin feeding on coralline algae surfaces and eventually switch to brown, red and green. Adult abalone feed primarily on brown algae, often in the form of unattached, drifting kelp; but when drifting kelp is scarce, adult abalone feed on other macro-algae and benthic diatom films.

Endangered and threatened corals that occur within the action area are all reef building species; they excrete calcium carbonate that forms an exoskeleton and also contributes to the structure of the reef. These corals have similar reproductive strategies (***Table 5***) and are capable of both sexual and asexual reproduction. Asexual reproduction occurs through budding (cloning of individual polyps) and fragmentation. External fertilization through broadcast spawning is the most common method of sexual reproduction among these corals. Broadcast spawning events involve a synchronous release of egg and sperm into the water column timed with the lunar cycle. In the Caribbean broadcast spawn events typically occur once a year during the late summer or as a split spawn in successive months. Most Indo-Pacific coral spawning events occur in late spring through early summer, depending on latitude (i.e. May-July in the Mariana Islands and November-January in American Samoa). The released gametes float to the surface where fertilization occurs. Fertilized embryos develop into a larval stage (planulae) that reside in the water column as plankton for a number of days before swimming to the substrate in search of an appropriate location to settle and eventual development into a polyp. A successful pioneer polyp will then grow and clone to form a colony. Unlike the other broadcast spawning species the pillar coral (*Dendrogyra Cylindrus*) is gonadochoric species meaning each pillar coral colony is composed of either male or female polyps exclusively; the other listed corals are hermaphroditic and a single colony of polyps releases both egg and sperm. The rough cactus coral (*Mycetophyllia ferox*) is an exception among the listed corals; they are a brooding species and they do not broadcast spawn eggs. Rather fertilization and embryogenesis occurs within the polyp of the rough cactus coral which release larvae at the planulae stage. The listed coral species can capture and consume prey including small fish and zooplankton. However, most of their energy is obtained from the organic byproducts of photosynthesis through a symbiotic relationship with zooxanthellae, photosynthetic dinoflagellates. Therefore these corals occur in the photic zone in relatively shallow waters (0-50 meters) on reef and lagoon habitats.

Table 5. General life histories of corals

Species	General Life History Descriptions of Reef-Building Corals		
	U.S. Range (Proportion in U.S.)[1]	Sexual reproduction	Habitat Depth
Acropora cervicornis	SE Florida, Caribbean (8%)	Hermaphroditic broadcast spawning	<50 meters
Acropora palmata	SE Florida, Caribbean (8%)	Hermaphroditic broadcast spawning	<50 meters
Acropora globiceps	American Samoa, Guam, CNMI[2], PRIA[3] (1.1%)	Hermaphroditic broadcast spawning	0-8 meters
Acropora jacquelineae	American Samoa (0.3%)	Hermaphroditic broadcast spawning	10-35 meters
Acropora retusa	American Samoa, Guam, PRIA (1.4%)	Hermaphroditic broadcast spawning	0-5 meters
Acropora speciosa	American Samoa, PRIA (0.2%)	Hermaphroditic broadcast spawning	12-40 meters
Euphyllia paradivisa	American Samoa (0.8%)	Hermaphroditic broadcast spawning	2-25 meters
Isopora crateriformis	American Samoa (0.4%)	Hermaphroditic broadcast spawning	0-12 meters
Seriatopora aculeata	Guam, CNMI (0.8%)	Hermaphroditic broadcast spawning	3-40 meters

Species	General Life History Descriptions of Reef-Building Corals		
	U.S. Range (Proportion in U.S.)[1]	Sexual reproduction	Habitat Depth
Orbicella franksi	SE Florida, Caribbean (8%)	Hermaphroditic broadcast spawning	<50 meters
Orbicella annularis	SE Florida, Caribbean (8%)	Hermaphroditic broadcast spawning	<50 meters
Orbicella faveolata	SE Florida, Caribbean (8%)	Hermaphroditic broadcast spawning	<50 meters
Dendrogyra cylindrus	SE Florida, Caribbean (8%)	**Gonochoric** broadcast spawning	<50 meters
Mycetophyllia ferox	SE Florida, Caribbean (8%)	Hermaphroditic **brooding**	<50 meters

1- Approximate proportion of species population occurring within United States and its territories based on estimates of reef area.
2- Commonwealth of the Northern Mariana Islands
3- Pacific Remote Island area, including Wake Island, Johnston Atoll, Palmyra Atoll, Kingman Reef, Jarvis Island, Baker Island, and Howland Island.

11.5.3.2 Primary Route of exposure

The primary route of exposure in marine invertebrates is contact with contaminated surface waters from the runoff and drift pathways. Black abalone occur in the intertidal zone and may, along with the other marine invertebrates occur in the nearshore subtidal zone. Because reliable methods were unavailable to estimate concentrations in the marine habitats relevant to these species (bin 8, 9, and 10; EPA Biological Evaluations 2017), freshwater bins were used as surrogates for tide pools (bin 5) and other inundated coastal habitats at low and high tide (bin 2 and 3, respectively). Additionally, we used the large static freshwater habitat (bin 7) as a surrogate for nearshore habitats such as estuaries under slack tide conditions.

11.5.3.3 Risk Hypotheses

We constructed the following risk hypotheses for chlorpyrifos, diazinon, and malathion considering the available exposure, response, and life history information referenced above.

11.5.3.3.1 White abalone and black abalone

1. Exposure to the pesticide is sufficient to reduce the abundance of larval/juvenile and adults via direct toxicity.
2. Exposure to the pesticide is sufficient to reduce the abundance of juvenile and adults via reduction in prey availability.
3. Exposure to the pesticide is sufficient to reduce ChE activity; the identified mechanism of toxicity.
4. Exposure to the pesticide is sufficient to reduce the productivity of adults via impairments to reproduction.
5. Exposure to the pesticide is sufficient to reduce the abundance and productivity of larval/juvenile and adults via impairments to ecologically significant behaviors (e.g. prey capture, settling, metamorphosis).
6. Exposure to the pesticide is sufficient to reduce the abundance and productivity of larval/juvenile and adults via reductions in growth.

11.5.3.3.2 Corals

1. Exposure to the pesticide is sufficient to reduce the abundance of populations via direct toxicity.
2. Exposure to the pesticide is sufficient to reduce the abundance of populations via reduction in prey availability.
3. Exposure to the pesticide is sufficient to reduce ChE activity; the identified mechanism of toxicity.
4. Exposure to the pesticide is sufficient to reduce the abundance and productivity of populations via impairments to ecologically significant behaviors (e.g. prey capture).
5. Exposure to the pesticide is sufficient to reduce the productivity of populations via impairments to reproduction (e.g. spawning cues).
6. Exposure to the pesticide is sufficient to reduce productivity of populations via effects on larvae (settling, metamorphosis, mortality, etc.)

11.5.4 Sea Turtles

11.5.4.1 Important Life history considerations

There are six species and 13 DPS of listed sea turtles. While these species have similar life history characteristics differences in diet and habitat use may lead to different levels of exposure (***Table 6***).

Table 6. General life histories of sea turtles

Species	General Life History Descriptions of Sea Turtles
(number of listed DPSs)	Summary
Green (6)	While it is unknown how long green turtles live, they are known to reach sexual maturity at ages of 20-50 years. Females return to the beaches where they were born (natal beaches) every 2-4 years to lay eggs (generally during summer). After emerging from the nest at night, hatchlings crawl across sand in the intertidal zone to reach the water. They swim to offshore areas where they reside for several years feeding close to the surface on a variety of pelagic plants and animals. Once they reach a certain age they leave the pelagic habitat and travel to nearshore foraging grounds where they feed primarily on algae and grasses in benthic habitats. Preferred prey: Early in life green turtle diet includes both plants and animals, as adults they are almost exclusively herbivorous, primarily consuming seagrasses and algae.
Hawksbill (1)	Female hawksbill turtles return to natal beaches every 2-3 years to nest. They usually nest high up on the beach under or in the beach/dune vegetation. They commonly nest on pocket beaches, with little or no sand. They nest at night time about every 14-16 days during the nesting season. The nesting season varies with locality, but in most locations nesting occurs sometime between April and November. A female hawksbill generally lays 3-5 nests per season, which contain an average of 130 eggs. Eggs incubate for around 2 months. Juveniles are initially pelagic- sheltering on floating mats of algae and foraging on the surface. After a few years they enter coastal foraging areas near reefs where they feed primarily on animals associated with coral reef environments. This species may also be found among rocky outcrops and high energy shoals, mangrove-fringed bays and estuaries. Preferred prey: Dietary items include sponges, other invertebrates, and algae.

Species	General Life History Descriptions of Sea Turtles
(number of listed DPSs)	Summary
Kemp's ridley (1)	Nesting is synchronized. Large groups of Kemp's ridley gather off a particular nesting beach. Then, wave upon wave of females come ashore and nest in what is known as an "arribada." Nesting occurs May-July, laying two to three clutches of approximately 100 eggs, which incubate for 50-60 days. Newly emerged hatchlings enter water and swim quickly from near shore to escape predators. Most employ an open ocean developmental stage. They remain in open ocean for about 2 years then return to coastal neritic zones (near shore area) as sub-adults where they forage for prey in muddy or sandy bottom substrates. This is also the primary foraging habitat for adults. Preferred prey: Diet includes crabs, fish, jellyfish, and mollusks.
Leatherback (1)	Leatherbacks mate in tropical waters adjacent to nesting beaches and along migratory corridors. Female leatherbacks lay clutches of approximately 100 eggs on sandy, tropical beaches. Females nest several times during a nesting season, typically at 8-12 day intervals. Incubation period is ~ 2 months. After nesting season, female leatherbacks migrate from tropical waters to more temperate latitudes, which support high densities of jellyfish prey in the summer. Preferred prey: Diet consists primarily of soft bodies prey such as jellyfish and salps.
Loggerhead (2)	Females nest from April-September and generally lay 3-5 nests per season. Hatchlings move from their nest to the surf, swim, and are swept through the surf zone, and continue swimming away from land for up to several days. Post-hatchling loggerheads take up residence in areas where surface waters converge to form local down-wellings. These areas are often characterized by accumulations of floating material. Post-hatchlings within this habitat are observed to be low-energy float-and-wait foragers that feed on a wide variety of floating items. As post-hatchlings, loggerheads may linger for months in waters just off the nesting beach or become transported by ocean currents within the Gulf of Mexico and North Atlantic. Somewhere between 7-12 years old, oceanic juveniles migrate to nearshore coastal areas (neritic zone) and continue maturing until adulthood. In addition to providing critically important habitat for juveniles, the neritic zone also provides crucial foraging habitat, inter-nesting habitat, and migratory habitat for adult loggerheads in the western North Atlantic. Preferred prey: Diet consists primarily of shellfish including crabs, clams, whelks and conch.
Olive ridley (2)	Synchronous nesters. Vast numbers of olive ridley turtles come ashore and nest in what is known as an "arribada"; females nest every year, once or twice in a season, laying clutches of approximately 100 eggs. Reach sexual maturity at around 15 years. Adults are mainly pelagic but also inhabit coastal areas including bays and estuaries. Preferred prey: Diet includes algae, benthic organisms, lobster, crabs, tunicates, mollusks, shrimp, and fish.

All species use three marine habitat zones:

(1) Beaches or occasionally estuarine shoreline habitats- supralittoral terrestrial zone where egg laying, embryonic development, and hatching occur. Eggs typically laid between high water mark and outer dune faces. Hatching and emergence from nests are relatively synchronous, generally occurring within 1-3 d and 2-4 d, respectively. Hatchlings emerge from their nests en masse almost exclusively at night. The tidal stage dictates the distance hatchlings must traverse the beach to achieve the water's edge.

(2) Open ocean / convergence zones – deep water habitats (>200 m) for ocean juvenile rearing stage and foraging habitat for adults.

(3) Coastal areas for benthic feeding and migration – neritic zone (0-200 m depth), the nearshore marine environment used by post-hatchlings moving from beach to convergence zones, by adults and subadults to forage, and as a migration corridor and breeding habitat for adults.

Immediately after sea turtle hatchlings emerge from the nest they begin a period of frenzied activity. This involves moving from their nest, across the beach, to the surf, where they swim and are swept through the surf zone, and continue oriented swimming toward off-shore, swimming and occasionally floating on sea weeds almost continuously for an extended period (e.g. 10-30 hours). During this period they rely on energy and nutrients stored within their retained yolk sacs (~ 5-day energy stores).

Post-hatchlings inhabit areas where surface waters converge to form local down-wellings that are characterized by accumulations of a variety of floating plant and animal material that they forage on. During this phase they are low energy swimmers. Loggerhead sea turtles may linger for months in waters just off the nesting beach or become transported by ocean currents with the Gulf of Mexico and North Atlantic.

All listed sea turtles have a period of oceanic rearing during their juvenile life stage that lasts for several years. The diet varies among species but includes both animal (primarily invertebrates) and plant material.

As subadults the turtles begin to utilize coastal foraging areas. Sea turtles can be found in close proximity to the shoreline and in shallow marine and estuarine waters (1-2 ft in depth). Subadults are commonly caught by fisherman on piers and trapped in skimmer nets.

Adults also use costal forage areas but there are differences in use among the different species. The loggerheads, Kemp's, and green turtles are most likely to be exposed to pesticides because they are more commonly found near shoreline habitats. Green turtles utilize beach habitats for lounging. Leatherback's are the most pelagic of the species and hawksbill are most frequently associated with coastal reef habitats. There can be a seasonal component to use of the shoreline areas with greatest use during the spring and summer months. However, all species utilize shallow coastal waters as migration through them is necessary to reach nesting sites.

11.5.4.2 Primary Route of exposure

NOAA Fisheries and USFWS share jurisdiction for sea turtles. USFWS evaluates the effects of this action on these species when they occupy terrestrial habitats. In this Opinion we evaluate effects of the action in aquatic habitats. Sea turtles are likely to be exposed to pesticides in aquatic habitats that accumulate in their food resources. Therefore, we rely on the estimated concentrations of the pesticide in the marine environment to assess the dietary route of exposure (surrogate bins 2, 3, and 7; EPA Biological Evaluations 2017a, b, c).

11.5.4.3 Risk Hypotheses

Adults:

1. Exposure to the pesticide is sufficient to reduce adult abundance via acute lethality.
2. Exposure to the pesticide is sufficient to reduce adult productivity via impairments to reproduction.

3. Exposure to the pesticide is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.
4. Exposure to the pesticide is sufficient to reduce ChE activity; the identified mechanism of toxicity.

Juveniles:
Juveniles green, leatherback, and olive ridley sea turtles are not expected to experience substantial exposure to the pesticide given their offshore residence during this life stage. The following risk hypotheses are for hawksbill, Kemp's ridley, and loggerhead sea turtles:

1. Exposure to the pesticide is sufficient to reduce Juvenile abundance via acute lethality.
2. Exposure to the pesticide is sufficient to reduce Juvenile abundance via reduction in prey availability.
3. Exposure to the pesticide is sufficient to reduce ChE activity; the identified mechanism of toxicity.
4. Exposure to the pesticide is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.
5. Exposure to the pesticide is sufficient to reduce abundance via impacts to growth.

11.5.5 Cetaceans

11.5.5.1 Important Life history considerations

The Southern Resident Killer whale (SRKW) is the only listed cetacean Likely to be Adversely Affected by the action (EPA 2017 BEs). The SRKW population contains three pods (J, K, and L pods) that are considered one "stock" under the Marine Mammal Protection Act (MMPA) and as a "distinct population segment, DPS" under the Endangered Species Act (ESA). They rarely if ever interbreed with other populations of orcas and maintain some unique characteristics compared to other populations (*e.g.* diet, ***Table 7***).

Table 7. Life history of characteristics of southern resident killer whale

Southern Resident Killer Whale Life History
Summary: Sexual maturity of female killer whales is achieved when the whales reach lengths of approximately 15-18 feet depending on geographic region. The gestation period for killer whales varies from 15-18 months, and birth may take place in any month, there is no distinct calving season. Calves are nursed for at least 1 year, and may be weaned between 1 and 2 years of age. The birth rate for killer whales is not well understood, but, in some populations, is estimated as every 5 years for an average period of 25 years. Males typically live for 30 years, but can live as long as 50-60 years; females typically live about 50 years, but can live as long as 80-90 years. Several factors may be limiting recovery to this population including quantity and quality of prey (particularly their primary prey, Chinook salmon), exposure to toxic chemicals that accumulate in top predators (e.g., persistent organic pollutants, POPs), and disturbance from sound and vessels. Oil spills are also a risk factor. The Southern Resident killer whales carry relatively high POP concentrations in their blubber. They receive the majority of these pollutants via their diet. Chinook salmon are a large part of the killer whales' diet; therefore they are likely an important source of contaminants to these whales. Because the whales are long-lived, and consume Chinook salmon in urban areas where exposure to POPs can be relatively high, they are a highly contaminated whale population. Persistent pollutants have been associated with reproductive impairment and calf survival, endocrine disruption, neurotoxicity, and cancer in humans and wildlife.

Southern Resident Killer Whale Life History
Seasonal movements: During Spring, Summer, and Fall SRKW are observed in the waters of Puget Sound, Strait of Juan de Fuca, and Southern Georgia Strait. While in inland waters during summer months, all of the pods concentrate their activity in Haro Strait, Boundary Pass, the southern Gulf Islands, the northeastern end of the Strait of Juan de Fuca, and several locations in southern Georgia Strait. However, at any time, SRKW can range in all inland waters of Washington state and British Columbia and along the outer coast from California to southeast Alaska. SRKW commonly occur and are observed foraging in areas where salmon frequent, especially during the times of year salmon are migrating to their natal rivers. All three pods typically arrive in May or June and spend most of their time in inland waters until departing in October or November. However, K and L pods make frequent trips lasting a few days to the outer coasts of Washington and southern Vancouver Island during this time period. During early autumn, Southern Resident pods, especially J pod, routinely expand their movements into Puget Sound, probably to take advantage of chum and Chinook salmon runs. There are no confirmed sightings of SRKWs inside Hood Canal. Although, SRKW can occur very near the shoreline, they are not expected to occupy shallow habitats with depths of < 20 feet. The range of Southern Residents throughout the rest of the year is not well known. Although sightings on the outer coast are extremely limited, researchers have confirmed that K and L pods have traveled as far south as central California and as for north as the southeast Alaska (one sighting occurred in Chatham Strait, AK, J. Ford pers. comm.). In recent years several sightings or acoustic detections have been obtained off the Washington, Oregon, and California coasts for these pods in the winter and spring and the NWFSC has initiated a satellite tagging program. Even fewer sightings/acoustic detections are available for J pod on the outer coast in the winter and spring, but the limited range of the sighting/acoustic detections and a lack of coincident occurrence during the K and L pods sightings suggest a much more restricted coastal range.
Habitat: Nearshore marine habitats greater than 7 meters in depth
Preferred Prey: Orca diets are population specific. SRKW primarily feed on salmon, preferring Chinook salmon. Most diet data is focused on inland waters in summer months, but preliminary data from the west coast also indicate that salmon, and Chinook, are important. Salmon life-history and habitat requirements must be considered when determining the vulnerability of SRKW to pesticide exposures.

11.5.5.2 Primary Route of exposure

EPA established that direct toxicity to listed killer whales is not expected given the deeper water habitats they typically occupy. EPA also concluded that these pesticides are likely to adversely affect SRKW due to reductions in their prey including Chinook salmon, the species preferred prey (EPA Biological Evaluations 2017). As discussed above (see anadromous fish), pesticide concentrations in the freshwater habits (bins 2-7) are relevant to evaluating impacts to Pacific salmonids and therefore they were used to evaluate impacts to SRKW prey.

11.5.5.3 Risk Hypotheses

SRKW primarily feed on salmon and prefer Chinook salmon. Pacific salmonids are likely to be exposed to chlorpyrifos, diazinon, and malathion during residency in fresh water and nearshore habitats. Localized depletions in the prey base may result in increased energy demands of SRKW due to abandonment of foraging areas in search of more abundant prey or expending substantial effort to find depleted prey resources within their range. Reductions in prey can lead to nutritional stress, reduced body size and condition, and can lower reproductive and survival rates. Food scarcity can also cause whales to draw on fat stores, mobilizing persistent contaminants that can affect reproduction and immune function. We constructed the following risk hypothesis for chlorpyrifos, diazinon, and malathion considering the available exposure, response, and life history information referenced above for SRKW:

Exposure to the pesticide is sufficient to reduce SRKW abundance via reduction in prey availability (primarily salmonids and other fish).

11.5.6 Pinnipeds

11.5.6.1 Important Life history considerations

The life history of three pinniped species are presented in ***Table 8***. The western DPS of the Steller sea lion is distributed off the Southern coast of Alaska and throughout the North Pacific, The Guadalupe fur seal is found in the coastal waters of California and Mexico, and the Hawaiian monk's seals occur in the Hawaiian Islands.

Table 8. General life histories of pinnipeds

Species	General Life History Descriptions of Pinnipeds		
	Summary	Habitat	Preferred prey
Steller sea lion, Western DPS	Steller sea lions are colonial breeders. Adult males, also known as bulls, establish and defend territories on rookeries to mate with females. Bulls become sexually mature between 3 and 8 years of age, but typically are not large enough to hold territory successfully until 9 or 10 years old. Mature males may go without eating for 1-2 months while they are aggressively defending their territory. Females typically reproduce for the first time at 4 to 6 years of age, usually giving birth to a single pup each year. Adult females, also known as cows, stay with their pups for a few days after birth before beginning a regular routine of alternating foraging trips at sea with nursing their pups on land. Females usually mate again with males within 2 weeks after giving birth. Males can live to be up to 20 years old, while females can live to be 30. Weaning is not sharply defined as it is for most other pinniped species, but probably takes place gradually during the winter and spring prior to the following breeding season. It is not uncommon to observe 1- or 2-year-old sea lions suckling from an adult female.	Steller sea lions forage near shore and pelagic waters. They are also capable of traveling long distances in a season and can dive to approximately 1300 feet (400 m) in depth. They use land habitat as haul-out sites for periods of rest, molting, and as rookeries for mating and pupping during the breeding season. At sea, they are seen alone or in small groups, but may gather in large "rafts" at the surface near rookeries and haul outs.	Steller sea lions are opportunistic predators, feeding primarily of a wide variety of fishes and cephalopods. Prey varies geographically and seasonally. Some of the more important prey species in Alaska include walleye pollock, Atka mackerel, Pacific herring, Capelin, Pacific sand lance, Pacific cod, and salmon. Steller sea lions have been known to prey on harbor seal, fur seal, ringed seal, and possibly sea otter pups, but this would represent only a supplemental component to the diet. They may disperse and range far distances to find prey, but are not known to migrate
Guadalupe fur seal	Guadalupe fur seals are solitary, non-social animals. Males are "polygamous" and may mate with up to 12 females during a single breeding season. Males form small territories that they defend by roaring or coughing. Breeding season is June through August. Females arriving in early June, and pups are born a few days after their arrival. A female will mate about a week after giving birth to her pup. Weaning occurs around 9 months.	Reside in the subtropical waters of the Southern California/ Mexico region. During breeding season, they are found in coastal rocky habitats and caves. Little is known about their whereabouts during the non-breeding season.	Guadalupe fur seals feed mainly at night on squid, mackerel, and lantern fish by diving to depths of up to 20 meters.

Species	General Life History Descriptions of Pinnipeds		
	Summary	Habitat	Preferred prey
Hawaiian monk seal	Females generally mature around age 5; it is unknown when males mature. Monk seals are promiscuous and mate underwater. Given male-dominated sex ratios at some breeding colonies, group mobbing of estrus females is known to occur, sometimes causing serious injury or even death to the female. The gestation period is 10-11 months. Birthing rates vary with a range of 30-70% of adult females birthing in a given year. While most births occur in late March and early April, birthing has been recorded year round. Nursing occurs for about 1 month, during which time the mother fasts and remains on land. After this period, the mother abandons her pup and returns to sea. Although they are generally solitary animals, females have been observed fostering others' offspring.	The main terrestrial habitat requirements include: haul-out areas for pupping, nursing, molting, and resting. These are primarily sandy beaches, but virtually all substrates are used at various islands. Monk seals live in warm subtropical waters and spend two-thirds of their time at sea. They use waters surrounding atolls, islands, and areas farther offshore on reefs and submerged banks. Monk seals are also found using deepwater coral beds as foraging habitat. When on land, monk seals breed and haul-out on sand, corals, and volcanic rock. Sandy, protected beaches surrounded by shallow waters are preferred when pupping. Monk seals are often seen resting on beaches during the day.	Limited food availability is a significant factor in the Hawaiian monk seal population decline. Monk seals are primarily benthic foragers. They are generalist feeders, feeding on a variety of prey including fish, cephalopods, and crustaceans. Their diet varies by location, sex, and age. Adults are generally nocturnal hunters while juveniles spend more time hunting species that hide in the sand or under rocks during the day. Monk seals generally hunt for food outside of the immediate shoreline areas in waters 60-300 feet (18-90 m) deep. Monk seals are also known to forage deeper than 1,000 feet (330 m), where they prey on eels and other benthic organisms.

11.5.6.2 Primary Route of exposure

Pinnipeds utilize beaches and other terrestrial habitats to haul-out for pupping, nursing, molting, and resting. Direct application and spray drift are possible pathways of contamination for these habitats and primary routes of exposure from these pathways include dermal, ingestion through preening and feeding. We rely on the Biological Evaluations dermal exposure estimates and estimated concentrations of the pesticide in the marine environment to assess the dietary route of exposure (surrogate bins 2, 3, and 7; EPA Biological Evaluations 2017a, b, c).

11.5.6.3 Risk Hypotheses

We constructed the following risk hypotheses for chlorpyrifos, diazinon, and malathion considering the available exposure, response, and life history information referenced above.

11.5.6.3.1 Steller sea lion, Guadalupe fur seal, and Hawaiian monk seal

1. Exposure to the pesticide is sufficient to reduce abundance from direct exposure (dietary, dermal, and inhalation).
2. Exposure to the pesticides is sufficient to reduce ChE; the identified mechanism of toxicity.
3. Exposure to the pesticides is sufficient to reduce abundance via impacts to growth.
4. Exposure to the pesticides is sufficient to reduce abundance and productivity via impairments to ecologically significant behaviors.
5. Exposure to the pesticides is sufficient to reduce adult productivity via impairments to reproduction.
6. Exposure to the pesticides is sufficient to reduce abundance via reduction in prey.

11.5.7 Plants

11.5.7.1 Important Life history considerations

Johnson's seagrass is the only marine plant to be listed under the ESA (***Table 9***).

Table 9. Life history characteristics of Johnson's seagrass

Johnson's Seagrass Life History
Summary: Johnson's seagrass is a creeping rhizome, it produces subterranean runners that grow horizontally. Where present it often grows in a patchy, non-contiguous distribution. Johnson's seagrass appears to reproduce through asexual branching only. Sexual reproduction has not been documented in this species; therefore, pollination is not considered a necessary component of the species life history.
Habitat: Prefers coastal lagoons and inlets in the intertidal zone at depths from 0- 4m. Johnson's seagrass can be found in natural and man-made habitats of the Intracoastal Waterway (ICW). It does not do as well in deeper habitats where other seagrasses thrive. Johnson's seagrass can be found in coarse sands and muddy substrates, turbid waters and areas with high tidal currents. The range of Johnson's seagrass is within lagoons along the along the east coast of Florida from Sebastian Inlet south to northern Biscayne Bay.

11.5.7.2 Primary Route of exposure

Johnson's seagrass occurs in shallow waters (<4 meters deep) of the intertidal zone and it can be fully exposed (dewatered) during periods of low tide. Therefore, direct contact with pesticides products via spray drift is possible. Additionally, aquatic habitat may also be exposed to the pesticides from runoff and drift pathways during periods of intertidal inundation. We use the EPA exposure estimates for the intertidal habitats were used to estimate exposure to Johnson's seagrass at low and high tide (bin 2 and 3; EPA Biological Evaluations 2017).

11.5.7.3 Risk Hypotheses

Tests with chlorpyrifos, diazinon, and malathion indicate these active ingredients can be phytotoxic, thus we have constructed the following risk hypotheses considering the available exposure, response, and life history information referenced above.

1. Exposure to the pesticide is sufficient to reduce abundance via direct mortality.
2. Exposure to the pesticides is sufficient to reduce abundance via impacts to growth.

11.6 Risk Analysis

In this section we integrate the exposure and response information to evaluate the likelihood of adverse effects from stressors of the action at the population and species level. We use two tools to integrating exposure and response, R-plots and MagTool. Where applicable, we may also use population models to estimate responses. A weight-of-evidence approach which considers the limitations and uncertainties inherent in the available information is then applied to characterize risk.

11.6.1 MagTool

MagTool is an Excel-based tool developed by EPA that utilizes Python programming language to integrate EECs, the extent of pesticide use sites within a species range, and mortality effects data to estimate risk at the population scale. MagTool predicts an anticipated magnitude of mortality based on estimates of exposure and assumed dose-response relationships. Probabilistic output is reported reflecting variability in EECs derived by incorporating geographically-specific estimates that account for two sources of variability: (1) the occurrence of pesticide use sites within the species range (six year data set), and (2) daily precipitation (30 year data set). Inputs include median lethal concentrations (LC50s) and corresponding slopes of dose-response curves for each taxa group of interest (e.g. anadromous fish, marine fish, etc.). The output from MagTool estimates the mortality risk to the population associated with all authorized use sites within the species range (excluding mosquito and wide area use; see discussion of model assumptions below in section 11.6.4).

11.6.2 R-plots

R-plots are a tool developed by the National Marine Fisheries Service (NMFS) that utilize the R programming language to collectively display EECs, the extent of pesticide use sites within a species range, and effects data so that the user can visually assess the risk at the population scale. The response data and exposure estimates summarized by the R-plots are the same as those presented in EPA's BEs and used by the MagTool (e.g. the ranges of EECs and the spatial overlaps with species range associated with each use site). Both mortality and sublethal effect data are summarized. Effects on mortality are displayed as a range of percent mortalities based on a selected LC50 and slope. Sublethal effects are displayed as the ranges of LOECs associated with available sublethal endpoints (e.g. growth). Effect data and EECs are displayed quantitatively using the same axis to visually estimate response magnitudes associated with each labeled use site. For a given species and pesticide, an R-plot provides a graphic summary of the sources of information (i.e. exposure, response, and use) needed to qualitatively assess the risk to the population posed by all labeled uses across the range of the species and across their different habitat uses (e.g. habitat bins).

11.6.3 Population models

Where sufficient data existed, we used empirically-based population models to derive quantitative population responses. Matrix life history models were constructed for four Pacific salmon life history strategies including those exhibited by ocean type Chinook salmon, stream-type Chinook salmon, coho salmon, and sockeye salmon. Responses evaluated included changes to population growth rate due to pesticide-induced direct mortality, and changes to the population growth rates due to reductions in somatic growth of individuals from sublethal effects and reductions in prey availability. The methods and results of these analyses are reported in Pacific Salmon Population Modeling (see Appendix B).

11.6.4 Weighing the uncertainties in the best commercial and scientific information

All estimates of exposure and response must rely on assumptions with associated uncertainties that may contribute to the possibility of overestimating or underestimating risk, or in some circumstances may do either. Uncertainties may be due to natural variability, lack of knowledge, measurement error, or model error. One way to account for uncertainties associated with variability is to integrate measures of variability into models to calculate the probability of risk; the underlying assumption is that risk can be accurately predicted by mathematically accounting for variability. For example, the Aquatic MagTool output used by NMFS and described in the Assessment Framework provides estimated probabilities of effects by integrating EECs of pesticides with responses observed in effects studies. The output probabilities are reported with an uncertainty (i.e. distribution) based only on two sources of variation; variation in cropped area over six years, and variation in precipitation over 30 years. In reality a much greater level of uncertainty than that incorporated into the MagTool estimates is found when other sources of available information are considered. Accounting for uncertainty is critical when weighing model outputs and when applying outputs in risk conclusions. This section describes how we utilized a variety of tools with different assumptions to increase our confidence in risk estimates, and how we weighed key assumptions and associated uncertainties of our risk assessment to reach conclusions consistent with the purpose of Section 7(a)(2) of the Endangered Species Act (to ensure the actions are not likely to jeopardize the continued existence of endangered or threatened species; or adversely modify or destroy their designated critical habitat).

In ***Table 10***, we identify key assumptions associated with estimates utilized in our assessment of the effects of the action. X's indicate if the assumption contributes to the possibility that risk will be underestimated or overestimated. In some cases, the assumption may contribute to the possibility of either underestimating or overestimating risk, depending on the specific circumstances being evaluated. In succeeding paragraphs below the table we discuss how these assumptions and associated uncertainties are factored into our weight-of-evidence approach presented in the risk characterization section below.

Table 10. Assessment assumptions and influence on risk estimates

Assumption (estimate)	Underestimate Risk	Overestimate Risk
1. Pesticide application rates- Pesticides will be applied at the highest labeled rate for the use site or crop grouping (EECs)		X
2. Treatment of authorized use sites- Pesticides will be applied on authorized use sites (MagTool, R-plot)		X
3. Species' Distribution- Individuals remain uniformly distributed across their ranges (default model parameter for MagTool).	X	X
4. Pesticide transport- The pesticide is not transported in toxic concentrations beyond the immediate edge of the field (MagTool)	X	
5. Movement of individuals- An individual is assumed to occur at a single fixed location and is not exposed to pesticides at other locations or at other times (MagTool)	X	
6. Annual maximal exposures– the risk calculation only considers the likelihood of exposure to maximum	X	

Assumption (estimate)	Underestimate Risk	Overestimate Risk
annual values (e.g. 24-hr EEC). It does not account for effects over the full effective range of predicted exposures (MagTool, R-plot)		
7. GIS data layers accurately represent the presence and absence of use sites (pesticide/species overlap analysis)	X	X
8. Exposure to multiple stressors do not increase risk – The risk estimates or information do not account for other real world stressors known to exacerbate response (e.g. temperature, other pesticides, etc.) (MagTool, R-plot)	X	
9. Species surrogacy – The sensitivity of endangered species and their prey to pesticide exposure is comparable to that of available surrogate species (R-plot, MagTool)	X	X
10. Exposure estimates accurately predict pesticide concentrations in habitats relevant to listed species (EECs, R-plot, MagTool)	X	X
11. Responses to pesticides that degrade over time in the environment can be accurately predicted using toxicity data generated under test conditions that maintain concentrations at relatively constant concentrations (EECs, MagTool, R-plot, Mixtures).	X	X
12. Effects to essential behaviors are assumed to have fitness consequences regardless of the presence/absence of a quantitative link to an apical endpoint (mortality, reproduction, or growth).	X	X

1) Pesticide application rate assumptions tend to **overestimate** risk: Exposure estimates generated by EPA using fate and transport models assume the pesticides are applied at the highest labeled rate for a particular crop, crop grouping, or other use site. This assumption contributes to the possibility that exposure and risk will be overestimated because applications may occur at lower than maximum rates. However, EPA's proposed action encompasses all uses authorized by approved product labels, so this assumption is

needed to determine whether label requirements are likely to avoid jeopardy to listed species and adverse modification to designated critical habitat (NRC NAS 2013).

2) Treatment of authorized use sites assumptions tend to **overestimate** risk**:** The MagTool assumes that pesticides will be applied to all locations where use is authorized to evaluate exposure. While R-plots merely display estimates for treated uses sites, we assume treatment may occur to any authorized use site. Similar to the previous uncertainty, this assumption allows us to evaluate the full extent of EPA's authorized approval of pesticide use based on labels. This assumption contributes to the possibility that exposure and risk may be overestimated. While we do not expect every site to be treated, it is imperative to consider the potential responses to treatments that may occur in close proximity to listed species locations to insure existing controls (i.e. product labeling) are adequate to avoid jeopardy and adverse modification. Usage data are not available at a useful scale to predict exposure to the threatened and endangered species. The proximity of pesticide use relative to the listed species is a much more important driver of risk than the percent of treated crop over a large area (i.e. a state). Additionally, the existing usage information has significant data gaps for agricultural crops and non-agricultural uses and is based on limited geographical sampling. Finally, pesticide usage is highly variable over time and we cannot reliably predict the changes in usage that will occur during the 15 year duration of the action. Therefore, to insure the action won't jeopardize the species we assume pesticides will be used where use is approved by labeling.

3) Species' distribution assumptions may **underestimate or overestimate** risk: The MagTool default assumption is that individuals will be uniformly distributed throughout each HUC12 and throughout the species range. Uniform distributions are rare and not expected for listed species under NMFS jurisdiction. Most species exhibit clumped distributions corresponding to the availability of suitable habitat and prey across the landscape (***Figure 1***). An assumption of uniform distribution across the landscape could thus lead to overestimating or underestimating risk, depending on the actual distribution. Risk may be overestimated if the actual distribution of individuals tends to be in, and remain in, areas where pesticides cannot be applied. Alternatively, the uniform distribution assumption may contribute to underestimates of risk when the percent of individuals that actually encounters use sites during their life exceeds the percent of the species range where the pesticide use is allowed. The MagTool allows the user to alter distributions among HUC12s, but does not account for non-uniform distribution within a HUC12. While flexibility is built into the MagTool to allow the user to over-ride the uniform distribution assumption, the level of species information required to accurately predict exposure probabilities does not exist. Most of the listed species under NMFS jurisdiction are mobile, highly migratory, and the location of each individual of a species at the sub-HUC12 level at any given time is unknown. Therefore, to mitigate the impact of this uniform distribution assumption, we consider the available information on the species life history in order to qualitatively weigh the likelihood of exposure (*e.g.*, the occurrence of pesticide use sites in close proximity to known migratory routes, seasonal presence of species at use sites versus timing of pesticide use, and other life history information presented see General Life History table in Species Groupings below).

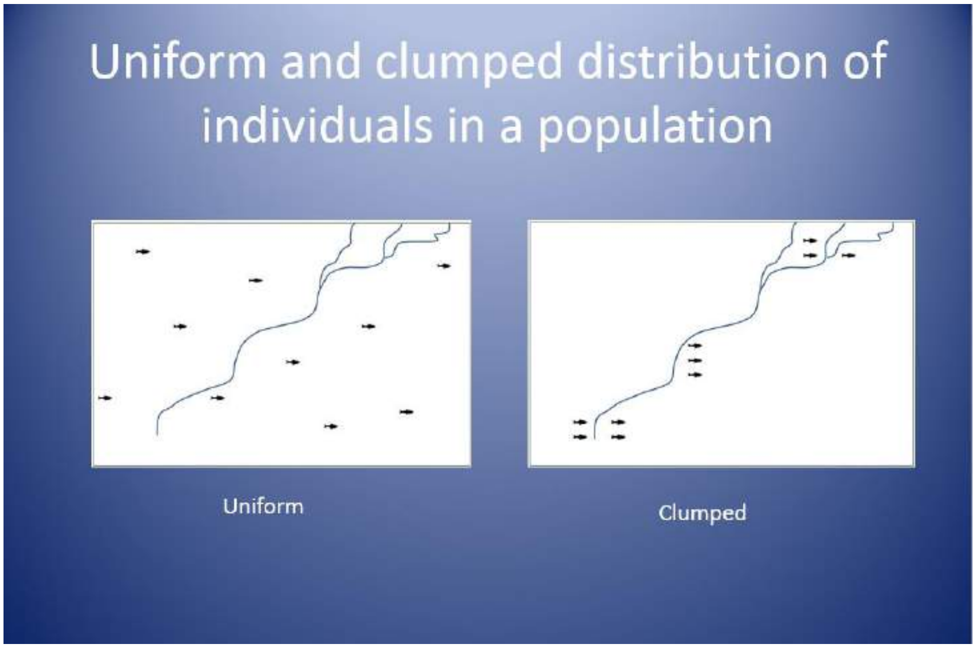


Figure 1. Uniform versus clumped distribution.

4) Pesticide transport assumptions tend to **underestimate** risk: The MagTool calculates the probability of a species' exposure by assuming it is equivalent to the proportion of a species range that can be treated with the pesticide. The estimated exposure probability may underestimate risk because it does not incorporate the size of the toxic footprint that may result due to transport of pesticides from drift, runoff, downstream transport, and other transport pathways (***Figure 2, Figure 3***). While the MagTool contains a separate drift calculator that estimates how far beyond the use site a given effect may occur due to the drift pathway, this information is not factored into the MagTool output of a species' exposure probability. This assumption contributes to the likelihood that exposure (e.g. EECs that cause reduced fitness due to lethal and sublethal effects) will be underestimated for specific uses. This factor is irrelevant for cases when the pesticide can be applied anywhere (i.e. chlorpyrifos treatments for mosquitos and wide-area use; malathion treatments for mosquitos). To mitigate the effect of this assumption on our risk estimates, we qualitatively assumed that transport would increase the probability of exposure beyond the immediate site of application depending on chemical persistence and the degree to which R-plot relationships revealed exposure estimates exceeded toxicity thresholds. The R-plots summarize exposure estimates for habitats immediately adjacent to use sites. Evaluation of where the use sites occur within the species range and the proximity of use sites to sensitive areas (e.g. rearing locations, migratory corridors, etc.) were factors assessed to determine the likelihood of exposure in our weight-of-evidence approach.

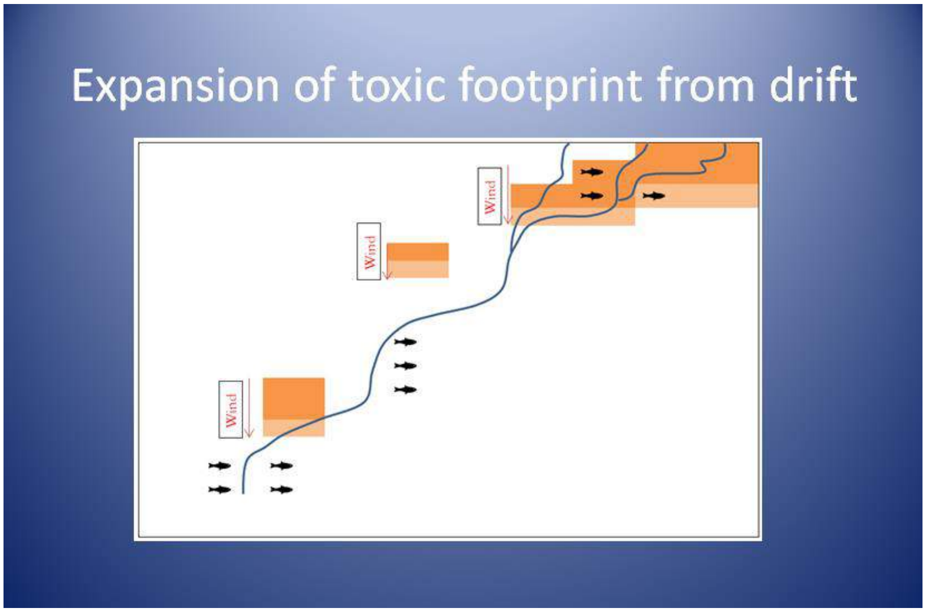


Figure 2. Pesticide are transported off the use site (dark orange) on air currents at toxic concentrations (drift, light orange). MagTool drift calculator suggests toxic concentrations due to drift transport can occur >1000 feet from the target pesticide use site.

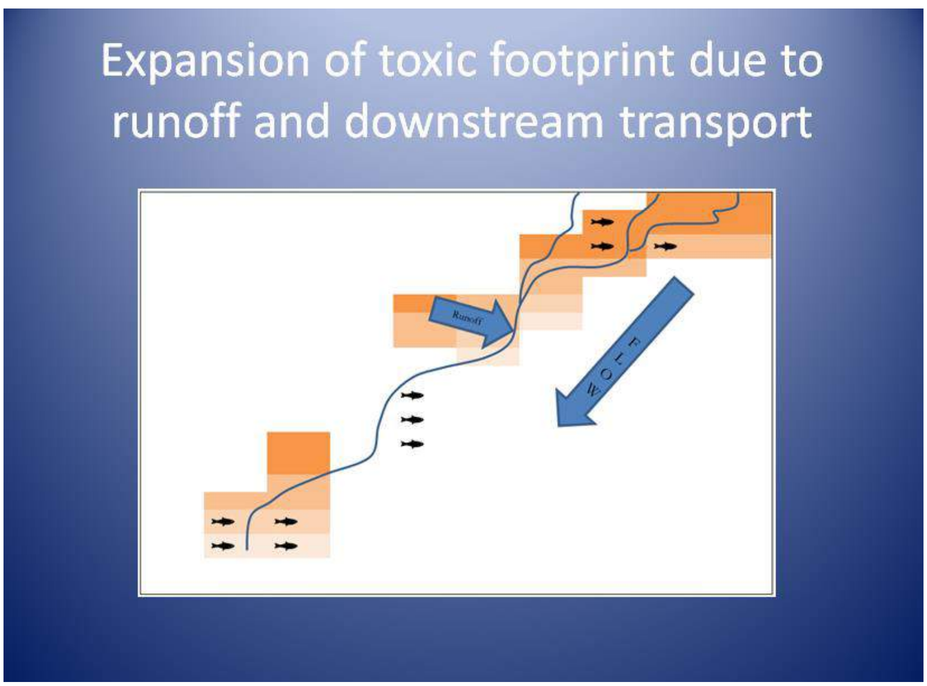


Figure 3. Pesticides are transported from use sites (dark orange) in surface waters via runoff and downstream transport (light orange). These transport mechanisms and others expand the toxic footprint increasing the likelihood of exposure to greater numbers of individuals. The exposure probability calculated

with MagTool may underestimate risk because they do not incorporate the size of the toxic footprint that may result due to transport of pesticides from drift, runoff, downstream transport, and other transport pathways.

5) Movement of individuals assumption tends to **underestimate** risk: The exposure probabilities generated by the MagTool do not account for movement of individuals within a HUC12 or among HUC12s. As noted earlier, data or tools to predict the location of individual members of a species at a particular time are generally not available. The MagTool assumes an individual occupies a fixed location in time and space. However, during the course of a year or a lifetime, an individual may move from areas that do not include use sites to ones that do (***Figure 4***). In fact, individuals that migrate long distances are likely to migrate directly through, or adjacent to, multiple use sites increasing the likelihood of exposure. This assumption of fixed locations contributes to the possibility that risk of exposure may be underestimated, because the movement of individuals could lead to them being exposed to multiple chemicals or applications at more than one location. Therefore, to mitigate the effects of this fixed-location assumption, we also considered life history characteristics related to movement of individuals when characterizing likelihood of exposure (changes in habitat use with life stage, migratory pathway, timing of residence and migration, etc.).

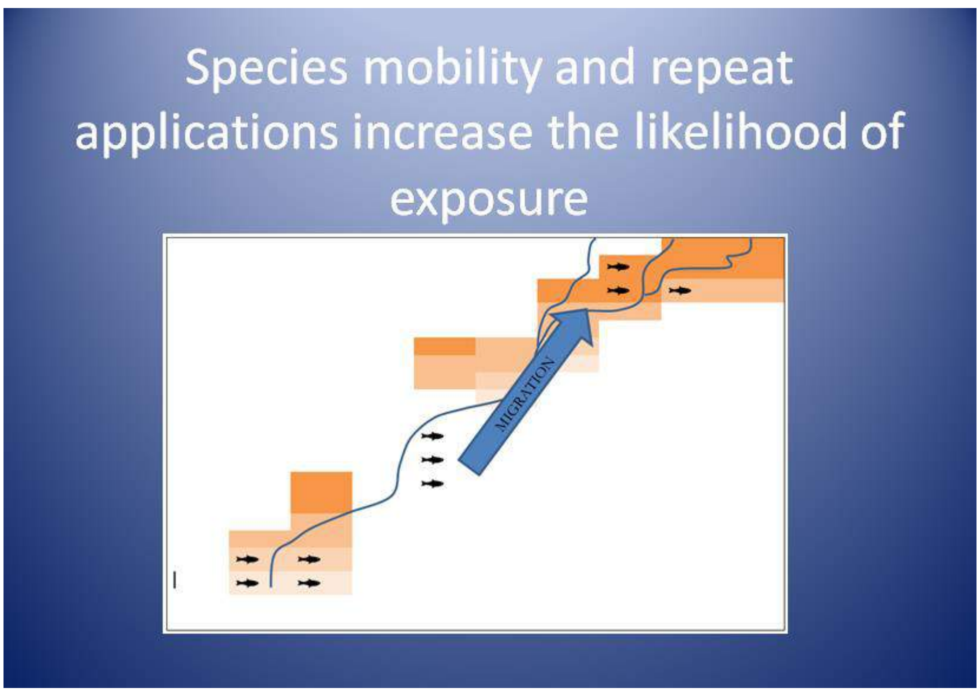


Figure 4. Over time, individuals can move from areas where the likelihood of pesticide exposure is relatively low due to the absence of authorized uses (e.g. residence in offshore marine habitats) to areas where the likelihood of pesticide exposure is relatively high given the presence of multiple use sites (e.g. migration through an agriculture basin during period when pesticide treatment may occur).

6) Annual maximum exposures assumptions tend to **underestimate** risk: The MagTool calculates probabilities of effect based on a limited set of potential exposures, i.e. the likelihood of exposure to maximum annual 24-hr peak or other maximum annual time-

weighted average duration (***Figure 5***). R-plots also display annual time-weighted average concentrations. However, exposure to lesser concentrations (submaximal) can also contribute to risk. While the maximum daily peak occurs one day a year, toxic residues may persist for days, weeks, or months due to repeated applications of pesticides and their persistence. The assumption of annual maximum exposures omits the entire range of exposures expected to cause mortality and other effects, and thus contributes to the likelihood that risk will be underestimated. Therefore, to mitigate the impact of this assumption, chemical persistence and the number of applications allowed were adopted as factors in our analysis to weigh the likelihood of exposure.

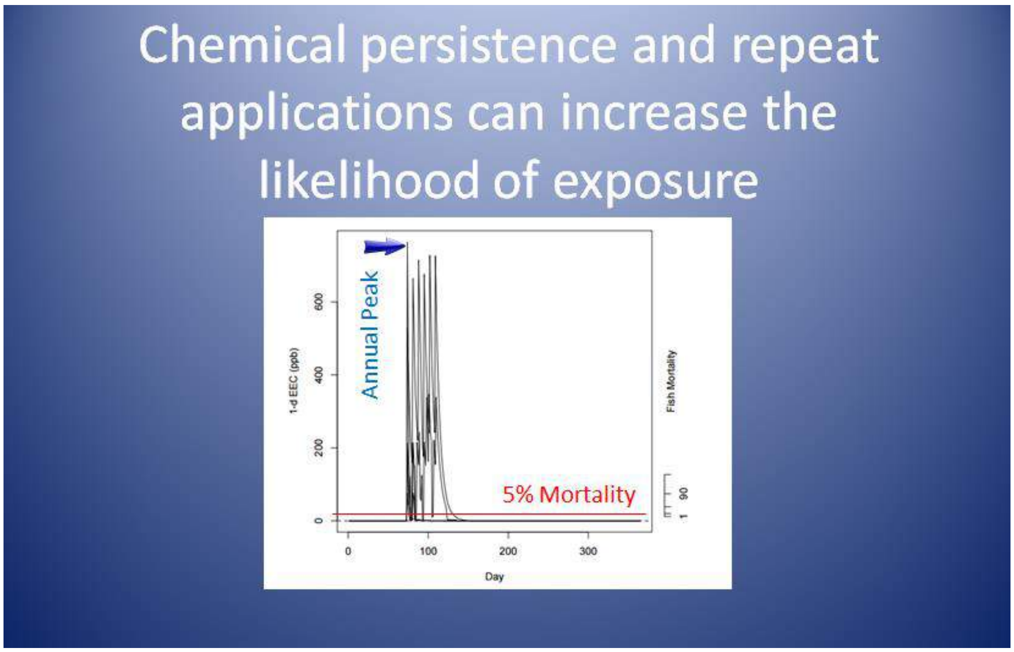


Figure 5. Exposure estimates for this malathion time-series plot suggest conditions conducive to mortality may persist for months due to the combinations of malathion's persistence and repeat applications. The MagTool predicts risk based on the likelihood of exposure to the maximum annual peak which occurs one day a year, but does not factor in all exposures to the pesticide the rest of the year, that while lower, may still produce mortality or other sublethal effects.

7) GIS data layer assumptions may **overestimate or underestimate** risk: Our analysis relies on GIS data layers representing land use classifications which we use as surrogates for locations where pesticides can be applied (pesticide use sites). Four issues arise that may contribute to an over- or under-estimate of risk.
    a. Accuracy of data layers. The GIS data layers contain many inaccuracies and local knowledge suggests that land use type is frequently misclassified. The extent of the inaccuracies is uncertain as information quantifying the level of inaccuracy was not available.
    b. The MagTool estimates rely on an assumption that recent land use (sampling from a 6-year data set) will represent future land use over the next 15 years. This assumption is uncertain as changes in cropping patterns and other land uses may contribute to assessment inaccuracies.

c. Overlapping data layers. In some cases, data layers for use sites overlap. The overlap may be due to a valid overlap in uses on a single site. For example, it is relatively common to plant more than one crop at a single location during the course of a year (double cropping). The MagTool assumes only one crop will occur at a given location during the course of the year. In cases where overlapping layers are the result of inaccuracies, the MagTool may overestimate or underestimate exposure. In cases where overlapping layers are valid (e.g. double cropping, mosquito adulticide and wide-area use, etc.) the MagTool will tend to underestimate exposure.
d. Data layer availability. The Cropland Data Layer used to identify locations of crop use sites does not include coverage for Alaska, Hawaii, and other lands under U.S. jurisdiction. We used the National Land Cover Database to identify cropland in Alaska and Hawaii. Additionally, we used regional data as surrogates to approximate the magnitude of EECs for pesticide use on U.S. territorial islands (i.e. Southeastern US-HUC3 for the Caribbean; Hawaii-HUC20 for Pacific islands).

Overall, these different kinds of inaccuracy in GIS data would not tend to systematically over- or under-estimate risk, and we assumed these four sources of uncertainty could contribute equally to the likelihood of underestimating or overestimating exposure. When data layers where not available to evaluate the presence/absence of use sites we expressed low confidence in risk estimates.

8) Assumption that exposure to multiple stressors will not increase risk may underestimate that risk: The risk estimates derived by the MagTool and information summarized in the R-plots do not account for other real world stressors known to exacerbate responses to organophosphate insecticides (i.e. temperature, exposure to other pesticides, etc.). This assumption contributes to the likelihood that risk will be underestimated. To account for potential increases in risk associated with multiple stressors, we evaluated the available information supporting risk hypotheses that (a) elevated temperatures could enhance the toxicity of pesticides in listed coldwater fishes, and (b) pesticide mixtures applied as multi-a.i. formulations or tank mixtures could increase risk from direct and indirect effects for the listed species. Exposure to temperature stress was evaluated based on the occurrence of impaired water quality due to exceedance of temperature thresholds (Clean Water Act section 303(d) listings) in the habitat of the listed species. The mixtures' risk hypotheses were evaluated qualitatively by generating exposure and response estimates for examples of multi-a.i. pesticide formulations and tank mixtures as described in the Effects of the Action below.

9) Species surrogacy assumptions may **underestimate or overestimate** risk: In most instances, the sensitivity of endangered species and their prey to the stressors of the action have not been tested; their sensitivities are assumed to be comparable to surrogate species that have been tested. These assumptions may underestimate or overestimate risk, depending on the relative sensitivity among the species. Species surrogacy represents a large source of uncertainty because sensitivities among even closely related species can span several orders of magnitude and frequently, extrapolations across taxa groups are necessary due to the absence of information with closely related species (e.g. the BEs include extrapolations of toxicity response data from mallard duck to estimate responses in sea turtles as they sometimes represented the nearest taxonomic relation with available information). EPA's BEs summarized the range of available toxicity data for different taxa as data arrays (e.g. LC50s for mortality and LOECs for sublethal endpoints). When enough data was available, Species Sensitivity Distributions (SSDs) were used to describe the variability in sensitivity among species to pesticides by utilizing empirical toxicity data and fitting them to a distribution curve. For example,

10) ***Figure*** 6 shows an SSD curve derived for malathion based on variability in toxicity of malathion among saltwater invertebrate species (y-axis, LC50s; EPA 2017c). Species in the figure with corresponding quantile values of >0.5 (x-axis) are less sensitive than the median, or 50th percentile of the distribution. When EPA had sufficient data to develop SSDs (e.g. fish mortality endpoints) the 5th percentile in sensitivity was used to generate output for the MagTool and R-plots (i.e. we selected a values that suggested a 95% probability that toxicity to species would not be underestimated). For endpoints with too little data available to generate an SSD (e.g. sublethal responses), the range of available data was considered (e.g. behavior LOECs) with an emphasis on the greatest sensitivity (e.g. lowest behavior LOEC). In either case, the aim was to weight the analysis in a way that errors were more likely to be protective of the listed species yet consider all of the available data.

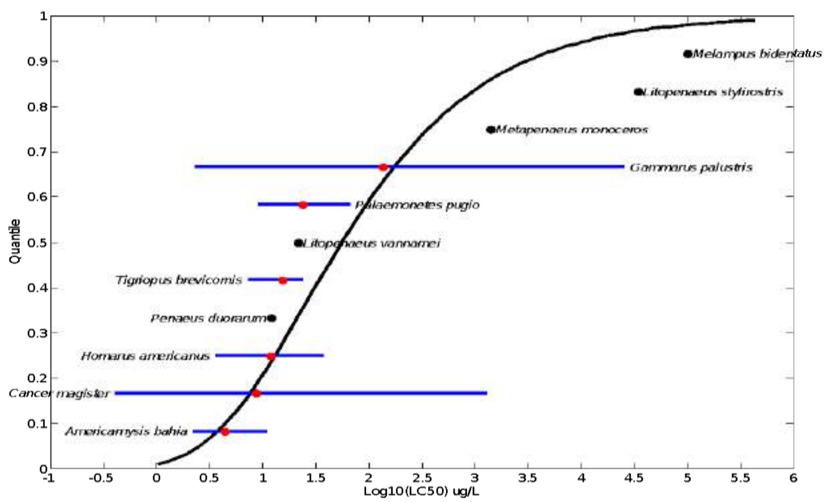


Figure 6. Species Sensitivity Distribution (SSD) example from the malathion BE (EPA 2017c). Log-gumbel distribution fit to malathion saltwater invertebrate data. Black points indicate single toxicity values. Red points indicate average of multiple toxicity values for a single species. Blue line indicates full range of toxicity values for a given species.

11) Exposure estimate assumptions may **underestimate or overestimate** risk: EPA developed estimates for the aquatic habitat bins with the PWC model (an integration of PRZM5 and the VVWM), as described in their BE (EPA 2017 a, b, c). The output generated using R-plot and MagTool relies on the EEC estimates generated with the PWC model. The accuracy of the exposure estimates depends on how well model inputs represent site-specific conditions. EPA generated geographically-specific EECs for a variety of aquatic habitats (bins) for all HUC2 regions in the U.S (section 11.3.1

describes aquatic bins). While a more refined HUC scale is possible, it was not deemed feasible for the analysis given the nation-wide scale of the assessment that includes all federally listed endangered and threatened species. A substantial amount of variability in environmental conditions occurs at the HUC2 scale that influences exposure. Input variables were selected to represent sites vulnerable to runoff within the region as described in EPAs BEs (EPA 2017 a, b, c). While alternative inputs (e.g. selection of a different meteorological station) could result in higher or lower EECs, overall the Services agreed with EPA that the approach was appropriate to evaluate the likelihood of fitness level impacts at the individual scale for the 15 year action (Step 2 described within the EPA's Biological Evaluations). The models are designed to predict pesticide concentrations in aquatic habitats on the edge of a treated field. We expect the models to provide reasonable estimates of exposure in habitats located in close proximity to treated areas, particularly when the size of the assumed drainage area is comparable with the size of single spray applications (e.g. smaller drainages areas such as those represented by the flowing aquatic bin 2, and the static freshwater bins 5, 6, and 7). While inputs are weighted to generate estimates at the higher end of the exposure range within the region, it's possible that exposure is underestimated for some sites (e.g. those that receive greater rainfall than assumed, or site with soil characteristics more conducive to runoff). However, overall we expect the EEC to provide reasonably accurate estimates with a tendency to overestimate exposure under most conditions. There is much greater uncertainty with regard to estimates generated for aquatic habitats represented by bin 3 and 4; unlike the other freshwater bin estimates which assume pesticide treatment of drainage areas consist with the size of single outdoor applications (<0.0001-600 acres), bins 3 and 4 assume drainage from much larger watersheds that would include multiple land uses, use sites, and areas where use may not be permitted (9,000-several million acres). The assumption that all of the use sites within these large watersheds are treated with pesticides tends to overestimate risk (assumption #2 above), while averaging concentrations over such large areas does not account for potential variation within the watershed and may underestimate risk when individuals are distributed in close proximity to use sites (assumption #3 above). Consequently, we gave less weight to exposure estimates generated for bins 3 and 4 than we gave to estimates generated for bins 2, 5, 6, and 7. Even greater uncertainty exists for marine habitats where model estimates that account for complex currents and tidal exchange are not available. Consequently, EPA used freshwater bins as surrogates to estimate exposure in marine and estuarine habitats. We feel the values derived for these bins are most likely to overestimate exposure given the potential for dissipation due to tidal action and the dilution potential of deeper water habitats. Therefore, we did not use the MagTool to generate quantitative responses for marine habitats and R-plot estimates for marine habitats were given little weight in drawing conclusions in our evaluation of population level effects.

12) The assumption that field and laboratory exposure result in comparable responses may **underestimate or overestimate** risk: Standardized laboratory toxicity tests typically require that pesticide concentrations be maintained at a relatively stable concentration for the duration of the exposure period. In the natural environment, pesticides continue to degrade and dissipate at varying rates depending on site-specific conditions and the

pesticide's physical-chemical properties. The conventional approach for handling the uncertainty associated with the differing exposure patterns was assumed; exposure estimates using time-weighted average (TWA) concentrations that factor in degradation and dissipation were assumed to produce similar responses to toxicity test conducted under relatively constant exposure concentrations conducted with comparable exposure durations. TWA exposure estimated for acute durations (1d and 4d) were used to estimate responses based on acute toxicity studies and TWA estimates for chronic durations (21-d) were used to estimate responses using chronic studies. Utilizing average concentrations estimated under natural conditions can either underestimate or overestimate risk because response is a function of both exposure duration and concentration. Actual response may vary depending on site-specific dissipation pattern and toxicokinetic factors. For example, cholinesterase inhibition occurs rapidly and adverse responses can occur with exposure at much shorter durations than the standard 96-hr duration acute study used to estimate lethality in fish. Consequently, a 4-day TWA may underestimate lethality if exposure for shorter durations is sufficient to elicit mortality. Given the rapid onset of AChE-inhibition, the primary mechanism of action of the three pesticides, we used both 1-day and 4-day TWAs to evaluate responses to acute exposures.

13) Assumptions on lack of information empirically linking effect endpoints with fitness level consequences may **underestimate or overestimate** risk: An adverse outcome pathway establishing causal links from the molecular level to individual and population level effects exists for these and other AChE-inhibiting compounds. Chlorpyrifos, diazinon, and malathion inhibit AChE, which interferes with normal nervous system transmission, and has been linked to behavioral, reproductive, and lethal effects. Yet, these links frequently do not provide the information needed to predict the degree to which the "apical endpoints" of growth, reproduction, and survival may be impaired. Sublethal effects to essential behaviors, such as impacts to a fish's ability to swim or a bird's ability to fly, can clearly translate to fitness level consequences by impairing an individual's ability to feed, escape predation, migrate, etc. If information is lacking to establish the degree to which impacts to a fish's ability to swim impact its ability to survive and reproduce, we can either assume the apical endpoints will not be impacted and likely underestimate the risk, or we can assume they will impact individual fitness which may overestimate risk. To ensure protection of the species, we logically inferred that impacts to a species essential behaviors (e.g. effects on the ability of salmon to feed, escape predation, migrate, home, osmoregulate, etc.) and impacts to the availability of food were capable of producing fitness level consequences regardless of the presence of empirical studies quantitatively linking these assessment measure to an apical endpoint.

11.6.5 Pesticide mixtures

Consideration of the toxicity resulting from exposure to pesticide mixtures is an important part of the Effects Analysis of this Opinion. This is due in part to the identified need to consider all effects of the action when making jeopardy determinations and establishing RPAs/RPMs. Pesticide mixtures are explicitly permitted on EPA-authorized product labels, and are therefore part of the action under consultation here. Additionally, monitoring data showing that pesticide mixtures are common in aquatic habitats throughout the United States (Gilliom et al 2007, Bradley et al 2017) supports the expectation that ESA-listed species will be exposed to complex pesticide mixtures. Tools to predict mixture toxicity are widely available and utilize readily available exposure and toxicity data. Finally, failing to consider mixtures may underestimate pesticide risk to such an extent as to lead to erroneous conclusions and ineffective protections for listed species.

Pesticide mixtures can be divided into three categories; formulated products, tank mixes, and environmental mixtures. Formulated products are produced and sold as one product containing multiple active ingredients. Since the exact types and amounts of the active ingredients are shown on the product labels, it is possible to predict the resulting aquatic concentrations following their use. Several formulated products containing malathion, chlorpyrifos, and diazinon have been identified as part of this action and are shown in ***Table 1***. Tank mixes refer to a situation where the pesticide user applies multiple pesticides simultaneously at the use site. Tank mixes are explicitly allowed on product labels and their use is often encouraged to increase pesticide efficacy. Environmental mixtures result from unrelated pesticide use over the landscape and are typically detected in ambient water quality monitoring efforts. Estimates of risk from these three types of mixtures were generated here using current product labels, routine toxicity data, and EECs. These estimates of risk contribute to the overall qualitative mixtures analysis.

Current methodologies for calculating mixture toxicity indicate that additivity is the appropriate initial assumption (Cedergreen 2014). Therefore, additive toxicity is the default assumption in this Opinion unless available data suggest antagonism (less than additive toxicity) or synergism (greater than additive toxicity) is more appropriate. Additive toxicity can be calculated by using either dose-additive or response-additive equations, depending on the nature of the pesticides under consideration. For chemicals with similar modes of action (i.e., organophosphate pesticide that inhibit AChE), dose-addition is appropriate. Conversely, response-addition is appropriate for chemicals with dissimilar modes of action. The preponderance of evidence supports this approach and is consistent with the best available scientific information and peer-reviewed publications.

Estimates of additive toxicity utilize two main pieces of information - exposure concentrations and taxa-specific toxicity values. Exposure concentrations were generated using EPA's Pesticide Water Calculator (PWC), which incorporates chemical-specific parameters (e.g., breakdown rates in water and soil) and application-specific parameters (e.g., application method and rate) to calculate anticipated water concentrations over several different averaging durations (e.g. 1-day and 4-day average peak concentrations). Likewise, standard measures of toxicity (typically the LC_{50}, or the concentration that is lethal to 50% of the test organisms) were gathered from various EPA sources for the relevant taxa groups to which NMFS listed species belong. Calculating toxicity at the taxa level is important, since taxa groups can have vastly different sensitivities to a given pesticide. For example, aquatic invertebrates are more sensitive to organophosphates than are mammals (i.e., much lower LC_{50} values), and therefore will have different estimates of expected risk following exposure to mixtures. Calculations of taxa-level toxicity are also useful for representing species for which no species-specific toxicity data are available (i.e., sawfish).

Calculations of dose-addition follow the reasoning that cumulative toxicity reflects the sum of the individual LC_{50}s normalized to their respective exposure concentrations. Here we used a sigmoidal equation of the following form:

E(Cmix) =100/(1+(cumulative LC50)^slope) where *slope* is an appropriate logistic slope (e.g. around 1 for enzyme inhibition) and the *cumulative* LC_{50} is the sum of each of the LC_{50} values normalized by their respective exposure concentrations.

Calculations of response-addition of chemicals A and B, or the sum of the toxic response, were done using the following equation:

E(C_mix)= 100*((mortality A)+(mortality B)-(mortality A*mortality B))

where mortality is a function of taxa-specific LC_{50} or median effective concentration (EC_{50}) values, chemical-specific EECs, and an appropriate probit slope (e.g. the standard 4.5 for mortality).

11.6.5.1 Formulated products

Pesticide Labels

The Description of the Action section of this Opinion summarizes current product labels and identifies approved active ingredients (a.i.s) specified on those labels. Some of the approved pesticides are formulated products, which contain two or more active ingredients in defined proportions. Currently registered formulated products containing chlorpyrifos, malathion or diazinon with their additional active ingredient are presented in ***Table 11***. Quantitative examples of select formulated products containing chlorpyrifos with bifenthrin, zeta-cypermethrin, or a cyhalothrin are developed below.

Table 11. Currently registered formulated products containing chlorpyrifos, diazinon or malathion and at least one other active ingredient.

Registration#	Product Name	Percent Active Ingredient	Active Ingredient
279-9545	F9047-2 EC Insecticide	3.08	Zeta-cypermethrin
		30.8	Chlorpyrifos
499-405	Whitmire PT 1920 Total Release	1.6	Cyfluthrin
		8	Chlorpyrifos
1381-243	Tundra Supreme	28.6	Chlorpyrifos
		9	Bifenthrin
8329-36	ULV Mosquito Master 412	4	Permethrin
		12	Chlorpyrifos
8329-73	ULV Mosquito Master 2+6	6	Chlorpyrifos
		2	Permethrin
34704-1086	Match-Up Insecticide	9	Bifenthrin
		28.6	Chlorpyrifos
39039-6	Warrior Cattle Ear Tag	10	Chlorpyrifos
		30	Diazinon

Registration#	Product Name	Percent Active Ingredient	Active Ingredient
62719-575	Cobalt	30	Chlorpyrifos
		0.54	Gamma-cyhalothrin
62719-615	Cobalt Advanced	1.44	Lambda-cyhalothrin
		28.12	Chlorpyrifos
66222-259	Mana24301	2.02	Bifenthrin
		19.8	Chlorpyrifos
67760-112	Bolton Insecticide	30	Chlorpyrifos
		0.99	Gamma-cyhalothrin
86363-11	Bifenchlor	9	Bifenthrin
		28.6	Chlorpyrifos
89168-20	Liberty	28.6	Chlorpyrifos
		9	Bifenthrin
11556-123	Co-Ral Plus Cattle Ear Tag	20	Diazinon
		20	Couamphos
11556-148	Corathon	35	Diazinon
		15	Coumaphos
4-122	Bonide	0.3	Carbaryl
		11.76	Captan
		6	Malathion
829-175	SA-50	75	Mineral Oil
		5	Malathion
67760-108	Fyanon Plus ULV	1.47	Gamma-cyhalothrin
		92.2	Malathion
67760-131	Malathion 851 g/L + Gamma-Cyhalothrin 12.8 g/L EC	1.11	Gamma-cyhalothrin
		73.7	Malathion

Mechanisms of Action
Chlorpyrifos, malathion and diazinon are organophosphate pesticides that elicit toxicity via the inhibition of the neurological enzyme acetylcholinesterase (AChE). High levels of AChE inhibition produce a suite of symptoms and can ultimately lead to death. The other active ingredients (i.e., bifenthrin) found in these formulations primarily belong to the pyrethroid class of chemicals that elicit toxicity through the disruption of sodium channel function (***Figure** 7*). Even though these two classes of chemicals act via different mechanisms, the ultimate outcome is impaired neurological function in the exposed animal. Reported LC_{50} values for each active ingredient and each taxa group are shown in ***Table 12***. The standard slope value of 4.5 was used to

represent the mortality dose-response relationship of each chemical and taxa group, except for bifenthrin where a fish-specific slope of 3.53 was used.

Table 12. Taxa-specific toxicity parameters of each active ingredient used in the calculation of formulated product toxicity. LC_{50} and EC_{50} values are the lowest reported for freshwater fish and freshwater invertebrates. A standard probit slope of 4.5 was used unless taxa-specific data were available.

Active Ingredient	Freshwater Fish		Freshwater Invertebrates	
	LC_{50}	slope	EC_{50}	slope
Bifenthrin[1]	0.15	3.53	0.000493	4.5
Lambda-Cyhalothrin[1]	0.029	4.5	0.00008	4.5
Cypermethrin[1]	0.39	4.5	0.00056	4.5
Chlorpyrifos[2]	1.7	4.5	0.0138	4.5

[1]EPA 2016 Preliminary Comparative Environmental Fate and Ecological Risk Assessment for the Registration Review of Eight Synthetic Pyrethroids and the Pyrethrins

[2]EPA 2017a Chlorpyrifos Biological Evaluation (Tables 2-3 and 3-3)

Chemical Properties

The properties of chlorpyrifos, malathion and diazinon (i.e., OPs) are presented in the Problem Formulation section of this Opinion. OPs are generally short-lived in the environment, breaking down via photolysis and hydrolysis within days to weeks. One notable exception is chlorpyrifos, which is persistent in water and sediments. Pyrethroids are generally non-persistent in water due to rapid degradation and sorption to particles. This class of chemicals is generally hydrophobic and will readily sorb onto particles and sink out of the water column into the sediment where they will persistent for some time.

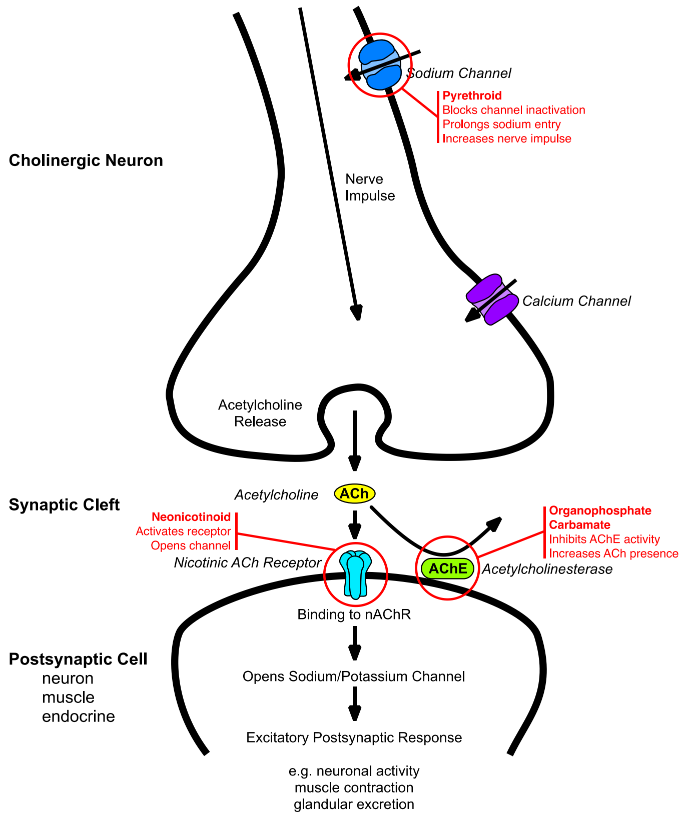


Figure 7. Three common classes of pesticides disrupt neurological signaling by different mechanisms.

Exposure and potential response to product formulations containing multiple active ingredients

The PWC (pesticide water calculator) was used to calculate acute concentrations of pesticide mixtures in a freshwater habitat (bin 7) from a drift event associated with a single application of a formulated product containing multiple active ingredients (

Table 13). Estimates were generated for formulated products that are aerially applied by spray boom to agricultural crops. A common scenario was used for all estimates (corn in HUC2 region 18). PWC inputs used to generate exposure estimates were consistent with current product labeling (*e.g.* application rate) and environmental fate PWC inputs used by EPA in the chlorpyrifos BE (2017) and in the preliminary comparative environmental fate and ecological risk assessment for the registration review of eight synthetic pyrethroids and the pyrethrins (EPA 2016). Mortality responses by freshwater fish and aquatic invertebrates were generated using the response-addition model described above.

Table 13. One-day and four-day peak Expected Environmental Concentration (EEC; µg/L) from a drift event from the aerial application of a multi-active ingredient formulated product to bin 7. Predicted mortality in freshwater fish and aquatic invertebrates was determined using the probit equation for each pesticide alone and the response-addition model for the mixture.

Product: EPA Reg No. 86363-11, BIFENCHLOR®[1]						
	1-day			**4-day**		
chemical	**EEC**	**Fish Mortality**	**Invertebrate Mortality**	**EEC**	**Fish Mortality**	**Invertebrate Mortality**
chlorpyrifos	2.0596	64.62%	100.0%	1.7247	51.12%	100.0%
bifenthrin	0.29651	85.19%	100.0%	0.109	31.22%	100.0%
mixture		**94.76%**	**100.0%**		**66.39%**	**100.0%**
Product: EPA Reg No: 279-9545, F9047-2 EC INSECTICIDE®						
	1-day			**4-day**		
chemical	**EEC**	**Fish Mortality**	**Invertebrate Mortality**	**EEC**	**Fish Mortality**	**Invertebrate Mortality**
chlorpyrifos	0.542	1.27%	100.0%	0.4539	0.49%	100.0%
cypermethrin	0.0149	0.00%	100.0%	0.0042	0.00%	100.0%
mixture		**1.27%**	**100.0%**		**0.49%**	**100.0%**
Product: EPA Reg No: 67760-112, BOLTON INSECTICIDE®						
	1-day			**4-day**		
chemical	**EEC**	**Fish Mortality**	**Invertebrate Mortality**	**EEC**	**Fish Mortality**	**Invertebrate Mortality**
chlorpyrifos	2.168	68.27%	100.0%	1.8155	55.11%	100.0%
gama-cyhalothrin	0.039	71.87%	100.0%	0.017	14.83%	100.0%
mixture		**91.07%**	**100.0%**		**61.77%**	**100.0%**
Product: EPA Reg No: 62719-615, COBALT ADVANCED®						
	1-day			**4-day**		
chemical	**EEC**	**Fish Mortality**	**Invertebrate Mortality**	**EEC**	**Fish Mortality**	**Invertebrate Mortality**
chlorpyrifos	1.7994	54.42%	100.0%	1.5068	40.68%	100.0%
lambda-cyhalothrin	0.0118	3.94%	100.0%	0.0051	0.03%	100.0%
mixture		**56.22%**	**100.0%**		**40.70%**	**100.0%**
Product: EPA Reg No: 62719-575, COBALT®						
	1-day			**4-day**		
chemical	**EEC**	**Fish Mortality**	**Invertebrate Mortality**	**EEC**	**Fish Mortality**	**Invertebrate Mortality**
chlorpyrifos	1.7994	54.42%	100.0%	1.5068	40.68%	100.0%
cyhalothrin	0.0177	16.73%	100.0%	0.0077	0.48%	100.0%

mixture		62.05%	100.0%		59.04%	100.0%

1- Several other products contain chlorpyrifos and bifenthrin in the same ratio including EPA registrations: 89168-20, 34704-1086, and 1381-243. Therefore these pesticides would be predicted to have the same response at the same application rate. Another product (67760-112) contains chlorpyrifos and bifenthrin at a different ratio.

Increases in fish mortality associated with the addition of a pyrethroid insecticide were substantial in many instances. In BIFENCHLOR®, mortality predicted for the chlorpyrifos component based on the 1-day peak concentration was 65%; however, mortality of 95% is predicted due to the additive toxicity of chlorpyrifos and bifenthrin. This same pattern would be predicted for three additional registered products that contain chlorpyrifos and bifenthrin in the same ratio. While two of the formulations evaluated showed relatively small increases in mortality (0-3%; F9047-2 EC INSECTICIDE® and COBALT ADVANCED®), the remaining three formulations predicted increases of mortality of approximately 6 – 30% depending on combinations and interval evaluated.

In the case of aquatic invertebrates, the toxicity for either pesticide alone was predicted to produce 100% mortality. No increase in toxicity is possible as estimates suggest either pesticide will completely eliminate the entire population of aquatic invertebrates. However, the model inputs were selected to provide exposure estimates that are likely on the higher end of the exposure distribution. Evaluation of concentrations associated with lower deposition from spray drift into the aquatic habitat allows us to assess which pesticide dominates the mixture toxicity in aquatic invertebrates.

Table 14. Reduced one-day and four-day peak Expected Environmental Concentration (EEC; µg/L) from those shown in Table 13. Predicted mortality in freshwater fish and aquatic invertebrates was determined using the probit equation for each pesticide alone and the response-addition model for the mixture.

Product: EPA Reg No. 86363-11, BIFENCHLOR®								
	Fish Mortality 75% reduction in EECs				Aquatic Invertebrate Mortality 99.8% reduction in EECs			
chemical	**1-d EEC**	**Mortality**	**4-d EEC**	**Mortality**	**1-d EEC**	**Mortality**	**4-d EEC**	**Mortality**
chlorpyrifos	0.5149	0.98%	0.4318	0.37%	0.0041	0.91%	0.0034	0.34%
bifenthrin	0.0741	13.99%	0.0273	0.45%	0.0006	61.15%	0.0002	10.55%
mixture		**14.84%**		**0.81%**		**61.50%**		**10.85%**

Various processes in the environment and differing application methods could lead to reductions in the EECs shown in ***Table 13***. For example, conditions that create larger spray droplets, lower release heights of spray material, lesser wind speeds, and changes in wind direction all represent situations that would reduce spray drift. Additionally, greater buffers between the treated area and the aquatic habitat will reduce EECs and if large enough, should eventually reduce them to a point were no effects will occur (***Figure 8***). Rather than modeling changes to all of the influencing variables simply assuming lower deposition rates allows us to explore the relative contributions of each pesticide to risk under scenarios that produce lower drift. ***Table 14*** shows predicted mortalities based on reductions in the BIFENCHLOR® EECs shown in ***Table 13*** (75% for fish and 99.8% for aquatic invertebrates). These reductions were chosen such that all of the cases in ***Table 14*** show EECs leading to predicted mortalities from chlorpyrifos exposure alone of <1%. For three of the cases (1-d EECs for fish and 1-d and 4-d EECs for invertebrates), the presence of the bifenthrin in the mixtures lead to substantial increases in mortalities (approximately 14%, 60%, and 10% respectively). The reduced 4-d EECs in fish showed little increase in the toxicity of the mixture (i.e. still <1%) from that seen for chlorpyrifos.

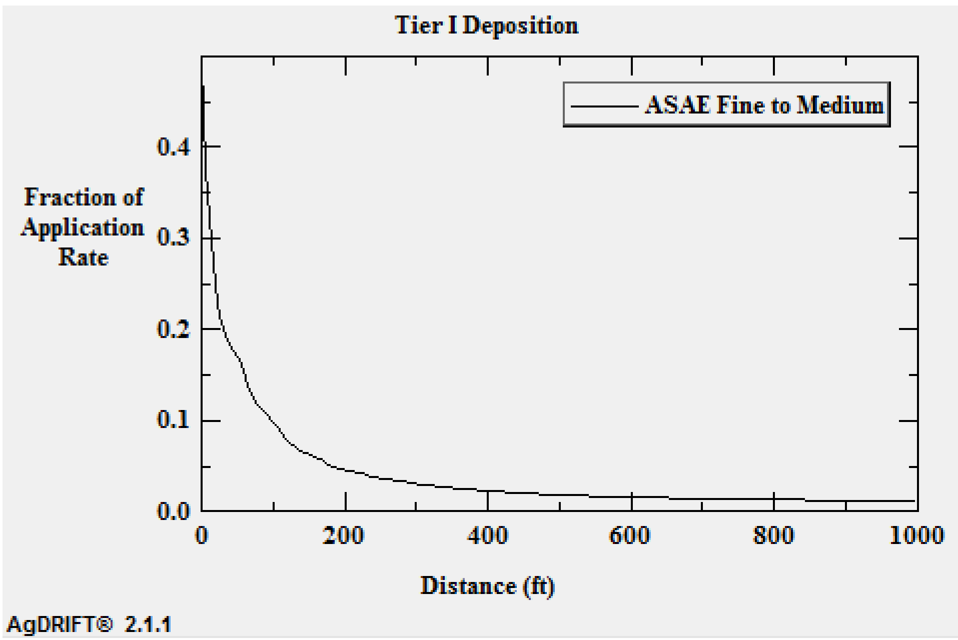


Figure 8. Deposition of pesticides from spray drift decreases as distance from target application site increases. Deposition is expressed as a fraction of the application rate to the target treatment area.

11.6.5.2 Tank mixtures

While pesticide labels explicitly allow, and sometimes even recommend, mixing the product with additional ingredients, including other pesticides, they typically do not define which ingredients to add at the time of application. So while tank mixtures need to be considered as a part of the action, unlike formulated products it is not feasible to develop a list of all tank mixtures. Sources of historical use data are available to provide some information about likely tank mixtures, with the CalDPR database (http://calpip.cdpr.ca.gov/main.cfm) being the most extensive.

Data from pesticide use in California does provide evidence that tank mixtures can be common practice associated with pesticide applications. Data from 2008-2012 shows that across all reported applications of chlorpyrifos, diazinon, or malathion at least one additional neurotoxic pesticide was frequently co-applied (27%, 64%, and 51% of total applications, respectively). For this purpose, the neurotoxic pesticides consist of the classes shown in ***Figure 8*** (organophosphates, carbamates, pyrethroids, or neonicotinoids). The most frequently co-applied class of neurotoxic pesticide was the pyrethroids (15%, 37%, and 35% of total applications, respectively) with permethrin being the most frequently co-applied pyrethroid (3%, 19%, and 17% of total applications, respectively). Finally, co-applications of permethrin with diazinon or malathion frequently occurred on vegetables (e.g. 33% and 35% of applications to leaf lettuce, respectively).

For a quantitative analysis of responses to a likely tank mixture, the PWC (pesticide water calculator) was used to calculate acute concentrations of pesticide mixtures in a freshwater habitat (bin 6) from a drift event associated with a single application of a tank mixture containing permethrin and either diazinon or malathion. A common scenario was used for both estimates (aerial application to vegetables in HUC2 region 18). PWC inputs used to generate exposure estimates were consistent with current product labeling (*e.g.* application rate) and environmental fate PWC inputs used by EPA in the diazinon and malathion BEs (EPA 2017 a, b, c) and in the preliminary comparative environmental fate and ecological risk assessment for the registration review of eight synthetic pyrethroids and the pyrethrins (EPA 2016). Reported LC_{50} values for each active ingredient and each taxa group are shown in ***Table 15***. The standard slope value of 4.5 was used to represent the mortality dose-response relationship of each chemical and taxa group. Mortality responses by freshwater fish and aquatic invertebrates were generated using the response-addition model described above and are shown in ***Table 16***.

Table 15. Taxa-specific toxicity parameters of each active ingredient used in the calculation of tank mixture toxicity. LC_{50} and EC_{50} values (µg/L) are the lowest reported for freshwater fish and freshwater invertebrates. A standard probit slope of 4.5 was used.

Active Ingredient	Freshwater Fish		Freshwater Invertebrates	
	LC_{50}	slope	EC_{50}	slope
Diazinon[1]	85	4.5	0.21	4.5
Malathion[1]	4.1	4.5	0.06	4.5
Permethrin[2]	0.79	4.5	0.0066	4.5

[1]EPA 2017 b, c Diazinon and Malathion Biological Evaluations (Tables 2-3 and 3-3)

[2]EPA 2016 Preliminary Comparative Environmental Fate and Ecological Risk Assessment for the Registration Review of Eight Synthetic Pyrethroids and the Pyrethrins

Table 16. One-day and four-day peak Expected Environmental Concentration (EEC; µg/L) from a drift event from the aerial application of two tank mixtures to bin 6. Predicted mortality in freshwater fish and aquatic invertebrates was determined using the probit equation for each pesticide alone and the response-addition model for the mixture.

Diazinon and Permethrin						
	1-day			4-day		
chemical	EEC	Fish Mortality	Invertebrate Mortality	EEC	Fish Mortality	Invertebrate Mortality
diazinon	3.306	0.0%	100.0%	3.043	0.0%	100.0%

permethrin	0.358	6.1%	100.0%	0.102	0.0%	100.0%
mixture		**6.1%**	**100.0%**		**0.0%**	**100.0%**
Malathion and Permethrin						
	1-day			**4-day**		
chemical	**EEC**	**Fish Mortality**	**Invertebrate Mortality**	**EEC**	**Fish Mortality**	**Invertebrate Mortality**
malathion	11.408	97.7%	100.0%	10.09	96.1%	100.0%
permethrin	0.358	6.1%	100.0%	0.102	0.0%	100.0%
mixture		**97.9%**	**100.0%**		**96.1%**	**100.0%**

Our simulation of a co-application of diazinon and permethrin in a tank mixture predicts an increase in fish mortality compared to diazinon alone; diazinon is not predicted to cause fish mortality under this scenario. However, mortality predicted due to exposure to 1-day peak concentrations of permethrin and the mixture of the two pesticides is 6%. These estimates suggest that permethrin will not persist in surface at concentrations sufficient to cause fish mortality for durations of ≥4 days. A modest combined increase in fish mortality was observed in the simulated malathion/permethrin tank mixture. However, the response was dominated by the malathion component.

All three insecticides are highly toxic to aquatic invertebrates. As with the formulation mixtures, each component alone was predicted to produce 100% mortality to aquatic invertebrates under the simulated conditions. Therefore, as before with formulated products, we reduced the EECs to evaluate aquatic invertebrate responses under reduced drift conditions and assess potential increases in toxicity associated with exposure to mixtures (***Table** 7*).

Table 17. Reduced one-day and four-day peak Expected Environmental Concentration (EEC; µg/L) from those shown in Table 16. Predicted mortality in aquatic invertebrates was determined using the probit equation for each pesticide alone and the response-addition model for the mixture.

Diazinon and Permethrin 96% reduction in EECs				
	1-day		**4-day**	
chemical	**EEC**	**Invertebrate Mortality**	**EEC**	**Invertebrate Mortality**
diazinon	0.1323	18.3%	0.1217	14.3%
permethrin	0.0143	93.48%	0.0041	17.5%
mixture		**94.7%**		**29.3%**
Malathion and Permethrin 96% reduction in EECs				
	1-day		**4-day**	
chemical	**EEC**	**Invertebrate Mortality**	**EEC**	**Invertebrate Mortality**

malathion	0.4563	100.0%	0.4037	100.0%
permethrin	0.0143	93.48%	0.0041	17.5%
mixture		**100.0%**		**100.0%**

At reduced concentrations the diazinon and permethrin tank mixture is predicted to cause greater toxicity to aquatic invertebrates than either pesticide does alone (***Table 17***). While the response is primarily due to the permethrin component using the 1-day TWA, a substantial increase in toxicity to aquatic invertebrates due to additive toxicity is seen using the 4-day TWA. Increases in mortality were not possible to observe in aquatic invertebrates exposed to the malathion and permethrin tank mixtures as malathion was still predicted to cause 100% mortality despite the 96% reduction in predicted EECs.

11.6.5.3 Environmental mixtures

Unrelated use of pesticides throughout the action area can lead to contamination of aquatic habitats, thereby posing a threat to the listed species occupying those habitats. Exposure to multiple pesticide ingredients most likely occurs in freshwater habitats and nearshore environments adjacent to areas where pesticides are used. In a typical year in the U.S., pesticides are applied at a rate of approximately five billion pounds of a.i. per year (Kiely et al. 2004). Ambient monitoring data shows that pesticide contamination in the nation's freshwater habitats is ubiquitous, and that pesticides usually occur in the environment as mixtures (Gilliom, 2007). For example, National Water-Quality Assessment monitoring detected two or more pesticides in more than 90% of samples from urban, agricultural, and mixed-use streams nationwide (Gilliom, 2007).

Therefore, given the scale and scope of pesticide use throughout the action area, it is expected that listed species will be exposed to environmental pesticide mixtures in freshwater and nearshore marine habitats. Here we do not estimate the resulting biological effects of exposure to environmental mixtures. However, given the assumption of additive mixture toxicity, it is reasonable to assume that any adverse impacts will be greater than those produced from the single a.i.s alone.

11.6.5.4 Conclusion

Quantitative examples of expected toxicity from pesticide mixtures including registered formulated products and tank mixes both show greater toxicity than what is expected from single pesticides; this suggests that the co-application of multiple pesticides increases the potential for adverse impacts over larger areas and consequently increased risks to threatened and endangered species. The magnitude of this toxicity, using mortality as the endpoint, is in most cases expected to adversely impact the health of listed fish and aquatic invertebrates.

Despite the uncertainties regarding mixtures (i.e., estimating exposure concentrations and understanding combined biological effects), it remains reasonable to conclude that exposure to pesticide mixtures poses a threat to listed aquatic species. Our overall qualitative analysis of mixtures supports the stated mixtures risk hypothesis.

11.7 Chemical Specific Effects Analysis

See separate chapters for chlorpyrifos (Chapter 12), diazinon (Chapter 13), and malathion (Chapter 14).

CHAPTER 12

CHLORPYRIFOS SPECIES EFFECTS ANALYSIS

TABLE OF CONTENTS

12 CHLORPYRIFOS EFFECTS ANALYSIS

12.1 Introduction

See Chapters 3 (Approach to the Assessment) and 11 (Effects Analysis Introduction) for descriptions of the methods and information used in this section. In this chapter we integrate the exposure and response information to evaluate the likelihood of adverse effects from stressors of the action at the population and species level. The information is organized by species. Within each species section the information is presented in the following order:

1. R- Plots figures: Demonstrate the relationship between geographically-specific exposure distributions and assessment measures (response distributions). These figures also convey the prevalence of registered use sites within the species range (example ***Figure 1***).
2. Likelihood of exposure tables: Tables summarizing assessment of likelihood of exposure to each pesticide use that occurs within the species range (example ***Table 1***).
3. Risk Hypotheses Tables: tables for each risk hypothesis summarizing risk and confidence associated with each registered use that occurs within the species range (example ***Table 3***).
4. Final effects analysis table and narrative summary: Each species sections concludes with a Table indicating which risk hypotheses were supported and associated narrative summary of overall risk of the action to the species (example ***Table 5***). Where applicable, the effects analysis table includes MagTool and/or Pacific salmon population model output. MagTool and population model output is also provided in appendix A: MagTool Results, and appendix B: Pacific Salmon Population Modeling.

12.2 Atlantic Salmon (Salmo salar)

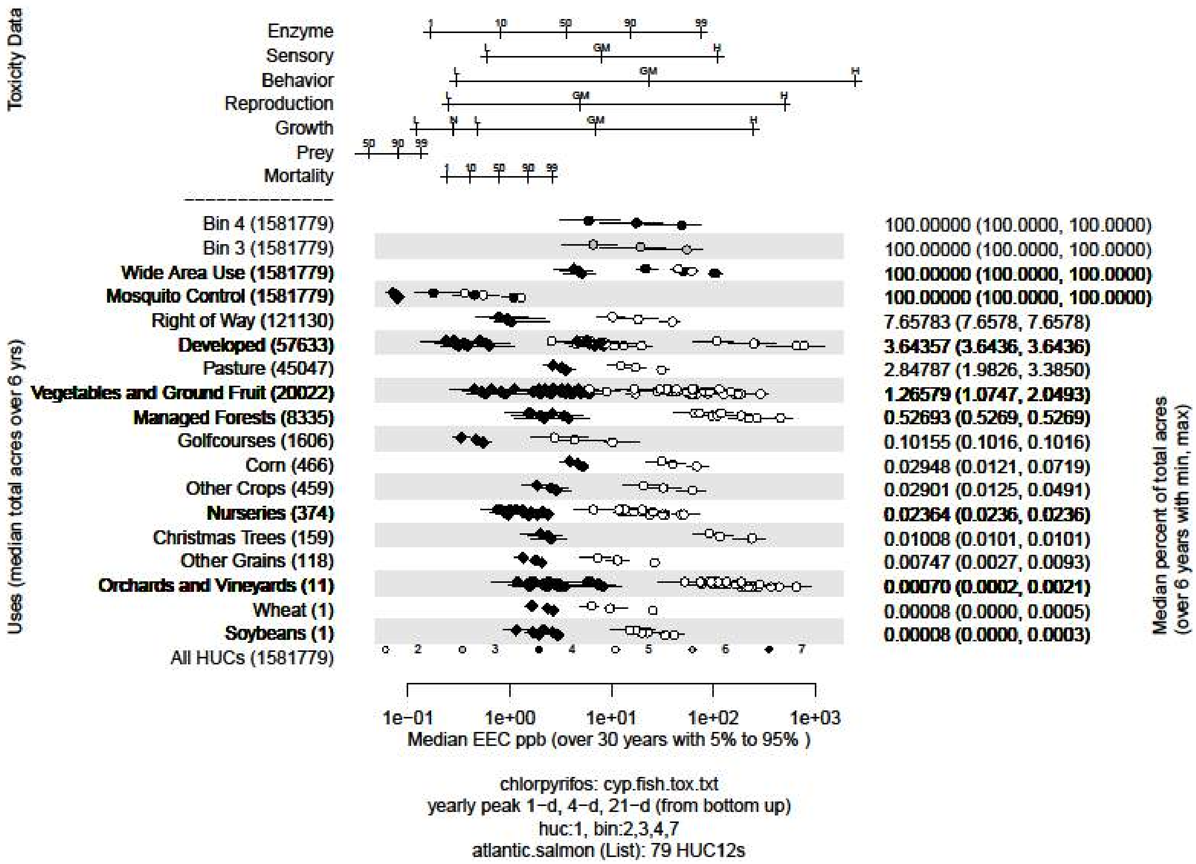


Figure 1. Effects analysis R-plot for Atlantic salmon (coastal marine habitat) and chlorpyrifos

Table 1. Likelihood of exposure determination for Atlantic salmon (coastal marine habitat) and chlorpyrifos

Full Range	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Wide Areas Use	3	yes	yes	yes	NA	2	**High**
Mosquito Control	3	yes	yes	yes	NA	2	**High**
Right of Way	3	yes	yes	yes	NA	2	**High**
Developed	2	yes	yes	yes	NA	2	**High**
Pasture	2	yes	yes	yes	NA	2	**High**
Vegetables and Ground Fruit	2	yes	yes	yes	NA	2	**High**
Managed Forest	1	yes	yes	yes	NA	2	**Low**
Golf Courses	1	yes	yes	yes	NA	2	**Low**
Corn	1	yes	yes	yes	NA	2	**Low**
Other Crops	1	yes	yes	yes	NA	2	**Low**
Nurseries	1	yes	yes	yes	NA	2	**Low**
Christmas Trees	1	yes	yes	yes	NA	2	**Low**
Other Grain s	1	yes	yes	yes	NA	2	**Low**
Bin 3	3	yes	yes	yes	NA	2	**High**
Bin 4	3	yes	yes	yes	NA	2	**High**

Life Stage: Juvenile and Adult (Marine Environment Only)

Table 2.Direct mortality risk hypothesis; Atlantic salmon and chlorpyrifos

Endpoint: Mortality (Marine Environment Only)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Areas Use	100	High	High
Mosquito Control	100	High	High
Right of Way	7.7	High	High
Developed	3.6	High	High
Pasture	2.8	High	High
Vegetables and Ground Fruit	1.3	High	High
Managed Forest	.5	High	Low
Golf Courses	.1	High	Low
Corn	.03	High	Low
Other Crops	.03	High	Low
Nurseries	.02	High	Low
Christmas Trees	.01	High	Low
Other Grain s	.007	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance via acute lethality.			
Risk	**Confidence**		

High	Low	

Table 3. Behavior and sensory risk hypothesis; Atlantic salmon and Chlorpyrifos

Endpoint: Behavior (Marine Environment Only)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Areas Use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	7.7	High	High
Developed	3.6	High	High
Pasture	2.8	High	High
Vegetables and Ground Fruit	1.3	High	High
Managed Forest	.5	High	Low
Golf Courses	.1	Medium	Low
Corn	.03	High	Low
Other Crops	.03	High	Low
Nurseries	.02	High	Low
Christmas Trees	.01	High	Low
Other Grain s	.007	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory (Marine Environment Only)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Areas Use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	7.7	High	High
Developed	3.6	High	High
Pasture	2.8	High	High
Vegetables and Ground Fruit	1.3	High	High
Managed Forest	.5	High	Low
Golf Courses	.1	High	Low
Corn	.03	High	Low
Other Crops	.03	High	Low
Nurseries	.02	High	Low
Christmas Trees	.01	High	Low
Other Grain s	.007	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		

High	**Low**	

Table 4. AChE risk hypothesis; Atlantic salmon and chlorpyrifos

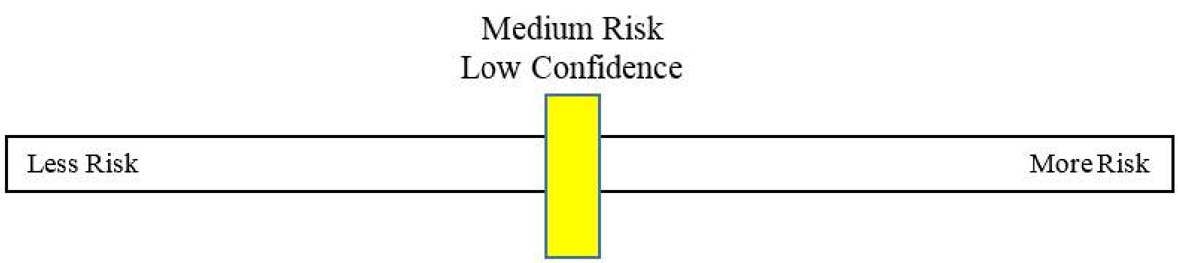
Endpoint: enzyme (Marine Environment Only)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Areas Use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	7.7	High	High
Developed	3.6	High	High
Pasture	2.8	High	High
Vegetables and Ground Fruit	1.3	High	High
Managed Forest	.5	High	Low
Golf Courses	.1	High	Low
Corn	.03	High	Low
Other Crops	.03	High	Low
Nurseries	.02	High	Low
Christmas Trees	.01	High	Low
Other Grain s	.007	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Low**		

Table 5. Effects analysis summary table: Atlantic salmon and chlorpyrifos

	R-plot Derived		**MagTool Range in median percent mortalities for aquatic bins**	**Risk Hypothesis Supported? Yes/No**
Juveniles and Adults (Marine Environment Only)	**Risk**	**Confidence**		
Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance via acute lethality.	High	Low	Not Available	Yes
Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance and adult	High	Low	Not Available	Yes

productivity via impairments to ecologically significant behaviors.				
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Low	Not Available	Yes

Effects analysis summary: Atlantic salmon are not anticipated to experience significant reductions in abundance or productivity (spawning adults) from exposure to chlorpyrifos in the marine environment. If exposed to formulated products and tank mixtures containing chlorpyrifos, Atlantic salmon may experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed Atlantic salmon. The overall risk to Atlantic salmon from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted chlorpyrifos concentrations in coastal habitats. Low confidence of risk is also attributed to lack of information regarding duration of residency of Atlantic salmon in the coastal marine environment within US waters.



12.3 Chum salmon, Columbia River ESU (Oncorhynchus keta)

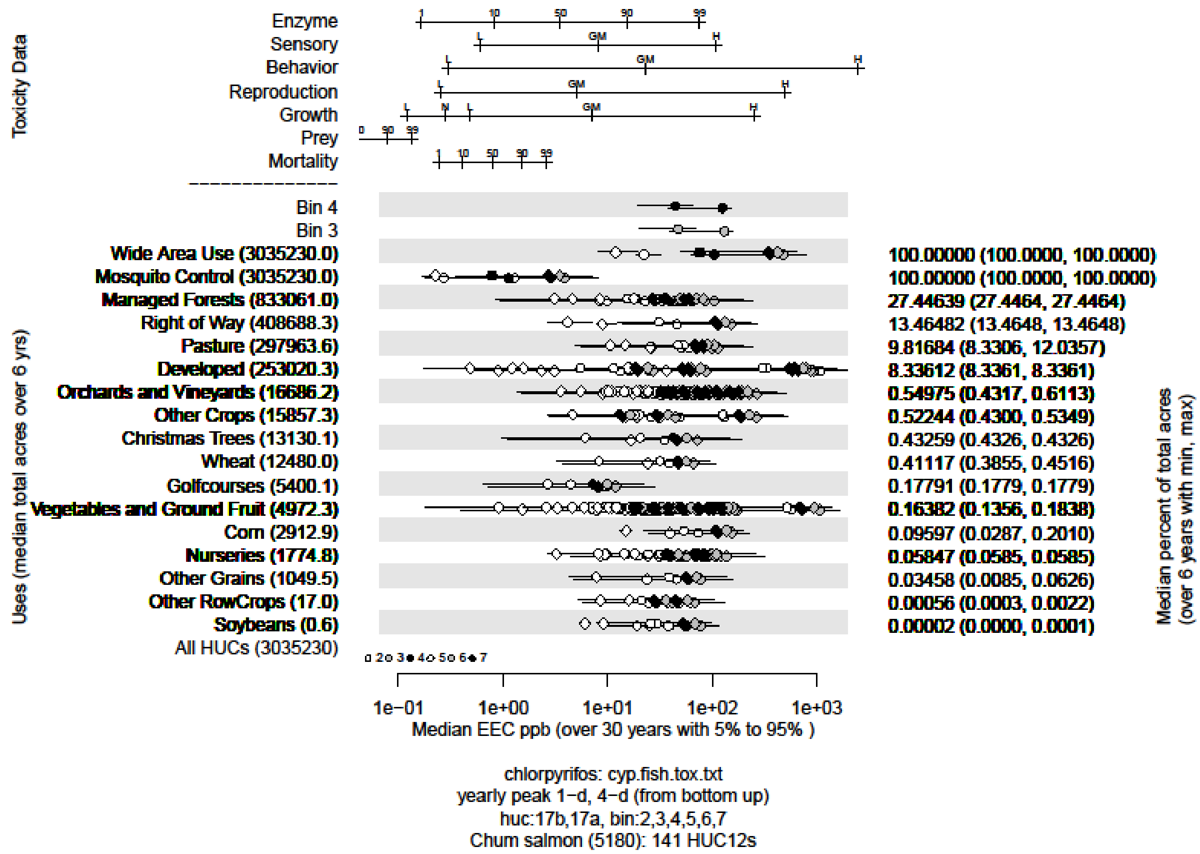


Figure 2. Effects analysis R-plot for Columbia River ESU chum salmon and chlorpyrifos

Table 6. Likelihood of exposure determination for Columbia River ESU chum salmon and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Full Range							
Wide Area Use	3	yes	yes	yes	NA	2	**High**
Mosquito Control	3	yes	yes	yes	NA	2	**High**
Managed Forest	3	yes	yes	yes	NA	2	**High**
Right of Way	3	yes	yes	yes	NA	2	**High**
Pasture	3	yes	yes	yes	NA	2	**High**
Developed	3	yes	yes	yes	NA	2	**High**
Orchards and Vineyards	1	yes	yes	yes	no	2	**Low**
Other Crops	1	yes	yes	yes	no	2	Low
Christmas Trees	1	yes	yes	yes	no	2	**Low**
Wheat	1	yes	yes	yes	no	2	**Low**
Golf courses	1	yes	yes	yes	no	2	**Low**
Vegetables and Ground Fruit	1	yes	yes	yes	no	2	**Low**
Corn	1	yes	yes	yes	no	2	**Low**
Nurseries	1	yes	yes	yes	no	2	**Low**
Other Grains	1	yes	yes	yes	no	2	**Low**
Other Row Crops	1	yes	yes	yes	no	2	**Low**
Soybeans	1	yes	yes	yes	no	2	**Low**
Bin 3	3	yes	yes	yes	no	2	**Low**
Bin 4	3	yes	yes	yes	no	2	**Low**

Life Stage: Juvenile and Adult (full range)

Table 7. Direct mortality risk hypothesis; Columbia River ESU chum salmon and chlorpyrifos

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	**High**
Managed Forest	27	High	**High**
Right of Way	13	High	**High**
Pasture	10	High	**High**
Developed	8	High	**High**
Orchards and Vineyards	1	High	**Low**
Other Crops	1	High	**Low**
Christmas Trees	<1	High	**Low**
Wheat	<1	High	**Low**
Golf courses	<1	High	**Low**
Vegetables and Ground Fruit	<1	High	**Low**
Corn	<1	High	**Low**
Nurseries	<1	High	**Low**
Other Grains	<1	High	**Low**

Other Row Crops	<1	High	**Low**
Soybeans	<1	High	**Low**
Bin 3		High	**Low**
Bin 4		High	**Low**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile and adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 8. Prey risk hypothesis; Columbia River ESU chum salmon and chlorpyrifos

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	**High**
Managed Forest	27	High	**High**
Right of Way	13	High	**High**
Pasture	10	High	**High**
Developed	8	High	**High**
Orchards and Vineyards	1	High	**Low**
Other Crops	1	High	**Low**
Christmas Trees	<1	High	**Low**
Wheat	<1	High	**Low**
Golf courses	<1	High	**Low**
Vegetables and Ground Fruit	<1	High	**Low**
Corn	<1	High	**Low**
Nurseries	<1	High	**Low**
Other Grains	<1	High	**Low**
Other Row Crops	<1	High	**Low**
Soybeans	<1	High	**Low**
Bin 3		High	**Low**
Bin 4		High	**Low**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 9. Behavior and sensory risk hypothesis; Columbia River ESU chum salmon and chlorpyrifos

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Wide Area Use	100	High	High
Mosquito Control	100	Medium	**High**
Managed Forest	27	High	**High**
Right of Way	13	High	**High**
Pasture	10	High	**High**
Developed	8	High	**High**
Orchards and Vineyards	1	High	**Low**
Other Crops	1	High	**Low**
Christmas Trees	<1	High	**Low**
Wheat	<1	High	**Low**
Golf courses	<1	High	**Low**
Vegetables and Ground Fruit	<1	High	**Low**
Corn	<1	High	**Low**
Nurseries	<1	High	**Low**
Other Grains	<1	High	**Low**
Other Row Crops	<1	High	**Low**
Soybeans	<1	High	**Low**
Bin 3		High	**Low**
Bin 4		High	**Low**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	**High**
Managed Forest	27	High	**High**
Right of Way	13	High	**High**
Pasture	10	High	**High**
Developed	8	High	**High**
Orchards and Vineyards	1	High	**Low**
Other Crops	1	High	**Low**
Christmas Trees	<1	High	**Low**
Wheat	<1	High	**Low**
Golf courses	<1	High	**Low**
Vegetables and Ground Fruit	<1	High	**Low**
Corn	<1	High	**Low**
Nurseries	<1	High	**Low**
Other Grains	<1	High	**Low**
Other Row Crops	<1	High	**Low**
Soybeans	<1	High	**Low**
Bin 3		High	**Low**

Bin 4		High	**Low**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile and adult abundance and adult productivity via impairments to ecologically significant behaviors			
Risk	**Confidence**		
High	**High**		

Table 10. AChE risk hypothesis; Columbia River ESU chum salmon and chlorpyrifos

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	**High**
Managed Forest	27	High	**High**
Right of Way	13	High	**High**
Pasture	10	High	**High**
Developed	8	High	**High**
Orchards and Vineyards	1	High	**Low**
Other Crops	1	High	**Low**
Christmas Trees	<1	High	**Low**
Wheat	<1	High	**Low**
Golf courses	<1	High	**Low**
Vegetables and Ground Fruit	<1	High	**Low**
Corn	<1	High	**Low**
Nurseries	<1	High	**Low**
Other Grains	<1	High	**Low**
Other Row Crops	<1	High	**Low**
Soybeans	<1	High	**Low**
Bin 3		High	**Low**
Bin 4		High	**Low**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Table 11. Growth risk hypothesis; Columbia River ESU chum salmon and chlorpyrifos

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	**High**
Managed Forest	27	High	**High**

Right of Way	13	High	**High**
Pasture	10	High	**High**
Developed	8	High	**High**
Orchards and Vineyards	1	High	**Low**
Other Crops	1	High	**Low**
Christmas Trees	<1	High	**Low**
Wheat	<1	High	**Low**
Golf courses	<1	High	**Low**
Vegetables and Ground Fruit	<1	High	**Low**
Corn	<1	High	**Low**
Nurseries	<1	High	**Low**
Other Grains	<1	High	**Low**
Other Row Crops	<1	High	**Low**
Soybeans	<1	High	**Low**
Bin 3		High	**Low**
Bin 4		High	**Low**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
High	**High**		

Table 12. Reproduction risk hypothesis; Columbia River ESU chum salmon and chlorpyrifos

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	**High**
Managed Forest	27	High	**High**
Right of Way	13	High	**High**
Pasture	10	High	**High**
Developed	8	High	**High**
Orchards and Vineyards	1	High	**Low**
Other Crops	1	High	**Low**
Christmas Trees	<1	High	**Low**
Wheat	<1	High	**Low**
Golf courses	<1	High	**Low**
Vegetables and Ground Fruit	<1	High	**Low**
Corn	<1	High	**Low**
Nurseries	<1	High	**Low**
Other Grains	<1	High	**Low**

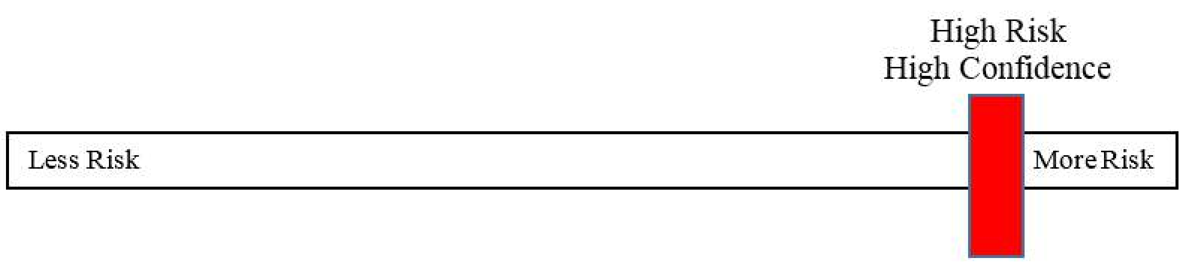
Other Row Crops	<1	High	**Low**
Soybeans	<1	High	**Low**
Bin 3		High	**Low**
Bin 4		High	**Low**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 13. Effects analysis summary table: Columbia River ESU chum salmon and chlorpyrifos

	R-plot Derived		**MagTool Range in median percent mortalities for aquatic bins**	**Population Model Population Model Results**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**			
Risk Hypothesis					
Exposure to chlorpyrifos is sufficient to reduce juvenile and adult abundance via acute lethality.	High	High	4-day: 61-99 **Error! Reference source not found.**	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via reduction in prey availability	High	High	4-day fish: 61-97 4-day invert: 61-100 **Error! Reference source not found.**	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce juvenile and adult abundance and adult productivity via impairments to ecologically significant behaviors	High	High	Not Available		Yes
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available		Yes

Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)	High	High	Not Available	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable	Yes

Effects analysis summary: Adult and juvenile Columbia River ESU chum salmon are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where chlorpyrifos achieves predicted levels. The MagTool results indicate that between 61-99 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, chum will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed chum. The overall risk to Columbia River ESU chum salmon from the effects of the action is high and the confidence associated with that risk is high.



12.4 Chum Salmon, Hood Canal summer-run ESU (Oncorhynchus keta)

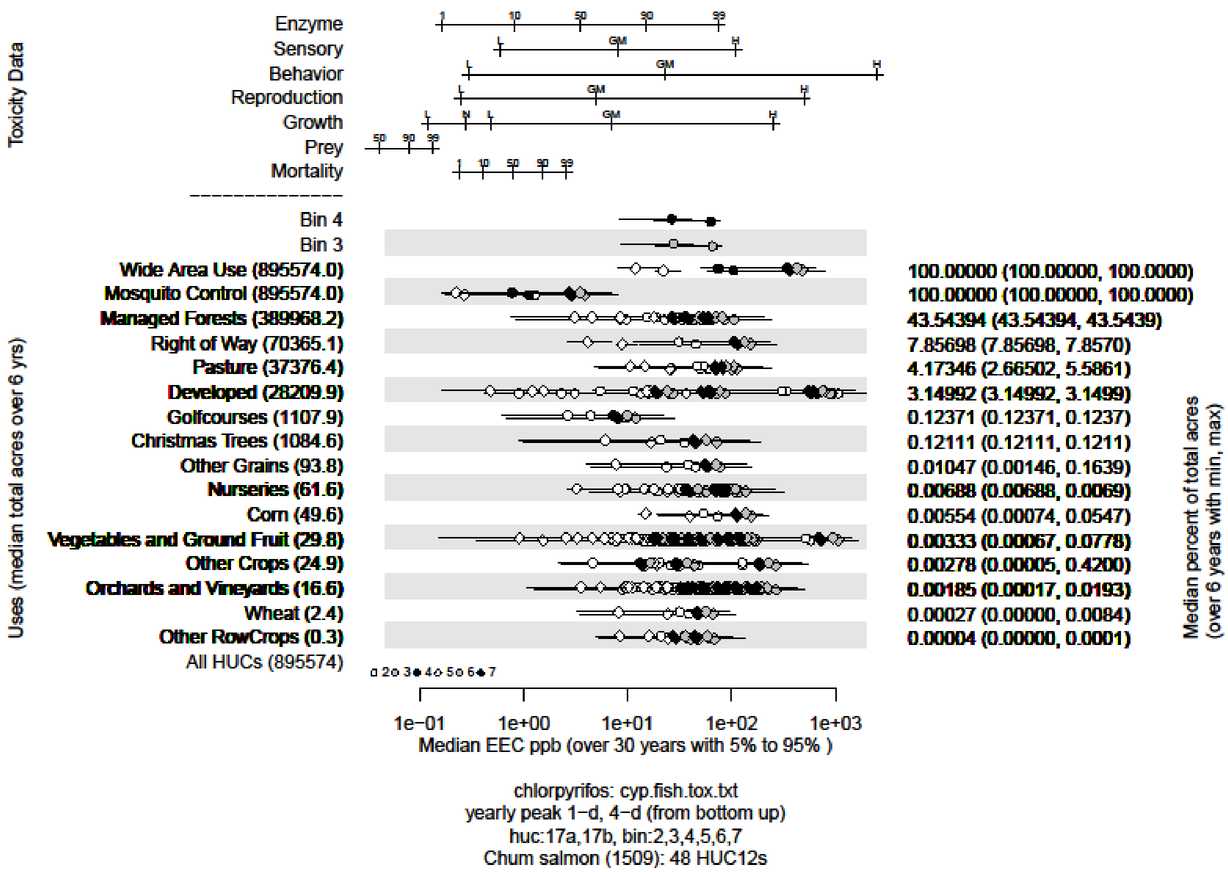


Figure 3. Effects analysis R-plot for Hood Canal summer-run ESU chum salmon and chlorpyrifos

Table 14. Likelihood of exposure determination for Hood Canal summer-run ESU chum salmon and chlorpyrifos

Full Range	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Wide Area Use	3	yes	yes	yes	NA	2	**High**
Mosquito Control	3	yes	yes	yes	NA	2	**High**
Managed Forest	3	yes	yes	yes	NA	2	**High**
Right of Way	3	yes	yes	yes	NA	2	**High**
Pasture	3	yes	yes	yes	NA	2	**High**
Developed	3	yes	yes	yes	NA	2	**High**
Golf Courses	1	yes	yes	yes	no	2	**Low**
Christmas Tree	1	yes	yes	yes	no	2	Low
Other Grains	1	yes	yes	yes	no	2	**Low**
Nurseries	1	yes	yes	yes	no	2	**Low**
Corn	1	yes	yes	yes	no	2	**Low**
Vegetables and Ground Fruit	1	yes	yes	yes	no	2	**Low**
Other Crops	1	yes	yes	yes	no	2	**Low**
Orchards and Vineyards	1	yes	yes	yes	no	2	**Low**
Wheat	1	yes	yes	yes	no	2	**Low**
Other Row Crops	1	yes	yes	yes	no	2	**Low**
Bin 3	3	yes	yes	yes	no	2	**High**
Bin 4	3	yes	yes	yes	no	2	**High**

Life Stage: Juvenile and Adult (full-range)

Table 15. Direct mortality risk hypothesis; Hood Canal summer-run chum salmon and chlorpyrifos

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	High	**High**
Managed Forest	44	High	**High**
Right of Way	8	High	**High**
Pasture	4	High	**High**
Developed	3	High	**High**
Golf Courses	<1	High	**Low**
Christmas Tree	<1	High	**Low**
Other Grains	<1	High	**Low**
Nurseries	<1	High	**Low**
Corn	<1	High	**Low**
Vegetables and Ground Fruit	<1	High	**Low**
Other Crops	<1	High	**Low**
Orchards and Vineyards	<1	High	**Low**

Wheat	<1	High	**Low**
Other Row Crops	<1	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile and adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 16. Prey risk hypothesis; Hood Canal summer-run chum salmon and chlorpyrifos

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	High	**High**
Managed Forest	44	High	**High**
Right of Way	8	High	**High**
Pasture	4	High	**High**
Developed	3	High	**High**
Golf Courses	<1	High	**Low**
Christmas Tree	<1	High	**Low**
Other Grains	<1	High	**Low**
Nurseries	<1	High	**Low**
Corn	<1	High	**Low**
Vegetables and Ground Fruit	<1	High	**Low**
Other Crops	<1	High	**Low**
Orchards and Vineyards	<1	High	**Low**
Wheat	<1	High	**Low**
Other Row Crops	<1	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 17. Behavior and sensory risk hypothesis; Hood Canal summer-run chum salmon and chlorpyrifos

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**

Mosquito Control	100	Medium	**High**
Managed Forest	44	High	**High**
Right of Way	8	High	**High**
Pasture	4	High	**High**
Developed	3	High	**High**
Golf Courses	<1	High	**Low**
Christmas Tree	<1	High	**Low**
Other Grains	<1	High	**Low**
Nurseries	<1	High	**Low**
Corn	<1	High	**Low**
Vegetables and Ground Fruit	<1	High	**Low**
Other Crops	<1	High	**Low**
Orchards and Vineyards	<1	High	**Low**
Wheat	<1	High	**Low**
Other Row Crops	<1	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	44	High	**High**
Right of Way	8	High	**High**
Pasture	4	High	**High**
Developed	3	High	**High**
Golf Courses	<1	High	**Low**
Christmas Tree	<1	High	**Low**
Other Grains	<1	High	**Low**
Nurseries	<1	High	**Low**
Corn	<1	High	**Low**
Vegetables and Ground Fruit	<1	High	**Low**
Other Crops	<1	High	**Low**
Orchards and Vineyards	<1	High	**Low**
Wheat	<1	High	**Low**
Other Row Crops	<1	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile and adult abundance and adult productivity via impairments to ecologically significant behaviors			

Risk	Confidence	
High	**High**	

Table 18. AChE risk hypothesis; Hood Canal summer-run chum salmon and chlorpyrifos

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	High	**High**
Managed Forest	44	High	**High**
Right of Way	8	High	**High**
Pasture	4	High	**High**
Developed	3	High	**High**
Golf Courses	<1	High	**Low**
Christmas Tree	<1	High	**Low**
Other Grains	<1	High	**Low**
Nurseries	<1	High	**Low**
Corn	<1	High	**Low**
Vegetables and Ground Fruit	<1	High	**Low**
Other Crops	<1	High	**Low**
Orchards and Vineyards	<1	High	**Low**
Wheat	<1	High	**Low**
Other Row Crops	<1	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Table 19. Growth risk hypothesis; Hood Canal summer-run chum salmon and chlorpyrifos

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	44	High	**High**
Right of Way	8	High	**High**
Pasture	4	High	**High**
Developed	3	High	**High**
Golf Courses	<1	High	**Low**

Christmas Tree	<1	High	**Low**
Other Grains	<1	High	**Low**
Nurseries	<1	High	**Low**
Corn	<1	High	**Low**
Vegetables and Ground Fruit	<1	High	**Low**
Other Crops	<1	High	**Low**
Orchards and Vineyards	<1	High	**Low**
Wheat	<1	High	**Low**
Other Row Crops	<1	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
High	**High**		

Table 20. Reproduction risk hypothesis; Hood Canal summer-run chum salmon and chlorpyrifos

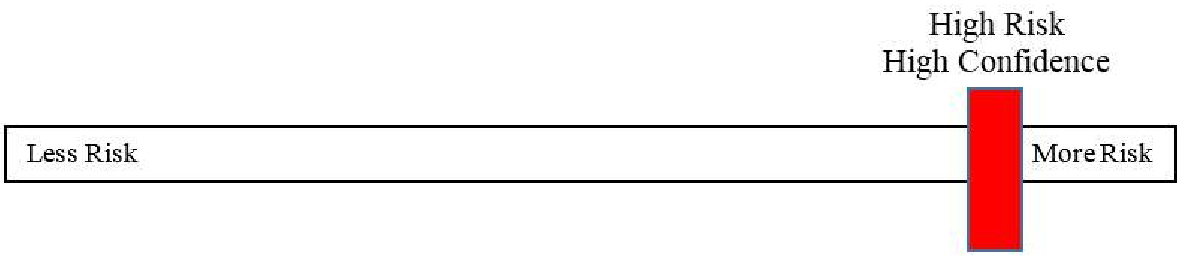
Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	44	High	**High**
Right of Way	8	High	**High**
Pasture	4	High	**High**
Developed	3	High	**High**
Golf Courses	<1	High	**Low**
Christmas Tree	<1	High	**Low**
Other Grains	<1	High	**Low**
Nurseries	<1	High	**Low**
Corn	<1	High	**Low**
Vegetables and Ground Fruit	<1	High	**Low**
Other Crops	<1	High	**Low**
Orchards and Vineyards	<1	High	**Low**
Wheat	<1	High	**Low**
Other Row Crops	<1	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			

Risk	Confidence	
High	**High**	

Table 21. Effects analysis summary table: Hood Canal summer-run ESU chum salmon and chlorpyrifos

Life Stage: Adults	R-plot Derived Risk	R-plot Derived Confidence	MagTool Range in median percent mortalities for aquatic bins	Population Model Results	Risk Hypothesis Supported? Yes/No
Risk Hypothesis					
Exposure to chlorpyrifos is sufficient to reduce juvenile and adult abundance via acute lethality.	High	High	4-day: 59-90 **Error! Reference source not found.**	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via reduction in prey availability	High	High	4-day fish: 57-88 4-day invert: 59-100 **Error! Reference source not found.**	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce juvenile and adult abundance and adult productivity via impairments to ecologically significant behaviors	High	High	Not Available		Yes
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available		Yes
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)	High	High	Not Available	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable	Yes

Effects analysis summary: Adult and juvenile Hood Canal summer-run ESU chum salmon are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where chlorpyrifos achieves predicted levels. The MagTool results indicate that between 59-90 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, chum will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed chum. The overall risk to Hood Canal summer-run ESU chum from the effects of the action is high and the confidence associated with that risk is high.



12.5 Chinook, California Coastal (Oncorhynchus tshawytscha)

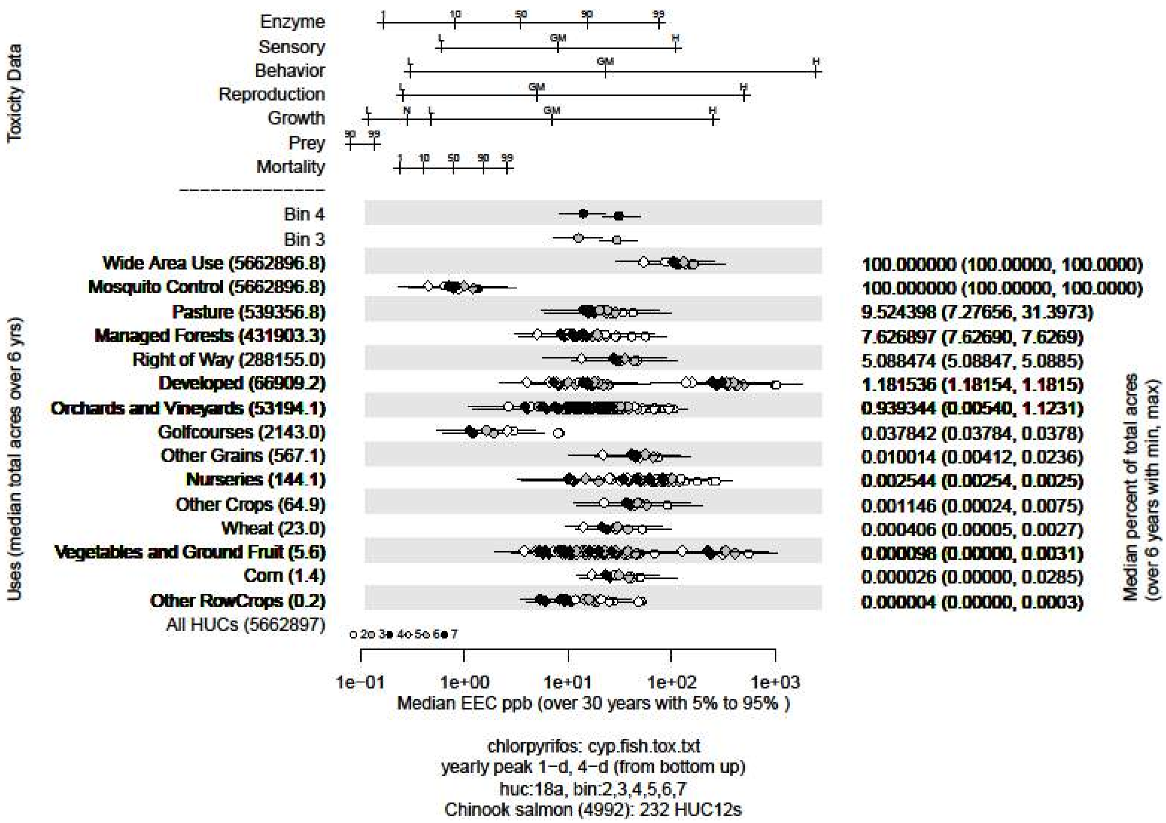


Figure 4. Effects analysis R-plot for California Coastal ESU chinook and chlorpyrifos

Table 22. Likelihood of exposure determination for California Coastal ESU Chinook salmon and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Wide Area Use	3	yes	yes	yes	NA	3	**High**
Mosquito Control	3	yes	yes	yes	NA	3	**High**
Pasture	3	yes	yes	yes	NA	3	**High**
Managed Forest	3	yes	yes	yes	NA	3	**High**
Right of Way	3	yes	yes	yes	NA	3	**High**
Developed	2	yes	yes	yes	NA	3	**High**
Orchards and Vineyards	1	yes	yes	yes	yes	3	**High**
Golf Courses	1	yes	yes	yes	no	3	**Low**
Other Grains	1	no	yes	yes	no	3	**Low**
Nurseries	1	yes	yes	yes	no	3	**Low**
Bin 3	3	yes	yes	yes	NA	3	**High**
Bin 4	3	yes	yes	yes	NA	3	**High**
Juveniles							
Wide Area Use	3	yes	yes	yes	NA	3	**High**
Mosquito Control	3	yes	yes	yes	NA	3	**High**
Pasture	3	yes	yes	yes	NA	3	**High**
Managed Forest	3	yes	yes	yes	NA	3	**High**
Right of Way	3	yes	yes	yes	NA	3	**High**
Developed	2	yes	yes	yes	NA	3	**High**
Orchards and Vineyards	1	yes	yes	yes	yes	3	**High**
Golf Courses	1	yes	yes	yes	no	3	**Low**
Other Grains	1	yes	yes	yes	no	3	**Low**
Nurseries	1	yes	yes	yes	no	3	**Low**
Bin 3	3	yes	yes	yes	NA	3	**High**
Bin 4	3	yes	yes	yes	NA	3	**High**

Life Stage: Adults (full-range)

Table 23. Direct mortality risk hypothesis; Adult California Coastal Chinook salmon and chlorpyrifos

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Pasture	9.5	High	High
Managed Forest	7.6	High	High
Right of Way	5.1	High	High
Developed	1.2	High	High
Orchards and Vineyards	0.9	High	High
Golf Courses	0.04	High	Low
Other Grains	0.01	High	Low
Nurseries	0.003	High	Low

Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 24. Reproduction risk hypothesis; Adult California Coastal Chinook salmon and chlorpyrifos

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	9.5	High	High
Managed Forest	7.6	High	High
Right of Way	5.1	High	High
Developed	1.2	High	High
Orchards and Vineyards	0.9	High	High
Golf Courses	0.04	Medium	Low
Other Grains	0.01	High	Low
Nurseries	0.003	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 25. Behavior and sensory risk hypothesis; Adult California Coastal Chinook salmon and chlorpyrifos

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	9.5	High	High
Managed Forest	7.6	High	High
Right of Way	5.1	High	High
Developed	1.2	High	High
Orchards and Vineyards	0.9	High	High
Golf Courses	0.04	Medium	Low
Other Grains	0.01	High	Low

Nurseries	0.003	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	9.5	High	High
Managed Forest	7.6	High	High
Right of Way	5.1	High	High
Developed	1.2	High	High
Orchards and Vineyards	0.9	High	High
Golf Courses	0.04	High	Low
Other Grains	0.01	High	Low
Nurseries	0.003	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 26. AChE risk hypothesis; Adult California Coastal Chinook salmon and chlorpyrifos

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	9.5	High	High
Managed Forest	7.6	High	High
Right of Way	5.1	High	High
Developed	1.2	High	High
Orchards and Vineyards	0.9	High	High
Golf Courses	0.04	High	Low
Other Grains	0.01	High	Low
Nurseries	0.003	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		

High	**High**	

Life Stage: Juveniles (full-range)

Table 27. Direct mortality risk hypothesis; Juvenile California Coastal Chinook salmon and chlorpyrifos

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Pasture	9.5	High	High
Managed Forest	7.6	High	High
Right of Way	5.1	High	High
Developed	1.2	High	High
Orchards and Vineyards	0.9	High	High
Golf Courses	0.04	High	Low
Other Grains	0.01	High	Low
Nurseries	0.003	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 28. Growth risk hypothesis; Juvenile California Coastal Chinook salmon and chlorpyrifos

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	9.5	High	High
Managed Forest	7.6	High	High
Right of Way	5.1	High	High
Developed	1.2	High	High
Orchards and Vineyards	0.9	High	High
Golf Courses	0.04	Medium	Low
Other Grains	0.01	High	Low
Nurseries	0.003	High	Low
Bin 3		High	High
Bin 4		High	High

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)		
Risk	Confidence	
High	High	

Table 29. Prey risk hypothesis; Juvenile California Coastal Chinook salmon and chlorpyrifos

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Pasture	9.5	High	High
Managed Forest	7.6	High	High
Right of Way	5.1	High	High
Developed	1.2	High	High
Orchards and Vineyards	0.9	High	High
Golf Courses	0.04	High	Low
Other Grains	0.01	High	Low
Nurseries	0.003	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 30. AChE risk hypothesis; Juvenile California Coastal Chinook salmon and chlorpyrifos

Endpoint: Enzyme			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	9.5	High	High
Managed Forest	7.6	High	High
Right of Way	5.1	High	High
Developed	1.2	High	High
Orchards and Vineyards	0.9	High	High
Golf Courses	0.04	High	Low
Other Grains	0.01	High	Low
Nurseries	0.003	High	Low
Bin 3		High	High

Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 31. Behavior and sensory risk hypothesis; Juvenile California Coastal Chinook salmon and chlorpyrifos

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	9.5	High	High
Managed Forest	7.6	High	High
Right of Way	5.1	High	High
Developed	1.2	High	High
Orchards and Vineyards	0.9	High	High
Golf Courses	0.04	Medium	Low
Other Grains	0.01	High	Low
Nurseries	0.003	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	9.5	High	High
Managed Forest	7.6	High	High
Right of Way	5.1	High	High
Developed	1.2	High	High
Orchards and Vineyards	0.9	High	High
Golf Courses	0.04	High	Low
Other Grains	0.01	High	Low
Nurseries	0.003	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

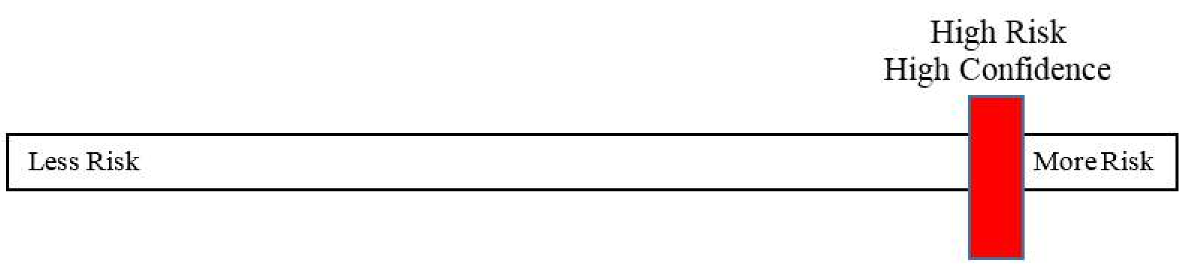
Table 32. Effects analysis summary table: California Coastal ESU Chinook salmon and chlorpyrifos

	R-plot Derived		**MagTool**	**Population Model Results**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 59-90 **Error! Reference source not found.**	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	Not Applicable	Yes
	R-plot Derived		**MagTool**	**Population Model Results**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities of aquatic bins**		

Risk Hypothesis						
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 59-90 **Error! Reference source not found.**	**Ocean-Type Chinook**		Yes
				Portion of juveniles exposed to chlorpyrifos Estimated Environmental Concentrations (EECs); 0.75-100 µg/l	**Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles**	
				25% 50% 75% 100%	1-12% (13-23) 1-23% (13-26) 2-35% (13-24) 3-97% (13-0)	
				Stream-Type Chinook		
				Portion of juveniles exposed to chlorpyrifos EECs; 0.75-100 µg/l	**Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles**	
				25% 50% 75% 100%	1-11% (5-18) 1-21% (5-22) 2-31% (4-21) 2-97% (4-0)	
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**		Yes
Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day invert: 59-100 **Error! Reference source not found.**	**Ocean-Type Chinook:** 5-24% (7-10)		Yes

Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Stream-Type Chinook:** 4-28% (3-4)	Yes
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	Yes

Effects analysis summary: Adult and juvenile California Coastal Chinook salmon are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Population modelling results indicate that chlorpyrifos-induced mortality to juveniles may lead to severe reductions in lambda up to 97%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 59-90 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, Chinook will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed Chinook. The overall risk to California Coastal Chinook salmon from the effects of the action is high and the confidence associated with that risk is high.



12.6 Chinook Salmon, Central Valley spring-run ESU (Oncorhynchus tshawytscha)

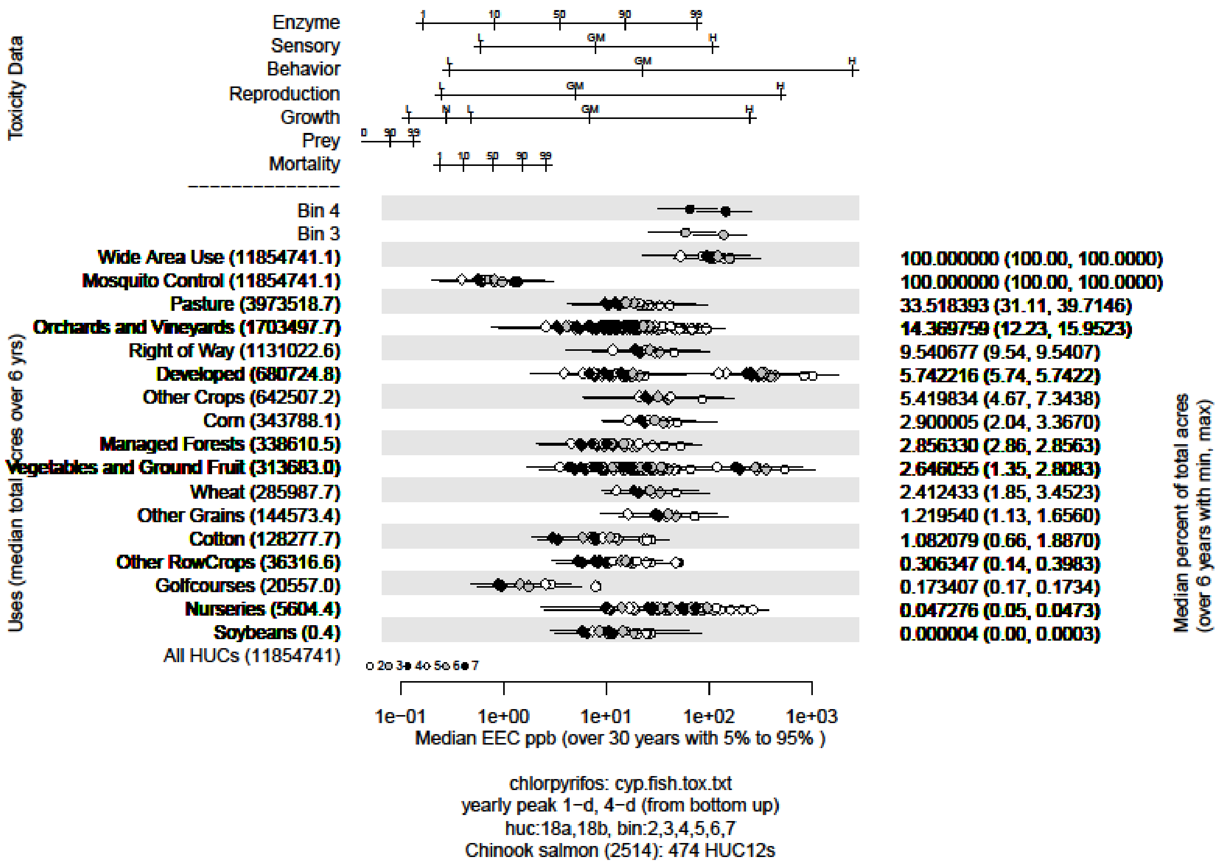


Figure 5. Effects analysis R-plot for Chinook salmon, Central Valley spring-run ESU and chlorpyrifos

Table 33. Likelihood of exposure determination for Chinook salmon, Central Valley spring-run ESU and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Orchards and Vineyards	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Developed	3	yes	yes	yes	NA	3	High
Other Crops	3	yes	yes	yes	NA	3	High
Corn	2	yes	yes	yes	NA	3	High
Managed Foret	2	yes	yes	yes	NA	3	High
Vegetables and Ground Fruit	2	yes	yes	yes	NA	3	High
Wheat	2	yes	yes	yes	NA	3	High
Other Grains	2	yes	yes	yes	NA	3	High
Cotton	2	yes	yes	yes	NA	3	High
Other Row Crops	1	yes	yes	yes	yes	3	High
Golf Courses	1	yes	yes	yes	no	3	Low
Nurseries	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High
Juveniles							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Orchards and Vineyards	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Developed	3	yes	yes	yes	NA	3	Med
Other Crops	3	yes	yes	yes	NA	3	Med
Corn	2	yes	yes	yes	NA	3	Med
Managed Foret	2	yes	yes	yes	NA	3	Med
Vegetables and Ground Fruit	2	yes	yes	yes	NA	3	Med
Wheat	2	yes	yes	yes	NA	3	Med
Other Grains	2	yes	yes	yes	NA	3	Med
Cotton	2	yes	yes	yes	NA	3	Med
Other Row Crops	1	yes	yes	yes	yes	3	High
Golf Courses	1	yes	yes	yes	no	3	Low
Nurseries	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High

Life Stage: Adults (full-range)

Table 34. Direct mortality risk hypothesis; Adult Chinook salmon, Central Valley spring-run ESU and chlorpyrifos

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Wide Area Use	100	High	High
Mosquito Control	100	High	High
Pasture	33.5	High	High
Orchards and Vineyards	14.4	High	High
Right of Way	9.5	High	High
Developed	5.7	High	High
Other Crops	5.4	High	High
Corn	2.9	High	High
Managed Forest	2.9	High	High
Vegetables and Ground Fruit	2.6	High	High
Wheat	2.4	High	High
Other Grains	1.2	High	High
Cotton	1.1	High	High
Other Row Crops	0.3	High	High
Golf Courses	0.2	High	Low
Nurseries	0.05	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 35. Reproduction risk hypothesis; Adult Chinook salmon, Central Valley spring-run ESU and chlorpyrifos

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	33.5	High	High
Orchards and Vineyards	14.4	High	High
Right of Way	9.5	High	High
Developed	5.7	High	High
Other Crops	5.4	High	High
Corn	2.9	High	High
Managed Forest	2.9	High	High
Vegetables and Ground Fruit	2.6	High	High
Wheat	2.4	High	High
Other Grains	1.2	High	High

Cotton	1.1	High	High
Other Row Crops	0.3	High	High
Golf Courses	0.2	Medium	Low
Nurseries	0.05	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 36. Behavior and sensory risk hypothesis; Adult Chinook salmon, Central Valley spring-run ESU and chlorpyrifos

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	33.5	High	High
Orchards and Vineyards	14.4	High	High
Right of Way	9.5	High	High
Developed	5.7	High	High
Other Crops	5.4	High	High
Corn	2.9	High	High
Managed Forest	2.9	High	High
Vegetables and Ground Fruit	2.6	High	High
Wheat	2.4	High	High
Other Grains	1.2	High	High
Cotton	1.1	High	High
Other Row Crops	0.3	High	High
Golf Courses	0.2	Medium	Low
Nurseries	0.05	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	33.5	High	High
Orchards and Vineyards	14.4	High	High

Right of Way	9.5	High	High
Developed	5.7	High	High
Other Crops	5.4	High	High
Corn	2.9	High	High
Managed Forest	2.9	High	High
Vegetables and Ground Fruit	2.6	High	High
Wheat	2.4	High	High
Other Grains	1.2	High	High
Cotton	1.1	High	High
Other Row Crops	0.3	High	High
Golf Courses	0.2	High	Low
Nurseries	0.05	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 37. AChE risk hypothesis; Adult Chinook salmon, Central Valley spring-run ESU and chlorpyrifos

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	33.5	High	High
Orchards and Vineyards	14.4	High	High
Right of Way	9.5	High	High
Developed	5.7	High	High
Other Crops	5.4	High	High
Corn	2.9	High	High
Managed Forest	2.9	High	High
Vegetables and Ground Fruit	2.6	High	High
Wheat	2.4	High	High
Other Grains	1.2	High	High
Cotton	1.1	High	High
Other Row Crops	0.3	High	High
Golf Courses	0.2	High	Low
Nurseries	0.05	High	Low
Bin 3		High	High
Bin 4		High	High

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity		
Risk	**Confidence**	
High	**High**	

Life Stage: Juveniles (full-range)

Table 38. Direct mortality risk hypothesis; Juvenile Chinook salmon, Central Valley spring-run ESU and chlorpyrifos

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Pasture	33.5	High	High
Orchards and Vineyards	14.4	High	High
Right of Way	9.5	High	High
Developed	5.7	High	High
Other Crops	5.4	High	High
Corn	2.9	High	High
Managed Forest	2.9	High	High
Vegetables and Ground Fruit	2.6	High	High
Wheat	2.4	High	High
Other Grains	1.2	High	High
Cotton	1.1	High	High
Other Row Crops	0.3	High	High
Golf Courses	0.2	High	Low
Nurseries	0.05	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 39. Growth risk hypothesis; Juvenile Chinook salmon, Central Valley spring-run ESU and chlorpyrifos

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High

Pasture	33.5	High	High
Orchards and Vineyards	14.4	High	High
Right of Way	9.5	High	High
Developed	5.7	High	High
Other Crops	5.4	High	High
Corn	2.9	High	High
Managed Forest	2.9	High	High
Vegetables and Ground Fruit	2.6	High	High
Wheat	2.4	High	High
Other Grains	1.2	High	High
Cotton	1.1	High	High
Other Row Crops	0.3	High	High
Golf Courses	0.2	Medium	Low
Nurseries	0.05	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 40. Prey risk hypothesis; Juvenile Chinook salmon, Central Valley spring-run ESU and chlorpyrifos

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Pasture	33.5	High	High
Orchards and Vineyards	14.4	High	High
Right of Way	9.5	High	High
Developed	5.7	High	High
Other Crops	5.4	High	High
Corn	2.9	High	High
Managed Forest	2.9	High	High
Vegetables and Ground Fruit	2.6	High	High
Wheat	2.4	High	High
Other Grains	1.2	High	High
Cotton	1.1	High	High
Other Row Crops	0.3	High	High
Golf Courses	0.2	High	Low

Nurseries	0.05	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 41. AChE risk hypothesis; Juvenile Chinook salmon, Central Valley spring-run ESU and chlorpyrifos

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	33.5	High	High
Orchards and Vineyards	14.4	High	High
Right of Way	9.5	High	High
Developed	5.7	High	High
Other Crops	5.4	High	High
Corn	2.9	High	High
Managed Forest	2.9	High	High
Vegetables and Ground Fruit	2.6	High	High
Wheat	2.4	High	High
Other Grains	1.2	High	High
Cotton	1.1	High	High
Other Row Crops	0.3	High	High
Golf Courses	0.2	High	Low
Nurseries	0.05	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 42. Behavior and sensory risk hypothesis; Juvenile Chinook salmon, Central Valley spring-run ESU and chlorpyrifos

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High

Mosquito Control	100	Medium	High
Pasture	33.5	High	High
Orchards and Vineyards	14.4	High	High
Right of Way	9.5	High	High
Developed	5.7	High	High
Other Crops	5.4	High	High
Corn	2.9	High	High
Managed Forest	2.9	High	High
Vegetables and Ground Fruit	2.6	High	High
Wheat	2.4	High	High
Other Grains	1.2	High	High
Cotton	1.1	High	High
Other Row Crops	0.3	High	High
Golf Courses	0.2	Medium	Low
Nurseries	0.05	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	33.5	High	High
Orchards and Vineyards	14.4	High	High
Right of Way	9.5	High	High
Developed	5.7	High	High
Other Crops	5.4	High	High
Corn	2.9	High	High
Managed Forest	2.9	High	High
Vegetables and Ground Fruit	2.6	High	High
Wheat	2.4	High	High
Other Grains	1.2	High	High
Cotton	1.1	High	High
Other Row Crops	0.3	High	High
Golf Courses	0.2	High	Low
Nurseries	0.05	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juveniles abundance and productivity via impairments to ecologically significant behaviors.			

Risk	Confidence	
High	**High**	

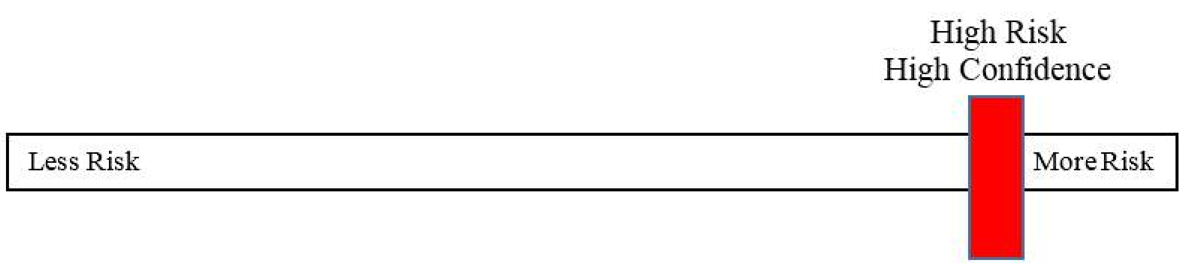
Table 43. Effects analysis summary table: Chinook salmon, Central Valley spring-run ESU and chlorpyrifos

	R-plot Derived		**MagTool**	**Population Model Results**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 82-100 **Error! Reference source not found.**	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	Not Applicable	Yes
	R-plot Derived		**MagTool**	**Population Model Results**	**Risk Hypothesis Supported?**
Life Stage: Juveniles	**Risk**	**Confidence**	**Range in median percent**		

<table>
<tr><th></th><th></th><th></th><th>mortalities of aquatic bins</th><th></th><th>Yes/No</th></tr>
<tr><td>Risk Hypothesis</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.</td><td>High</td><td>High</td><td>4-day: 82-100 Error! Reference source not found.</td><td><table>
<tr><th colspan="2">Ocean-Type Chinook</th></tr>
<tr><th>Portion of juveniles exposed to chlorpyrifos EECs; 0.75-100 µg/l</th><th>Mean percent reduction (STD) in a population’s intrinsic growth, lambda, from death of juveniles</th></tr>
<tr><td>25%</td><td>1-12% (13-23)</td></tr>
<tr><td>50%</td><td>1-23% (13-26)</td></tr>
<tr><td>75%</td><td>2-35% (13-24)</td></tr>
<tr><td>100%</td><td>3-97% (13-0)</td></tr>
<tr><th colspan="2">Stream-Type Chinook</th></tr>
<tr><th>Portion of juveniles exposed to chlorpyrifos EECs; 0.75-100 µg/l</th><th>Mean percent reduction (STD) in a population’s intrinsic growth, lambda, from death of juveniles</th></tr>
<tr><td>25%</td><td>1-11% (5-18)</td></tr>
<tr><td>50%</td><td>1-21% (5-22)</td></tr>
<tr><td>75%</td><td>2-31% (4-21)</td></tr>
<tr><td>100%</td><td>2-97% (4-0)</td></tr>
</table></td><td>Yes</td></tr>
<tr><td>Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)</td><td>High</td><td>High</td><td>Not Available</td><td>Anticipated reductions in a population’s intrinsic rate of growth (lambda) (± 1 STD)</td><td>Yes</td></tr>
<tr><td>Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability</td><td>High</td><td>High</td><td>4-day invert: 82-100 Error! Reference source not found.</td><td>Ocean-Type Chinook:
5-24% (7-10)</td><td>Yes</td></tr>
</table>

Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Stream-Type Chinook:** 4-28% (3-4)	Yes
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	**Yes**

Effects analysis summary: Adult and juvenile Central Valley spring-run Chinook salmon are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Population modelling results indicate that chlorpyrifos-induced mortality to juveniles may lead to severe reductions in lambda up to 97%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 82-100 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, Chinook will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed Chinook. The overall risk to Central Valley spring-run Chinook salmon from the effects of the action is high and the confidence associated with that risk is high.



12.7 Chinook Salmon, Lower Columbia River ESU (Oncorhynchus tshawytscha)

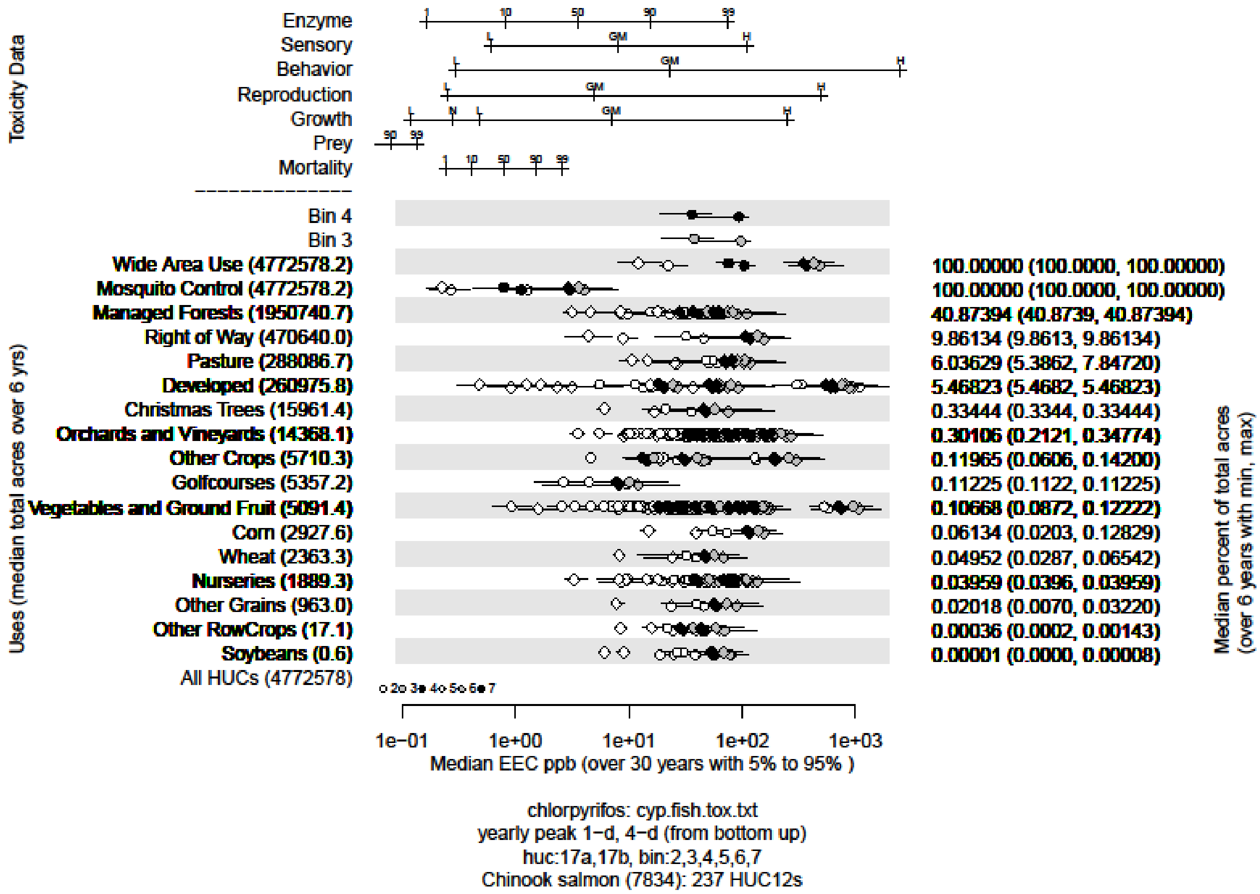


Figure 6. Effects analysis R-plot for Lower Columbia River ESU, Chinook salmon and chlorpyrifos

Table 44. Likelihood of exposure determination for Lower Columbia River ESU, Chinook salmon and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Managed Forest	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Developed	3	yes	yes	yes	NA	3	High
Christmas Trees	1	yes	yes	yes	yes	3	High
Orchards and Vineyards	1	yes	yes	yes	yes	3	High
Other Crops	1	yes	yes	yes	yes	3	High
Golf Courses	1	yes	yes	yes	no	3	Low
Vegetables and Ground Fruit	1	yes	yes	yes	yes	3	High
Corn	1	yes	yes	yes	yes	3	High
Wheat	1	yes	yes	yes	yes	3	High
Nurseries	1	yes	yes	yes	no	3	Low
Other Grains	1	yes	yes	yes	yes	3	High
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High
Juveniles							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Managed Forest	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Developed	3	yes	yes	yes	NA	3	High
Christmas Trees	1	yes	yes	yes	yes	3	High
Orchards and Vineyards	1	yes	yes	yes	yes	3	High
Other Crops	1	yes	yes	yes	yes	3	High
Golf Courses	1	yes	yes	yes	no	3	Low
Vegetables and Ground Fruit	1	yes	yes	yes	yes	3	High
Corn	1	yes	yes	yes	yes	3	High
Wheat	1	yes	yes	yes	yes	3	High
Nurseries	1	yes	yes	yes	no	3	Low
Other Grains	1	yes	yes	yes	yes	3	High
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High

Life Stage: Adults (full-range)

Table 45. Direct mortality risk hypothesis; Adult Chinook salmon, Lower Columbia River ESU and chlorpyrifos

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	High	**High**
Managed Forest	40.9	High	**High**
Right of Way	9.9	High	**High**

Pasture	6.0	High	**High**
Developed	5.5	High	**High**
Christmas Trees	0.3	High	**High**
Orchards and Vineyards	0.3	High	**High**
Other Crops	0.1	High	**High**
Golf Courses	0.1	High	**Low**
Vegetables and Ground Fruit	0.1	High	**High**
Corn	0.06	High	**High**
Wheat	0.05	High	**High**
Nurseries	0.04	High	**Low**
Other Grains	0.02	High	**High**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 46. Reproduction risk hypothesis; Adult Chinook salmon, Lower Columbia River ESU and chlorpyrifos

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	40.9	High	**High**
Right of Way	9.9	High	**High**
Pasture	6.0	High	**High**
Developed	5.5	High	**High**
Christmas Trees	0.3	High	**High**
Orchards and Vineyards	0.3	High	**High**
Other Crops	0.1	High	**High**
Golf Courses	0.1	High	**Low**
Vegetables and Ground Fruit	0.1	High	**High**
Corn	0.06	High	**High**
Wheat	0.05	High	**High**
Nurseries	0.04	High	**Low**
Other Grains	0.02	High	**High**
Bin 3		High	**High**
Bin 4		High	**High**

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction		
Risk	**Confidence**	
High	**High**	

Table 47. Behavior and sensory risk hypothesis; Adult Chinook salmon, Lower Columbia River ESU and chlorpyrifos

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	40.9	High	**High**
Right of Way	9.9	High	**High**
Pasture	6.0	High	**High**
Developed	5.5	High	**High**
Christmas Trees	0.3	High	**High**
Orchards and Vineyards	0.3	High	**High**
Other Crops	0.1	High	**High**
Golf Courses	0.1	Medium	**Low**
Vegetables and Ground Fruit	0.1	High	**High**
Corn	0.06	High	**High**
Wheat	0.05	High	**High**
Nurseries	0.04	High	**Low**
Other Grains	0.02	High	**High**
Bin 3		High	**High**
Bin 4		High	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	40.9	High	**High**
Right of Way	9.9	High	**High**
Pasture	6.0	High	**High**
Developed	5.5	High	**High**
Christmas Trees	0.3	High	**High**
Orchards and Vineyards	0.3	High	**High**
Other Crops	0.1	High	**High**
Golf Courses	0.1	High	**Low**

Vegetables and Ground Fruit	0.1	High	**High**
Corn	0.06	High	**High**
Wheat	0.05	High	**High**
Nurseries	0.04	High	**Low**
Other Grains	0.02	High	**High**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 48. AChE risk hypothesis; Adult Chinook salmon, Lower Columbia River ESU and chlorpyrifos

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	High	**High**
Managed Forest	40.9	High	**High**
Right of Way	9.9	High	**High**
Pasture	6.0	High	**High**
Developed	5.5	High	**High**
Christmas Trees	0.3	High	**High**
Orchards and Vineyards	0.3	High	**High**
Other Crops	0.1	High	**High**
Golf Courses	0.1	High	**Low**
Vegetables and Ground Fruit	0.1	High	**High**
Corn	0.06	High	**High**
Wheat	0.05	High	**High**
Nurseries	0.04	High	**Low**
Other Grains	0.02	High	**High**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 49. Direct mortality risk hypothesis; Juvenile Chinook salmon, Lower Columbia River ESU and chlorpyrifos

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	40.9	High	High
Right of Way	9.9	High	High
Pasture	6.0	High	High
Developed	5.5	High	High
Christmas Trees	0.3	High	High
Orchards and Vineyards	0.3	High	High
Other Crops	0.1	High	High
Golf Courses	0.1	High	Low
Vegetables and Ground Fruit	0.1	High	High
Corn	0.06	High	High
Wheat	0.05	High	High
Nurseries	0.04	High	Low
Other Grains	0.02	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 50. Growth risk hypothesis; Juvenile Chinook salmon, Lower Columbia River ESU and chlorpyrifos

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	40.9	High	High
Right of Way	9.9	High	High
Pasture	6.0	High	High
Developed	5.5	High	High
Christmas Trees	0.3	High	High
Orchards and Vineyards	0.3	High	High
Other Crops	0.1	High	High

Golf Courses	0.1	High	Low
Vegetables and Ground Fruit	0.1	High	High
Corn	0.06	High	High
Wheat	0.05	High	High
Nurseries	0.04	High	Low
Other Grains	0.02	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 51. Prey risk hypothesis; Juvenile Chinook salmon, Lower Columbia River ESU and chlorpyrifos

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	High	**High**
Managed Forest	40.9	High	**High**
Right of Way	9.9	High	**High**
Pasture	6.0	High	**High**
Developed	5.5	High	**High**
Christmas Trees	0.3	High	**High**
Orchards and Vineyards	0.3	High	**High**
Other Crops	0.1	High	**High**
Golf Courses	0.1	High	**Low**
Vegetables and Ground Fruit	0.1	High	**High**
Corn	0.06	High	**High**
Wheat	0.05	High	**High**
Nurseries	0.04	High	**Low**
Other Grains	0.02	High	**High**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 52. AChE risk hypothesis; Juvenile Chinook salmon, Lower Columbia River ESU and chlorpyrifos

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	40.9	High	High
Right of Way	9.9	High	High
Pasture	6.0	High	High
Developed	5.5	High	High
Christmas Trees	0.3	High	High
Orchards and Vineyards	0.3	High	High
Other Crops	0.1	High	High
Golf Courses	0.1	High	Low
Vegetables and Ground Fruit	0.1	High	High
Corn	0.06	High	High
Wheat	0.05	High	High
Nurseries	0.04	High	Low
Other Grains	0.02	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 53. Behavior and sensory risk hypothesis; Juvenile Chinook salmon, Lower Columbia River ESU and chlorpyrifos

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	40.9	High	**High**
Right of Way	9.9	High	**High**
Pasture	6.0	High	**High**
Developed	5.5	High	**High**
Christmas Trees	0.3	High	**High**
Orchards and Vineyards	0.3	High	**High**
Other Crops	0.1	High	**High**

Golf Courses	0.1	Medium	**Low**
Vegetables and Ground Fruit	0.1	High	**High**
Corn	0.06	High	**High**
Wheat	0.05	High	**High**
Nurseries	0.04	High	**Low**
Other Grains	0.02	High	**High**
Bin 3		High	**High**
Bin 4		High	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	40.9	High	**High**
Right of Way	9.9	High	**High**
Pasture	6.0	High	**High**
Developed	5.5	High	**High**
Christmas Trees	0.3	High	**High**
Orchards and Vineyards	0.3	High	**High**
Other Crops	0.1	High	**High**
Golf Courses	0.1	High	**Low**
Vegetables and Ground Fruit	0.1	High	**High**
Corn	0.06	High	**High**
Wheat	0.05	High	**High**
Nurseries	0.04	High	**Low**
Other Grains	0.02	High	**High**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 54. Effects analysis summary table: Chinook salmon, Lower Columbia River ESU and chlorpyrifos

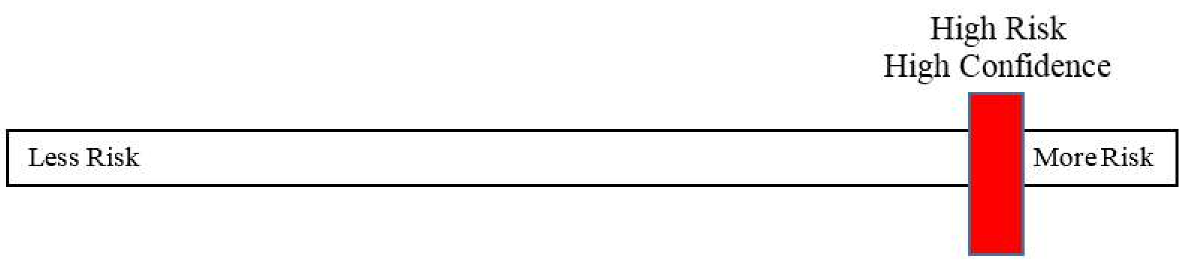
	R-plot Derived		**MagTool**	**Population Model Results**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					

Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 63-99 **Error! Reference source not found.**	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	Not Applicable	Yes
	R-plot Derived		**MagTool Range in median percent mortalities of aquatic bins**	**Population Model Results**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Juveniles	**Risk**	**Confidence**			
Risk Hypothesis					
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 63-99 **Error! Reference source not found.**	**Ocean-Type Chinook** **Portion of juveniles exposed to chlorpyrifos EECs; 0.75-100 µg/l** | **Mean percent reduction (STD) in a population's intrinsic growth, lambda, from**	Yes

				death of juveniles 25% 1-12% (13-23) 50% 1-23% (13-26) 75% 2-35% (13-24) 100% 3-97% (13-0) **Stream-Type Chinook** **Portion of juveniles exposed to chlorpyrifos EECs; 0.75-100 µg/l** / **Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles** 25% 1-11% (5-18) 50% 1-21% (5-22) 75% 2-31% (4-21) 100% 2-97% (4-0)	
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**	Yes
Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day invert: 63-100 **Error! Reference source not found.**	**Ocean-Type Chinook:** 5-24% (7-10) **Stream-Type Chinook:** 4-28% (3-4)	Yes
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available		Yes
Exposure to chlorpyrifos is sufficient to	High	High	Not Available	Not Applicable	**Yes**

reduce juvenile abundance via impairments to ecologically significant behaviors.					

Effects analysis summary: Adult and juvenile Chinook salmon, Lower Columbia River ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Population modelling results indicate that chlorpyrifos-induced mortality to juveniles may lead to severe reductions in lambda up to 97%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 63-99 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, Chinook will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed Chinook. The overall risk to Chinook salmon, Lower Columbia River ESU from the effects of the action is high and the confidence associated with that risk is high



12.8 Chinook Salmon, Puget Sound ESU (Oncorhynchus tshawytscha)

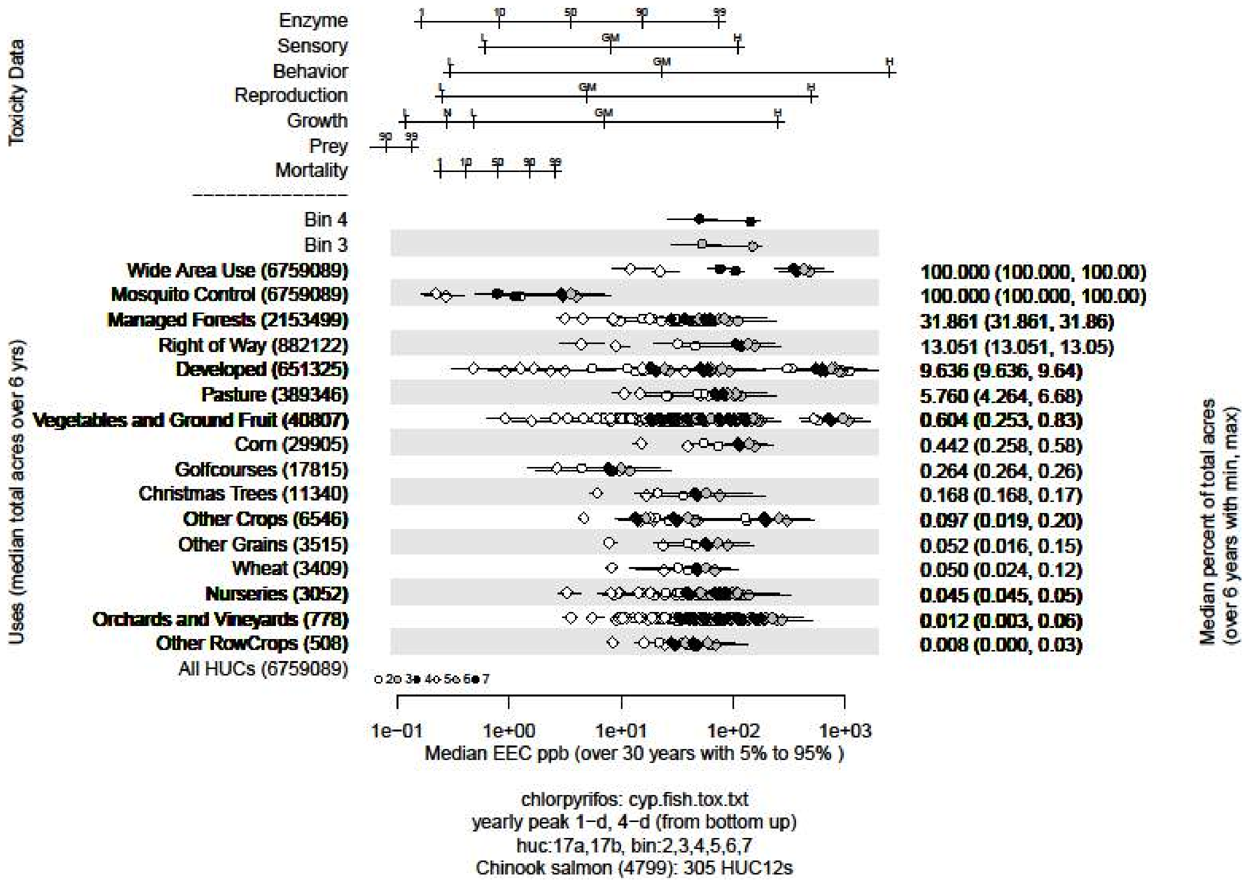


Figure 7. Effects analysis R-plot for Chinook salmon, Puget Sound ESU and chlorpyrifos

Table 55. Likelihood of exposure determination for Chinook salmon, Puget Sound ESU and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Managed Forest	3	yes	yes	yes	NA	3	High
Right of Was	3	yes	yes	yes	NA	3	High
Developed	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Vegetables and Ground Fruit	1	yes	yes	yes	yes	3	High
Corn	1	yes	yes	yes	yes	3	High
Golf Courses	1	yes	yes	yes	no	3	Low
Christmas Trees	1	yes	yes	yes	no	3	Low
Other Crops	1	yes	yes	yes	no	3	Low
Other Grains	1	yes	yes	yes	yes	3	High
Wheat	1	yes	yes	yes	yes	3	High
Nurseries	1	yes	yes	yes	no	3	Low
Orchards and Vineyards	1	yes	yes	yes	no	3	Low
Other Row Crops	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High
Juveniles							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Managed Forest	3	yes	yes	yes	NA	3	High
Right of Was	3	yes	yes	yes	NA	3	High
Developed	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Vegetables and Ground Fruit	1	yes	yes	yes	yes	3	High
Corn	1	yes	yes	yes	yes	3	High
Golf Courses	1	yes	yes	yes	no	3	Low
Christmas Trees	1	yes	yes	yes	no	3	Low
Other Crops	1	yes	yes	yes	no	3	Low
Other Grains	1	yes	yes	yes	yes	3	High
Wheat	1	yes	yes	yes	yes	3	High
Nurseries	1	yes	yes	yes	no	3	Low
Orchards and Vineyards	1	yes	yes	yes	no	3	Low
Other Row Crops	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High

Life Stage: Adults (full-range)

Table 56. Direct mortality risk hypothesis; Chinook salmon, Puget Sound ESU and chlorpyrifos; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	High	**High**
Managed Forest	31.9	High	**High**

Right of Was	13.1	High	**High**
Developed	9.6	High	**High**
Pasture	5.8	High	**High**
Vegetables and Ground Fruit	0.6	High	**High**
Corn	0.4	High	**High**
Golf Courses	0.3	High	**Low**
Christmas Trees	0.2	High	**Low**
Other Crops	0.1	High	**Low**
Other Grains	0.05	High	**High**
Wheat	0.05	High	**High**
Nurseries	0.05	High	**Low**
Orchards and Vineyards	0.01	High	**Low**
Other Row Crops	0.01	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 57. Reproduction risk hypothesis; Chinook salmon, Puget Sound ESU and chlorpyrifos; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	31.9	High	**High**
Right of Was	13.1	High	**High**
Developed	9.6	High	**High**
Pasture	5.8	High	**High**
Vegetables and Ground Fruit	0.6	High	**High**
Corn	0.4	High	**High**
Golf Courses	0.3	High	**Low**
Christmas Trees	0.2	High	**Low**
Other Crops	0.1	High	**Low**
Other Grains	0.05	High	**High**
Wheat	0.05	High	**High**
Nurseries	0.05	High	**Low**
Orchards and Vineyards	0.01	High	**Low**
Other Row Crops	0.01	High	**Low**

Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 58. Behavior and sensory risk hypothesis; Chinook salmon, Puget Sound ESU and chlorpyrifos; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	31.9	High	**High**
Right of Was	13.1	High	**High**
Developed	9.6	High	**High**
Pasture	5.8	High	**High**
Vegetables and Ground Fruit	0.6	High	**High**
Corn	0.4	High	**High**
Golf Courses	0.3	Medium	**Low**
Christmas Trees	0.2	High	**Low**
Other Crops	0.1	High	**Low**
Other Grains	0.05	High	**High**
Wheat	0.05	High	**High**
Nurseries	0.05	High	**Low**
Orchards and Vineyards	0.01	High	**Low**
Other Row Crops	0.01	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	31.9	High	**High**
Right of Was	13.1	High	**High**
Developed	9.6	High	**High**
Pasture	5.8	High	**High**
Vegetables and Ground Fruit	0.6	High	**High**
Corn	0.4	High	**High**
Golf Courses	0.3	High	**Low**

Christmas Trees	0.2	High	**Low**
Other Crops	0.1	High	**Low**
Other Grains	0.05	High	**High**
Wheat	0.05	High	**High**
Nurseries	0.05	High	**Low**
Orchards and Vineyards	0.01	High	**Low**
Other Row Crops	0.01	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 59. AChE risk hypothesis; Chinook salmon, Puget Sound ESU and chlorpyrifos; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	High	**High**
Managed Forest	31.9	High	**High**
Right of Was	13.1	High	**High**
Developed	9.6	High	**High**
Pasture	5.8	High	**High**
Vegetables and Ground Fruit	0.6	High	**High**
Corn	0.4	High	**High**
Golf Courses	0.3	High	**Low**
Christmas Trees	0.2	High	**Low**
Other Crops	0.1	High	**Low**
Other Grains	0.05	High	**High**
Wheat	0.05	High	**High**
Nurseries	0.05	High	**Low**
Orchards and Vineyards	0.01	High	**Low**
Other Row Crops	0.01	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 60. Direct mortality risk hypothesis; Chinook salmon, Puget Sound ESU and chlorpyrifos; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	31.9	High	High
Right of Was	13.1	High	High
Developed	9.6	High	High
Pasture	5.8	High	High
Vegetables and Ground Fruit	0.6	High	High
Corn	0.4	High	High
Golf Courses	0.3	High	Low
Christmas Trees	0.2	High	Low
Other Crops	0.1	High	Low
Other Grains	0.05	High	High
Wheat	0.05	High	High
Nurseries	0.05	High	Low
Orchards and Vineyards	0.01	High	Low
Other Row Crops	0.01	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 61. Growth risk hypothesis; Chinook salmon, Puget Sound ESU and chlorpyrifos; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	31.9	High	High
Right of Was	13.1	High	High
Developed	9.6	High	High
Pasture	5.8	High	High
Vegetables and Ground Fruit	0.6	High	High
Corn	0.4	High	High

Golf Courses	0.3	High	Low
Christmas Trees	0.2	High	Low
Other Crops	0.1	High	Low
Other Grains	0.05	High	High
Wheat	0.05	High	High
Nurseries	0.05	High	Low
Orchards and Vineyards	0.01	High	Low
Other Row Crops	0.01	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 62. Prey risk hypothesis; Chinook salmon, Puget Sound ESU and chlorpyrifos; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	High	**High**
Managed Forest	31.9	High	**High**
Right of Was	13.1	High	**High**
Developed	9.6	High	**High**
Pasture	5.8	High	**High**
Vegetables and Ground Fruit	0.6	High	**High**
Corn	0.4	High	**High**
Golf Courses	0.3	High	**Low**
Christmas Trees	0.2	High	**Low**
Other Crops	0.1	High	**Low**
Other Grains	0.05	High	**High**
Wheat	0.05	High	**High**
Nurseries	0.05	High	**Low**
Orchards and Vineyards	0.01	High	**Low**
Other Row Crops	0.01	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 63. AChE risk hypothesis; Chinook salmon, Puget Sound ESU and chlorpyrifos; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	31.9	High	High
Right of Was	13.1	High	High
Developed	9.6	High	High
Pasture	5.8	High	High
Vegetables and Ground Fruit	0.6	High	High
Corn	0.4	High	High
Golf Courses	0.3	High	Low
Christmas Trees	0.2	High	Low
Other Crops	0.1	High	Low
Other Grains	0.05	High	High
Wheat	0.05	High	High
Nurseries	0.05	High	Low
Orchards and Vineyards	0.01	High	Low
Other Row Crops	0.01	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 64. Behavior and sensory risk hypothesis; Chinook salmon, Puget Sound ESU and chlorpyrifos; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	31.9	High	**High**
Right of Was	13.1	High	**High**
Developed	9.6	High	**High**
Pasture	5.8	High	**High**
Vegetables and Ground Fruit	0.6	High	**High**

Corn	0.4	High	**High**
Golf Courses	0.3	Medium	**Low**
Christmas Trees	0.2	High	**Low**
Other Crops	0.1	High	**Low**
Other Grains	0.05	High	**High**
Wheat	0.05	High	**High**
Nurseries	0.05	High	**Low**
Orchards and Vineyards	0.01	High	**Low**
Other Row Crops	0.01	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	31.9	High	**High**
Right of Was	13.1	High	**High**
Developed	9.6	High	**High**
Pasture	5.8	High	**High**
Vegetables and Ground Fruit	0.6	High	**High**
Corn	0.4	High	**High**
Golf Courses	0.3	High	**Low**
Christmas Trees	0.2	High	**Low**
Other Crops	0.1	High	**Low**
Other Grains	0.05	High	**High**
Wheat	0.05	High	**High**
Nurseries	0.05	High	**Low**
Orchards and Vineyards	0.01	High	**Low**
Other Row Crops	0.01	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 65. Effects analysis summary table: Chinook salmon, Puget Sound ESU and chlorpyrifos

	R-plot Derived	MagTool	Population Model Results	

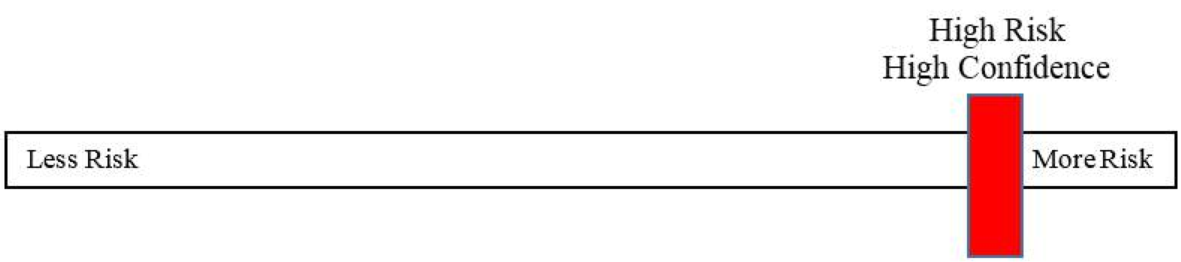
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		**Risk Hypothesis Supported? Yes/No**
Risk Hypothesis					
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 61-94 **Error! Reference source not found.**	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	Not Applicable	Yes

	R-plot Derived		**MagTool Range in median percent mortalities of aquatic bins**	**Population Model Results**		**Risk Hypothesis Supported? Yes/No**
Life Stage: Juveniles	**Risk**	**Confidence**				
Risk Hypothesis						
Exposure to chlorpyrifos is sufficient to	High	High	4-day: 61-94	**Ocean-Type Chinook**		Yes
				Portion of juveniles	**Mean percent reduction**	

reduce juvenile abundance via acute lethality.			**Error! Reference source not found.**	**exposed to chlorpyrifos EECs; 0.75-100 µg/l**	**(STD) in a population's intrinsic growth, lambda, from death of juveniles**	
				25% 50% 75% 100%	1-12% (13-23) 1-23% (13-26) 2-35% (13-24) 3-97% (13-0)	
				Stream-Type Chinook		
				Portion of juveniles exposed to chlorpyrifos EECs; 0.75-100 µg/l	**Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles**	
				25% 50% 75% 100%	1-11% (5-18) 1-21% (5-22) 2-31% (4-21) 2-97% (4-0)	
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**		Yes
Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day invert: 62-100 **Error! Reference source not found.**	**Ocean-Type Chinook:** 5-24% (7-10)		Yes
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified	High	High	Not Available	**Stream-Type Chinook:** 4-28% (3-4)		Yes

mechanism of toxicity					
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	**Yes**

Effects analysis summary: Adult and juvenile Chinook salmon, Puget Sound ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Population modelling results indicate that chlorpyrifos-induced mortality to juveniles may lead to severe reductions in lambda up to 97%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 61-94 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, Chinook will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed Chinook. The overall risk to Chinook salmon, Puget Sound ESU from the effects of the action is high and the confidence associated with that risk is high.



12.9 Chinook Salmon, Sacramento River winter-run (Oncorhynchus tshawytscha)

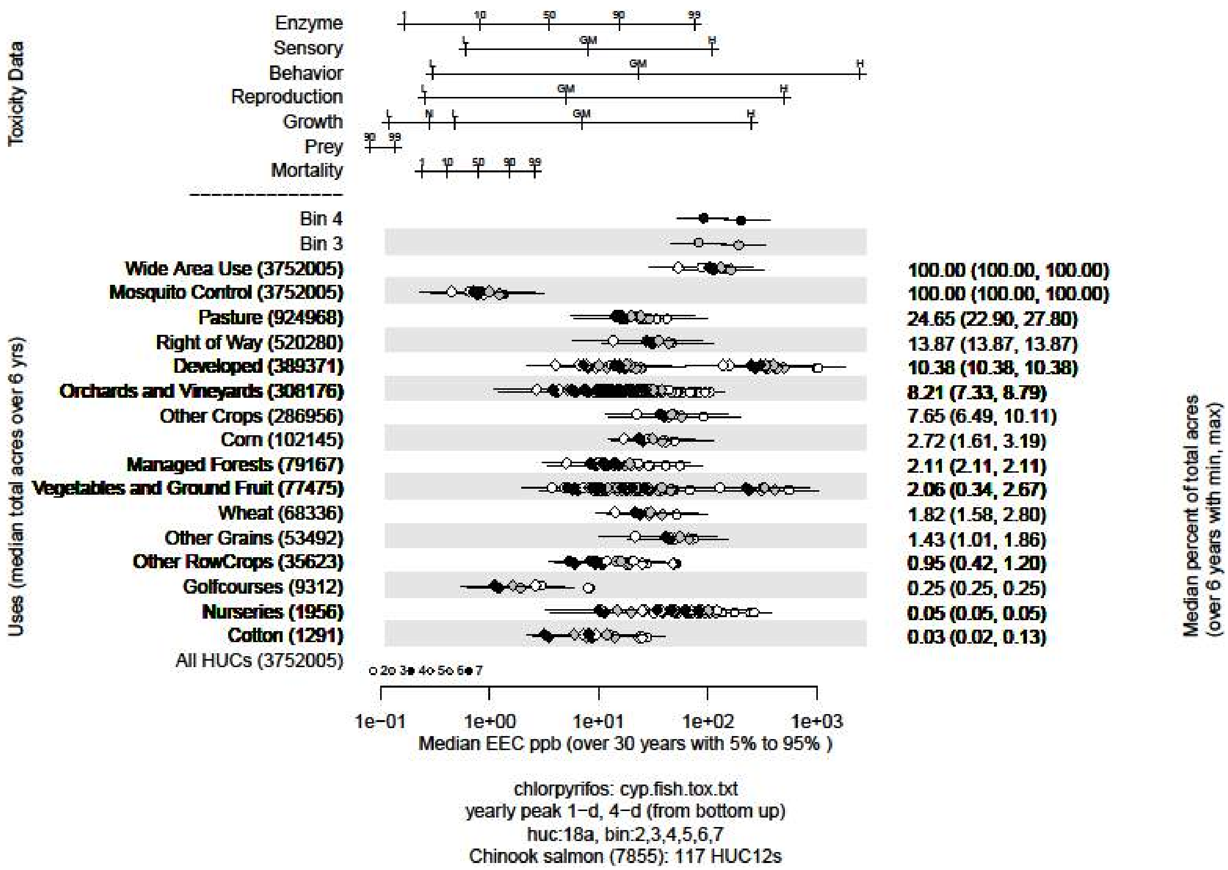


Figure 8. Effects analysis R-plot for Chinook salmon, Sacramento River winter-run ESU and chlorpyrifos

Table 66. Likelihood of exposure determination for Chinook salmon, Sacramento River winter-run ESU and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Developed	3	yes	yes	yes	NA	3	High
Orchards and Vineyards	3	yes	yes	yes	NA	3	High
Other Crops	3	yes	yes	yes	NA	3	High
Corn	2	yes	yes	yes	NA	3	High
Managed Forest	2	yes	yes	yes	NA	3	High
Vegetables and Ground Fruit	2	yes	yes	yes	NA	3	High
Wheat	2	yes	yes	yes	NA	3	High
Other Grains	2	yes	yes	yes	NA	3	High
Other Row Crops	2	yes	yes	yes	NA	3	High
Golf Courses	1	yes	yes	yes	no	3	Low
Nurseries	1	yes	yes	yes	no	3	Low
Cotton	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High
Juveniles							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Developed	3	yes	yes	yes	NA	3	High
Orchards and Vineyards	3	yes	yes	yes	NA	3	High
Other Crops	3	yes	yes	yes	NA	3	High
Corn	2	yes	yes	yes	NA	3	High
Managed Forest	2	yes	yes	yes	NA	3	High
Vegetables and Ground Fruit	2	yes	yes	yes	NA	3	High
Wheat	2	yes	yes	yes	NA	3	High
Other Grains	2	yes	yes	yes	NA	3	High
Other Row Crops	2	yes	yes	yes	NA	3	High
Golf Courses	1	yes	yes	yes	no	3	Low
Nurseries	1	yes	yes	yes	no	3	Low
Cotton	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High

Life Stage: Adults (full-range)

Table 67. Direct mortality risk hypothesis; Chinook salmon, Sacramento River winter-run ESU and chlorpyrifos; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High

Mosquito Control	100	High	High
Pasture	24.7	High	High
Right of Way	13.9	High	High
Developed	10.4	High	High
Orchards and Vineyards	8.2	High	High
Other Crops	7.7	High	High
Corn	2.7	High	High
Managed Forest	2.1	High	High
Vegetables and Ground Fruit	2.1	High	High
Wheat	1.8	High	High
Other Grains	1.4	High	High
Other Row Crops	1.0	High	High
Golf Courses	0.3	High	Low
Nurseries	0.05	High	Low
Cotton	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 68. Reproduction risk hypothesis; Chinook salmon, Sacramento River winter-run ESU and chlorpyrifos; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	24.7	High	High
Right of Way	13.9	High	High
Developed	10.4	High	High
Orchards and Vineyards	8.2	High	High
Other Crops	7.7	High	High
Corn	2.7	High	High
Managed Forest	2.1	High	High
Vegetables and Ground Fruit	2.1	High	High
Wheat	1.8	High	High
Other Grains	1.4	High	High
Other Row Crops	1.0	High	High

Golf Courses	0.3	Medium	Low
Nurseries	0.05	High	Low
Cotton	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 69. Behavior and sensory risk hypothesis; Chinook salmon, Sacramento River winter-run ESU and chlorpyrifos; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	24.7	High	High
Right of Way	13.9	High	High
Developed	10.4	High	High
Orchards and Vineyards	8.2	High	High
Other Crops	7.7	High	High
Corn	2.7	High	High
Managed Forest	2.1	High	High
Vegetables and Ground Fruit	2.1	High	High
Wheat	1.8	High	High
Other Grains	1.4	High	High
Other Row Crops	1.0	High	High
Golf Courses	0.3	Medium	Low
Nurseries	0.05	High	Low
Cotton	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	24.7	High	High
Right of Way	13.9	High	High
Developed	10.4	High	High

Orchards and Vineyards	8.2	High	High
Other Crops	7.7	High	High
Corn	2.7	High	High
Managed Forest	2.1	High	High
Vegetables and Ground Fruit	2.1	High	High
Wheat	1.8	High	High
Other Grains	1.4	High	High
Other Row Crops	1.0	High	High
Golf Courses	0.3	High	Low
Nurseries	0.05	High	Low
Cotton	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 70. AChE risk hypothesis; Chinook salmon, Sacramento River winter-run ESU and chlorpyrifos; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	24.7	High	High
Right of Way	13.9	High	High
Developed	10.4	High	High
Orchards and Vineyards	8.2	High	High
Other Crops	7.7	High	High
Corn	2.7	High	High
Managed Forest	2.1	High	High
Vegetables and Ground Fruit	2.1	High	High
Wheat	1.8	High	High
Other Grains	1.4	High	High
Other Row Crops	1.0	High	High
Golf Courses	0.3	High	Low
Nurseries	0.05	High	Low
Cotton	0.03	High	Low
Bin 3		High	High

Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 71. Direct mortality risk hypothesis; Chinook salmon, Sacramento River winter-run ESU and chlorpyrifos; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Pasture	24.7	High	High
Right of Way	13.9	High	High
Developed	10.4	High	High
Orchards and Vineyards	8.2	High	High
Other Crops	7.7	High	High
Corn	2.7	High	High
Managed Forest	2.1	High	High
Vegetables and Ground Fruit	2.1	High	High
Wheat	1.8	High	High
Other Grains	1.4	High	High
Other Row Crops	1.0	High	High
Golf Courses	0.3	High	Low
Nurseries	0.05	High	Low
Cotton	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 72. Growth risk hypothesis; Chinook salmon, Sacramento River winter-run ESU and chlorpyrifos; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure

Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	24.7	High	High
Right of Way	13.9	High	High
Developed	10.4	High	High
Orchards and Vineyards	8.2	High	High
Other Crops	7.7	High	High
Corn	2.7	High	High
Managed Forest	2.1	High	High
Vegetables and Ground Fruit	2.1	High	High
Wheat	1.8	High	High
Other Grains	1.4	High	High
Other Row Crops	1.0	High	High
Golf Courses	0.3	Medium	Low
Nurseries	0.05	High	Low
Cotton	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 73. Prey risk hypothesis; Chinook salmon, Sacramento River winter-run ESU and chlorpyrifos; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Pasture	24.7	High	High
Right of Way	13.9	High	High
Developed	10.4	High	High
Orchards and Vineyards	8.2	High	High
Other Crops	7.7	High	High
Corn	2.7	High	High
Managed Forest	2.1	High	High
Vegetables and Ground Fruit	2.1	High	High
Wheat	1.8	High	High
Other Grains	1.4	High	High

Other Row Crops	1.0	High	High
Golf Courses	0.3	High	Low
Nurseries	0.05	High	Low
Cotton	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 74. AChE risk hypothesis; Chinook salmon, Sacramento River winter-run ESU and chlorpyrifos; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	24.7	High	High
Right of Way	13.9	High	High
Developed	10.4	High	High
Orchards and Vineyards	8.2	High	High
Other Crops	7.7	High	High
Corn	2.7	High	High
Managed Forest	2.1	High	High
Vegetables and Ground Fruit	2.1	High	High
Wheat	1.8	High	High
Other Grains	1.4	High	High
Other Row Crops	1.0	High	High
Golf Courses	0.3	High	Low
Nurseries	0.05	High	Low
Cotton	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 75. Behavior and sensory risk hypothesis; Chinook salmon, Sacramento River winter-run ESU and chlorpyrifos; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	24.7	High	High
Right of Way	13.9	High	High
Developed	10.4	High	High
Orchards and Vineyards	8.2	High	High
Other Crops	7.7	High	High
Corn	2.7	High	High
Managed Forest	2.1	High	High
Vegetables and Ground Fruit	2.1	High	High
Wheat	1.8	High	High
Other Grains	1.4	High	High
Other Row Crops	1.0	High	High
Golf Courses	0.3	Medium	Low
Nurseries	0.05	High	Low
Cotton	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	24.7	High	High
Right of Way	13.9	High	High
Developed	10.4	High	High
Orchards and Vineyards	8.2	High	High
Other Crops	7.7	High	High
Corn	2.7	High	High
Managed Forest	2.1	High	High
Vegetables and Ground Fruit	2.1	High	High
Wheat	1.8	High	High
Other Grains	1.4	High	High
Other Row Crops	1.0	High	High
Golf Courses	0.3	High	Low

Nurseries	0.05	High	Low
Cotton	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

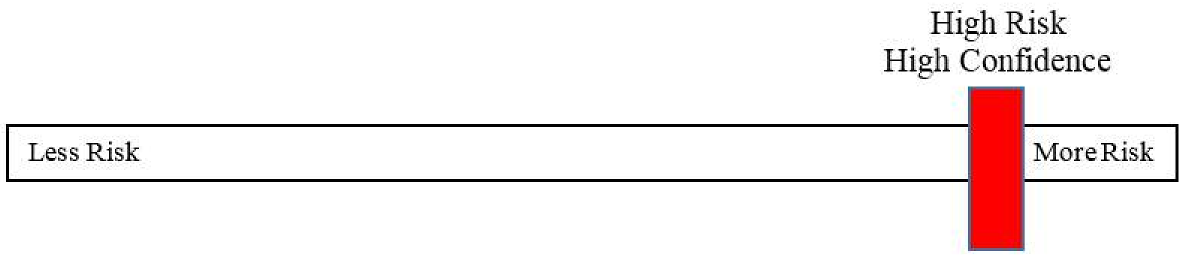
Table 76. Effects analysis summary table: Chinook salmon, Sacramento River winter-run ESU and chlorpyrifos

	R-plot Derived		**MagTool**	**Population Model Results**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 76-99 **Error! Reference source not found.**	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to	High	High	Not Available	Not Applicable	Yes

<table>
<tr><td>reduce ChE activity; the identified mechanism of toxicity</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Life Stage: Juveniles</td><td colspan="2">R-plot Derived</td><td rowspan="2">MagTool Range in median percent mortalities of aquatic bins</td><td rowspan="2">Population Model Results</td><td rowspan="2">Risk Hypothesis Supported? Yes/No</td></tr>
<tr><td>Risk</td><td>Confidence</td></tr>
<tr><td>Risk Hypothesis</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.</td><td>High</td><td>High</td><td>4-day: 76-99 Error! Reference source not found.</td><td><table>
<tr><td colspan="2">Ocean-Type Chinook</td></tr>
<tr><td>Portion of juveniles exposed to chlorpyrifos EECs; 0.75-100 µg/l</td><td>Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles</td></tr>
<tr><td>25%
50%
75%
100%</td><td>1-12% (13-23)
1-23% (13-26)
2-35% (13-24)
3-97% (13-0)</td></tr>
<tr><td colspan="2">Stream-Type Chinook</td></tr>
<tr><td>Portion of juveniles exposed to chlorpyrifos EECs; 0.75-100 µg/l</td><td>Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles</td></tr>
<tr><td>25%
50%
75%
100%</td><td>1-11% (5-18)
1-21% (5-22)
2-31% (4-21)
2-97% (4-0)</td></tr>
</table></td><td>Yes</td></tr>
<tr><td>Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to</td><td>High</td><td>High</td><td>Not Available</td><td>Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)</td><td>Yes</td></tr>
</table>

growth (direct toxicity)					
Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day invert: 76-100 **Error! Reference source not found.**	**Ocean-Type Chinook:** 5-24% (7-10)	Yes
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Stream-Type Chinook:** 4-28% (3-4)	Yes
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	**Yes**

Effects analysis summary: Adult and juvenile Chinook salmon, Sacramento River winter-run ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Population modelling results indicate that chlorpyrifos-induced mortality to juveniles may lead to severe reductions in lambda up to 97%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 76-99 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, Chinook will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed Chinook. The overall risk to Chinook salmon, Sacramento River winter-run ESU from the effects of the action is high and the confidence associated with that risk is high.


High Risk
High Confidence
Less Risk
More Risk

12.10 Chinook Salmon, Snake River fall-run ESU (Oncorhynchus tshawytscha)

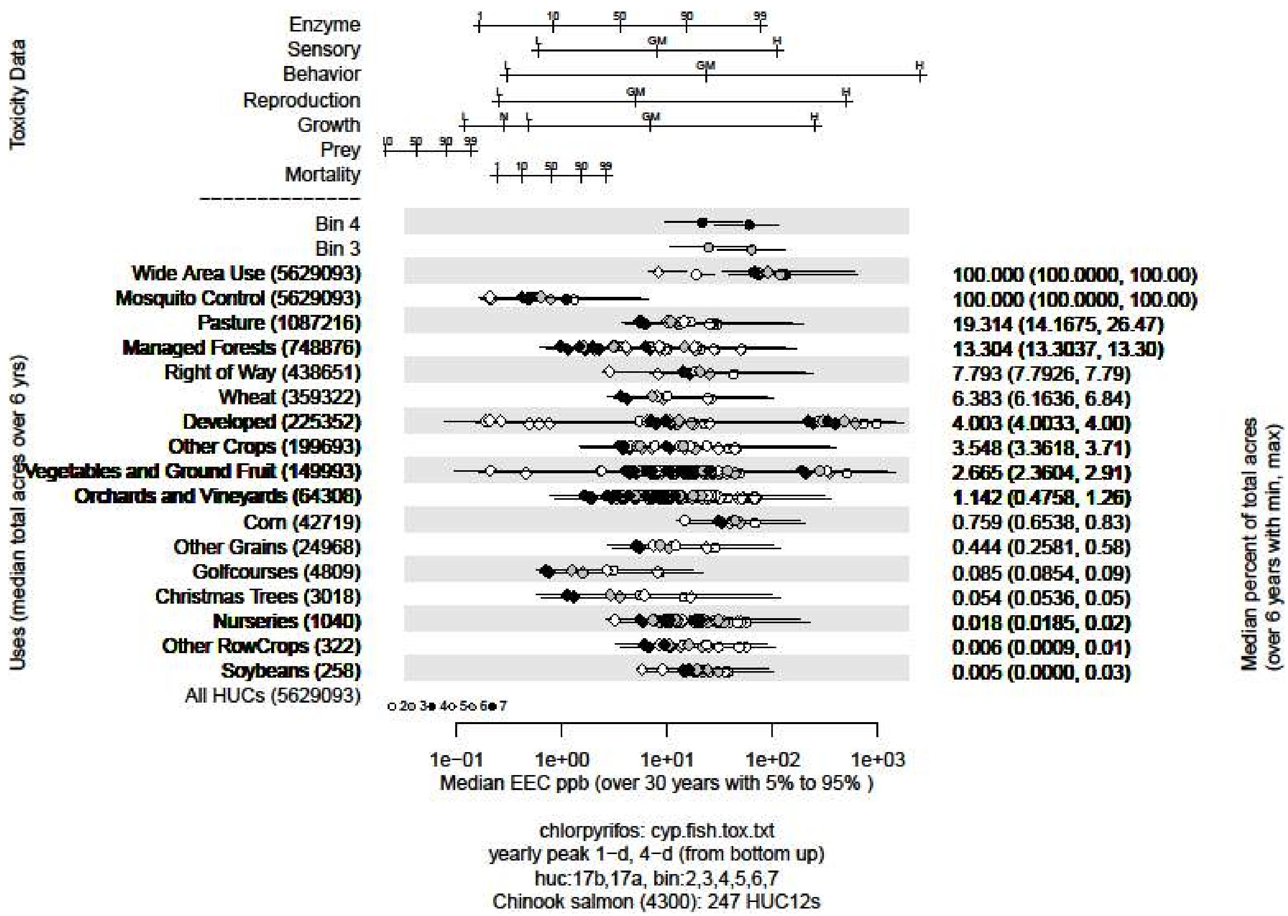


Figure 9. Effects analysis R-plot for Chinook salmon, Snake River fall-run ESU and chlorpyrifos

Table 77. Likelihood of exposure determination for Chinook salmon, Snake River fall-run ESU and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Managed Forest	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Wheat	3	yes	yes	yes	NA	3	High
Developed	2	yes	yes	yes	NA	3	High
Other Crops	2	yes	yes	yes	NA	3	High
Vegetables and Ground Fruit	2	yes	yes	yes	NA	3	High
orchards and Vineyards	2	yes	yes	yes	NA	3	High
Corn	1	yes	yes	yes	yes	3	High
Other Grains	1	no	yes	yes	yes	3	Med
Golf Courses	1	yes	yes	yes	no	3	Low
Christmas Trees	1	yes	yes	yes	no	3	Low
Nurseries	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High
Juveniles							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Managed Forest	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Wheat	3	yes	yes	yes	NA	3	High
Developed	2	yes	yes	yes	NA	3	High
Other Crops	2	yes	yes	yes	NA	3	High
Vegetables and Ground Fruit	2	yes	yes	yes	NA	3	High
orchards and Vineyards	2	yes	yes	yes	NA	3	High
Corn	1	yes	yes	yes	yes	3	High
Other Grains	1	yes	yes	yes	yes	3	High
Golf Courses	1	yes	yes	yes	no	3	Low
Christmas Trees	1	yes	yes	yes	no	3	Low
Nurseries	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High

Life Stage: Adults (full-range)

Table 78. Direct mortality risk hypothesis; Chinook salmon, Snake River fall-run ESU and chlorpyrifos; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High

Pasture	19.3	High	High
Managed Forest	13.3	High	High
Right of Way	7.8	High	High
Wheat	6.4	High	High
Developed	4.0	High	High
Other Crops	3.5	High	High
Vegetables and Ground Fruit	2.7	High	High
orchards and Vineyards	1.1	High	High
Corn	0.8	High	High
Other Grains	0.4	High	Medium
Golf Courses	0.09	High	Low
Christmas Trees	0.05	High	Low
Nurseries	0.02	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 79. Reproduction risk hypothesis; Chinook salmon, Snake River fall-run ESU and chlorpyrifos; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	19.3	High	High
Managed Forest	13.3	High	High
Right of Way	7.8	High	High
Wheat	6.4	High	High
Developed	4.0	High	High
Other Crops	3.5	High	High
Vegetables and Ground Fruit	2.7	High	High
orchards and Vineyards	1.1	High	High
Corn	0.8	High	High
Other Grains	0.4	High	Medium
Golf Courses	0.09	High	Low
Christmas Trees	0.05	High	Low
Nurseries	0.02	High	Low
Bin 3		High	High

Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 80. Behavior and sensory risk hypothesis; Chinook salmon, Snake River fall-run ESU and chlorpyrifos; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	19.3	High	High
Managed Forest	13.3	High	High
Right of Way	7.8	High	High
Wheat	6.4	High	High
Developed	4.0	High	High
Other Crops	3.5	High	High
Vegetables and Ground Fruit	2.7	High	High
orchards and Vineyards	1.1	High	High
Corn	0.8	High	High
Other Grains	0.4	High	Medium
Golf Courses	0.09	Medium	Low
Christmas Trees	0.05	High	Low
Nurseries	0.02	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	19.3	High	High
Managed Forest	13.3	High	High
Right of Way	7.8	High	High
Wheat	6.4	High	High
Developed	4.0	High	High
Other Crops	3.5	High	High
Vegetables and Ground Fruit	2.7	High	High

orchards and Vineyards	1.1	High	High
Corn	0.8	High	High
Other Grains	0.4	High	Medium
Golf Courses	0.09	High	Low
Christmas Trees	0.05	High	Low
Nurseries	0.02	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 81. AChE risk hypothesis; Chinook salmon, Snake River fall-run ESU and chlorpyrifos; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Pasture	19.3	High	High
Managed Forest	13.3	High	High
Right of Way	7.8	High	High
Wheat	6.4	High	High
Developed	4.0	High	High
Other Crops	3.5	High	High
Vegetables and Ground Fruit	2.7	High	High
orchards and Vineyards	1.1	High	High
Corn	0.8	High	High
Other Grains	0.4	High	Medium
Golf Courses	0.09	High	Low
Christmas Trees	0.05	High	Low
Nurseries	0.02	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 82. Direct mortality risk hypothesis; Chinook salmon, Snake River fall-run ESU and chlorpyrifos; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Pasture	19.3	High	High
Managed Forest	13.3	High	High
Right of Way	7.8	High	High
Wheat	6.4	High	High
Developed	4.0	High	High
Other Crops	3.5	High	High
Vegetables and Ground Fruit	2.7	High	High
orchards and Vineyards	1.1	High	High
Corn	0.8	High	High
Other Grains	0.4	High	High
Golf Courses	0.09	High	Low
Christmas Trees	0.05	High	Low
Nurseries	0.02	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 83. Growth risk hypothesis; Chinook salmon, Snake River fall-run ESU and chlorpyrifos; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	19.3	High	High
Managed Forest	13.3	High	High
Right of Way	7.8	High	High
Wheat	6.4	High	High
Developed	4.0	High	High
Other Crops	3.5	High	High
Vegetables and Ground Fruit	2.7	High	High

orchards and Vineyards	1.1	High	High
Corn	0.8	High	High
Other Grains	0.4	High	High
Golf Courses	0.09	High	Low
Christmas Trees	0.05	High	Low
Nurseries	0.02	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 84. Prey risk hypothesis; Chinook salmon, Snake River fall-run ESU and chlorpyrifos; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Pasture	19.3	High	High
Managed Forest	13.3	High	High
Right of Way	7.8	High	High
Wheat	6.4	High	High
Developed	4.0	High	High
Other Crops	3.5	High	High
Vegetables and Ground Fruit	2.7	High	High
orchards and Vineyards	1.1	High	High
Corn	0.8	High	High
Other Grains	0.4	High	High
Golf Courses	0.09	High	Low
Christmas Trees	0.05	High	Low
Nurseries	0.02	High	Low
Bin 3		High	High
Bin 4		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 85. AChE risk hypothesis; Chinook salmon, Snake River fall-run ESU and chlorpyrifos; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Pasture	19.3	High	High
Managed Forest	13.3	High	High
Right of Way	7.8	High	High
Wheat	6.4	High	High
Developed	4.0	High	High
Other Crops	3.5	High	High
Vegetables and Ground Fruit	2.7	High	High
orchards and Vineyards	1.1	High	High
Corn	0.8	High	High
Other Grains	0.4	High	High
Golf Courses	0.09	High	Low
Christmas Trees	0.05	High	Low
Nurseries	0.02	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 86. Behavior and sensory risk hypothesis; Chinook salmon, Snake River fall-run ESU and chlorpyrifos; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	19.3	High	High
Managed Forest	13.3	High	High
Right of Way	7.8	High	High
Wheat	6.4	High	High
Developed	4.0	High	High
Other Crops	3.5	High	High
Vegetables and Ground Fruit	2.7	High	High

orchards and Vineyards	1.1	High	High
Corn	0.8	High	High
Other Grains	0.4	High	High
Golf Courses	0.09	Medium	Low
Christmas Trees	0.05	High	Low
Nurseries	0.02	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	19.3	High	High
Managed Forest	13.3	High	High
Right of Way	7.8	High	High
Wheat	6.4	High	High
Developed	4.0	High	High
Other Crops	3.5	High	High
Vegetables and Ground Fruit	2.7	High	High
orchards and Vineyards	1.1	High	High
Corn	0.8	High	High
Other Grains	0.4	High	High
Golf Courses	0.09	High	Low
Christmas Trees	0.05	High	Low
Nurseries	0.02	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 87. Effects analysis summary table: Chinook salmon, Snake River fall-run ESU and chlorpyrifos

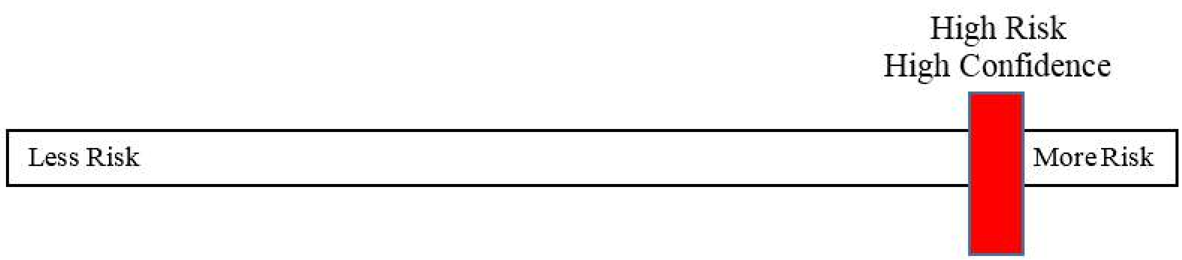
	R-plot Derived		**MagTool**	**Population Model Results**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					

Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 59-92 **Error! Reference source not found.**	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	Not Applicable	Yes
	R-plot Derived		**MagTool Range in median percent mortalities of aquatic bins**	**Population Model Results**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Juveniles	**Risk**	**Confidence**			
Risk Hypothesis					
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 59-92 **Error! Reference source not found.**	**Ocean-Type Chinook** **Portion of juveniles exposed to chlorpyrifos EECs; 0.75-100 µg/l** | **Mean percent reduction (STD) in a population's intrinsic growth, lambda, from**	Yes

				death of juveniles 25% 1-12% (13-23) 50% 1-23% (13-26) 75% 2-35% (13-24) 100% 3-97% (13-0) **Stream-Type Chinook** **Portion of juveniles exposed to chlorpyrifos EECs; 0.75-100 µg/l** | **Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles** 25% 1-11% (5-18) 50% 1-21% (5-22) 75% 2-31% (4-21) 100% 2-97% (4-0)	
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**	Yes
Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day invert: 60-98 **Error! Reference source not found.**	**Ocean-Type Chinook:** 5-24% (7-10) **Stream-Type Chinook:** 4-28% (3-4)	Yes
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available		Yes
Exposure to chlorpyrifos is sufficient to	High	High	Not Available	Not Applicable	**Yes**

reduce juvenile abundance via impairments to ecologically significant behaviors.					

Effects analysis summary: Adult and juvenile Chinook salmon, Snake River fall-run ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Population modelling results indicate that chlorpyrifos-induced mortality to juveniles may lead to severe reductions in lambda up to 97%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 59-92 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, Chinook will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed Chinook. The overall risk to Chinook salmon, Snake River fall-run ESU from the effects of the action is high and the confidence associated with that risk is high.



12.11 Chinook Salmon, Snake River spring/summer-run ESU (Oncorhynchus tshawytscha)

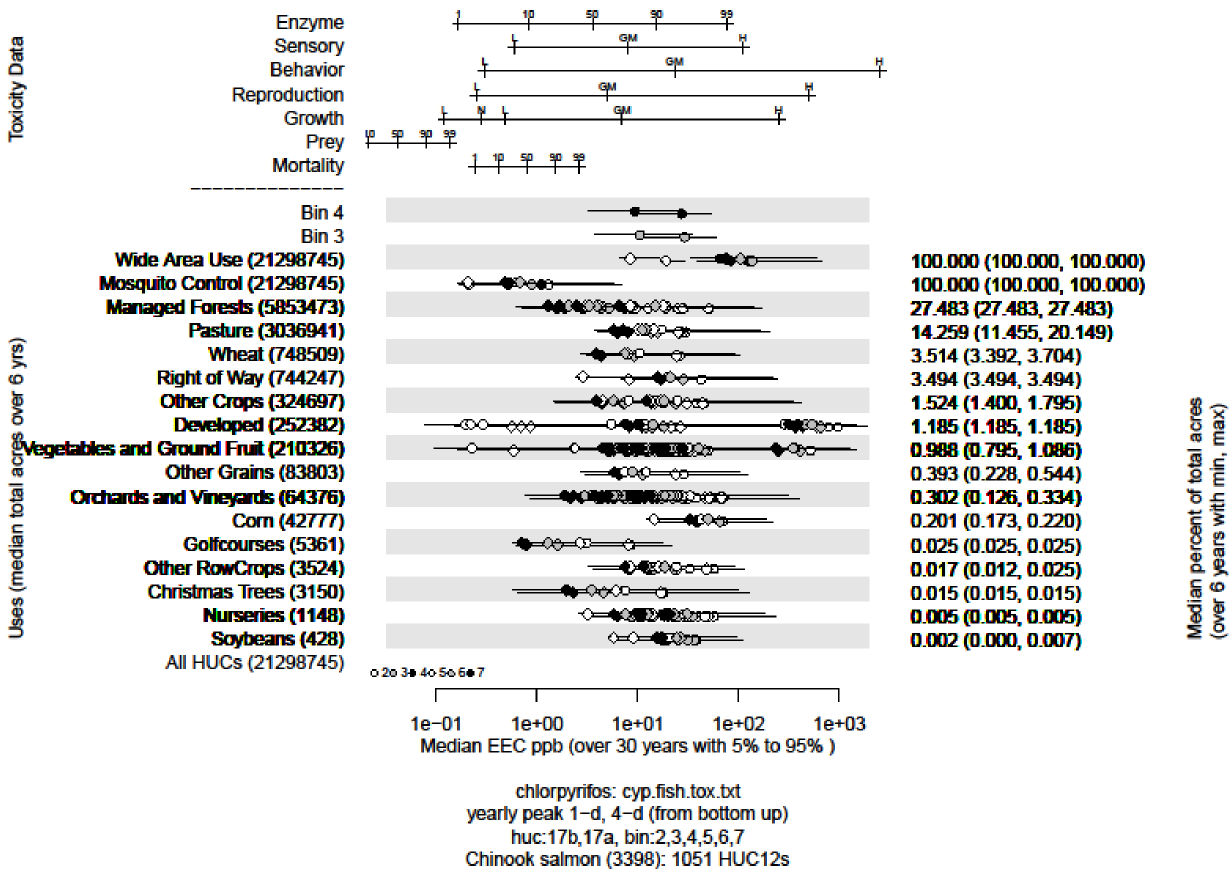


Figure 10. Effects analysis R-plot for Chinook salmon, Snake River spring/summer-run ESU and chlorpyrifos

Table 88. Likelihood of exposure determination for Chinook salmon, Snake River spring/summer-run ESU and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Managed Forest	3	yes	yes	yes	NA	3	High
Pastures	3	yes	yes	yes	NA	3	High
Wheat	2	yes	yes	yes	NA	3	High
Righ of Way	2	yes	yes	yes	NA	3	High
Other Crops	2	yes	yes	yes	NA	3	High
Developed	2	yes	yes	yes	NA	3	High
Vegetables and Ground	2	yes	yes	yes	NA	3	High
Other Grains	1	yes	yes	yes	no	3	Low
Orchards and Vineyards	1	yes	yes	yes	yes	3	High
Corn	1	yes	yes	yes	yes	3	High
Golf Courses	1	yes	yes	yes	no	3	Low
Other Row Crops	1	yes	yes	yes	no	3	Low
Christmas Trees	1	yes	yes	yes	no	3	Low
Nurseries	1	yes	yes	yes	no	3	Low
Soybeans	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High
Juveniles							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Managed Forest	3	yes	yes	yes	NA	3	High
Pastures	3	yes	yes	yes	NA	3	High
Wheat	2	yes	yes	yes	NA	3	High
Righ of Way	2	yes	yes	yes	NA	3	High
Other Crops	2	yes	yes	yes	NA	3	High
Developed	2	yes	yes	yes	NA	3	High
Vegetables and Ground	2	yes	yes	yes	NA	3	High
Other Grains	1	yes	yes	yes	no	3	Low
Orchards and Vineyards	1	yes	yes	yes	yes	3	High
Corn	1	yes	yes	yes	yes	3	High
Golf Courses	1	yes	yes	yes	no	3	Low
Other Row Crops	1	yes	yes	yes	no	3	Low
Christmas Trees	1	yes	yes	yes	no	3	Low
Nurseries	1	yes	yes	yes	no	3	Low
Soybeans	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High

Life Stage: Adults (full-range)

Table 89. Direct mortality risk hypothesis; Chinook salmon, Snake River spring/summer-run ESU and chlorpyrifos; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	27.5	High	High
Pastures	14.3	High	High
Wheat	3.5	High	High
Right of Way	3.5	High	High
Other Crops	1.5	High	High
Developed	1.2	High	High
Vegetables and Ground	1.0	High	High
Other Grains	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Corn	0.2	High	High
Golf Courses	0.03	High	Low
Other Row Crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.01	High	Low
Soybeans	0.002	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 90. Reproduction risk hypothesis; Chinook salmon, Snake River spring/summer-run ESU and chlorpyrifos; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	27.5	High	High
Pastures	14.3	High	High
Wheat	3.5	High	High
Right of Way	3.5	High	High
Other Crops	1.5	High	High

Developed	1.2	High	High
Vegetables and Ground	1.0	High	High
Other Grains	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Corn	0.2	High	High
Golf Courses	0.03	High	Low
Other Row Crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.01	High	Low
Soybeans	0.002	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 91. Behavior and sensory risk hypothesis; Chinook salmon, Snake River spring/summer-run ESU and chlorpyrifos; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	27.5	High	High
Pastures	14.3	High	High
Wheat	3.5	High	High
Right of Way	3.5	High	High
Other Crops	1.5	High	High
Developed	1.2	High	High
Vegetables and Ground	1.0	High	High
Other Grains	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Corn	0.2	High	High
Golf Courses	0.03	Medium	Low
Other Row Crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.01	High	Low
Soybeans	0.002	High	Low
Bin 3		High	High

Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	27.5	High	High
Pastures	14.3	High	High
Wheat	3.5	High	High
Right of Way	3.5	High	High
Other Crops	1.5	High	High
Developed	1.2	High	High
Vegetables and Ground	1.0	High	High
Other Grains	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Corn	0.2	High	High
Golf Courses	0.03	High	Low
Other Row Crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.01	High	Low
Soybeans	0.002	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 92. AChE risk hypothesis; Chinook salmon, Snake River spring/summer-run ESU and chlorpyrifos; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	27.5	High	High
Pastures	14.3	High	High
Wheat	3.5	High	High
Right of Way	3.5	High	High
Other Crops	1.5	High	High
Developed	1.2	High	High

Vegetables and Ground	1.0	High	High
Other Grains	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Corn	0.2	High	High
Golf Courses	0.03	High	Low
Other Row Crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.01	High	Low
Soybeans	0.002	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 93. Direct mortality risk hypothesis; Chinook salmon, Snake River spring/summer-run ESU and chlorpyrifos; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	27.5	High	High
Pastures	14.3	High	High
Wheat	3.5	High	High
Right of Way	3.5	High	High
Other Crops	1.5	High	High
Developed	1.2	High	High
Vegetables and Ground	1.0	High	High
Other Grains	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Corn	0.2	High	High
Golf Courses	0.03	High	Low
Other Row Crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.01	High	Low
Soybeans	0.002	High	Low

Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 94. Growth risk hypothesis; Chinook salmon, Snake River spring/summer-run ESU and chlorpyrifos; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	27.5	High	High
Pastures	14.3	High	High
Wheat	3.5	High	High
Right of Way	3.5	High	High
Other Crops	1.5	High	High
Developed	1.2	High	High
Vegetables and Ground	1.0	High	High
Other Grains	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Corn	0.2	High	High
Golf Courses	0.03	High	Low
Other Row Crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.01	High	Low
Soybeans	0.002	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 95. Prey risk hypothesis; Chinook salmon, Snake River spring/summer-run ESU and chlorpyrifos; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	27.5	High	High
Pastures	14.3	High	High
Wheat	3.5	High	High
Right of Way	3.5	High	High
Other Crops	1.5	High	High
Developed	1.2	High	High
Vegetables and Ground	1.0	High	High
Other Grains	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Corn	0.2	High	High
Golf Courses	0.03	High	Low
Other Row Crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.01	High	Low
Soybeans	0.002	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 96. AChE risk hypothesis; Chinook salmon, Snake River spring/summer-run ESU and chlorpyrifos; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	27.5	High	High
Pastures	14.3	High	High
Wheat	3.5	High	High
Right of Way	3.5	High	High
Other Crops	1.5	High	High
Developed	1.2	High	High
Vegetables and Ground	1.0	High	High
Other Grains	0.4	High	Low
Orchards and Vineyards	0.3	High	High

Corn	0.2	High	High
Golf Courses	0.03	High	Low
Other Row Crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.01	High	Low
Soybeans	0.002	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 97. Behavior and sensory risk hypothesis; Chinook salmon, Snake River spring/summer-run ESU and chlorpyrifos; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	27.5	High	High
Pastures	14.3	High	High
Wheat	3.5	High	High
Right of Way	3.5	High	High
Other Crops	1.5	High	High
Developed	1.2	High	High
Vegetables and Ground	1.0	High	High
Other Grains	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Corn	0.2	High	High
Golf Courses	0.03	Medium	Low
Other Row Crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.01	High	Low
Soybeans	0.002	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High

Managed Forest	27.5	High	High
Pastures	14.3	High	High
Wheat	3.5	High	High
Right of Way	3.5	High	High
Other Crops	1.5	High	High
Developed	1.2	High	High
Vegetables and Ground	1.0	High	High
Other Grains	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Corn	0.2	High	High
Golf Courses	0.03	High	Low
Other Row Crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.01	High	Low
Soybeans	0.002	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

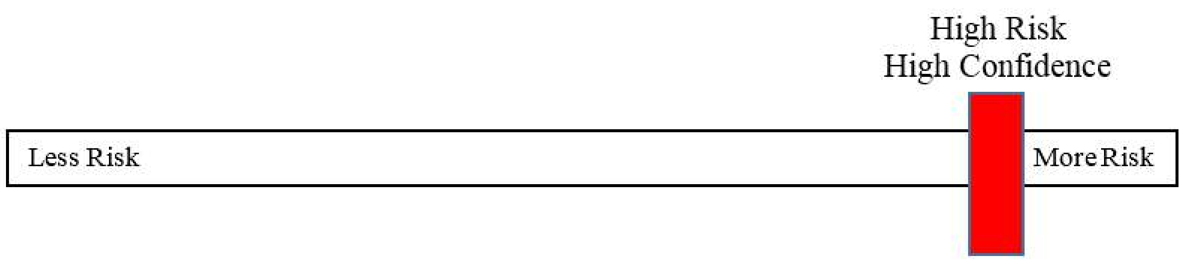
Table 98. Effects analysis summary table: Chinook salmon, Snake River spring/summer-run ESU and chlorpyrifos

	R-plot Derived		**MagTool**	**Population Model Results**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 53-84 **Error! Reference source not found.**	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce adult	High	High	Not Available	Not Applicable	Yes

<table>
<tr><td>productivity via impairments to reproduction</td><td></td><td></td><td></td><td colspan="2"></td><td></td></tr>
<tr><td>Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.</td><td>High</td><td>High</td><td>Not Available</td><td colspan="2">Not Applicable</td><td>Yes</td></tr>
<tr><td>Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity</td><td>High</td><td>High</td><td>Not Available</td><td colspan="2">Not Applicable</td><td>Yes</td></tr>
<tr><td rowspan="2">Life Stage: Juveniles</td><td colspan="2">R-plot Derived</td><td rowspan="2">MagTool Range in median percent mortalities of aquatic bins</td><td rowspan="2" colspan="2">Population Model Results</td><td rowspan="2">Risk Hypothesis Supported? Yes/No</td></tr>
<tr><td>Risk</td><td>Confidence</td></tr>
<tr><td>Risk Hypothesis</td><td></td><td></td><td></td><td colspan="2"></td><td></td></tr>
<tr><td rowspan="6">Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.</td><td rowspan="6">High</td><td rowspan="6">High</td><td rowspan="6">4-day: 53-84 Error! Reference source not found.</td><td colspan="2">Ocean-Type Chinook</td><td rowspan="6">Yes</td></tr>
<tr><td>Portion of juveniles exposed to chlorpyrifos EECs; 0.75-100 µg/l</td><td>Mean percent reduction (STD) in a population’s intrinsic growth, lambda, from death of juveniles</td></tr>
<tr><td>25%
50%
75%
100%</td><td>1-12% (13-23)
1-23% (13-26)
2-35% (13-24)
3-97% (13-0)</td></tr>
<tr><td colspan="2">Stream-Type Chinook</td></tr>
<tr><td>Portion of juveniles exposed to</td><td>Mean percent reduction (STD) in a</td></tr>
</table>

				chlorpyrifos EECs; 0.75-100 µg/l	**population's intrinsic growth, lambda, from death of juveniles**	
				25% 50% 75% 100%	1-11% (5-18) 1-21% (5-22) 2-31% (4-21) 2-97% (4-0)	
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**		Yes
Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day invert: 54-99 **Error! Reference source not found.**	**Ocean-Type Chinook:** 5-24% (7-10) **Stream-Type Chinook:** 4-28% (3-4)		Yes
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available			Yes
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable		**Yes**

Effects analysis summary: Adult and juvenile Chinook salmon, Snake River spring/summer-run ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Population modelling results indicate that chlorpyrifos-induced mortality to juveniles may lead to severe reductions in lambda up to 97%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 53-84 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, Chinook will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed Chinook. The overall risk to Chinook salmon, Snake River spring/summer-run ESU from the effects of the action is high and the confidence associated with that risk is high.



12.12 Chinook salmon, Upper Columbia River spring-run ESU (Oncorhynchus tshawytscha)

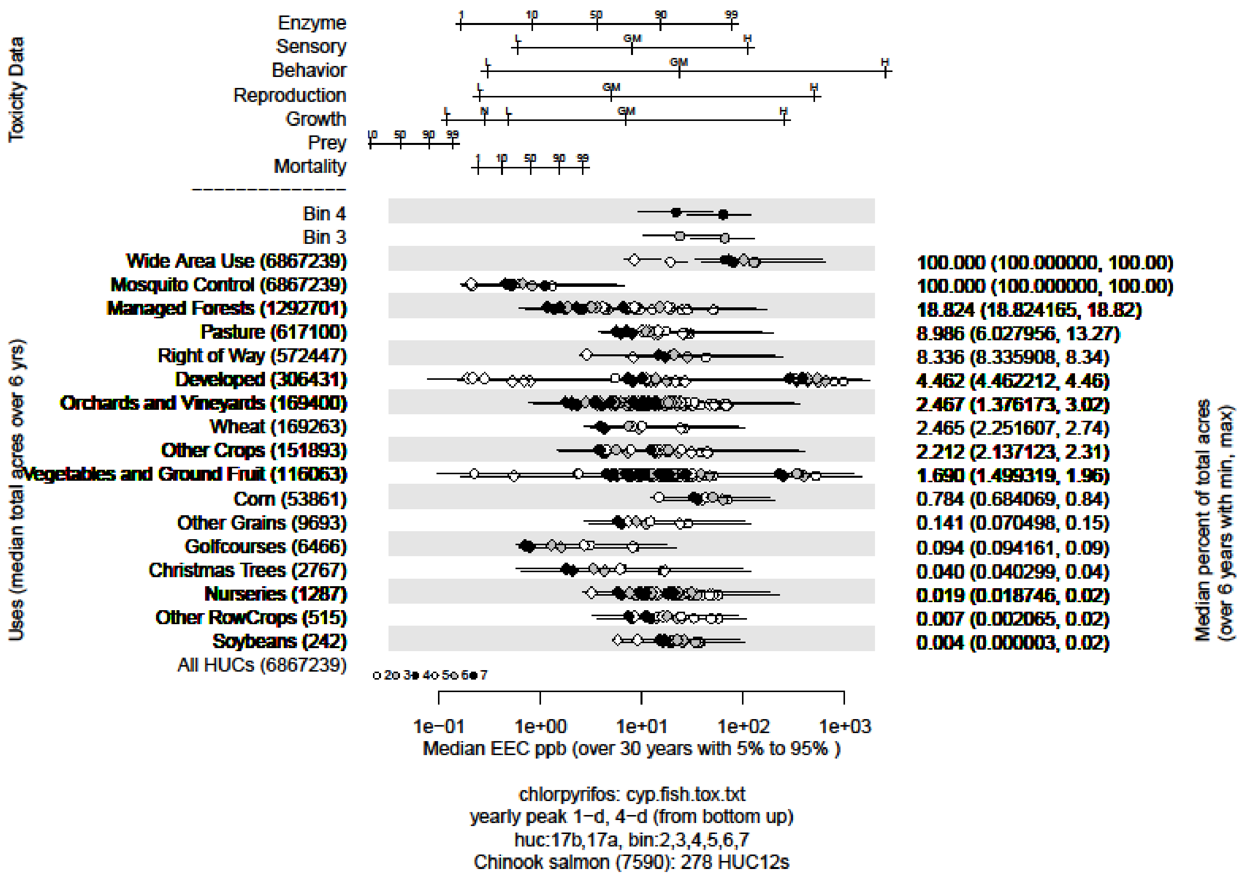


Figure 11. Effects analysis R-plot for Chinook salmon, upper Columbia spring-run ESU and chlorpyrifos

Table 99. Likelihood of exposure determination for Chinook salmon, upper Columbia spring-run ESU and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Managed Forest	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Developed	2	yes	yes	yes	NA	3	High
Orchards and Vineyards	2	yes	yes	yes	NA	3	High
Wheat	2	yes	yes	yes	NA	3	High
Other Crops	2	yes	yes	yes	NA	3	High
Vegetables and Ground Fruit	2	yes	yes	yes	NA	3	High
Corn	1	yes	yes	yes	yes	3	High
Other Grains	1	yes	yes	yes	no	3	Low
Golf Courses	1	yes	yes	yes	no	3	Low
Christmas Trees	1	yes	yes	yes	no	3	Low
Nurseries	1	yes	yes	yes	no	3	Low
Other Row Crops	1	yes	yes	yes	no	3	Low
Soybeans	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High
Juveniles							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Managed Forest	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Developed	2	yes	yes	yes	NA	3	High
Orchards and Vineyards	2	yes	yes	yes	NA	3	High
Wheat	2	yes	yes	yes	NA	3	High
Other Crops	2	yes	yes	yes	NA	3	High
Vegetables and Ground Fruit	2	yes	yes	yes	NA	3	High
Corn	1	yes	yes	yes	yes	3	High
Other Grains	1	yes	yes	yes	no	3	Low
Golf Courses	1	yes	yes	yes	no	3	Low
Christmas Trees	1	yes	yes	yes	no	3	Low
Nurseries	1	yes	yes	yes	no	3	Low
Other Row Crops	1	yes	yes	yes	no	3	Low
Soybeans	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High

Life Stage: Adults (full-range)

Table 100. Direct mortality risk hypothesis; Chinook salmon, upper Columbia spring-run ESU and chlorpyrifos; Adults

Endpoint: Mortality

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	18.8	High	High
Pasture	9.0	High	High
Right of Way	8.3	High	High
Developed	4.5	High	High
Orchards and Vineyards	2.5	High	High
Wheat	2.5	High	High
Other Crops	2.2	High	High
Vegetables and Ground Fruit	1.7	High	High
Corn	0.8	High	High
Other Grains	0.1	High	Low
Golf Courses	0.1	High	Low
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Soybeans	0.004	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 101. Reproduction risk hypothesis; Chinook salmon, upper Columbia spring-run ESU and chlorpyrifos; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	18.8	High	High
Pasture	9.0	High	High
Right of Way	8.3	High	High
Developed	4.5	High	High
Orchards and Vineyards	2.5	High	High
Wheat	2.5	High	High
Other Crops	2.2	High	High

Vegetables and Ground Fruit	1.7	High	High
Corn	0.8	High	High
Other Grains	0.1	High	Low
Golf Courses	0.1	High	Low
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Soybeans	0.004	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 102. Behavior and sensory risk hypothesis; Chinook salmon, upper Columbia spring-run ESU and chlorpyrifos; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	18.8	High	High
Pasture	9.0	High	High
Right of Way	8.3	High	High
Developed	4.5	High	High
Orchards and Vineyards	2.5	High	High
Wheat	2.5	High	High
Other Crops	2.2	High	High
Vegetables and Ground Fruit	1.7	High	High
Corn	0.8	High	High
Other Grains	0.1	High	Low
Golf Courses	0.1	Medium	Low
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Soybeans	0.004	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	18.8	High	High
Pasture	9.0	High	High
Right of Way	8.3	High	High
Developed	4.5	High	High
Orchards and Vineyards	2.5	High	High
Wheat	2.5	High	High
Other Crops	2.2	High	High
Vegetables and Ground Fruit	1.7	High	High
Corn	0.8	High	High
Other Grains	0.1	High	Low
Golf Courses	0.1	High	Low
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Soybeans	0.004	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 103. AChE risk hypothesis; Chinook salmon, upper Columbia spring-run ESU and chlorpyrifos; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	18.8	High	High
Pasture	9.0	High	High
Right of Way	8.3	High	High
Developed	4.5	High	High
Orchards and Vineyards	2.5	High	High
Wheat	2.5	High	High
Other Crops	2.2	High	High

Vegetables and Ground Fruit	1.7	High	High
Corn	0.8	High	High
Other Grains	0.1	High	Low
Golf Courses	0.1	High	Low
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Soybeans	0.004	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 104. Direct mortality risk hypothesis; Chinook salmon, upper Columbia spring-run ESU and chlorpyrifos; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	18.8	High	High
Pasture	9.0	High	High
Right of Way	8.3	High	High
Developed	4.5	High	High
Orchards and Vineyards	2.5	High	High
Wheat	2.5	High	High
Other Crops	2.2	High	High
Vegetables and Ground Fruit	1.7	High	High
Corn	0.8	High	High
Other Grains	0.1	High	Low
Golf Courses	0.1	High	Low
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Soybeans	0.004	High	Low
Bin 3		High	High
Bin 4		High	High

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.		
Risk	Confidence	
High	High	

Table 105. Growth risk hypothesis; Chinook salmon, upper Columbia spring-run ESU and chlorpyrifos; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	18.8	High	High
Pasture	9.0	High	High
Right of Way	8.3	High	High
Developed	4.5	High	High
Orchards and Vineyards	2.5	High	High
Wheat	2.5	High	High
Other Crops	2.2	High	High
Vegetables and Ground Fruit	1.7	High	High
Corn	0.8	High	High
Other Grains	0.1	High	Low
Golf Courses	0.1	High	Low
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Soybeans	0.004	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 106. Prey risk hypothesis; Chinook salmon, upper Columbia spring-run ESU and chlorpyrifos; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High

Managed Forest	18.8	High	High
Pasture	9.0	High	High
Right of Way	8.3	High	High
Developed	4.5	High	High
Orchards and Vineyards	2.5	High	High
Wheat	2.5	High	High
Other Crops	2.2	High	High
Vegetables and Ground Fruit	1.7	High	High
Corn	0.8	High	High
Other Grains	0.1	High	Low
Golf Courses	0.1	High	Low
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Soybeans	0.004	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 107. AChE risk hypothesis; Chinook salmon, upper Columbia spring-run ESU and chlorpyrifos; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	18.8	High	High
Pasture	9.0	High	High
Right of Way	8.3	High	High
Developed	4.5	High	High
Orchards and Vineyards	2.5	High	High
Wheat	2.5	High	High
Other Crops	2.2	High	High
Vegetables and Ground Fruit	1.7	High	High
Corn	0.8	High	High
Other Grains	0.1	High	Low
Golf Courses	0.1	High	Low

Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Soybeans	0.004	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 108. Behavior and sensory risk hypothesis; Chinook salmon, upper Columbia spring-run ESU and chlorpyrifos; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	18.8	High	High
Pasture	9.0	High	High
Right of Way	8.3	High	High
Developed	4.5	High	High
Orchards and Vineyards	2.5	High	High
Wheat	2.5	High	High
Other Crops	2.2	High	High
Vegetables and Ground Fruit	1.7	High	High
Corn	0.8	High	High
Other Grains	0.1	High	Low
Golf Courses	0.1	Medium	Low
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Soybeans	0.004	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	18.8	High	High
Pasture	9.0	High	High

Right of Way	8.3	High	High
Developed	4.5	High	High
Orchards and Vineyards	2.5	High	High
Wheat	2.5	High	High
Other Crops	2.2	High	High
Vegetables and Ground Fruit	1.7	High	High
Corn	0.8	High	High
Other Grains	0.1	High	Low
Golf Courses	0.1	High	Low
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Soybeans	0.004	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

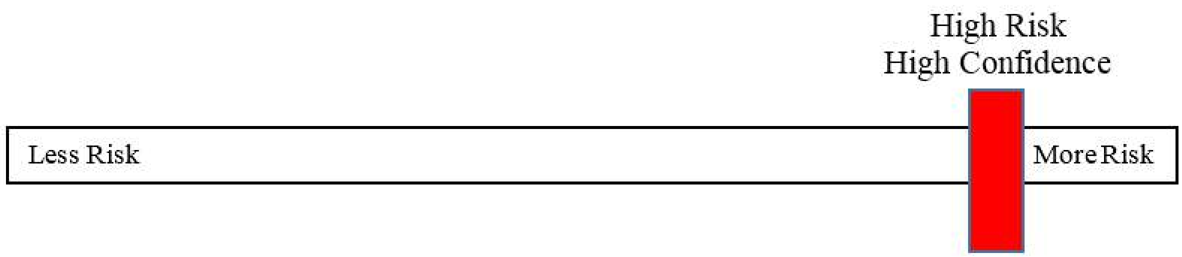
Table 109. Effects analysis summary table: Chinook salmon, upper Columbia spring-run ESU and chlorpyrifos

	R-plot Derived		**MagTool**	**Population Model Results**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 50-94 **Error! Reference source not found.**	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce adult productivity via	High	High	Not Available	Not Applicable	Yes

<table>
<tr><td>impairments to reproduction</td><td></td><td></td><td></td><td colspan="2"></td><td></td></tr>
<tr><td>Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.</td><td>High</td><td>High</td><td>Not Available</td><td colspan="2">Not Applicable</td><td>Yes</td></tr>
<tr><td>Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity</td><td>High</td><td>High</td><td>Not Available</td><td colspan="2">Not Applicable</td><td>Yes</td></tr>
<tr><td></td><td colspan="2">R-plot Derived</td><td rowspan="2">MagTool Range in median percent mortalities of aquatic bins</td><td colspan="2" rowspan="2">Population Model Results</td><td rowspan="2">Risk Hypothesis Supported? Yes/No</td></tr>
<tr><td>Life Stage: Juveniles</td><td>Risk</td><td>Confidence</td></tr>
<tr><td>Risk Hypothesis</td><td></td><td></td><td></td><td colspan="2"></td><td></td></tr>
<tr><td rowspan="5">Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.</td><td rowspan="5">High</td><td rowspan="5">High</td><td rowspan="5">4-day: 50-94 Error! Reference source not found.</td><td colspan="2">Ocean-Type Chinook</td><td rowspan="5">Yes</td></tr>
<tr><td>Portion of juveniles exposed to chlorpyrifos EECs; 0.75-100 µg/l</td><td>Mean percent reduction (STD) in a population’s intrinsic growth, lambda, from death of juveniles</td></tr>
<tr><td>25%
50%
75%
100%</td><td>1-12% (13-23)
1-23% (13-26)
2-35% (13-24)
3-97% (13-0)</td></tr>
<tr><td colspan="2">Stream-Type Chinook</td></tr>
<tr><td>Portion of juveniles exposed to chlorpyrifos</td><td>Mean percent reduction (STD) in a population’s</td></tr>
</table>

				EECs; 0.75-100 µg/l	**intrinsic growth, lambda, from death of juveniles**	
				25% 50% 75% 100%	1-11% (5-18) 1-21% (5-22) 2-31% (4-21) 2-97% (4-0)	
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**		Yes
Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day invert: 50-98 **Error! Reference source not found.**	**Ocean-Type Chinook:** 5-24% (7-10) **Stream-Type Chinook:** 4-28% (3-4)		Yes
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available			Yes
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable		**Yes**

Effects analysis summary: Adult and juvenile Chinook salmon, upper Columbia spring-run ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Population modelling results indicate that chlorpyrifos-induced mortality to juveniles may lead to severe reductions in lambda up to 97%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 50-94 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, Chinook will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed Chinook. The overall risk to Chinook salmon, upper Columbia spring-run ESU from the effects of the action is high and the confidence associated with that risk is high.



12.13 Chinook Salmon, Upper Willamette River ESU (Oncorhynchus tshawytscha)

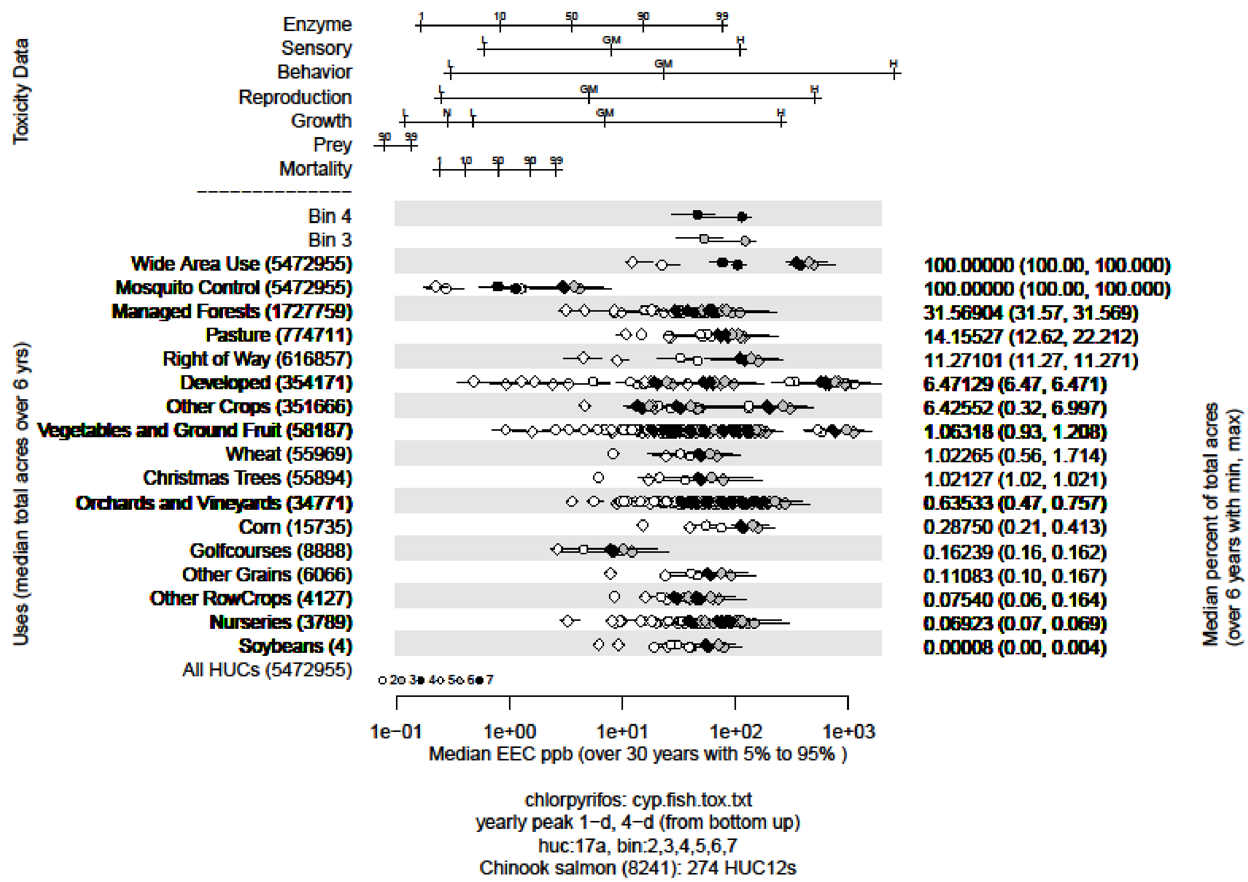


Figure 12. Effects analysis R-plot for Chinook salmon, upper Willamette River ESU and chlorpyrifos

Table 110. Likelihood of exposure determination for Chinook salmon, upper Willamette River ESU and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Managed Forest	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Developed	3	yes	yes	yes	NA	3	High
Other Crops	3	yes	yes	yes	NA	3	High
Vegetables and Ground fruit	2	yes	yes	yes	NA	3	High
Wheat	2	yes	yes	yes	NA	3	High
Christmas Trees	2	yes	yes	yes	NA	3	High
Orchards and Vineyards	1	yes	yes	yes	yes	3	High
Corn	1	yes	yes	yes	yes	3	High
Golf Courses	1	yes	yes	yes	no	3	Low
Other grains	1	yes	yes	yes	yes	3	High
Other Row Crops	1	yes	yes	yes	yes	3	High
Nurseries	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High
Juveniles							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Managed Forest	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Developed	3	yes	yes	yes	NA	3	High
Other Crops	3	yes	yes	yes	NA	3	High
Vegetables and Ground fruit	2	yes	yes	yes	NA	3	High
Wheat	2	yes	yes	yes	NA	3	High
Christmas Trees	2	yes	yes	yes	NA	3	High
Orchards and Vineyards	1	yes	yes	yes	yes	3	High
Corn	1	yes	yes	yes	yes	3	High
Golf Courses	1	yes	yes	yes	no	3	Low
Other grains	1	yes	yes	yes	yes	3	High
Other Row Crops	1	yes	yes	yes	yes	3	High
Nurseries	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High

Life Stage: Adults (full-range)

Table 111. Direct mortality risk hypothesis; Chinook salmon, upper Willamette River ESU and chlorpyrifos; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	31.6	High	High
Pasture	14.2	High	High
Right of Way	11.3	High	High
Developed	6.5	High	High
Other Crops	6.4	High	High
Vegetables and Ground fruit	1.1	High	High
Wheat	1.0	High	High
Christmas Trees	1.0	High	High
Orchards and Vineyards	0.6	High	High
Corn	0.3	High	High
Golf Courses	0.2	High	Low
Other grains	0.1	High	High
Other Row Crops	0.08	High	High
Nurseries	0.07	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 112. Reproduction risk hypothesis; Chinook salmon, upper Willamette River ESU and chlorpyrifos; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	31.6	High	High
Pasture	14.2	High	High
Right of Way	11.3	High	High
Developed	6.5	High	High
Other Crops	6.4	High	High
Vegetables and Ground fruit	1.1	High	High
Wheat	1.0	High	High
Christmas Trees	1.0	High	High
Orchards and Vineyards	0.6	High	High
Corn	0.3	High	High

Golf Courses	0.2	High	Low
Other grains	0.1	High	High
Other Row Crops	0.08	High	High
Nurseries	0.07	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 113. Behavior and sensory risk hypothesis; Chinook salmon, upper Willamette River ESU and chlorpyrifos; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	31.6	High	High
Pasture	14.2	High	High
Right of Way	11.3	High	High
Developed	6.5	High	High
Other Crops	6.4	High	High
Vegetables and Ground fruit	1.1	High	High
Wheat	1.0	High	High
Christmas Trees	1.0	High	High
Orchards and Vineyards	0.6	High	High
Corn	0.3	High	High
Golf Courses	0.2	Medium	Low
Other grains	0.1	High	High
Other Row Crops	0.08	High	High
Nurseries	0.07	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	31.6	High	High
Pasture	14.2	High	High
Right of Way	11.3	High	High

Developed	6.5	High	High
Other Crops	6.4	High	High
Vegetables and Ground fruit	1.1	High	High
Wheat	1.0	High	High
Christmas Trees	1.0	High	High
Orchards and Vineyards	0.6	High	High
Corn	0.3	High	High
Golf Courses	0.2	High	Low
Other grains	0.1	High	High
Other Row Crops	0.08	High	High
Nurseries	0.07	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 114. AChE risk hypothesis; Chinook salmon, upper Willamette River ESU and chlorpyrifos; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	31.6	High	High
Pasture	14.2	High	High
Right of Way	11.3	High	High
Developed	6.5	High	High
Other Crops	6.4	High	High
Vegetables and Ground fruit	1.1	High	High
Wheat	1.0	High	High
Christmas Trees	1.0	High	High
Orchards and Vineyards	0.6	High	High
Corn	0.3	High	High
Golf Courses	0.2	High	Low
Other grains	0.1	High	High
Other Row Crops	0.08	High	High
Nurseries	0.07	High	Low
Bin 3		High	High
Bin 4		High	High

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity		
Risk	**Confidence**	
High	**High**	

Life Stage: Juveniles (full-range)

Table 115. Direct mortality risk hypothesis; Chinook salmon, upper Willamette River ESU and chlorpyrifos; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	31.6	High	High
Pasture	14.2	High	High
Right of Way	11.3	High	High
Developed	6.5	High	High
Other Crops	6.4	High	High
Vegetables and Ground fruit	1.1	High	High
Wheat	1.0	High	High
Christmas Trees	1.0	High	High
Orchards and Vineyards	0.6	High	High
Corn	0.3	High	High
Golf Courses	0.2	High	Low
Other grains	0.1	High	High
Other Row Crops	0.08	High	High
Nurseries	0.07	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 116. Growth risk hypothesis; Chinook salmon, upper Willamette River ESU and chlorpyrifos; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High

Mosquito Control	100	Medium	High
Managed Forest	31.6	High	High
Pasture	14.2	High	High
Right of Way	11.3	High	High
Developed	6.5	High	High
Other Crops	6.4	High	High
Vegetables and Ground fruit	1.1	High	High
Wheat	1.0	High	High
Christmas Trees	1.0	High	High
Orchards and Vineyards	0.6	High	High
Corn	0.3	High	High
Golf Courses	0.2	High	Low
Other grains	0.1	High	High
Other Row Crops	0.08	High	High
Nurseries	0.07	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 117. Prey risk hypothesis; Chinook salmon, upper Willamette River ESU and chlorpyrifos; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	31.6	High	High
Pasture	14.2	High	High
Right of Way	11.3	High	High
Developed	6.5	High	High
Other Crops	6.4	High	High
Vegetables and Ground fruit	1.1	High	High
Wheat	1.0	High	High
Christmas Trees	1.0	High	High
Orchards and Vineyards	0.6	High	High
Corn	0.3	High	High
Golf Courses	0.2	High	Low
Other grains	0.1	High	High

Other Row Crops	0.08	High	High
Nurseries	0.07	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 118. AChE risk hypothesis; Chinook salmon, upper Willamette River ESU and chlorpyrifos; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	31.6	High	High
Pasture	14.2	High	High
Right of Way	11.3	High	High
Developed	6.5	High	High
Other Crops	6.4	High	High
Vegetables and Ground fruit	1.1	High	High
Wheat	1.0	High	High
Christmas Trees	1.0	High	High
Orchards and Vineyards	0.6	High	High
Corn	0.3	High	High
Golf Courses	0.2	High	Low
Other grains	0.1	High	High
Other Row Crops	0.08	High	High
Nurseries	0.07	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 119. Behavior and sensory risk hypothesis; Chinook salmon, upper Willamette River ESU and chlorpyrifos; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	31.6	High	High
Pasture	14.2	High	High
Right of Way	11.3	High	High
Developed	6.5	High	High
Other Crops	6.4	High	High
Vegetables and Ground fruit	1.1	High	High
Wheat	1.0	High	High
Christmas Trees	1.0	High	High
Orchards and Vineyards	0.6	High	High
Corn	0.3	High	High
Golf Courses	0.2	Medium	Low
Other grains	0.1	High	High
Other Row Crops	0.08	High	High
Nurseries	0.07	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	31.6	High	High
Pasture	14.2	High	High
Right of Way	11.3	High	High
Developed	6.5	High	High
Other Crops	6.4	High	High
Vegetables and Ground fruit	1.1	High	High
Wheat	1.0	High	High
Christmas Trees	1.0	High	High
Orchards and Vineyards	0.6	High	High
Corn	0.3	High	High
Golf Courses	0.2	High	Low
Other grains	0.1	High	High
Other Row Crops	0.08	High	High
Nurseries	0.07	High	Low
Bin 3		High	High
Bin 4		High	High

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.		
Risk	**Confidence**	
High	**High**	

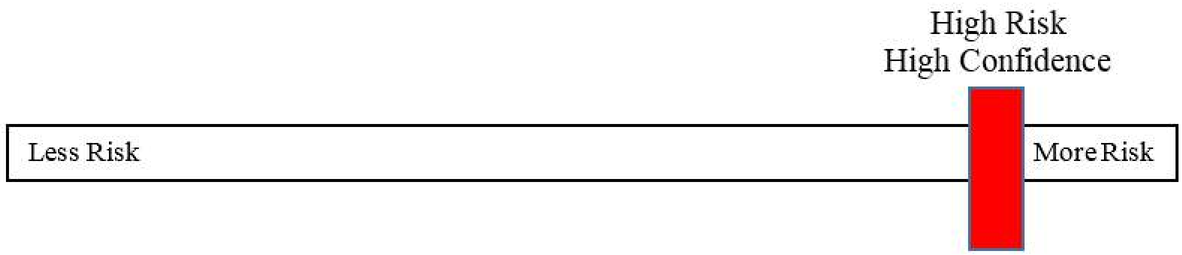
Table 120. Effects analysis summary table: Chinook salmon, upper Willamette River ESU and chlorpyrifos

	R-plot Derived		**MagTool**	**Population Model Results**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 74-99 **Error! Reference source not found.**	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified	High	High	Not Available	Not Applicable	Yes

mechanism of toxicity					
	R-plot Derived		**MagTool Range in median percent mortalities of aquatic bins**	**Population Model Results**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Juveniles	**Risk**	**Confidence**			
Risk Hypothesis					
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 74-99 **Error! Reference source not found.**	**Ocean-Type Chinook** **Portion of juveniles exposed to chlorpyrifos EECs; 0.75-100 µg/l** — **Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles** 25% — 1-12% (13-23) 50% — 1-23% (13-26) 75% — 2-35% (13-24) 100% — 3-97% (13-0) **Stream-Type Chinook** **Portion of juveniles exposed to chlorpyrifos EECs; 0.75-100 µg/l** — **Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles** 25% — 1-11% (5-18) 50% — 1-21% (5-22) 75% — 2-31% (4-21) 100% — 2-97% (4-0)	Yes
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**	Yes
Exposure to chlorpyrifos is	High	High	4-day invert: 74-99		Yes

sufficient to reduce Juvenile abundance via reduction in prey availability			**Error! Reference source not found.**	**Ocean-Type Chinook:** 5-24% (7-10)	
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Stream-Type Chinook:** 4-28% (3-4)	Yes
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	**Yes**

Effects analysis summary: Adult and juvenile Chinook salmon, upper Willamette River ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Population modelling results indicate that chlorpyrifos-induced mortality to juveniles may lead to severe reductions in lambda up to 97%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 74-99 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, Chinook will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed Chinook. The overall risk to Chinook salmon, upper Willamette River ESU from the effects of the action is high and the confidence associated with that risk is high.


High Risk
High Confidence
Less Risk
More Risk

12.14 Coho Salmon, Central California Coast ESU (Oncorhynchus kisutch)

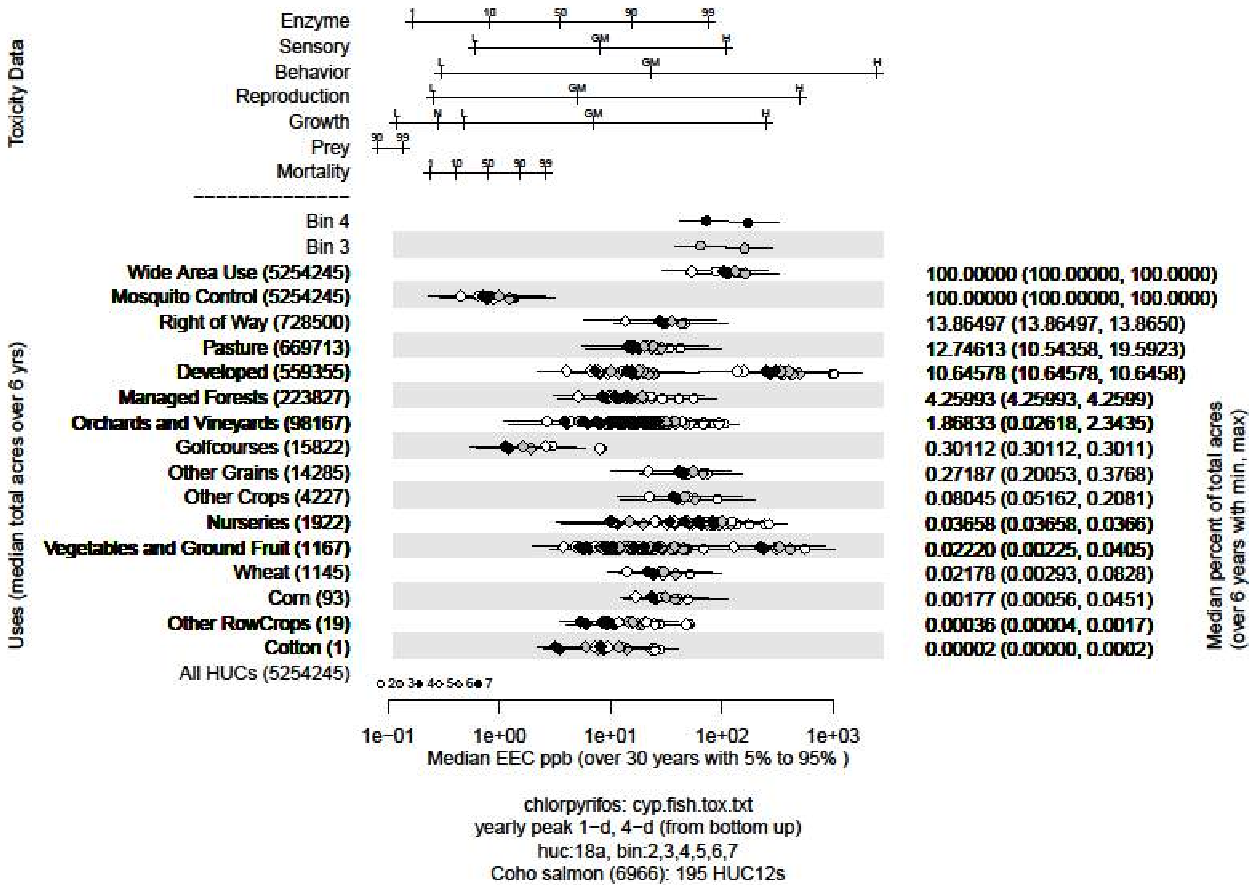


Figure 13. Effects analysis R-plot for Coho salmon, Central California Coast ESU and chlorpyrifos

Table 121. Likelihood of exposure determination for Coho salmon, Central California Coast ESU and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Wide Area use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Developed	3	yes	yes	yes	NA	3	High
Managed Forest	2	yes	yes	yes	NA	3	High
Orchards and Vineyards	2	yes	yes	yes	NA	3	High
Golf Courses	1	yes	yes	yes	NA	3	Low
Other Grains	1	no	yes	yes	NA	3	Low
Other Crops	1	yes	yes	yes	NA	3	Low
Nurseries	1	yes	yes	yes	NA	3	Low
Vegetables and Ground fruit	1	yes	yes	yes	NA	3	Low
Wheat	1	yes	yes	yes	NA	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High
Juveniles							
Wide Area use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Developed	3	yes	yes	yes	NA	3	High
Managed Forest	2	yes	yes	yes	NA	3	High
Orchards and Vineyards	2	yes	yes	yes	NA	3	High
Golf Courses	1	yes	yes	yes	NA	3	Low
Other Grains	1	yes	yes	yes	NA	3	Low
Other Crops	1	yes	yes	yes	NA	3	Low
Nurseries	1	yes	yes	yes	NA	3	Low
Vegetables and Ground fruit	1	yes	yes	yes	NA	3	Low
Wheat	1	yes	yes	yes	NA	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High

Life Stage: Adults (full-range)

Table 122. Direct mortality risk hypothesis; Coho salmon, Central California Coast ESU and chlorpyrifos; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area use	100	High	High
Mosquito Control	100	High	High
Right of Way	13.9	High	High
Pasture	12.7	High	High

Developed	10.8	High	High
Managed Forest	4.3	High	High
Orchards and Vineyards	1.9	High	High
Golf Courses	0.3	High	Low
Other Grains	0.3	High	Low
Other Crops	0.1	High	Low
Nurseries	0.04	High	Low
Vegetables and Ground fruit	0.02	High	Low
Wheat	0.02	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 123. Reproduction risk hypothesis; Coho salmon, Central California Coast ESU and chlorpyrifos; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	13.9	High	High
Pasture	12.7	High	High
Developed	10.8	High	High
Managed Forest	4.3	High	High
Orchards and Vineyards	1.9	High	High
Golf Courses	0.3	Medium	Low
Other Grains	0.3	High	Low
Other Crops	0.1	High	Low
Nurseries	0.04	High	Low
Vegetables and Ground fruit	0.02	High	Low
Wheat	0.02	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 124. Behavior and sensory risk hypothesis; Coho salmon, Central California Coast ESU and chlorpyrifos; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	13.9	High	High
Pasture	12.7	High	High
Developed	10.8	High	High
Managed Forest	4.3	High	High
Orchards and Vineyards	1.9	High	High
Golf Courses	0.3	Medium	Low
Other Grains	0.3	High	Low
Other Crops	0.1	High	Low
Nurseries	0.04	High	Low
Vegetables and Ground fruit	0.02	High	Low
Wheat	0.02	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	13.9	High	High
Pasture	12.7	High	High
Developed	10.8	High	High
Managed Forest	4.3	High	High
Orchards and Vineyards	1.9	High	High
Golf Courses	0.3	High	Low
Other Grains	0.3	High	Low
Other Crops	0.1	High	Low
Nurseries	0.04	High	Low
Vegetables and Ground fruit	0.02	High	Low
Wheat	0.02	High	Low
Bin 3		High	High
Bin 4		High	High

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.		
Risk	**Confidence**	
High	**High**	

Table 125. AChE risk hypothesis; Coho salmon, Central California Coast ESU and chlorpyrifos; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	13.9	High	High
Pasture	12.7	High	High
Developed	10.8	High	High
Managed Forest	4.3	High	High
Orchards and Vineyards	1.9	High	High
Golf Courses	0.3	High	Low
Other Grains	0.3	High	Low
Other Crops	0.1	High	Low
Nurseries	0.04	High	Low
Vegetables and Ground fruit	0.02	High	Low
Wheat	0.02	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 126. Direct mortality risk hypothesis; Coho salmon, Central California Coast ESU and chlorpyrifos; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area use	100	High	High
Mosquito Control	100	High	High
Right of Way	13.9	High	High
Pasture	12.7	High	High
Developed	10.8	High	High

Managed Forest	4.3	High	High
Orchards and Vineyards	1.9	High	High
Golf Courses	0.3	High	Low
Other Grains	0.3	High	Low
Other Crops	0.1	High	Low
Nurseries	0.04	High	Low
Vegetables and Ground fruit	0.02	High	Low
Wheat	0.02	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 127. Growth risk hypothesis; Coho salmon, Central California Coast ESU and chlorpyrifos; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	13.9	High	High
Pasture	12.7	High	High
Developed	10.8	High	High
Managed Forest	4.3	High	High
Orchards and Vineyards	1.9	High	High
Golf Courses	0.3	Medium	Low
Other Grains	0.3	High	Low
Other Crops	0.1	High	Low
Nurseries	0.04	High	Low
Vegetables and Ground fruit	0.02	High	Low
Wheat	0.02	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 128. Prey risk hypothesis; Coho salmon, Central California Coast ESU and chlorpyrifos; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area use	100	High	High
Mosquito Control	100	High	High
Right of Way	13.9	High	High
Pasture	12.7	High	High
Developed	10.8	High	High
Managed Forest	4.3	High	High
Orchards and Vineyards	1.9	High	High
Golf Courses	0.3	High	Low
Other Grains	0.3	High	Low
Other Crops	0.1	High	Low
Nurseries	0.04	High	Low
Vegetables and Ground fruit	0.02	High	Low
Wheat	0.02	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 129. AChE risk hypothesis; Coho salmon, Central California Coast ESU and chlorpyrifos; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	13.9	High	High
Pasture	12.7	High	High
Developed	10.8	High	High
Managed Forest	4.3	High	High
Orchards and Vineyards	1.9	High	High
Golf Courses	0.3	High	Low
Other Grains	0.3	High	Low
Other Crops	0.1	High	Low
Nurseries	0.04	High	Low

Vegetables and Ground fruit	0.02	High	Low
Wheat	0.02	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 130. Behavior and sensory risk hypothesis; Coho salmon, Central California Coast ESU and chlorpyrifos; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	13.9	High	High
Pasture	12.7	High	High
Developed	10.8	High	High
Managed Forest	4.3	High	High
Orchards and Vineyards	1.9	High	High
Golf Courses	0.3	Medium	Low
Other Grains	0.3	High	Low
Other Crops	0.1	High	Low
Nurseries	0.04	High	Low
Vegetables and Ground fruit	0.02	High	Low
Wheat	0.02	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	13.9	High	High
Pasture	12.7	High	High
Developed	10.8	High	High
Managed Forest	4.3	High	High
Orchards and Vineyards	1.9	High	High
Golf Courses	0.3	High	Low

Other Grains	0.3	High	Low
Other Crops	0.1	High	Low
Nurseries	0.04	High	Low
Vegetables and Ground fruit	0.02	High	Low
Wheat	0.02	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

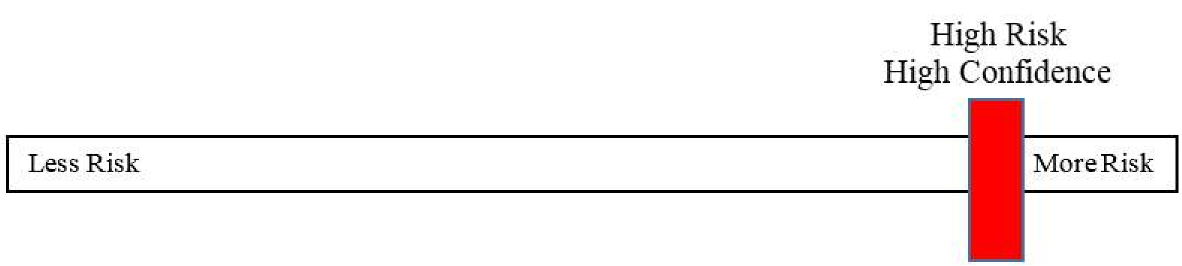
Table 131. Effects analysis summary table: Coho salmon, Central California Coast ESU and chlorpyrifos

	R-plot Derived		**MagTool**	**Population Model Results: Coho Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 44-96 **Error! Reference source not found.**	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically	High	High	Not Available	Not Applicable	Yes

significant behaviors.						
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	Not Applicable		Yes
	R-plot Derived		**MagTool Range in median percent mortalities of aquatic bins**	**Population Model Results: Coho Salmon**		**Risk Hypothesis Supported? Yes/No**
Life Stage: Juveniles	**Risk**	**Confidence**				
Risk Hypothesis						
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 44-96 **Error! Reference source not found.**	**Portion of juveniles exposed to chlorpyrifos EECs; 0.75-100 µg/l**	**Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles**	Yes
				25%	1-14% (8-23)	
				50%	1-27% (8-28)	
				75%	2-40% (7-27)	
				100%	3-99% (7-0)	
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**		Yes
Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via	High	High	4-day invert: 44-100 **Error! Reference**			Yes

reduction in prey availability			**source not found.**	5-32% (7-8)	
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available		Yes
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	**Yes**

Effects analysis summary: Adult and juvenile Coho salmon, Central California Coast ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Population modelling results indicate that chlorpyrifos-induced mortality to juveniles may lead to severe reductions in lambda up to 99%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 44-96 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, Coho will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed Coho. The overall risk to Coho salmon, Central California Coast ESU from the effects of the action is high and the confidence associated with that risk is high.



12.15 Coho Salmon, Lower Columbia River ESU (Oncorhynchus kisutch)

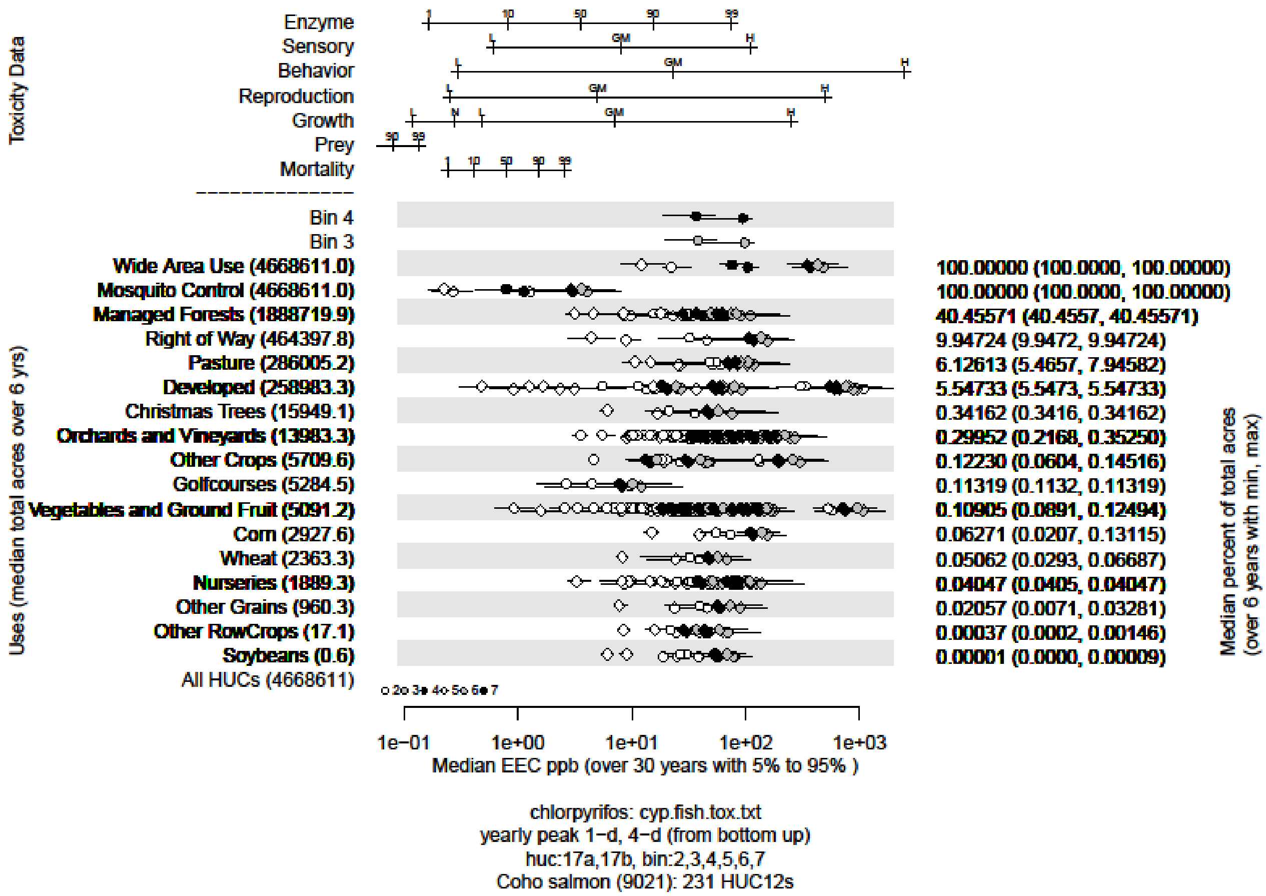


Figure 14. Effects analysis R-plot for Coho salmon, lower Columbia River ESU and chlorpyrifos

Table 132. Likelihood of exposure determination for Coho salmon, lower Columbia River ESU and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Managed Forest	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Developed	3	yes	yes	yes	NA	3	High
Christmas Trees	1	yes	yes	yes	NA	3	Low
Orchards and Vineyards	1	yes	yes	yes	NA	3	Low
Other crops	1	no	yes	yes	NA	3	Low
Golf Courses	1	yes	yes	yes	NA	3	Low
Vegetables and Ground Fruit	1	yes	yes	yes	NA	3	Low
Corn	1	yes	yes	yes	NA	3	Low
Wheat	1	yes	yes	yes	NA	3	Low
Nurseries	1	yes	yes	yes	NA	3	Low
Other Grains	1	yes	yes	yes	NA	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High
Juveniles							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Managed Forest	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Developed	3	yes	yes	yes	NA	3	High
Christmas Trees	1	yes	yes	yes	NA	3	Low
Orchards and Vineyards	1	yes	yes	yes	NA	3	Low
Other crops	1	yes	yes	yes	NA	3	Low
Golf Courses	1	yes	yes	yes	NA	3	Low
Vegetables and Ground Fruit	1	yes	yes	yes	NA	3	Low
Corn	1	yes	yes	yes	NA	3	Low
Wheat	1	yes	yes	yes	NA	3	Low
Nurseries	1	yes	yes	yes	NA	3	Low
Other Grains	1	yes	yes	yes	NA	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High

Life Stage: Adults (full-range)

Table 133. Direct mortality risk hypothesis; Coho salmon, lower Columbia River ESU and chlorpyrifos; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**

Mosquito Control	100	High	**High**
Managed Forest	40.5	High	**High**
Right of Way	9.9	High	**High**
Pasture	6.1	High	**High**
Developed	5.5	High	**High**
Christmas Trees	0.3	High	**Low**
Orchards and Vineyards	0.3	High	**Low**
Other crops	0.1	High	**Low**
Golf Courses	0.1	High	**Low**
Vegetables and Ground Fruit	0.1	High	**Low**
Corn	0.06	High	**Low**
Wheat	0.05	High	**Low**
Nurseries	0.04	High	**Low**
Other Grains	0.02	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 134. Reproduction risk hypothesis; Coho salmon, lower Columbia River ESU and chlorpyrifos; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	40.5	High	**High**
Right of Way	9.9	High	**High**
Pasture	6.1	High	**High**
Developed	5.5	High	**High**
Christmas Trees	0.3	High	**Low**
Orchards and Vineyards	0.3	High	**Low**
Other crops	0.1	High	**Low**
Golf Courses	0.1	Medium	**Low**
Vegetables and Ground Fruit	0.1	High	**Low**
Corn	0.06	High	**Low**
Wheat	0.05	High	**Low**
Nurseries	0.04	High	**Low**
Other Grains	0.02	High	**Low**

Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 135. Behavior and sensory risk hypothesis; Coho salmon, lower Columbia River ESU and chlorpyrifos; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	40.5	High	**High**
Right of Way	9.9	High	**High**
Pasture	6.1	High	**High**
Developed	5.5	High	**High**
Christmas Trees	0.3	High	**Low**
Orchards and Vineyards	0.3	High	**Low**
Other crops	0.1	High	**Low**
Golf Courses	0.1	Medium	**Low**
Vegetables and Ground Fruit	0.1	High	**Low**
Corn	0.06	High	**Low**
Wheat	0.05	High	**Low**
Nurseries	0.04	High	**Low**
Other Grains	0.02	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	40.5	High	**High**
Right of Way	9.9	High	**High**
Pasture	6.1	High	**High**
Developed	5.5	High	**High**
Christmas Trees	0.3	High	**Low**
Orchards and Vineyards	0.3	High	**Low**
Other crops	0.1	High	**Low**

Golf Courses	0.1	High	**Low**
Vegetables and Ground Fruit	0.1	High	**Low**
Corn	0.06	High	**Low**
Wheat	0.05	High	**Low**
Nurseries	0.04	High	**Low**
Other Grains	0.02	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 136. AChE risk hypothesis; Coho salmon, lower Columbia River ESU and chlorpyrifos; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	40.5	High	**High**
Right of Way	9.9	High	**High**
Pasture	6.1	High	**High**
Developed	5.5	High	**High**
Christmas Trees	0.3	High	**Low**
Orchards and Vineyards	0.3	High	**Low**
Other crops	0.1	High	**Low**
Golf Courses	0.1	High	**Low**
Vegetables and Ground Fruit	0.1	High	**Low**
Corn	0.06	High	**Low**
Wheat	0.05	High	**Low**
Nurseries	0.04	High	**Low**
Other Grains	0.02	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 137. Direct mortality risk hypothesis; Coho salmon, lower Columbia River ESU and chlorpyrifos; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	40.5	High	High
Right of Way	9.9	High	High
Pasture	6.1	High	High
Developed	5.5	High	High
Christmas Trees	0.3	High	Low
Orchards and Vineyards	0.3	High	Low
Other crops	0.1	High	Low
Golf Courses	0.1	High	Low
Vegetables and Ground Fruit	0.1	High	Low
Corn	0.06	High	Low
Wheat	0.05	High	Low
Nurseries	0.04	High	Low
Other Grains	0.02	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 138. Growth risk hypothesis; Coho salmon, lower Columbia River ESU and chlorpyrifos; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	40.5	High	High
Right of Way	9.9	High	High
Pasture	6.1	High	High
Developed	5.5	High	High
Christmas Trees	0.3	High	Low
Orchards and Vineyards	0.3	High	Low
Other crops	0.1	High	Low

Golf Courses	0.1	Medium	Low
Vegetables and Ground Fruit	0.1	High	Low
Corn	0.06	High	Low
Wheat	0.05	High	Low
Nurseries	0.04	High	Low
Other Grains	0.02	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 139. Prey risk hypothesis; Coho salmon, lower Columbia River ESU and chlorpyrifos; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	High	**High**
Managed Forest	40.5	High	**High**
Right of Way	9.9	High	**High**
Pasture	6.1	High	**High**
Developed	5.5	High	**High**
Christmas Trees	0.3	High	**Low**
Orchards and Vineyards	0.3	High	**Low**
Other crops	0.1	High	**Low**
Golf Courses	0.1	High	**Low**
Vegetables and Ground Fruit	0.1	High	**Low**
Corn	0.06	High	**Low**
Wheat	0.05	High	**Low**
Nurseries	0.04	High	**Low**
Other Grains	0.02	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 140. AChE risk hypothesis; Coho salmon, lower Columbia River ESU and chlorpyrifos; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	40.5	High	High
Right of Way	9.9	High	High
Pasture	6.1	High	High
Developed	5.5	High	High
Christmas Trees	0.3	High	Low
Orchards and Vineyards	0.3	High	Low
Other crops	0.1	High	Low
Golf Courses	0.1	High	Low
Vegetables and Ground Fruit	0.1	High	Low
Corn	0.06	High	Low
Wheat	0.05	High	Low
Nurseries	0.04	High	Low
Other Grains	0.02	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 141. Behavior and sensory risk hypothesis; Coho salmon, lower Columbia River ESU and chlorpyrifos; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	40.5	High	**High**
Right of Way	9.9	High	**High**
Pasture	6.1	High	**High**
Developed	5.5	High	**High**
Christmas Trees	0.3	High	**Low**
Orchards and Vineyards	0.3	High	**Low**
Other crops	0.1	High	**Low**

Golf Courses	0.1	Medium	**Low**
Vegetables and Ground Fruit	0.1	High	**Low**
Corn	0.06	High	**Low**
Wheat	0.05	High	**Low**
Nurseries	0.04	High	**Low**
Other Grains	0.02	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	40.5	High	**High**
Right of Way	9.9	High	**High**
Pasture	6.1	High	**High**
Developed	5.5	High	**High**
Christmas Trees	0.3	High	**Low**
Orchards and Vineyards	0.3	High	**Low**
Other crops	0.1	High	**Low**
Golf Courses	0.1	High	**Low**
Vegetables and Ground Fruit	0.1	High	**Low**
Corn	0.06	High	**Low**
Wheat	0.05	High	**Low**
Nurseries	0.04	High	**Low**
Other Grains	0.02	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

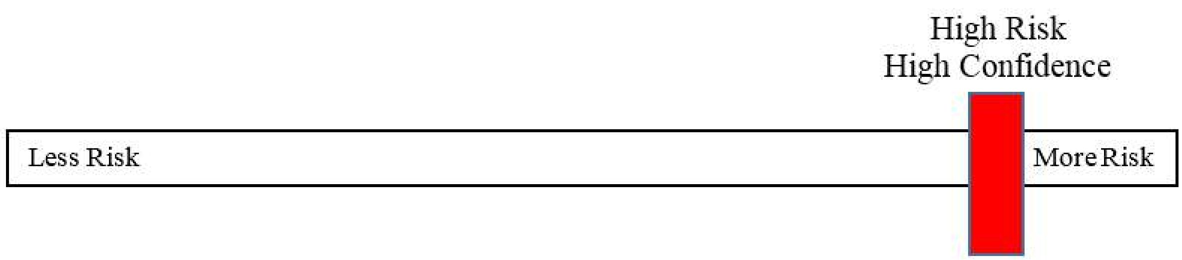
Table 142. Effects analysis summary table: Coho salmon, lower Columbia River ESU and chlorpyrifos

	R-plot Derived		**MagTool**	**Population Model Results: Coho Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					

Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 63-97 **Error! Reference source not found.**	Not Applicable		Yes
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable		Yes
Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable		Yes
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	Not Applicable		Yes
	R-plot Derived		**MagTool Range in median percent mortalities of aquatic bins**	**Population Model Results: Coho Salmon**		**Risk Hypothesis Supported? Yes/No**
Life Stage: Juveniles	**Risk**	**Confidence**				
Risk Hypothesis						
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 63-97 **Error! Reference source not found.**	**Portion of juveniles exposed to chlorpyrifos EECs; 0.75-100 µg/l**	**Mean percent reduction (STD) in a population's intrinsic growth, lambda,**	Yes

					from death of juveniles	
				25%	1-14% (8-23)	
				50%	1-27% (8-28)	
				75%	2-40% (7-27)	
				100%	3-99% (7-0)	
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**		Yes
Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day invert: 63-100 **Error! Reference source not found.**	5-32% (7-8)		Yes
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available			Yes
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable		**Yes**

Effects analysis summary: Adult and juvenile Coho salmon, lower Columbia River ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Population modelling results indicate that chlorpyrifos-induced mortality to juveniles may lead to severe reductions in lambda up to 99%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 63-97 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, Coho will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed Coho. The overall risk to Coho salmon, lower Columbia River ESU from the effects of the action is high and the confidence associated with that risk is high.



12.16 Coho Salmon, Oregon Coast ESU (Oncorhynchus kisutch)

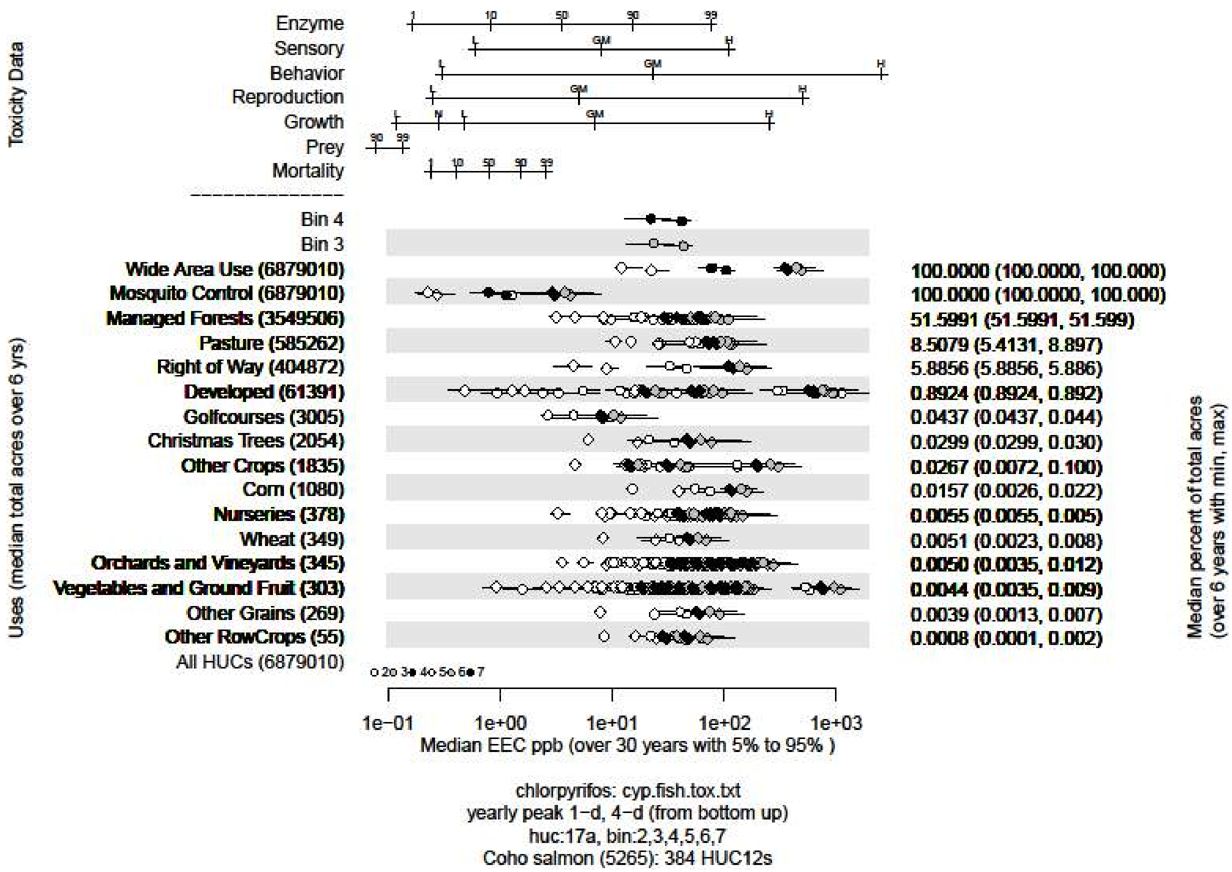


Figure 15. Effects analysis R-plot for Coho salmon, Oregon coast ESU and chlorpyrifos

Table 143. Likelihood of exposure determination for Coho salmon, Oregon coast ESU and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Managed Forest	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Developed	1	yes	yes	yes	yes	3	High
Golf Courses	1	yes	yes	yes	no	3	Low
Christmas Trees	1	yes	yes	yes	no	3	Low
Other Crops	1	yes	yes	yes	no	3	Low
Corn	1	yes	yes	yes	no	3	Low
Nurseries	1	yes	yes	yes	no	3	Low
Wheat	1	yes	yes	yes	no	3	Low
Orchards and Vineyards	1	yes	yes	yes	no	3	Low
Vegetables and Ground Fruit	1	yes	yes	yes	no	3	Low
Other Grains	1	no	yes	yes	no	3	Low
Other Row Crops	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High
Juveniles							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Managed Forest	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Developed	1	yes	yes	yes	yes	3	High
Golf Courses	1	yes	yes	yes	no	3	Low
Christmas Trees	1	yes	yes	yes	no	3	Low
Other Crops	1	yes	yes	yes	no	3	Low
Corn	1	yes	yes	yes	no	3	Low
Nurseries	1	yes	yes	yes	no	3	Low
Wheat	1	yes	yes	yes	no	3	Low
Orchards and Vineyards	1	yes	yes	yes	no	3	Low
Vegetables and Ground Fruit	1	yes	yes	yes	no	3	Low
Other Grains	1	yes	yes	yes	no	3	Low
Other Row Crops	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High

Life Stage: Adults (full-range)

Table 144. Direct mortality risk hypothesis; Coho salmon, Oregon coast ESU and chlorpyrifos; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	High	**High**
Managed Forest	51.6	High	**High**

Pasture	8.5	High	**High**
Right of Way	5.9	High	**High**
Developed	0.9	High	**High**
Golf Courses	0.04	High	**Low**
Christmas Trees	0.03	High	**Low**
Other Crops	0.03	High	**Low**
Corn	0.02	High	**Low**
Nurseries	0.006	High	**Low**
Wheat	0.005	High	**Low**
Orchards and Vineyards	0.005	High	**Low**
Vegetables and Ground Fruit	0.004	High	**Low**
Other Grains	0.004	High	**Low**
Other Row Crops	0.0008	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 145. Reproduction risk hypothesis; Coho salmon, Oregon coast ESU and chlorpyrifos; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	51.6	High	**High**
Pasture	8.5	High	**High**
Right of Way	5.9	High	**High**
Developed	0.9	High	**High**
Golf Courses	0.04	Medium	**Low**
Christmas Trees	0.03	High	**Low**
Other Crops	0.03	High	**Low**
Corn	0.02	High	**Low**
Nurseries	0.005	High	**Low**
Wheat	0.005	High	**Low**
Orchards and Vineyards	0.005	High	**Low**
Vegetables and Ground Fruit	0.004	High	**Low**
Other Grains	0.004	High	**Low**
Other Row Crops	0.0008	High	**Low**

Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 146. Behavior and sensory risk hypothesis; Coho salmon, Oregon coast ESU and chlorpyrifos; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	51.6	High	**High**
Pasture	8.5	High	**High**
Right of Way	5.9	High	**High**
Developed	0.9	High	**High**
Golf Courses	0.04	Medium	**Low**
Christmas Trees	0.03	High	**Low**
Other Crops	0.03	High	**Low**
Corn	0.02	High	**Low**
Nurseries	0.005	High	**Low**
Wheat	0.005	High	**Low**
Orchards and Vineyards	0.005	High	**Low**
Vegetables and Ground Fruit	0.004	High	**Low**
Other Grains	0.004	High	**Low**
Other Row Crops	0.0008	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	51.6	High	**High**
Pasture	8.5	High	**High**
Right of Way	5.9	High	**High**
Developed	0.9	High	**High**
Golf Courses	0.04	High	**Low**
Christmas Trees	0.03	High	**Low**
Other Crops	0.03	High	**Low**
Corn	0.02	High	**Low**

Nurseries	0.005	High	**Low**
Wheat	0.005	High	**Low**
Orchards and Vineyards	0.005	High	**Low**
Vegetables and Ground Fruit	0.004	High	**Low**
Other Grains	0.004	High	**Low**
Other Row Crops	0.0008	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 147. AChE risk hypothesis; Coho salmon, Oregon coast ESU and chlorpyrifos; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	51.6	High	**High**
Pasture	8.5	High	**High**
Right of Way	5.9	High	**High**
Developed	0.9	High	**High**
Golf Courses	0.04	High	**Low**
Christmas Trees	0.03	High	**Low**
Other Crops	0.03	High	**Low**
Corn	0.02	High	**Low**
Nurseries	0.005	High	**Low**
Wheat	0.005	High	**Low**
Orchards and Vineyards	0.005	High	**Low**
Vegetables and Ground Fruit	0.004	High	**Low**
Other Grains	0.004	High	**Low**
Other Row Crops	0.0008	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 148. Direct mortality risk hypothesis; Coho salmon, Oregon coast ESU and chlorpyrifos; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	51.6	High	High
Pasture	8.5	High	High
Right of Way	5.9	High	High
Developed	0.9	High	High
Golf Courses	0.04	High	Low
Christmas Trees	0.03	High	Low
Other Crops	0.03	High	Low
Corn	0.02	High	Low
Nurseries	0.006	High	Low
Wheat	0.005	High	Low
Orchards and Vineyards	0.005	High	Low
Vegetables and Ground Fruit	0.004	High	Low
Other Grains	0.004	High	Low
Other Row Crops	0.0008	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 149. Growth risk hypothesis; Coho salmon, Oregon coast ESU and chlorpyrifos; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	51.6	High	High
Pasture	8.5	High	High
Right of Way	5.9	High	High
Developed	0.9	High	High
Golf Courses	0.04	Medium	Low
Christmas Trees	0.03	High	Low
Other Crops	0.03	High	Low

Corn	0.02	High	Low
Nurseries	0.005	High	Low
Wheat	0.005	High	Low
Orchards and Vineyards	0.005	High	Low
Vegetables and Ground Fruit	0.004	High	Low
Other Grains	0.004	High	Low
Other Row Crops	0.0008	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 150. Prey risk hypothesis; Coho salmon, Oregon coast ESU and chlorpyrifos; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	High	**High**
Managed Forest	51.6	High	**High**
Pasture	8.5	High	**High**
Right of Way	5.9	High	**High**
Developed	0.9	High	**High**
Golf Courses	0.04	High	**Low**
Christmas Trees	0.03	High	**Low**
Other Crops	0.03	High	**Low**
Corn	0.02	High	**Low**
Nurseries	0.005	High	**Low**
Wheat	0.005	High	**Low**
Orchards and Vineyards	0.005	High	**Low**
Vegetables and Ground Fruit	0.004	High	**Low**
Other Grains	0.004	High	**Low**
Other Row Crops	0.0008	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 151. AChE risk hypothesis; Coho salmon, Oregon coast ESU and chlorpyrifos; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	51.6	High	High
Pasture	8.5	High	High
Right of Way	5.9	High	High
Developed	0.9	High	High
Golf Courses	0.04	High	Low
Christmas Trees	0.03	High	Low
Other Crops	0.03	High	Low
Corn	0.02	High	Low
Nurseries	0.005	High	Low
Wheat	0.005	High	Low
Orchards and Vineyards	0.005	High	Low
Vegetables and Ground Fruit	0.004	High	Low
Other Grains	0.004	High	Low
Other Row Crops	0.0008	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 152. Behavior and sensory risk hypothesis; Coho salmon, Oregon coast ESU and chlorpyrifos; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	51.6	High	**High**
Pasture	8.5	High	**High**
Right of Way	5.9	High	**High**
Developed	0.9	High	**High**
Golf Courses	0.04	Medium	**Low**
Christmas Trees	0.03	High	**Low**

Other Crops	0.03	High	**Low**
Corn	0.02	High	**Low**
Nurseries	0.005	High	**Low**
Wheat	0.005	High	**Low**
Orchards and Vineyards	0.005	High	**Low**
Vegetables and Ground Fruit	0.004	High	**Low**
Other Grains	0.004	High	**Low**
Other Row Crops	0.0008	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	51.6	High	**High**
Pasture	8.5	High	**High**
Right of Way	5.9	High	**High**
Developed	0.9	High	**High**
Golf Courses	0.04	High	**Low**
Christmas Trees	0.03	High	**Low**
Other Crops	0.03	High	**Low**
Corn	0.02	High	**Low**
Nurseries	0.005	High	**Low**
Wheat	0.005	High	**Low**
Orchards and Vineyards	0.005	High	**Low**
Vegetables and Ground Fruit	0.004	High	**Low**
Other Grains	0.004	High	**Low**
Other Row Crops	0.0008	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 153. Effects analysis summary table: Coho salmon, Oregon coast ESU and chlorpyrifos

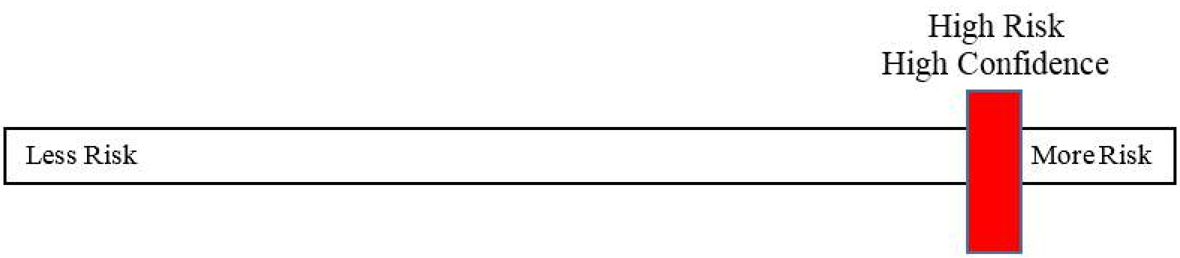
	R-plot Derived	**MagTool**	**Population Model Results: Coho Salmon**	

Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		**Risk Hypothesis Supported? Yes/No**
Risk Hypothesis					
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 67-100 **Error! Reference source not found.**	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	Not Applicable	Yes
	R-plot Derived		**MagTool Range in median percent mortalities of aquatic bins**	**Population Model Results: Coho Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Juveniles	**Risk**	**Confidence**			
Risk Hypothesis					

<table>
<tr><td rowspan="6">Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.</td><td rowspan="6">High</td><td rowspan="6">High</td><td rowspan="6">4-day: 67-100 Error! Reference source not found.</td><td>Portion of juveniles exposed to chlorpyrifos EECs; 0.75-100 µg/l</td><td>Mean percent reduction (STD) in a population’s intrinsic growth, lambda, from death of juveniles</td><td rowspan="6">Yes</td></tr>
<tr><td>25%</td><td>1-14% (8-23)</td></tr>
<tr><td>50%</td><td>1-27% (8-28)</td></tr>
<tr><td>75%</td><td>2-40% (7-27)</td></tr>
<tr><td>100%</td><td>3-99% (7-0)</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)</td><td>High</td><td>High</td><td>Not Available</td><td colspan="2">Anticipated reductions in a population’s intrinsic rate of growth (lambda) (± 1 STD)</td><td>Yes</td></tr>
<tr><td>Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability</td><td>High</td><td>High</td><td>4-day invert: 67-100 Error! Reference source not found.</td><td colspan="2" rowspan="2">5-32% (7-8)</td><td>Yes</td></tr>
<tr><td>Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity</td><td>High</td><td>High</td><td>Not Available</td><td>Yes</td></tr>
<tr><td>Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impairments to ecologically</td><td>High</td><td>High</td><td>Not Available</td><td colspan="2">Not Applicable</td><td>Yes</td></tr>
</table>

significant behaviors.					

Effects analysis summary: Adult and juvenile Coho salmon, Oregon coast ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Population modelling results indicate that chlorpyrifos-induced mortality to juveniles may lead to severe reductions in lambda up to 99%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 67-100 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, Coho will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed Coho. The overall risk to Coho salmon, Oregon coast ESU from the effects of the action is high and the confidence associated with that risk is high.



12.17 Coho Salmon, Southern Oregon/Northern California Coast ESU (Oncorhynchus kisutch)

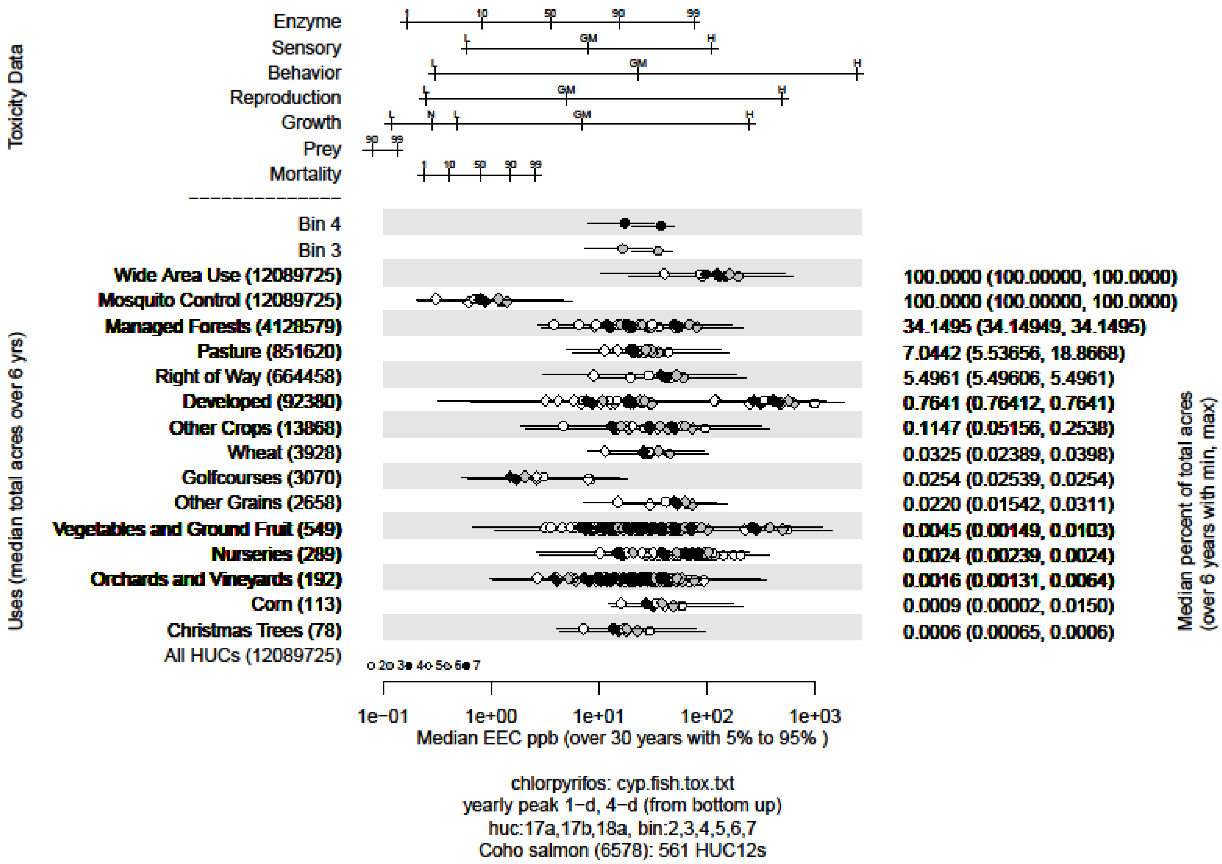


Figure 16. Effects analysis R-plot for Coho salmon, southern Oregon/northern California coast ESU and chlorpyrifos

Table 154. Likelihood of exposure determination for Coho salmon, southern Oregon/northern California coast ESU and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Wide Area Use	3	yes	yes	yes	NA	3	**High**
Mosquito Control	3	yes	yes	yes	NA	3	**High**
Managed Forest	3	yes	yes	yes	NA	3	**High**
Pasture	3	yes	yes	yes	NA	3	**High**
Right of Way	3	yes	yes	yes	NA	3	**High**
Developed	1	yes	yes	yes	yes	3	**High**
Other Crops	1	yes	yes	yes	yes	3	**High**
Wheat	1	yes	yes	yes	no	3	**Low**
Golf Courses	1	no	yes	yes	no	3	**Low**
Other Grains	1	yes	no	yes	no	3	**Low**
Vegetables and Ground Fruit	1	yes	yes	yes	no	3	**Low**
Nurseries	1	yes	yes	yes	no	3	**Low**
Orchards and Vineyards	1	yes	yes	yes	no	3	**Low**
Bin 3	3	yes	yes	yes	NA	3	**High**
Bin 4	3	yes	yes	yes	NA	3	**High**
Juveniles							
Wide Area Use	3	yes	yes	yes	NA	3	**High**
Mosquito Control	3	yes	yes	yes	NA	3	**High**
Managed Forest	3	yes	yes	yes	NA	3	**High**
Pasture	3	yes	yes	yes	NA	3	**High**
Right of Way	3	yes	yes	yes	NA	3	**High**
Developed	1	yes	yes	yes	yes	3	**High**
Other Crops	1	yes	yes	yes	yes	3	**High**
Wheat	1	yes	yes	yes	no	3	**Low**
Golf Courses	1	yes	yes	yes	no	3	**Low**
Other Grains	1	yes	yes	yes	no	3	**Low**
Vegetables and Ground Fruit	1	yes	yes	yes	no	3	**Low**
Nurseries	1	yes	yes	yes	no	3	**Low**
Orchards and Vineyards	1	yes	yes	yes	no	3	**Low**
Bin 3	3	yes	yes	yes	NA	3	**High**
Bin 4	3	yes	yes	yes	NA	3	**High**

Life Stage: Adults (full-range)

Table 155. Direct mortality risk hypothesis; Coho salmon, southern Oregon/northern California coast ESU and chlorpyrifos; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	High	**High**
Managed Forest	34.1	High	**High**
Pasture	7.0	High	**High**

Right of Way	5.4	High	**High**
Developed	0.8	High	**High**
Other Crops	0.1	High	**High**
Wheat	0.03	High	**Low**
Golf Courses		High	**Low**
Other Grains	0.02	High	**Low**
Vegetables and Ground Fruit	0.005	High	**Low**
Nurseries	0.002	High	**Low**
Orchards and Vineyards	0.002	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 156. Reproduction risk hypothesis; Coho salmon, southern Oregon/northern California coast ESU and chlorpyrifos; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	34.1	High	**High**
Pasture	7.0	High	**High**
Right of Way	5.4	High	**High**
Developed	0.8	High	**High**
Other Crops	0.1	High	**High**
Wheat	0.03	High	**Low**
Golf Courses		Medium	**Low**
Other Grains	0.02	High	**Low**
Vegetables and Ground Fruit	0.005	High	**Low**
Nurseries	0.002	High	**Low**
Orchards and Vineyards	0.002	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 157. Behavior and sensory risk hypothesis; Coho salmon, southern Oregon/northern California coast ESU and chlorpyrifos; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	34.1	High	**High**
Pasture	7.0	High	**High**
Right of Way	5.4	High	**High**
Developed	0.8	High	**High**
Other Crops	0.1	High	**High**
Wheat	0.03	High	**Low**
Golf Courses		Medium	**Low**
Other Grains	0.02	High	**Low**
Vegetables and Ground Fruit	0.005	High	**Low**
Nurseries	0.002	High	**Low**
Orchards and Vineyards	0.002	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	34.1	High	**High**
Pasture	7.0	High	**High**
Right of Way	5.4	High	**High**
Developed	0.8	High	**High**
Other Crops	0.1	High	**High**
Wheat	0.03	High	**Low**
Golf Courses		High	**Low**
Other Grains	0.02	High	**Low**
Vegetables and Ground Fruit	0.005	High	**Low**
Nurseries	0.002	High	**Low**
Orchards and Vineyards	0.002	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.		
Risk	**Confidence**	
High	**High**	

Table 158. AChE risk hypothesis; Coho salmon, southern Oregon/northern California coast ESU and chlorpyrifos; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	34.1	High	**High**
Pasture	7.0	High	**High**
Right of Way	5.4	High	**High**
Developed	0.8	High	**High**
Other Crops	0.1	High	**High**
Wheat	0.03	High	**Low**
Golf Courses		High	**Low**
Other Grains	0.02	High	**Low**
Vegetables and Ground Fruit	0.005	High	**Low**
Nurseries	0.002	High	**Low**
Orchards and Vineyards	0.002	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 159. Direct mortality risk hypothesis; Coho salmon, southern Oregon/northern California coast ESU and chlorpyrifos; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	34.1	High	High
Pasture	7.0	High	High

Right of Way	5.4	High	High
Developed	0.8	High	High
Other Crops	0.1	High	High
Wheat	0.03	High	Low
Golf Courses		High	Low
Other Grains	0.02	High	Low
Vegetables and Ground Fruit	0.005	High	Low
Nurseries	0.002	High	Low
Orchards and Vineyards	0.002	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 160. Growth risk hypothesis; Coho salmon, southern Oregon/northern California coast ESU and chlorpyrifos; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	34.1	High	High
Pasture	7.0	High	High
Right of Way	5.4	High	High
Developed	0.8	High	High
Other Crops	0.1	High	High
Wheat	0.03	High	Low
Golf Courses		Medium	Low
Other Grains	0.02	High	Low
Vegetables and Ground Fruit	0.005	High	Low
Nurseries	0.002	High	Low
Orchards and Vineyards	0.002	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 161. Prey risk hypothesis; Coho salmon, southern Oregon/northern California coast ESU and chlorpyrifos; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	High	**High**
Managed Forest	34.1	High	**High**
Pasture	7.0	High	**High**
Right of Way	5.4	High	**High**
Developed	0.8	High	**High**
Other Crops	0.1	High	**High**
Wheat	0.03	High	**Low**
Golf Courses		High	**Low**
Other Grains	0.02	High	**Low**
Vegetables and Ground Fruit	0.005	High	**Low**
Nurseries	0.002	High	**Low**
Orchards and Vineyards	0.002	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 162. AChE risk hypothesis; Coho salmon, southern Oregon/northern California coast ESU and chlorpyrifos; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	34.1	High	High
Pasture	7.0	High	High
Right of Way	5.4	High	High
Developed	0.8	High	High
Other Crops	0.1	High	High
Wheat	0.03	High	Low
Golf Courses		High	Low
Other Grains	0.02	High	Low

Vegetables and Ground Fruit	0.005	High	Low
Nurseries	0.002	High	Low
Orchards and Vineyards	0.002	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 163. Behavior and sensory risk hypothesis; Coho salmon, southern Oregon/northern California coast ESU and chlorpyrifos; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	34.1	High	**High**
Pasture	7.0	High	**High**
Right of Way	5.4	High	**High**
Developed	0.8	High	**High**
Other Crops	0.1	High	**High**
Wheat	0.03	High	**Low**
Golf Courses		Medium	**Low**
Other Grains	0.02	High	**Low**
Vegetables and Ground Fruit	0.005	High	**Low**
Nurseries	0.002	High	**Low**
Orchards and Vineyards	0.002	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	34.1	High	**High**
Pasture	7.0	High	**High**
Right of Way	5.4	High	**High**
Developed	0.8	High	**High**
Other Crops	0.1	High	**High**

Wheat	0.03	High	**Low**
Golf Courses		High	**Low**
Other Grains	0.02	High	**Low**
Vegetables and Ground Fruit	0.005	High	**Low**
Nurseries	0.002	High	**Low**
Orchards and Vineyards	0.002	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

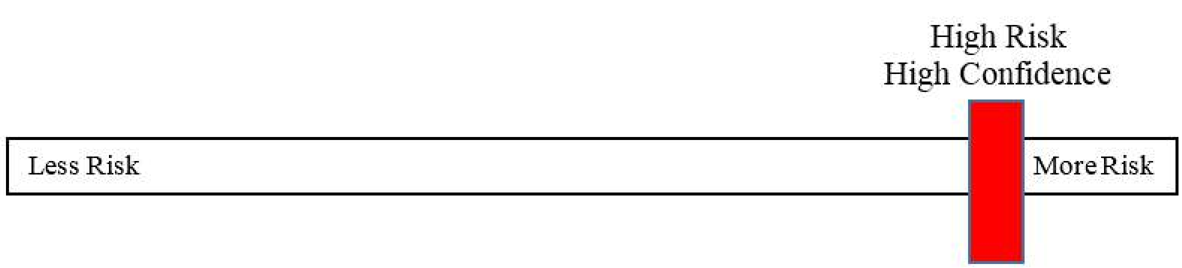
Table 164. Effects analysis summary table: Coho salmon, southern Oregon/northern California coast ESU and chlorpyrifos

	R-plot Derived		**MagTool**	**Population Model Results: Coho Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 48-96 **Error! Reference source not found.**	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via	High	High	Not Available	Not Applicable	Yes

impairments to ecologically significant behaviors.						
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	Not Applicable		Yes
	R-plot Derived		**MagTool Range in median percent mortalities of aquatic bins**	**Population Model Results: Coho Salmon**		**Risk Hypothesis Supported? Yes/No**
Life Stage: Juveniles	**Risk**	**Confidence**				
Risk Hypothesis						
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 48-96 **Error! Reference source not found.**	**Portion of juveniles exposed to chlorpyrifos EECs; 0.75-100 µg/l**	**Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles**	Yes
				25%	1-14% (8-23)	
				50%	1-27% (8-28)	
				75%	2-40% (7-27)	
				100%	3-99% (7-0)	
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**		Yes
Exposure to chlorpyrifos is sufficient to	High	High	4-day invert: 67-100			Yes

reduce Juvenile abundance via reduction in prey availability			**Error! Reference source not found.**	5-32% (7-8)	
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available		Yes
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	**Yes**

Effects analysis summary: Adult and juvenile Coho salmon, southern Oregon/northern California coast ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Population modelling results indicate that chlorpyrifos-induced mortality to juveniles may lead to severe reductions in lambda up to 99%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 48-96 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, Coho will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed Coho. The overall risk to Coho salmon, southern Oregon/northern California coast ESU from the effects of the action is high and the confidence associated with that risk is high.



12.18 Sockeye Salmon, Ozette Lake ESU (Oncorhynchus nerka)

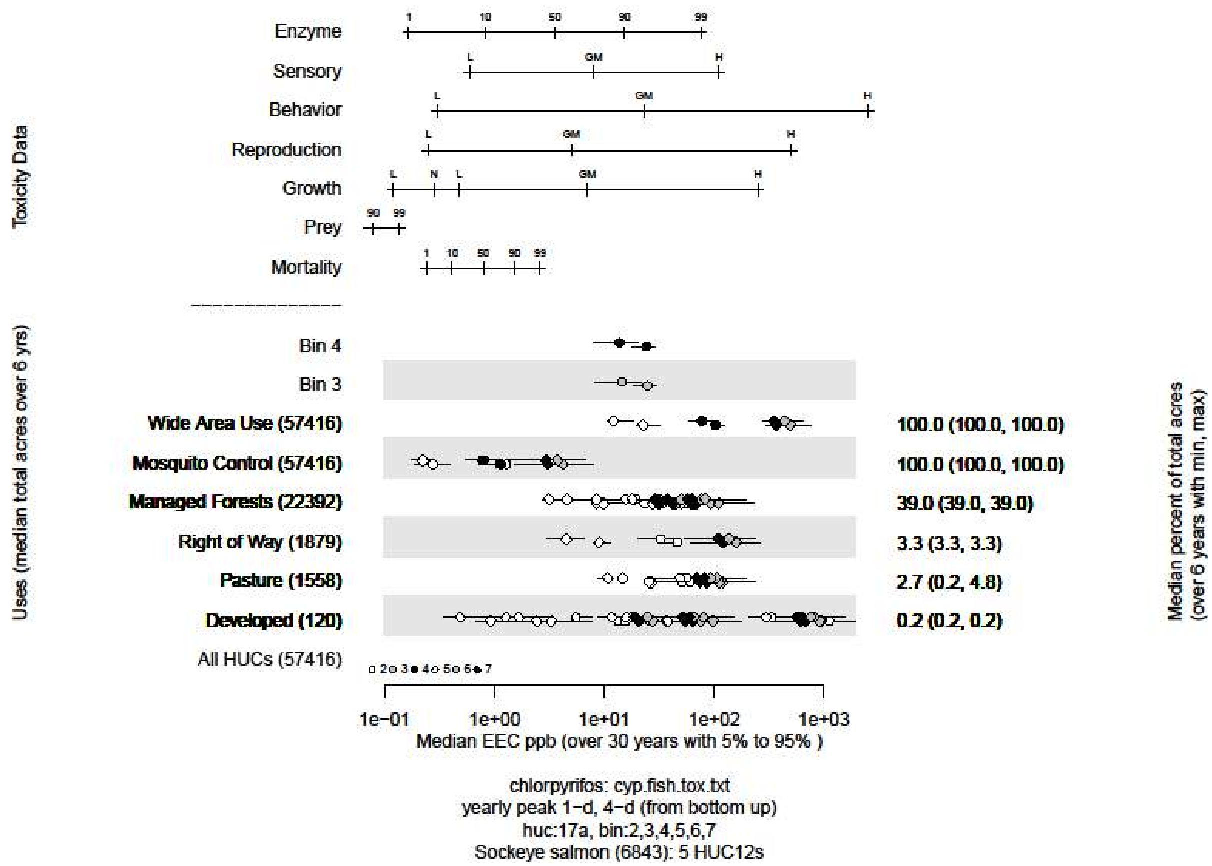


Figure 17. Effects analysis R-plot for Sockeye salmon, Ozette Lake ESU and chlorpyrifos

Table 165. Likelihood of exposure determination for Sockeye salmon, Ozette Lake ESU and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adult							
Wide Area Use	3	yes	yes	yes	NA	2	**Med**
Mosquito Control	3	yes	yes	yes	NA	2	**Med**
Managed Forest	3	yes	yes	yes	NA	2	**Med**
Right of Way	2	yes	yes	yes	NA	2	**Med**
Pasture	2	yes	yes	yes	NA	2	**Med**
Developed	1	yes	yes	yes	no	2	**Low**
Bin 3	3	yes	yes	yes	NA	2	**Med**
Bin 4	3	yes	yes	yes	NA	2	**Med**
Juvenile							
Wide Area Use	3	yes	yes	yes	NA	3	**High**
Mosquito Control	3	yes	yes	yes	NA	3	**High**
Managed Forest	3	yes	yes	yes	NA	3	**High**
Right of Way	2	yes	yes	yes	NA	3	**High**
Pasture	2	yes	yes	yes	NA	3	**High**
Developed	1	yes	yes	yes	no	3	**Low**
Bin 3	3	yes	yes	yes	NA	3	**High**
Bin 4	3	yes	yes	yes	NA	3	**High**

Life Stage: Adults (full-range)

Table 166. Direct mortality risk hypothesis; Sockeye salmon, Ozette Lake ESU and chlorpyrifos; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Medium
Mosquito Control	100	High	Medium
Managed Forest	39	High	Medium
Right of Way	3	High	Medium
Pasture	3	High	Medium
Developed	<1	High	Low
Bin 3		High	Medium
Bin 4		High	Medium
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 167. Reproduction risk hypothesis; Sockeye salmon, Ozette Lake ESU and chlorpyrifos; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Medium
Mosquito Control	100	High	Medium
Managed Forest	39	High	Medium
Right of Way	3	High	Medium
Pasture	3	High	Medium
Developed	<1	High	Low
Bin 3		High	Medium
Bin 4		High	Medium
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 168. Behavior and sensory risk hypothesis; Sockeye salmon, Ozette Lake ESU and chlorpyrifos; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Medium
Mosquito Control	100	Medium	Medium
Managed Forest	39	High	Medium
Right of Way	3	High	Medium
Pasture	3	High	Medium
Developed	<1	High	Low
Bin 3		High	Medium
Bin 4		High	Medium
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Medium
Mosquito Control	100	Medium	Medium
Managed Forest	39	High	Medium
Right of Way	3	High	Medium
Pasture	3	High	Medium
Developed	<1	High	Low
Bin 3		High	Medium
Bin 4		High	Medium
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		

High	**High**	

Table 169. AChE risk hypothesis; Sockeye salmon, Ozette Lake ESU and chlorpyrifos; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Medium
Mosquito Control	100	High	Medium
Managed Forest	39	High	Medium
Right of Way	3	High	Medium
Pasture	3	High	Medium
Developed	<1	High	Low
Bin 3		High	Medium
Bin 4		High	Medium
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 170. Direct mortality risk hypothesis; Sockeye salmon, Ozette Lake ESU and chlorpyrifos; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	39	High	High
Right of Way	3	High	High
Pasture	3	High	High
Developed	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 171. Growth risk hypothesis; Sockeye salmon, Ozette Lake ESU and chlorpyrifos; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure

Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	39	High	High
Right of Way	3	High	High
Pasture	3	High	High
Developed	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 172. Prey risk hypothesis; Sockeye salmon, Ozette Lake ESU and chlorpyrifos; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	39	High	High
Right of Way	3	High	High
Pasture	3	High	High
Developed	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 173. AChE risk hypothesis; Sockeye salmon, Ozette Lake ESU and chlorpyrifos; Juveniles

Endpoint: Enzyme			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100		High
Mosquito Control	100		High
Managed Forest	39		High
Right of Way	3		High
Pasture	3		High
Developed	<1		Low
Bin 3			High
Bin 4			High

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity		
Risk	Confidence	
High	High	

Table 174. Behavior and sensory risk hypothesis; Sockeye salmon, Ozette Lake ESU and chlorpyrifos; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	39	High	High
Right of Way	3	High	High
Pasture	3	High	High
Developed	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	39	High	High
Right of Way	3	High	High
Pasture	3	High	High
Developed	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 175. Effects analysis summary table: Sockeye salmon, Ozette Lake ESU and chlorpyrifos

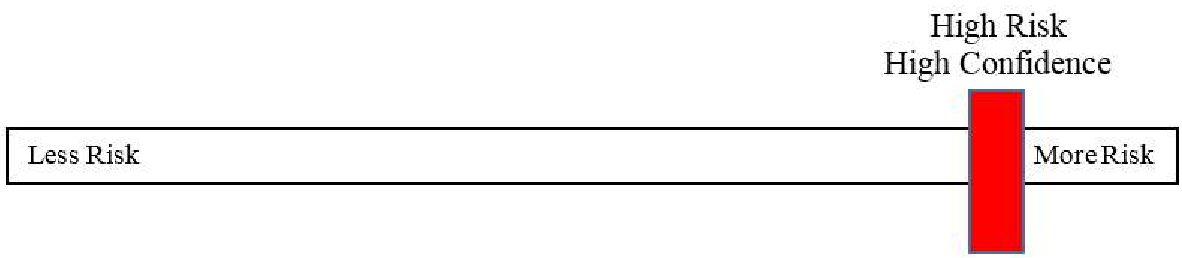
	R-plot Derived		**MagTool**	**Population Model Results: Sockeye Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					

Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 44-100 **Error! Reference source not found.**	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	Yes
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	Not Applicable	Yes
	R-plot Derived		**MagTool Range in median percent mortalities of aquatic bins**	**Population Model Results: Sockeye Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Juveniles	**Risk**	**Confidence**			
Risk Hypothesis					

Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 45-100 **Error! Reference source not found.**	**Portion of juveniles exposed to chlorpyrifos EECs; 0.75-100 µg/l**	**Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles**	Yes
				25%	1-11% (8-19)	
				50%	1-20% (8-22)	
				75%	2-29% (8-20)	
				100%	2-97% (8-0)	
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**		Yes
Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day invert: 45-100 **Error! Reference source not found.**	4-27% (4-6)		Yes
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available			Yes
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impairments to ecologically	High	High	Not Available	Not Applicable		**Yes**

significant behaviors.					

Effects analysis summary: Adult and juvenile Sockeye salmon, Ozette Lake ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Population modelling results indicate that chlorpyrifos-induced mortality to juveniles may lead to severe reductions in lambda up to 97%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 45-100 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, sockeye will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed sockeye. The overall risk to Sockeye salmon, Ozette Lake ESU from the effects of the action is high and the confidence associated with that risk is high.



12.19 Sockeye Salmon, Snake River ESU (Oncorhynchus nerka)

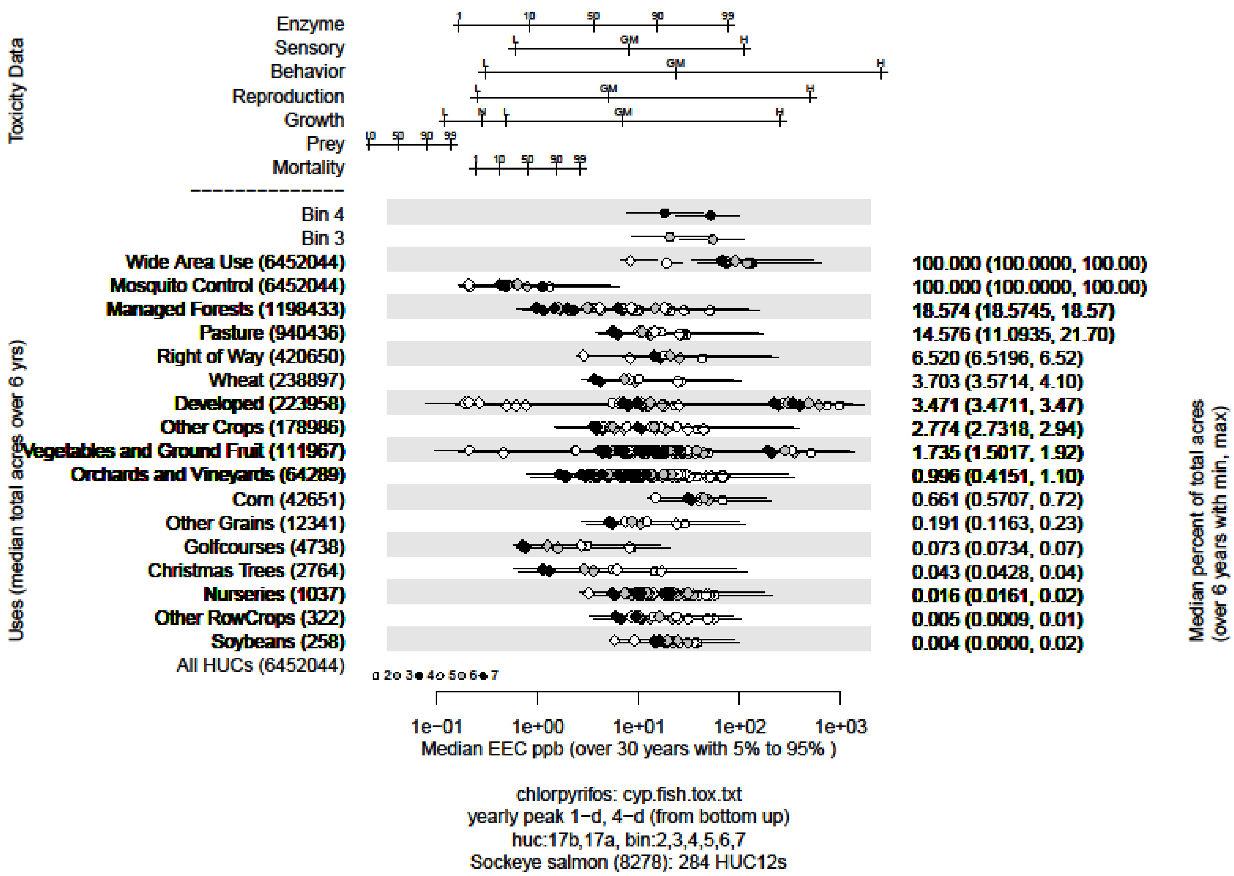


Figure 18. Effects analysis R-plot for Sockeye salmon, Snake River ESU and chlorpyrifos

Table 176. Likelihood of exposure determination for Sockeye salmon, Snake River ESU and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adult (Full Range)							
Wide Area Use	3	yes	yes	yes	NA	3	**High**
Mosquito Control	3	yes	yes	yes	NA	3	**High**
Managed Forest	3	yes	yes	yes	NA	3	**High**
Pasture	3	yes	yes	yes	Na	3	**High**
Right of Way	3	yes	yes	yes	NA	3	**High**
Wheat	2	yes	yes	yes	NA	3	**High**
Developed	2	yes	yes	yes	Na	3	**High**
Other Crops	2	yes	yes	yes	NA	3	**High**
Vegetable & Ground Fruit	2	yes	yes	yes	NA	3	**High**
Orchards and Vineyards	2	yes	yes	yes	NA	3	**High**
Corn	1	yes	yes	yes	yes	3	**High**
Other Grains	1	yes	yes	yes	yes	3	**High**
Golf Course	1	yes	yes	yes	no	3	Low
Christmas Trees	1	yes	yes	yes	yes	3	**High**
Nursery	1	yes	yes	yes	no	3	Low
Other Row Crops	1	yes	yes	yes	no	3	Low
Soybeans	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	**High**
Bin 4	3	yes	yes	yes	NA	3	**High**
Juvenile and Adults (Sawtooth Lakes)							
Wide Area Use	3	yes	yes	yes	NA	3	**High**
Mosquito Control	3	yes	yes	yes	NA	3	**High**
Managed Forest	3	yes	yes	yes	NA	3	**High**
Pasture	3	yes	yes	yes	NA	3	**High**
Right of Way	2	yes	yes	yes	NA	3	**High**
Developed	1	yes	yes	yes	no	3	Low
Other Grains	1	no	yes	yes	no	3	Low
Wheat	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	**High**
Bin 4	3	yes	yes	yes	NA	3	**High**

Life Stage: Juvenile and adult migration (full-range)

Table 177. Direct mortality risk hypothesis; Sockeye salmon, Snake River ESU and chlorpyrifos; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	19	High	High
Pasture	15	High	High
Right of Way	7	High	High
Wheat	4	High	High
Developed	3	High	High
Other Crops	3	High	High
Vegetable & Ground Fruit	2	High	High
Orchards and Vineyards	1	High	High

Corn	1	High	High
Other Grains	<1	High	High
Golf Course	<1	High	Low
Christmas Trees	<1	High	High
Nursery	<1	High	Low
Other Row Crops	<1	High	Low
Soybeans	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis:			
Risk	**Confidence**		
High	**High**		

Table 178. Prey risk hypothesis; Sockeye salmon, Snake River ESU and chlorpyrifos; Adults

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	19	High	High
Pasture	15	High	High
Right of Way	7	High	High
Wheat	4	High	High
Developed	3	High	High
Other Crops	3	High	High
Vegetable & Ground Fruit	2	High	High
Orchards and Vineyards	1	High	High
Corn	1	High	High
Other Grains	<1	High	High
Golf Course	<1	High	Low
Christmas Trees	<1	High	High
Nursery	<1	High	Low
Other Row Crops	<1	High	Low
Soybeans	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 179. Behavior and sensory risk hypothesis; Sockeye salmon, Snake River ESU and chlorpyrifos; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	19	High	High
Pasture	15	High	High
Right of Way	7	High	High
Wheat	4	High	High
Developed	3	High	High
Other Crops	3	High	High
Vegetable & Ground Fruit	2	High	High
Orchards and Vineyards	1	High	High
Corn	1	High	High
Other Grains	<1	High	High
Golf Course	<1	Medium	Low
Christmas Trees	<1	High	High
Nursery	<1	High	Low
Other Row Crops	<1	High	Low
Soybeans	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	19	High	High
Pasture	15	High	High
Right of Way	7	High	High
Wheat	4	High	High
Developed	3	High	High
Other Crops	3	High	High
Vegetable & Ground Fruit	2	High	High
Orchards and Vineyards	1	High	High
Corn	1	High	High
Other Grains	<1	High	High
Golf Course	<1	High	Low
Christmas Trees	<1	High	High

Nursery	<1	High	Low
Other Row Crops	<1	High	Low
Soybeans	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance and productivity via impairments to ecologically significant behaviors			
Risk	**Confidence**		
High	**High**		

Table 180. AChE risk hypothesis; Sockeye salmon, Snake River ESU and chlorpyrifos; Adults

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	19	High	High
Pasture	15	High	High
Right of Way	7	High	High
Wheat	4	High	High
Developed	3	High	High
Other Crops	3	High	High
Vegetable & Ground Fruit	2	High	High
Orchards and Vineyards	1	High	High
Corn	1	High	High
Other Grains	<1	High	High
Golf Course	<1	High	Low
Christmas Trees	<1	High	High
Nursery	<1	High	Low
Other Row Crops	<1	High	Low
Soybeans	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Table 181. Growth risk hypothesis; Sockeye salmon, Snake River ESU and chlorpyrifos; Adults

Endpoint: Growth

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	19	High	High
Pasture	15	High	High
Right of Way	7	High	High
Wheat	4	High	High
Developed	3	High	High
Other Crops	3	High	High
Vegetable & Ground Fruit	2	High	High
Orchards and Vineyards	1	High	High
Corn	1	High	High
Other Grains	<1	High	High
Golf Course	<1	High	Low
Christmas Trees	<1	High	High
Nursery	<1	High	Low
Other Row Crops	<1	High	Low
Soybeans	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
High	**High**		

Life Stage: Juvenile rearing and adult spawning (Sawtooth Lakes)

Table 182. Direct mortality risk hypothesis; Sockeye salmon, Snake River ESU and chlorpyrifos; Adults and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	34	High	High
Pasture	22	High	High
Right of Way	1	High	High
Developed	<1	High	Low
Other Grains	<1	High	Low
Wheat	<1	High	Low
Bin 3		High	High

Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 183. Growth risk hypothesis; Sockeye salmon, Snake River ESU and chlorpyrifos; Adults and Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	34	High	High
Pasture	22	High	High
Right of Way	1	High	High
Developed	<1	High	Low
Other Grains	<1	High	Low
Wheat	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
High	**High**		

Table 184. Prey risk hypothesis; Sockeye salmon, Snake River ESU and chlorpyrifos; Adults and Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	34	High	High
Pasture	22	High	High
Right of Way	1	High	High
Developed	<1	High	Low
Other Grains	<1	High	Low
Wheat	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 185. AChE risk hypothesis; Sockeye salmon, Snake River ESU and chlorpyrifos; Adults and Juveniles

Endpoint: Enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	34	High	High
Pasture	22	High	High
Right of Way	1	High	High
Developed	<1	High	Low
Other Grains	<1	High	Low
Wheat	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Table 186. Reproduction risk hypothesis; Sockeye salmon, Snake River ESU and chlorpyrifos; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	34	High	High
Pasture	22	High	High
Right of Way	1	High	High
Developed	<1	High	Low
Other Grains	<1	High	Low
Wheat	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 187. Behavior and sensory risk hypothesis; Sockeye salmon, Snake River ESU and chlorpyrifos; Adults and Juveniles

Endpoint: Behavior

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	34	High	High
Pasture	22	High	High
Right of Way	1	High	High
Developed	<1	High	Low
Other Grains	<1	High	Low
Wheat	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	34	High	High
Pasture	22	High	High
Right of Way	1	High	High
Developed	<1	High	Low
Other Grains	<1	High	Low
Wheat	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

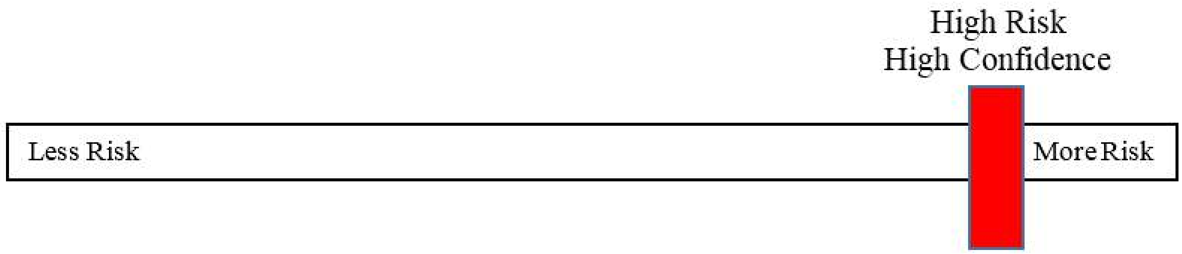
Table 188. Effects analysis summary table: Sockeye salmon, Snake River ESU and chlorpyrifos

	R-plot Derived		MagTool	Population Model Results: Sockeye Salmon	Risk Hypothesis Supported? Yes/No
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 58-88 **Error! Reference source not found.**	Not Applicable	Yes

Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable		Yes
Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable		Yes
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	Not Applicable		Yes
	R-plot Derived		**MagTool Range in median percent mortalities of aquatic bins**	**Population Model Results: Sockeye Salmon**		**Risk Hypothesis Supported? Yes/No**
Life Stage: Juveniles	**Risk**	**Confidence**				
Risk Hypothesis						
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 53-88 **Error! Reference source not found.**	**Portion of juveniles exposed to chlorpyrifos EECs; 0.75-100 µg/l**	**Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles**	Yes
				25%	1-11% (8-19)	
				50%	1-20% (8-22)	

				75% 2-29% (8-20) 100% 2-97% (8-0)	
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**	Yes
Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day invert: 53-98 **Error! Reference source not found.**	4-27% (4-6)	Yes
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available		Yes
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	**Yes**

Effects analysis summary: Adult and juvenile Sockeye salmon, Snake River ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Population modelling results indicate that chlorpyrifos-induced mortality to juveniles may lead to severe reductions in lambda up to 97%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 53-88 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, sockeye will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed sockeye. The overall risk to Sockeye salmon, Snake River ESU from the effects of the action is high and the confidence associated with that risk is high.



12.20 Steelhead, California Central Valley DPS (Oncorhynchus mykiss)

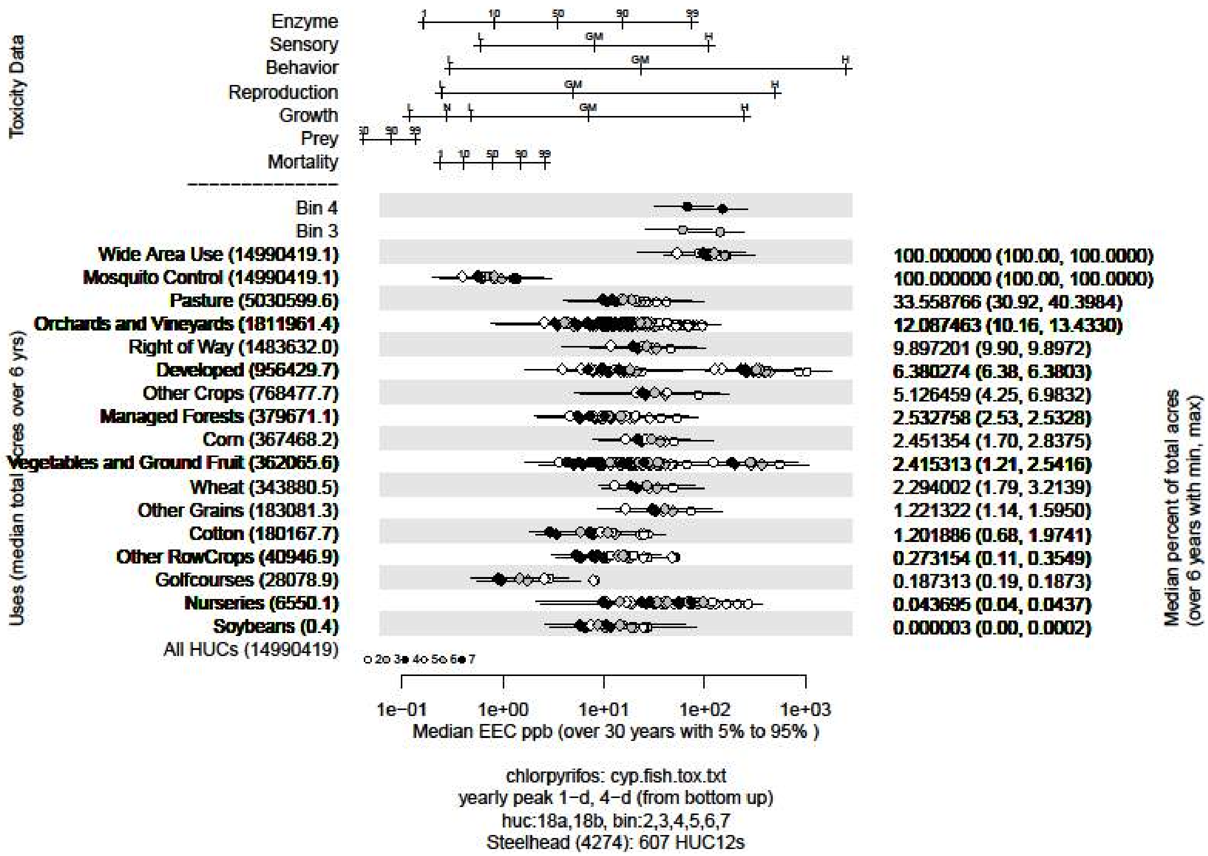


Figure 19. Effects analysis R-plot for Steelhead, California Central Valley DPS and chlorpyrifos

Table 189. Likelihood of exposure determination for Steelhead, California Central Valley DPS and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Orchards and Vineyards	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Developed	3	yes	yes	yes	NA	3	High
Other Crops	3	yes	yes	yes	NA	3	High
Managed Forest	2	yes	yes	yes	NA	3	High
Corn	2	yes	yes	yes	NA	3	High
Vegetables and Ground Fruit	2	yes	yes	yes	NA	3	High
Wheat	2	yes	yes	yes	NA	3	High
Other Grains	2	yes	yes	yes	NA	3	High
Cotton	2	yes	yes	yes	NA	3	High
Other Row Crops	1	yes	yes	yes	yes	3	High
Golf Courses	1	yes	yes	yes	no	3	Low
Nurseries	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High
Juveniles							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Orchards and Vineyards	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Developed	3	yes	yes	yes	NA	3	High
Other Crops	3	yes	yes	yes	NA	3	High
Managed Forest	2	yes	yes	yes	NA	3	High
Corn	2	yes	yes	yes	NA	3	High
Vegetables and Ground Fruit	2	yes	yes	yes	NA	3	High
Wheat	2	yes	yes	yes	NA	3	High
Other Grains	2	yes	yes	yes	NA	3	High
Cotton	2	yes	yes	yes	NA	3	High
Other Row Crops	1	yes	yes	yes	yes	3	High
Golf Courses	1	yes	yes	yes	no	3	Low
Nurseries	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High

Life Stage: Adults (full-range)

Table 190. Direct mortality risk hypothesis; Steelhead, California Central Valley DPS and chlorpyrifos; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High

Mosquito Control	100	High	High
Pasture	33.6	High	High
Orchards and Vineyards	12.1	High	High
Right of Way	9.9	High	High
Developed	6.4	High	High
Other Crops	5.1	High	High
Managed Forest	2.5	High	High
Corn	2.5	High	High
Vegetables and Ground Fruit	2.4	High	High
What	2.3	High	High
Other Grains	1.2	High	High
Cotton	1.2	High	High
Other Row Crops	0.3	High	High
Golf Courses	0.2	High	Low
Nurseries	0.04	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 191. Reproduction risk hypothesis; Steelhead, California Central Valley DPS and chlorpyrifos; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	33.6	High	High
Orchards and Vineyards	12.1	High	High
Right of Way	9.9	High	High
Developed	6.4	High	High
Other Crops	5.1	High	High
Managed Forest	2.5	High	High
Corn	2.5	High	High
Vegetables and Ground Fruit	2.4	High	High
What	2.3	High	High
Other Grains	1.2	High	High
Cotton	1.2	High	High
Other Row Crops	0.3	High	High

Golf Courses	0.2	Medium	Low
Nurseries	0.04	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 192. Behavior and sensory risk hypothesis; Steelhead, California Central Valley DPS and chlorpyrifos; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	33.6	High	High
Orchards and Vineyards	12.1	High	High
Right of Way	9.9	High	High
Developed	6.4	High	High
Other Crops	5.1	High	High
Managed Forest	2.5	High	High
Corn	2.5	High	High
Vegetables and Ground Fruit	2.4	High	High
What	2.3	High	High
Other Grains	1.2	High	High
Cotton	1.2	High	High
Other Row Crops	0.3	High	High
Golf Courses	0.2	Medium	Low
Nurseries	0.04	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	33.6	High	High
Orchards and Vineyards	12.1	High	High
Right of Way	9.9	High	High
Developed	6.4	High	High

Other Crops	5.1	High	High
Managed Forest	2.5	High	High
Corn	2.5	High	High
Vegetables and Ground Fruit	2.4	High	High
What	2.3	High	High
Other Grains	1.2	High	High
Cotton	1.2	High	High
Other Row Crops	0.3	High	High
Golf Courses	0.2	High	Low
Nurseries	0.04	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 193. AChE risk hypothesis; Steelhead, California Central Valley DPS and chlorpyrifos; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	33.6	High	High
Orchards and Vineyards	12.1	High	High
Right of Way	9.9	High	High
Developed	6.4	High	High
Other Crops	5.1	High	High
Managed Forest	2.5	High	High
Corn	2.5	High	High
Vegetables and Ground Fruit	2.4	High	High
What	2.3	High	High
Other Grains	1.2	High	High
Cotton	1.2	High	High
Other Row Crops	0.3	High	High
Golf Courses	0.2	High	Low
Nurseries	0.04	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			

Risk	Confidence	
High	**High**	

Life Stage: Juveniles (full-range)

Table 194. Direct mortality risk hypothesis; Steelhead, California Central Valley DPS and chlorpyrifos; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Pasture	33.6	High	High
Orchards and Vineyards	12.1	High	High
Right of Way	9.9	High	High
Developed	6.4	High	High
Other Crops	5.1	High	High
Managed Forest	2.5	High	High
Corn	2.5	High	High
Vegetables and Ground Fruit	2.4	High	High
What	2.3	High	High
Other Grains	1.2	High	High
Cotton	1.2	High	High
Other Row Crops	0.3	High	High
Golf Courses	0.2	High	Low
Nurseries	0.04	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 195. Growth risk hypothesis; Steelhead, California Central Valley DPS and chlorpyrifos; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	33.6	High	High

Orchards and Vineyards	12.1	High	High
Right of Way	9.9	High	High
Developed	6.4	High	High
Other Crops	5.1	High	High
Managed Forest	2.5	High	High
Corn	2.5	High	High
Vegetables and Ground Fruit	2.4	High	High
What	2.3	High	High
Other Grains	1.2	High	High
Cotton	1.2	High	High
Other Row Crops	0.3	High	High
Golf Courses	0.2	Medium	Low
Nurseries	0.04	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 196. Prey risk hypothesis; Steelhead, California Central Valley DPS and chlorpyrifos; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Pasture	33.6	High	High
Orchards and Vineyards	12.1	High	High
Right of Way	9.9	High	High
Developed	6.4	High	High
Other Crops	5.1	High	High
Managed Forest	2.5	High	High
Corn	2.5	High	High
Vegetables and Ground Fruit	2.4	High	High
What	2.3	High	High
Other Grains	1.2	High	High
Cotton	1.2	High	High
Other Row Crops	0.3	High	High
Golf Courses	0.2	High	Low
Nurseries	0.04	High	Low

Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 197. AChE risk hypothesis; Steelhead, California Central Valley DPS and chlorpyrifos; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	33.6	High	High
Orchards and Vineyards	12.1	High	High
Right of Way	9.9	High	High
Developed	6.4	High	High
Other Crops	5.1	High	High
Managed Forest	2.5	High	High
Corn	2.5	High	High
Vegetables and Ground Fruit	2.4	High	High
What	2.3	High	High
Other Grains	1.2	High	High
Cotton	1.2	High	High
Other Row Crops	0.3	High	High
Golf Courses	0.2	High	Low
Nurseries	0.04	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 198. Behavior and sensory risk hypothesis; Steelhead, California Central Valley DPS and chlorpyrifos; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High

Pasture	33.6	High	High
Orchards and Vineyards	12.1	High	High
Right of Way	9.9	High	High
Developed	6.4	High	High
Other Crops	5.1	High	High
Managed Forest	2.5	High	High
Corn	2.5	High	High
Vegetables and Ground Fruit	2.4	High	High
What	2.3	High	High
Other Grains	1.2	High	High
Cotton	1.2	High	High
Other Row Crops	0.3	High	High
Golf Courses	0.2	Medium	Low
Nurseries	0.04	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	33.6	High	High
Orchards and Vineyards	12.1	High	High
Right of Way	9.9	High	High
Developed	6.4	High	High
Other Crops	5.1	High	High
Managed Forest	2.5	High	High
Corn	2.5	High	High
Vegetables and Ground Fruit	2.4	High	High
What	2.3	High	High
Other Grains	1.2	High	High
Cotton	1.2	High	High
Other Row Crops	0.3	High	High
Golf Courses	0.2	High	Low
Nurseries	0.04	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		

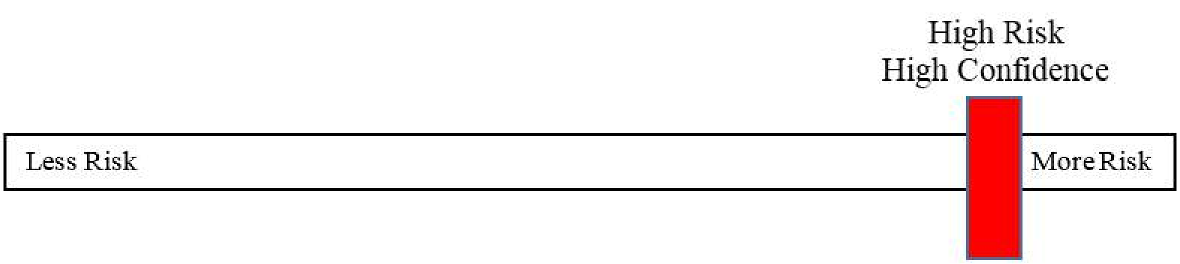
High	**High**	

Table 199. Effects analysis summary table: Steelhead, California Central Valley DPS and chlorpyrifos

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 79-99 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 79-99 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce	High	High	4-day fish: 79-98	**Yes**

Juvenile abundance via reduction in prey availability			4-day invert: 79-100 **Error! Reference source not found.**	
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, California Central Valley DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where chlorpyrifos achieves predicted levels. The MagTool results indicate that between 79-99 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed steelhead. The overall risk to Steelhead, California Central Valley DPS from the effects of the action is high and the confidence associated with that risk is high.



12.21 Steelhead, Central California Coast DPS (Oncorhynchus mykiss)

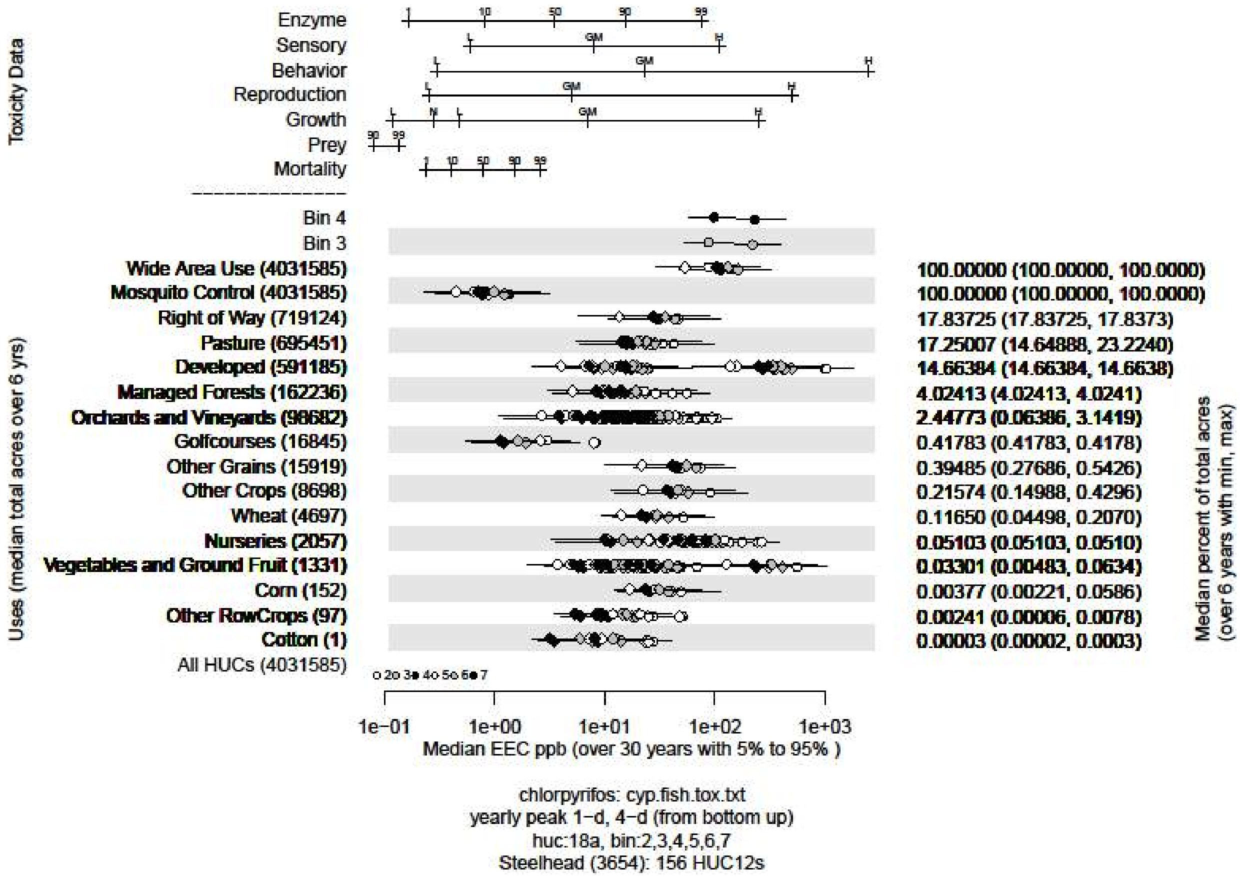


Figure 20. Effects analysis R-plot for Steelhead, Central California Coast DPS and chlorpyrifos

Table 200. Likelihood of exposure determination for Steelhead, Central California Coast DPS and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Wide Area use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Developed	3	yes	yes	yes	NA	3	High
Managed Forest	2	yes	yes	yes	NA	3	High
Orchards and Vineyards	2	yes	yes	yes	NA	3	High
Golf Courses	1	yes	yes	yes	no	3	Low
Other grains	1	yes	yes	yes	yes	3	High
Other Crops	1	yes	yes	yes	yes	3	High
Wheat	1	yes	yes	yes	yes	3	High
Nurseries	1	yes	yes	yes	no	3	Low
Vegetables and Ground Fruit	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin4	3	yes	yes	yes	NA	3	High
Juveniles							
Wide Area use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Developed	3	yes	yes	yes	NA	3	High
Managed Forest	2	yes	yes	yes	NA	3	High
Orchards and Vineyards	2	yes	yes	yes	NA	3	High
Golf Courses	1	yes	yes	yes	no	3	Low
Other grains	1	yes	yes	yes	yes	3	High
Other Crops	1	yes	yes	yes	yes	3	High
Wheat	1	yes	yes	yes	yes	3	High
Nurseries	1	yes	yes	yes	no	3	Low
Vegetables and Ground Fruit	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin4	3	yes	yes	yes	NA	3	High

Life Stage: Adults (full-range)

Table 201. Direct mortality risk hypothesis; Steelhead, Central California Coast DPS and chlorpyrifos; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area use	100	High	High
Mosquito Control	100	High	High
Right of Way	17.8	High	High
Pasture	17.3	High	High
Developed	14.7	High	High

Managed Forest	4.0	High	High
Orchards and Vineyards	2.4	High	High
Golf Courses	0.4	High	Low
Other grains	0.4	High	High
Other Crops	0.2	High	High
Wheat	0.1	High	High
Nurseries	0.05	High	Low
Vegetables and Ground Fruit	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 202. Reproduction risk hypothesis; Steelhead, Central California Coast DPS and chlorpyrifos; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	17.8	High	High
Pasture	17.3	High	High
Developed	14.7	High	High
Managed Forest	4.0	High	High
Orchards and Vineyards	2.4	High	High
Golf Courses	0.4	Medium	Low
Other grains	0.4	High	High
Other Crops	0.2	High	High
Wheat	0.1	High	High
Nurseries	0.05	High	Low
Vegetables and Ground Fruit	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 203. Behavior and sensory risk hypothesis; Steelhead, Central California Coast DPS and chlorpyrifos; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	17.8	High	High
Pasture	17.3	High	High
Developed	14.7	High	High
Managed Forest	4.0	High	High
Orchards and Vineyards	2.4	High	High
Golf Courses	0.4	Medium	Low
Other grains	0.4	High	High
Other Crops	0.2	High	High
Wheat	0.1	High	High
Nurseries	0.05	High	Low
Vegetables and Ground Fruit	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	17.8	High	High
Pasture	17.3	High	High
Developed	14.7	High	High
Managed Forest	4.0	High	High
Orchards and Vineyards	2.4	High	High
Golf Courses	0.4	High	Low
Other grains	0.4	High	High
Other Crops	0.2	High	High
Wheat	0.1	High	High
Nurseries	0.05	High	Low
Vegetables and Ground Fruit	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			

Risk	Confidence	
High	**High**	

Table 204. AChE risk hypothesis; Steelhead, Central California Coast DPS and chlorpyrifos; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	17.8	High	High
Pasture	17.3	High	High
Developed	14.7	High	High
Managed Forest	4.0	High	High
Orchards and Vineyards	2.4	High	High
Golf Courses	0.4	High	Low
Other grains	0.4	High	High
Other Crops	0.2	High	High
Wheat	0.1	High	High
Nurseries	0.05	High	Low
Vegetables and Ground Fruit	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 205. Direct mortality risk hypothesis; Steelhead, Central California Coast DPS and chlorpyrifos; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area use	100	High	High
Mosquito Control	100	High	High
Right of Way	17.8	High	High
Pasture	17.3	High	High
Developed	14.7	High	High
Managed Forest	4.0	High	High

Orchards and Vineyards	2.4	High	High
Golf Courses	0.4	High	Low
Other grains	0.4	High	High
Other Crops	0.2	High	High
Wheat	0.1	High	High
Nurseries	0.05	High	Low
Vegetables and Ground Fruit	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 206. Growth risk hypothesis; Steelhead, Central California Coast DPS and chlorpyrifos; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	17.8	High	High
Pasture	17.3	High	High
Developed	14.7	High	High
Managed Forest	4.0	High	High
Orchards and Vineyards	2.4	High	High
Golf Courses	0.4	Medium	Low
Other grains	0.4	High	High
Other Crops	0.2	High	High
Wheat	0.1	High	High
Nurseries	0.05	High	Low
Vegetables and Ground Fruit	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 207. Prey risk hypothesis; Steelhead, Central California Coast DPS and chlorpyrifos; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area use	100	High	High
Mosquito Control	100	High	High
Right of Way	17.8	High	High
Pasture	17.3	High	High
Developed	14.7	High	High
Managed Forest	4.0	High	High
Orchards and Vineyards	2.4	High	High
Golf Courses	0.4	High	Low
Other grains	0.4	High	High
Other Crops	0.2	High	High
Wheat	0.1	High	High
Nurseries	0.05	High	Low
Vegetables and Ground Fruit	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 208. AChE risk hypothesis; Steelhead, Central California Coast DPS and chlorpyrifos; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	17.8	High	High
Pasture	17.3	High	High
Developed	14.7	High	High
Managed Forest	4.0	High	High
Orchards and Vineyards	2.4	High	High
Golf Courses	0.4	High	Low
Other grains	0.4	High	High
Other Crops	0.2	High	High
Wheat	0.1	High	High
Nurseries	0.05	High	Low

Vegetables and Ground Fruit	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 209. Behavior and sensory risk hypothesis; Steelhead, Central California Coast DPS and chlorpyrifos; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	17.8	High	High
Pasture	17.3	High	High
Developed	14.7	High	High
Managed Forest	4.0	High	High
Orchards and Vineyards	2.4	High	High
Golf Courses	0.4	Medium	Low
Other grains	0.4	High	High
Other Crops	0.2	High	High
Wheat	0.1	High	High
Nurseries	0.05	High	Low
Vegetables and Ground Fruit	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	17.8	High	High
Pasture	17.3	High	High
Developed	14.7	High	High
Managed Forest	4.0	High	High
Orchards and Vineyards	2.4	High	High
Golf Courses	0.4	High	Low
Other grains	0.4	High	High

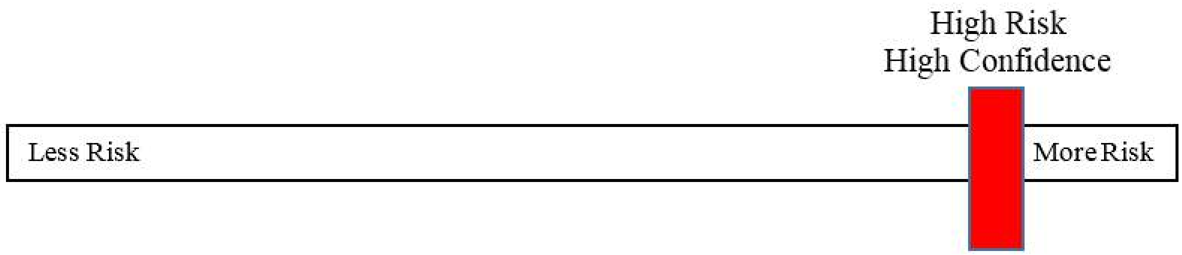
Other Crops	0.2	High	High
Wheat	0.1	High	High
Nurseries	0.05	High	Low
Vegetables and Ground Fruit	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 210. Effects analysis summary table: Steelhead, Central California Coast DPS and chlorpyrifos

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 57-98 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				

Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 57-98 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day fish: 57-94 4-day invert: 57-100 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, Central California Coast DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where chlorpyrifos achieves predicted levels. The MagTool results indicate that between 57-98 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed steelhead. The overall risk to Steelhead, Central California Coast DPS from the effects of the action is high and the confidence associated with that risk is high.


High Risk
High Confidence
Less Risk
More Risk

12.22 Steelhead, Lower Columbia River DPS (Oncorhynchus mykiss)

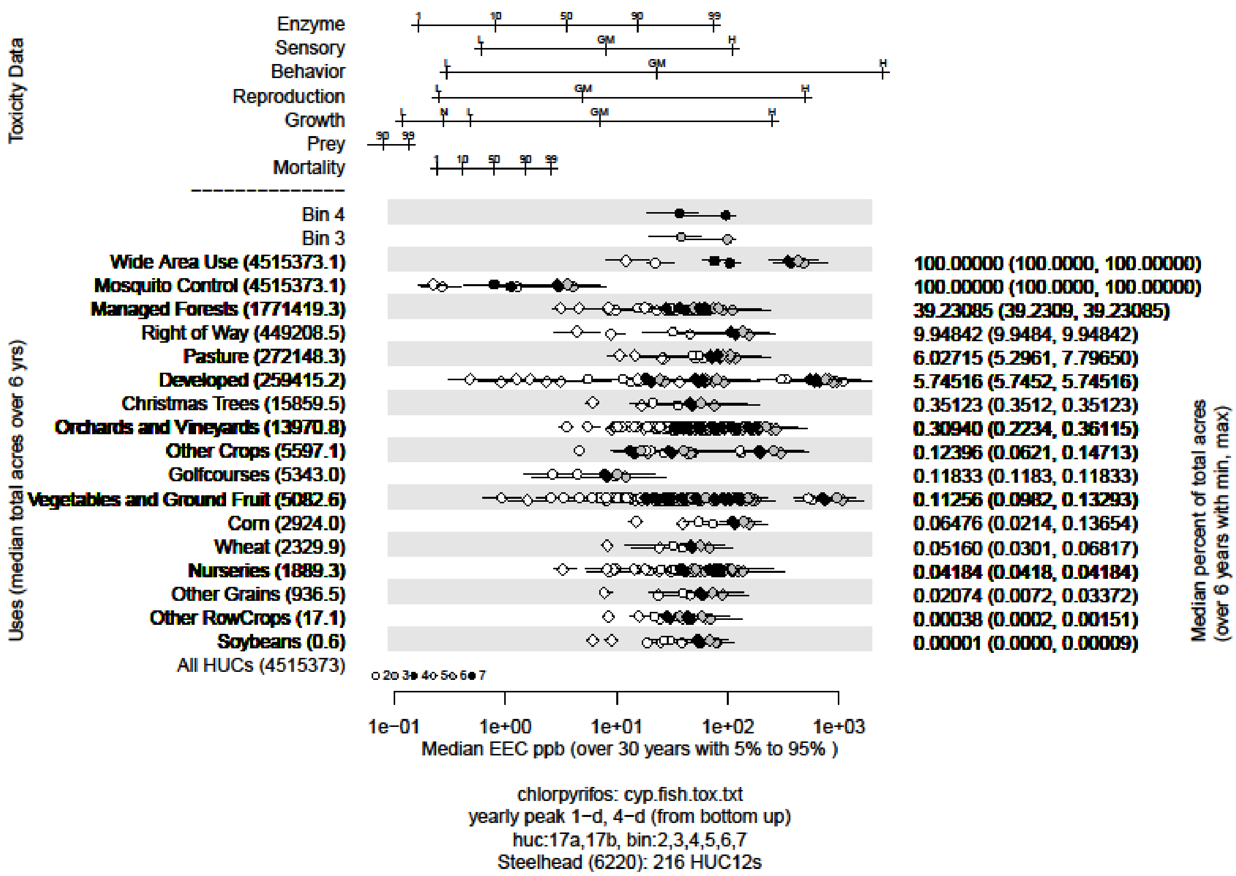


Figure 21. Effects analysis R-plot for Steelhead, Lower Columbia River DPS and chlorpyrifos

Table 211. Likelihood of exposure determination for Steelhead, Lower Columbia River DPS and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Managed Forest	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Developed	3	yes	yes	yes	NA	3	High
Christmas Tees	1	yes	yes	yes	no	3	Low
Orchards and Vineyards	1	yes	yes	yes	yes	3	High
Other Crops	1	yes	yes	yes	yes	3	High
Golf Courses	1	yes	yes	yes	no	3	Low
Vegetables and Ground Fruit	1	yes	yes	yes	yes	3	High
Corn	1	yes	yes	yes	yes	3	High
Wheat	1	yes	yes	yes	yes	3	High
Nurseries	1	yes	yes	yes	no	3	Low
Other Grains	1	yes	yes	yes	yes	3	High
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High
Juveniles							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Managed Forest	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Developed	3	yes	yes	yes	NA	3	High
Christmas Tees	1	yes	yes	yes	no	3	Low
Orchards and Vineyards	1	yes	yes	yes	yes	3	High
Other Crops	1	yes	yes	yes	yes	3	High
Golf Courses	1	yes	yes	yes	no	3	Low
Vegetables and Ground Fruit	1	yes	yes	yes	yes	3	High
Corn	1	yes	yes	yes	yes	3	High
Wheat	1	yes	yes	yes	yes	3	High
Nurseries	1	yes	yes	yes	no	3	Low
Other Grains	1	yes	yes	yes	yes	3	High
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High

Life Stage: Adults (full-range)

Table 212. Direct mortality risk hypothesis; Steelhead, Lower Columbia River DPS and chlorpyrifos; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	39.2	High	High
Right of Way	9.9	High	High
Pasture	6.0	High	High

Developed	5.7	High	High
Christmas Tees	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Other Crops	0.1	High	High
Golf Courses	0.1	High	Low
Vegetables and Ground Fruit	0.1	High	High
Corn	0.06	High	High
Wheat	0.05	High	High
Nurseries	0.04	High	Low
Other Grains	0.02	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 213. Reproduction risk hypothesis; Steelhead, Lower Columbia River DPS and chlorpyrifos; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	39.2	High	High
Right of Way	9.9	High	High
Pasture	6.0	High	High
Developed	5.7	High	High
Christmas Tees	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Other Crops	0.1	High	High
Golf Courses	0.1	High	Low
Vegetables and Ground Fruit	0.1	High	High
Corn	0.06	High	High
Wheat	0.05	High	High
Nurseries	0.04	High	Low
Other Grains	0.02	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			

Risk	Confidence	
High	**High**	

Table 214. Behavior and sensory risk hypothesis; Steelhead, Lower Columbia River DPS and chlorpyrifos; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	39.2	High	High
Right of Way	9.9	High	High
Pasture	6.0	High	High
Developed	5.7	High	High
Christmas Tees	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Other Crops	0.1	High	High
Golf Courses	0.1	Medium	Low
Vegetables and Ground Fruit	0.1	High	High
Corn	0.06	High	High
Wheat	0.05	High	High
Nurseries	0.04	High	Low
Other Grains	0.02	High	High
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	39.2	High	High
Right of Way	9.9	High	High
Pasture	6.0	High	High
Developed	5.7	High	High
Christmas Tees	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Other Crops	0.1	High	High
Golf Courses	0.1	High	Low
Vegetables and Ground Fruit	0.1	High	High
Corn	0.06	High	High

Wheat	0.05	High	High
Nurseries	0.04	High	Low
Other Grains	0.02	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 215. AChE risk hypothesis; Steelhead, Lower Columbia River DPS and chlorpyrifos; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	39.2	High	High
Right of Way	9.9	High	High
Pasture	6.0	High	High
Developed	5.7	High	High
Christmas Tees	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Other Crops	0.1	High	High
Golf Courses	0.1	High	Low
Vegetables and Ground Fruit	0.1	High	High
Corn	0.06	High	High
Wheat	0.05	High	High
Nurseries	0.04	High	Low
Other Grains	0.02	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 216. Direct mortality risk hypothesis; Steelhead, Lower Columbia River DPS and chlorpyrifos; Juveniles

Endpoint: Mortality

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	39.2	High	High
Right of Way	9.9	High	High
Pasture	6.0	High	High
Developed	5.7	High	High
Christmas Tees	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Other Crops	0.1	High	High
Golf Courses	0.1	High	Low
Vegetables and Ground Fruit	0.1	High	High
Corn	0.06	High	High
Wheat	0.05	High	High
Nurseries	0.04	High	Low
Other Grains	0.02	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 217. Growth risk hypothesis; Steelhead, Lower Columbia River DPS and chlorpyrifos; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	39.2	High	High
Right of Way	9.9	High	High
Pasture	6.0	High	High
Developed	5.7	High	High
Christmas Tees	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Other Crops	0.1	High	High
Golf Courses	0.1	High	Low
Vegetables and Ground Fruit	0.1	High	High
Corn	0.06	High	High

Wheat	0.05	High	High
Nurseries	0.04	High	Low
Other Grains	0.02	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 218. Prey risk hypothesis; Steelhead, Lower Columbia River DPS and chlorpyrifos; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	39.2	High	High
Right of Way	9.9	High	High
Pasture	6.0	High	High
Developed	5.7	High	High
Christmas Tees	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Other Crops	0.1	High	High
Golf Courses	0.1	High	Low
Vegetables and Ground Fruit	0.1	High	High
Corn	0.06	High	High
Wheat	0.05	High	High
Nurseries	0.04	High	Low
Other Grains	0.02	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 219. AChE risk hypothesis; Steelhead, Lower Columbia River DPS and chlorpyrifos; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High

Mosquito Control	100	High	High
Managed Forest	39.2	High	High
Right of Way	9.9	High	High
Pasture	6.0	High	High
Developed	5.7	High	High
Christmas Tees	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Other Crops	0.1	High	High
Golf Courses	0.1	High	Low
Vegetables and Ground Fruit	0.1	High	High
Corn	0.06	High	High
Wheat	0.05	High	High
Nurseries	0.04	High	Low
Other Grains	0.02	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 220. Behavior and sensory risk hypothesis; Steelhead, Lower Columbia River DPS and chlorpyrifos; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	39.2	High	High
Right of Way	9.9	High	High
Pasture	6.0	High	High
Developed	5.7	High	High
Christmas Tees	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Other Crops	0.1	High	High
Golf Courses	0.1	Medium	Low
Vegetables and Ground Fruit	0.1	High	High
Corn	0.06	High	High
Wheat	0.05	High	High
Nurseries	0.04	High	Low

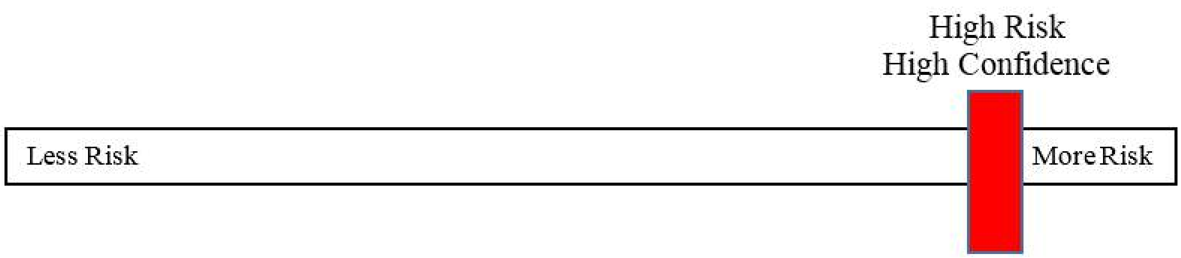
Other Grains	0.02	High	High
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	39.2	High	High
Right of Way	9.9	High	High
Pasture	6.0	High	High
Developed	5.7	High	High
Christmas Tees	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Other Crops	0.1	High	High
Golf Courses	0.1	High	Low
Vegetables and Ground Fruit	0.1	High	High
Corn	0.06	High	High
Wheat	0.05	High	High
Nurseries	0.04	High	Low
Other Grains	0.02	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 221. Effects analysis summary table: Steelhead, Lower Columbia River DPS and chlorpyrifos

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 61-95 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via	High	High	Not Available	**Yes**

impairments to reproduction				
Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 61-95 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day fish: 60-93 4-day invert: 62-97 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, Lower Columbia River DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where chlorpyrifos achieves predicted levels. The MagTool results indicate that between 61-95 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed steelhead. The overall risk to Steelhead, Lower Columbia River DPS from the effects of the action is high and the confidence associated with that risk is high.



12.23 Steelhead, Middle Columbia River DPS

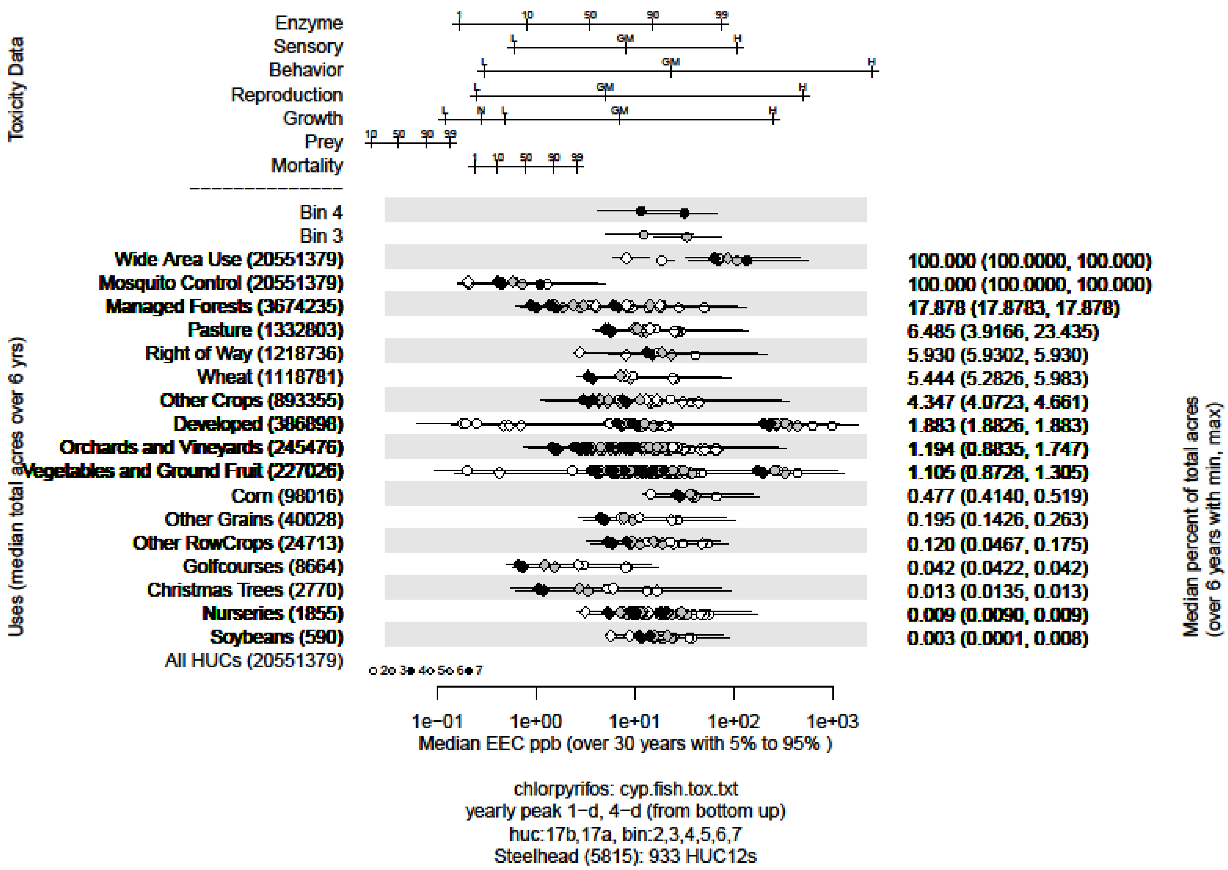


Figure 22. Effects analysis R-plot for Steelhead, Middle Columbia River DPS and chlorpyrifos

Table 222. Likelihood of exposure determination for Steelhead, Middle Columbia River DPS and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Managed Forest	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Wheat	3	yes	yes	yes	NA	3	High
Other Crops	2	yes	yes	yes	NA	3	High
Developed	2	yes	yes	yes	NA	3	High
Orchards and Vineyards	2	yes	yes	yes	NA	3	High
Vegetables and Ground Fruit	2	yes	yes	yes	NA	3	High
Corn	1	yes	yes	yes	yes	3	High
Other Grains	1	yes	yes	yes	no	3	Low
Other Row Crops	1	yes	yes	yes	yes	3	High
Golf Courses	1	yes	yes	yes	no	3	Low
Christmas Trees	1	yes	yes	yes	no	3	Low
Nurseries	1	yes	yes	yes	no	3	Low
Soybeans	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High
Juveniles							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Managed Forest	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Wheat	3	yes	yes	yes	NA	3	High
Other Crops	2	yes	yes	yes	NA	3	High
Developed	2	yes	yes	yes	NA	3	High
Orchards and Vineyards	2	yes	yes	yes	NA	3	High
Vegetables and Ground Fruit	2	yes	yes	yes	NA	3	High
Corn	1	yes	yes	yes	yes	3	High
Other Grains	1	yes	yes	yes	no	3	Low
Other Row Crops	1	yes	yes	yes	yes	3	High
Golf Courses	1	yes	yes	yes	no	3	Low
Christmas Trees	1	yes	yes	yes	no	3	Low
Nurseries	1	yes	yes	yes	no	3	Low
Soybeans	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High

Life Stage: Adults (full-range)

Table 223. Direct mortality risk hypothesis; Steelhead, Middle Columbia River DPS and chlorpyrifos; Adults

Endpoint: Mortality

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	**High**
Mosquito Control	100	High	**High**
Managed Forest	17.9	High	**High**
Pasture	6.5	High	**High**
Right of Way	5.9	High	**High**
Wheat	5.4	High	**High**
Other Crops	4.3	High	**High**
Developed	1.9	High	**High**
Orchards and Vineyards	1.2	High	**High**
Vegetables and Ground Fruit	1.1	High	**High**
Corn	0.5	High	**High**
Other Grains	0.2	High	**Low**
Other Row Crops	0.1	High	**High**
Golf Courses	0.04	High	**Low**
Christmas Trees	0.01	High	**Low**
Nurseries	0.01	High	**Low**
Soybeans	0.003	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 224. Reproduction risk hypothesis; Steelhead, Middle Columbia River DPS and chlorpyrifos; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	17.9	High	**High**
Pasture	6.5	High	**High**
Right of Way	5.9	High	**High**
Wheat	5.4	High	**High**
Other Crops	4.3	High	**High**
Developed	1.9	High	**High**
Orchards and Vineyards	1.2	High	**High**
Vegetables and Ground Fruit	1.1	High	**High**

Corn	0.5	High	**High**
Other Grains	0.2	High	**Low**
Other Row Crops	0.1	High	**High**
Golf Courses	0.04	High	**Low**
Christmas Trees	0.01	High	**Low**
Nurseries	0.01	High	**Low**
Soybeans	0.003	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 225. Behavior and sensory risk hypothesis; Steelhead, Middle Columbia River DPS and chlorpyrifos; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	17.9	High	**High**
Pasture	6.5	High	**High**
Right of Way	5.9	High	**High**
Wheat	5.4	High	**High**
Other Crops	4.3	High	**High**
Developed	1.9	High	**High**
Orchards and Vineyards	1.2	High	**High**
Vegetables and Ground Fruit	1.1	High	**High**
Corn	0.5	High	**High**
Other Grains	0.2	High	**Low**
Other Row Crops	0.1	High	**High**
Golf Courses	0.04	Medium	**Low**
Christmas Trees	0.01	High	**Low**
Nurseries	0.01	High	**Low**
Soybeans	0.003	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**

Mosquito Control	100	Medium	**High**
Managed Forest	17.9	High	**High**
Pasture	6.5	High	**High**
Right of Way	5.9	High	**High**
Wheat	5.4	High	**High**
Other Crops	4.3	High	**High**
Developed	1.9	High	**High**
Orchards and Vineyards	1.2	High	**High**
Vegetables and Ground Fruit	1.1	High	**High**
Corn	0.5	High	**High**
Other Grains	0.2	High	**Low**
Other Row Crops	0.1	High	**High**
Golf Courses	0.04	High	**Low**
Christmas Trees	0.01	High	**Low**
Nurseries	0.01	High	**Low**
Soybeans	0.003	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 226. AChE risk hypothesis; Steelhead, Middle Columbia River DPS and chlorpyrifos; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	17.9	High	**High**
Pasture	6.5	High	**High**
Right of Way	5.9	High	**High**
Wheat	5.4	High	**High**
Other Crops	4.3	High	**High**
Developed	1.9	High	**High**
Orchards and Vineyards	1.2	High	**High**
Vegetables and Ground Fruit	1.1	High	**High**
Corn	0.5	High	**High**
Other Grains	0.2	High	**Low**
Other Row Crops	0.1	High	**High**

Golf Courses	0.04	High	**Low**
Christmas Trees	0.01	High	**Low**
Nurseries	0.01	High	**Low**
Soybeans	0.003	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 227. Direct mortality risk hypothesis; Steelhead, Middle Columbia River DPS and chlorpyrifos; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	17.9	High	High
Pasture	6.5	High	High
Right of Way	5.9	High	High
Wheat	5.4	High	High
Other Crops	4.3	High	High
Developed	1.9	High	High
Orchards and Vineyards	1.2	High	High
Vegetables and Ground Fruit	1.1	High	High
Corn	0.5	High	High
Other Grains	0.2	High	Low
Other Row Crops	0.1	High	High
Golf Courses	0.04	High	Low
Christmas Trees	0.01	High	Low
Nurseries	0.01	High	Low
Soybeans	0.003	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 228. Growth risk hypothesis; Steelhead, Middle Columbia River DPS and chlorpyrifos; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	17.9	High	High
Pasture	6.5	High	High
Right of Way	5.9	High	High
Wheat	5.4	High	High
Other Crops	4.3	High	High
Developed	1.9	High	High
Orchards and Vineyards	1.2	High	High
Vegetables and Ground Fruit	1.1	High	High
Corn	0.5	High	High
Other Grains	0.2	High	Low
Other Row Crops	0.1	High	High
Golf Courses	0.04	High	Low
Christmas Trees	0.01	High	Low
Nurseries	0.01	High	Low
Soybeans	0.003	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 229. Prey risk hypothesis; Steelhead, Middle Columbia River DPS and chlorpyrifos; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	High	**High**
Managed Forest	17.9	High	**High**
Pasture	6.5	High	**High**
Right of Way	5.9	High	**High**
Wheat	5.4	High	**High**
Other Crops	4.3	High	**High**
Developed	1.9	High	**High**

Orchards and Vineyards	1.2	High	**High**
Vegetables and Ground Fruit	1.1	High	**High**
Corn	0.5	High	**High**
Other Grains	0.2	High	**Low**
Other Row Crops	0.1	High	**High**
Golf Courses	0.04	High	**Low**
Christmas Trees	0.01	High	**Low**
Nurseries	0.01	High	**Low**
Soybeans	0.003	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 230. AChE risk hypothesis; Steelhead, Middle Columbia River DPS and chlorpyrifos; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	17.9	High	High
Pasture	6.5	High	High
Right of Way	5.9	High	High
Wheat	5.4	High	High
Other Crops	4.3	High	High
Developed	1.9	High	High
Orchards and Vineyards	1.2	High	High
Vegetables and Ground Fruit	1.1	High	High
Corn	0.5	High	High
Other Grains	0.2	High	Low
Other Row Crops	0.1	High	High
Golf Courses	0.04	High	Low
Christmas Trees	0.01	High	Low
Nurseries	0.01	High	Low
Soybeans	0.003	High	Low
Bin 3		High	High
Bin 4		High	High

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity		
Risk	Confidence	
High	High	

Table 231. Behavior and sensory risk hypothesis; Steelhead, Middle Columbia River DPS and chlorpyrifos; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	17.9	High	**High**
Pasture	6.5	High	**High**
Right of Way	5.9	High	**High**
Wheat	5.4	High	**High**
Other Crops	4.3	High	**High**
Developed	1.9	High	**High**
Orchards and Vineyards	1.2	High	**High**
Vegetables and Ground Fruit	1.1	High	**High**
Corn	0.5	High	**High**
Other Grains	0.2	High	**Low**
Other Row Crops	0.1	High	**High**
Golf Courses	0.04	Medium	**Low**
Christmas Trees	0.01	High	**Low**
Nurseries	0.01	High	**Low**
Soybeans	0.003	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Managed Forest	17.9	High	**High**
Pasture	6.5	High	**High**
Right of Way	5.9	High	**High**
Wheat	5.4	High	**High**
Other Crops	4.3	High	**High**
Developed	1.9	High	**High**
Orchards and Vineyards	1.2	High	**High**

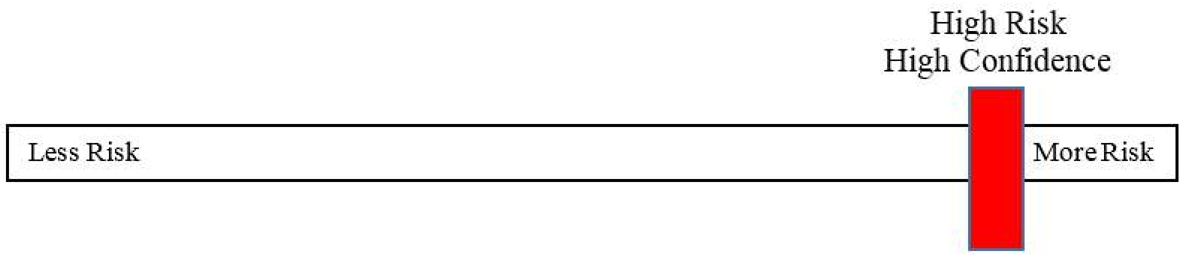
Vegetables and Ground Fruit	1.1	High	**High**
Corn	0.5	High	**High**
Other Grains	0.2	High	**Low**
Other Row Crops	0.1	High	**High**
Golf Courses	0.04	High	**Low**
Christmas Trees	0.01	High	**Low**
Nurseries	0.01	High	**Low**
Soybeans	0.003	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 232. Effects analysis summary table: Steelhead, Middle Columbia River DPS and chlorpyrifos

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 45-80 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	

Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	**Risk Hypothesis Supported? Yes/No**
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 45-80 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day fish: 42-66 4-day invert: 45-99 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, Middle Columbia River DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where chlorpyrifos achieves predicted levels. The MagTool results indicate that between 45-80 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed steelhead. The overall risk to Steelhead, Middle Columbia River DPS from the effects of the action is high and the confidence associated with that risk is high.


High Risk
High Confidence
Less Risk
More Risk

12.24 Steelhead, Northern California DPS (Oncorhynchus mykiss)

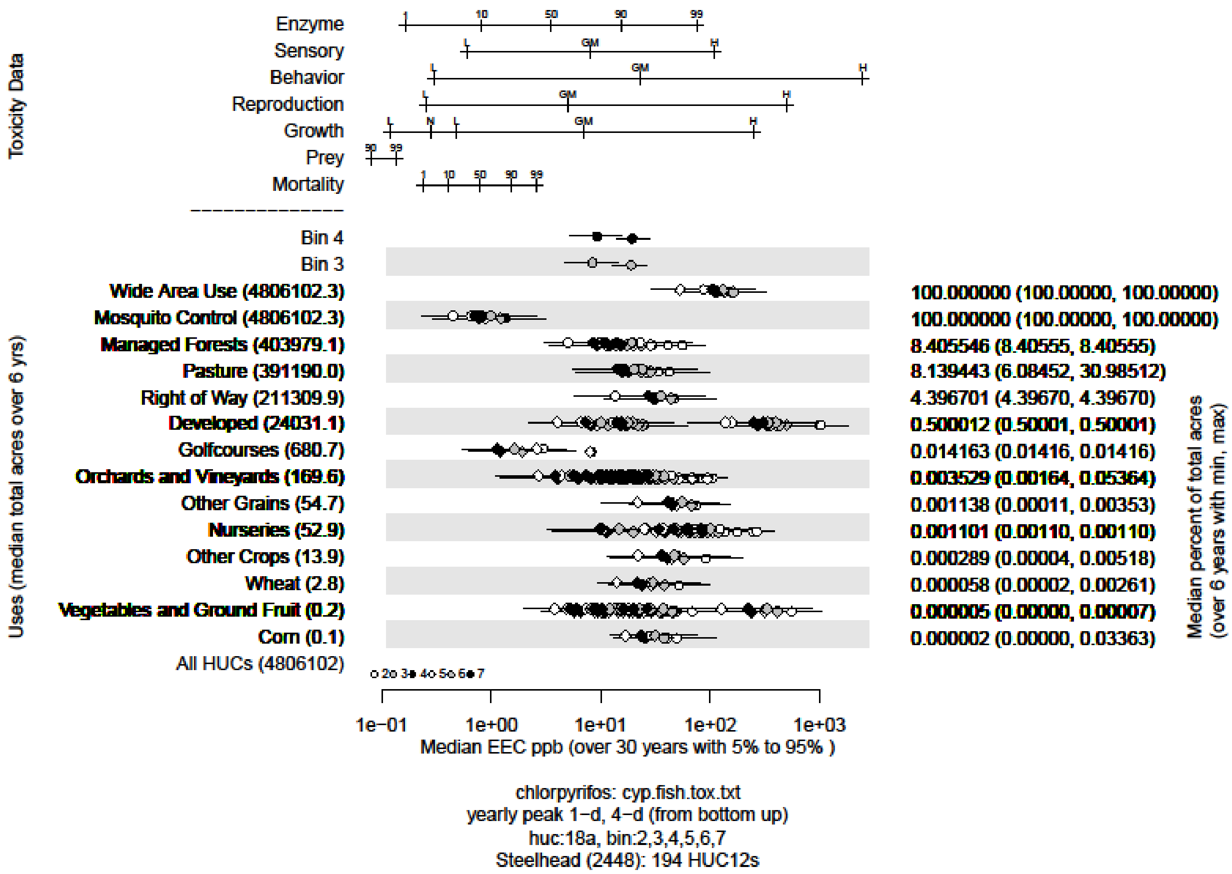


Figure 23. Effects analysis R-plot for Steelhead, Northern California DPS and chlorpyrifos

Table 233. Likelihood of exposure determination for Steelhead, Northern California DPS and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Wide Area Use	3	yes	yes	yes	NA	3	**High**
Mosquito Control	3	yes	yes	yes	NA	3	**High**
Managed Forest	3	yes	yes	yes	NA	3	**High**
Pasture	3	yes	yes	yes	NA	3	**High**
Right of Way	2	yes	yes	yes	NA	3	**High**
Developed	1	yes	yes	yes	yes	3	**High**
Golf Courses	1	yes	yes	yes	no	3	**Low**
Orchards and Vineyards	1	yes	yes	yes	yes	3	**High**
Bin 3	3	yes	yes	yes	NA	3	**High**
Bin 4	3	yes	yes	yes	NA	3	**High**
Juveniles							
Wide Area Use	3	yes	yes	yes	NA	3	**High**
Mosquito Control	3	yes	yes	yes	NA	3	**High**
Managed Forest	3	yes	yes	yes	NA	3	**High**
Pasture	3	yes	yes	yes	NA	3	**High**
Right of Way	2	yes	yes	yes	NA	3	**High**
Developed	1	yes	yes	yes	yes	3	**High**
Golf Courses	1	yes	yes	yes	no	3	**Low**
Orchards and Vineyards	1	yes	yes	yes	yes	3	**High**
Bin 3	3	yes	yes	yes	NA	3	**High**
Bin 4	3	yes	yes	yes	NA	3	**High**

Life Stage: Adults (full-range)

Table 234. Direct mortality risk hypothesis; Steelhead, Northern California DPS and chlorpyrifos; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	8.4	High	High
Pasture	8.1	High	High
Right of Way	4.4	High	High
Developed	0.5	High	High
Golf Courses	0.01	High	Low
Orchards and Vineyards	0.003	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			

Risk	Confidence	
High	**High**	

Table 235. Reproduction risk hypothesis; Steelhead, Northern California DPS and chlorpyrifos; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	8.4	High	High
Pasture	8.1	High	High
Right of Way	4.4	High	High
Developed	0.5	High	High
Golf Courses	0.01	Medium	Low
Orchards and Vineyards	0.003	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 236. Behavior and sensory risk hypothesis; Steelhead, Northern California DPS and chlorpyrifos; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	8.4	High	High
Pasture	8.1	High	High
Right of Way	4.4	High	High
Developed	0.5	High	High
Golf Courses	0.01	Medium	Low
Orchards and Vineyards	0.003	High	High
Bin 3		Medium	High
Bin 4		Medium	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High

Mosquito Control	100	Medium	High
Managed Forest	8.4	High	High
Pasture	8.1	High	High
Right of Way	4.4	High	High
Developed	0.5	High	High
Golf Courses	0.01	High	Low
Orchards and Vineyards	0.003	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 237. AChE risk hypothesis; Steelhead, Northern California DPS and chlorpyrifos; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	8.4	High	High
Pasture	8.1	High	High
Right of Way	4.4	High	High
Developed	0.5	High	High
Golf Courses	0.01	High	Low
Orchards and Vineyards	0.003	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 238. Direct mortality risk hypothesis; Steelhead, Northern California DPS and chlorpyrifos; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High

Managed Forest	8.4	High	High
Pasture	8.1	High	High
Right of Way	4.4	High	High
Developed	0.5	High	High
Golf Courses	0.01	High	Low
Orchards and Vineyards	0.003	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 239. Growth risk hypothesis; Steelhead, Northern California DPS and chlorpyrifos; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	8.4	High	High
Pasture	8.1	High	High
Right of Way	4.4	High	High
Developed	0.5	High	High
Golf Courses	0.01	Medium	Low
Orchards and Vineyards	0.003	High	High
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 240. Prey risk hypothesis; Steelhead, Northern California DPS and chlorpyrifos; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	8.4	High	High
Pasture	8.1	High	High
Right of Way	4.4	High	High

Developed	0.5	High	High
Golf Courses	0.01	High	Low
Orchards and Vineyards	0.003	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 241. AChE risk hypothesis; Steelhead, Northern California DPS and chlorpyrifos; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	8.4	High	High
Pasture	8.1	High	High
Right of Way	4.4	High	High
Developed	0.5	High	High
Golf Courses	0.01	High	Low
Orchards and Vineyards	0.003	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 242. Behavior and sensory risk hypothesis; Steelhead, Northern California DPS and chlorpyrifos; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	8.4	High	High
Pasture	8.1	High	High
Right of Way	4.4	High	High
Developed	0.5	High	High
Golf Courses	0.01	Medium	Low

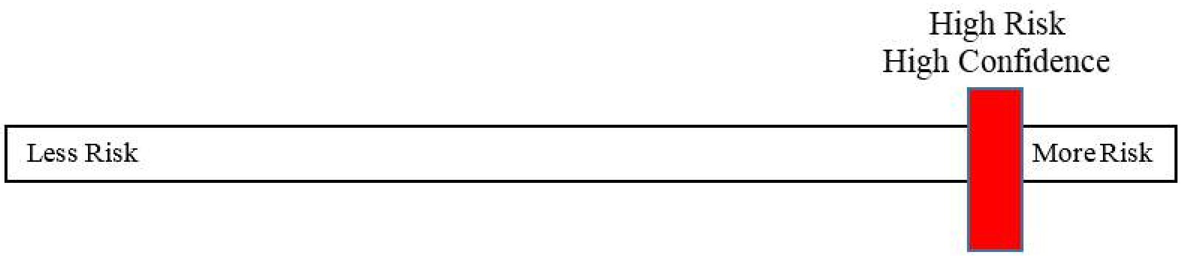
Orchards and Vineyards	0.003	High	High
Bin 3		Medium	High
Bin 4		Medium	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	8.4	High	High
Pasture	8.1	High	High
Right of Way	4.4	High	High
Developed	0.5	High	High
Golf Courses	0.01	High	Low
Orchards and Vineyards	0.003	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 243. Effects analysis summary table: Steelhead, Northern California DPS and chlorpyrifos

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 21-95 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to	High	High	Not Available	**Yes**

ecologically significant behaviors.				
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 21-95 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day fish: 21-84 4-day invert: 21-100 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, Northern California DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where chlorpyrifos achieves predicted levels. The MagTool results indicate that between 21-95 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed steelhead. The overall risk to Steelhead, Northern California DPS from the effects of the action is high and the confidence associated with that risk is high.



12.25 Steelhead, Puget Sound DPS (Oncorhynchus mykiss)

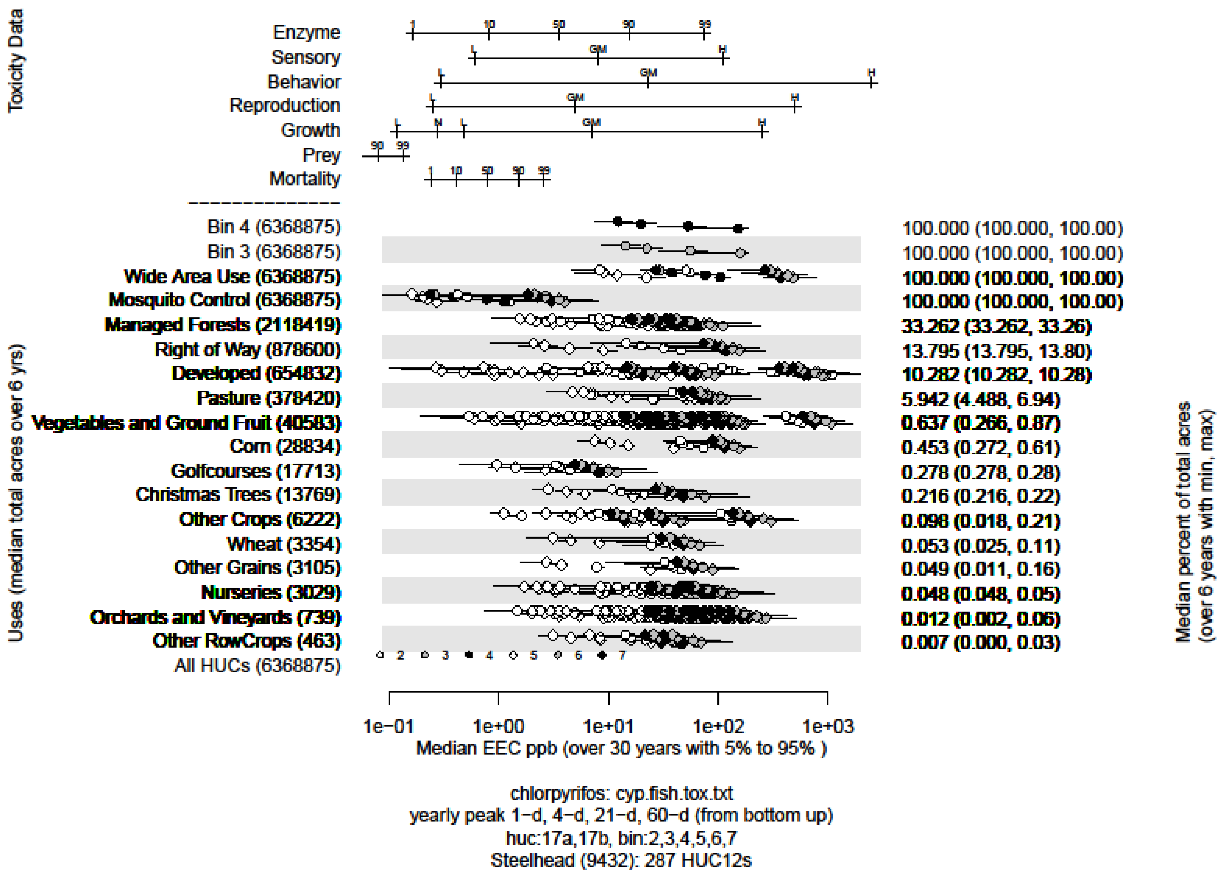


Figure 24. Effects analysis R-plot for Steelhead, Puget Sound DPS and chlorpyrifos

Table 244. Likelihood of exposure determination for Steelhead, Puget Sound DPS and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Managed Forests	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Developed	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Vegetables and Ground Fruit	1	yes	yes	yes	NA	3	Low
Corn	1	yes	yes	yes	NA	3	Low
Golf Courses	1	yes	yes	yes	NA	3	Low
Christmas Trees	1	yes	yes	yes	NA	3	Low
Other Crops	1	yes	yes	yes	NA	3	Low
Wheat	1	yes	yes	yes	NA	3	Low
Other Grains	1	yes	yes	yes	NA	3	Low
Nurseries	1	yes	yes	yes	NA	3	Low
Orchards and Vineyards	1	yes	yes	yes	NA	3	Low
Other Row Crops	1	yes	yes	yes	NA	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High
Juveniles							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Managed Forests	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Developed	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Vegetables and Ground Fruit	1	yes	yes	yes	NA	3	Low
Corn	1	yes	yes	yes	NA	3	Low
Golf Courses	1	yes	yes	yes	NA	3	Low
Christmas Trees	1	yes	yes	yes	NA	3	Low
Other Crops	1	yes	yes	yes	NA	3	Low
Wheat	1	yes	yes	yes	NA	3	Low
Other Grains	1	yes	yes	yes	NA	3	Low
Nurseries	1	yes	yes	yes	NA	3	Low
Orchards and Vineyards	1	yes	yes	yes	NA	3	Low
Other Row Crops	1	yes	yes	yes	NA	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High

Life Stage: Adults (full-range)

Table 245. Direct mortality risk hypothesis; Steelhead, Puget Sound DPS and chlorpyrifos; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High

Mosquito Control	100	High	High
Managed Forests	33.2	High	High
Right of Way	13.8	High	High
Developed	10.3	High	High
Pasture	5.9	High	High
Vegetables and Ground Fruit	0.6	High	Low
Corn	0.5	High	Low
Golf Courses	0.3	High	Low
Christmas Trees	0.2	High	Low
Other Crops	0.1	High	Low
Wheat	0.05	High	Low
Other Grains	0.05	High	Low
Nurseries	0.05	High	Low
Orchards and Vineyards	0.01	High	Low
Other Row Crops	0.007	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 246. Reproduction risk hypothesis; Steelhead, Puget Sound DPS and chlorpyrifos; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forests	33.2	High	High
Right of Way	13.8	High	High
Developed	10.3	High	High
Pasture	5.9	High	High
Vegetables and Ground Fruit	0.6	High	Low
Corn	0.5	High	Low
Golf Courses	0.3	High	Low
Christmas Trees	0.2	High	Low
Other Crops	0.1	High	Low
Wheat	0.05	High	Low
Other Grains	0.05	High	Low
Nurseries	0.05	High	Low

Orchards and Vineyards	0.01	High	Low
Other Row Crops	0.007	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 247. Behavior and sensory risk hypothesis; Steelhead, Puget Sound DPS and chlorpyrifos; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forests	33.2	High	High
Right of Way	13.8	High	High
Developed	10.3	High	High
Pasture	5.9	High	High
Vegetables and Ground Fruit	0.6	High	Low
Corn	0.5	High	Low
Golf Courses	0.3	Medium	Low
Christmas Trees	0.2	High	Low
Other Crops	0.1	High	Low
Wheat	0.05	High	Low
Other Grains	0.05	High	Low
Nurseries	0.05	High	Low
Orchards and Vineyards	0.01	High	Low
Other Row Crops	0.007	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forests	33.2	High	High
Right of Way	13.8	High	High
Developed	10.3	High	High
Pasture	5.9	High	High

Vegetables and Ground Fruit	0.6	High	Low
Corn	0.5	High	Low
Golf Courses	0.3	High	Low
Christmas Trees	0.2	High	Low
Other Crops	0.1	High	Low
Wheat	0.05	High	Low
Other Grains	0.05	High	Low
Nurseries	0.05	High	Low
Orchards and Vineyards	0.01	High	Low
Other Row Crops	0.007	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 248. AChE risk hypothesis; Steelhead, Puget Sound DPS and chlorpyrifos; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forests	33.2	High	High
Right of Way	13.8	High	High
Developed	10.3	High	High
Pasture	5.9	High	High
Vegetables and Ground Fruit	0.6	High	Low
Corn	0.5	High	Low
Golf Courses	0.3	High	Low
Christmas Trees	0.2	High	Low
Other Crops	0.1	High	Low
Wheat	0.05	High	Low
Other Grains	0.05	High	Low
Nurseries	0.05	High	Low
Orchards and Vineyards	0.01	High	Low
Other Row Crops	0.007	High	Low
Bin 3		High	High
Bin 4		High	High

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity		
Risk	**Confidence**	
High	**High**	

Life Stage: Juveniles (full-range)

Table 249. Direct mortality risk hypothesis; Steelhead, Puget Sound DPS and chlorpyrifos; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forests	33.2	High	High
Right of Way	13.8	High	High
Developed	10.3	High	High
Pasture	5.9	High	High
Vegetables and Ground Fruit	0.6	High	Low
Corn	0.5	High	Low
Golf Courses	0.3	High	Low
Christmas Trees	0.2	High	Low
Other Crops	0.1	High	Low
Wheat	0.05	High	Low
Other Grains	0.05	High	Low
Nurseries	0.05	High	Low
Orchards and Vineyards	0.01	High	Low
Other Row Crops	0.007	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 250. Growth risk hypothesis; Steelhead, Puget Sound DPS and chlorpyrifos; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forests	33.2	High	High

Right of Way	13.8	High	High
Developed	10.3	High	High
Pasture	5.9	High	High
Vegetables and Ground Fruit	0.6	High	Low
Corn	0.5	High	Low
Golf Courses	0.3	High	Low
Christmas Trees	0.2	High	Low
Other Crops	0.1	High	Low
Wheat	0.05	High	Low
Other Grains	0.05	High	Low
Nurseries	0.05	High	Low
Orchards and Vineyards	0.01	High	Low
Other Row Crops	0.007	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 251. Prey risk hypothesis; Steelhead, Puget Sound DPS and chlorpyrifos; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forests	33.2	High	High
Right of Way	13.8	High	High
Developed	10.3	High	High
Pasture	5.9	High	High
Vegetables and Ground Fruit	0.6	High	Low
Corn	0.5	High	Low
Golf Courses	0.3	High	Low
Christmas Trees	0.2	High	Low
Other Crops	0.1	High	Low
Wheat	0.05	High	Low
Other Grains	0.05	High	Low
Nurseries	0.05	High	Low
Orchards and Vineyards	0.01	High	Low
Other Row Crops	0.007	High	Low

Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 252. AChE risk hypothesis; Steelhead, Puget Sound DPS and chlorpyrifos; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forests	33.2	High	High
Right of Way	13.8	High	High
Developed	10.3	High	High
Pasture	5.9	High	High
Vegetables and Ground Fruit	0.6	High	Low
Corn	0.5	High	Low
Golf Courses	0.3	High	Low
Christmas Trees	0.2	High	Low
Other Crops	0.1	High	Low
Wheat	0.05	High	Low
Other Grains	0.05	High	Low
Nurseries	0.05	High	Low
Orchards and Vineyards	0.01	High	Low
Other Row Crops	0.007	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 253. Behavior and sensory risk hypothesis; Steelhead, Puget Sound DPS and chlorpyrifos; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forests	33.2	High	High

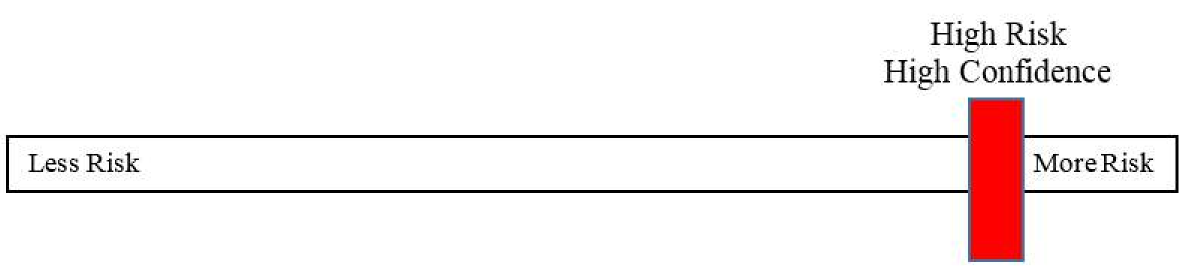
Right of Way	13.8	High	High
Developed	10.3	High	High
Pasture	5.9	High	High
Vegetables and Ground Fruit	0.6	High	Low
Corn	0.5	High	Low
Golf Courses	0.3	Medium	Low
Christmas Trees	0.2	High	Low
Other Crops	0.1	High	Low
Wheat	0.05	High	Low
Other Grains	0.05	High	Low
Nurseries	0.05	High	Low
Orchards and Vineyards	0.01	High	Low
Other Row Crops	0.007	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forests	33.2	High	High
Right of Way	13.8	High	High
Developed	10.3	High	High
Pasture	5.9	High	High
Vegetables and Ground Fruit	0.6	High	Low
Corn	0.5	High	Low
Golf Courses	0.3	High	Low
Christmas Trees	0.2	High	Low
Other Crops	0.1	High	Low
Wheat	0.05	High	Low
Other Grains	0.05	High	Low
Nurseries	0.05	High	Low
Orchards and Vineyards	0.01	High	Low
Other Row Crops	0.007	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 254. Effects analysis summary table: Steelhead, Puget Sound DPS and chlorpyrifos

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 64-96 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 64-94 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via	High	High	4-day fish: 62-94 4-day invert:	**Yes**

reduction in prey availability			65-100 **Error! Reference source not found.**	
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, Puget Sound DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where chlorpyrifos achieves predicted levels. The MagTool results indicate that between 64-96 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed steelhead. The overall risk to Steelhead, Puget Sound DPS from the effects of the action is high and the confidence associated with that risk is high.



12.26 Steelhead, Snake River Basin DPS

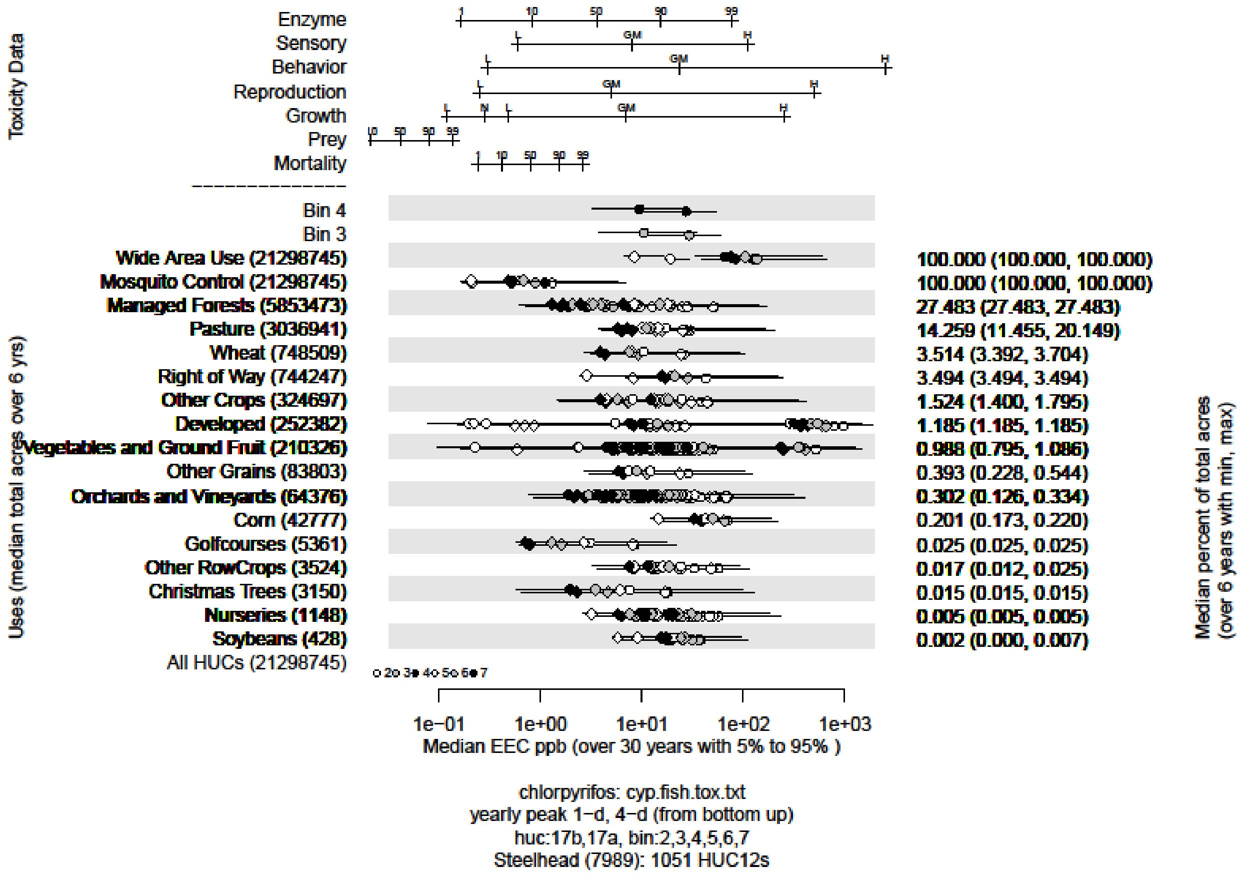


Figure 25. Effects analysis R-plot for Steelhead, Snake River Basin DPS and chlorpyrifos

Table 255. Likelihood of exposure determination for Steelhead, Snake River Basin DPS and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Managed Forest	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Wheat	2	yes	yes	yes	NA	3	High
Right of Way	2	yes	yes	yes	NA	3	High
Other Crops	2	yes	yes	yes	NA	3	High
Developed	2	yes	yes	yes	NA	3	High
Vegetables and Ground Fruit	2	yes	yes	yes	NA	3	High
Other Grains	1	yes	yes	yes	yes	3	High
Orchards and Vineyards	1	yes	yes	yes	yes	3	High
Corn	1	yes	yes	yes	yes	3	High
Golf Courses	1	yes	yes	yes	no	3	Low
Other Row Crops	1	yes	yes	yes	no	3	Low
Christmas Trees	1	yes	yes	yes	no	3	Low
Nurseries	1	yes	yes	yes	no	3	Low
Soybeans	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High
Juveniles							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Managed Forest	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Wheat	2	yes	yes	yes	NA	3	High
Right of Way	2	yes	yes	yes	NA	3	High
Other Crops	2	yes	yes	yes	NA	3	High
Developed	2	yes	yes	yes	NA	3	High
Vegetables and Ground Fruit	2	yes	yes	yes	NA	3	High
Other Grains	1	yes	yes	yes	yes	3	High
Orchards and Vineyards	1	yes	yes	yes	yes	3	High
Corn	1	yes	yes	yes	yes	3	High
Golf Courses	1	yes	yes	yes	no	3	Low
Other Row Crops	1	yes	yes	yes	no	3	Low
Christmas Trees	1	yes	yes	yes	no	3	Low
Nurseries	1	yes	yes	yes	no	3	Low
Soybeans	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High

Life Stage: Adults (full-range)

Table 256. Direct mortality risk hypothesis; Steelhead, Snake River Basin DPS and chlorpyrifos; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High

Managed Forest	27.5	High	High
Pasture	14.3	High	High
Wheat	3.5	High	High
Right of Way	3.5	High	High
Other Crops	1.5	High	High
Developed	1.2	High	High
Vegetables and Ground Fruit	1.0	High	High
Other Grains	0.4	High	High
Orchards and Vineyards	0.3	High	High
Corn	0.2	High	High
Golf Courses	0.03	High	Low
Other Row Crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.005	High	Low
Soybeans	0.002	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 257. Reproduction risk hypothesis; Steelhead, Snake River Basin DPS and chlorpyrifos; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	27.5	High	High
Pasture	14.3	High	High
Wheat	3.5	High	High
Right of Way	3.5	High	High
Other Crops	1.5	High	High
Developed	1.2	High	High
Vegetables and Ground Fruit	1.0	High	High
Other Grains	0.4	High	High
Orchards and Vineyards	0.3	High	High
Corn	0.2	High	High
Golf Courses	0.03	High	Low
Other Row Crops	0.02	High	Low

Christmas Trees	0.02	High	Low
Nurseries	0.005	High	Low
Soybeans	0.002	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 258. Behavior and sensory risk hypothesis; Steelhead, Snake River Basin DPS and chlorpyrifos; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	27.5	High	High
Pasture	14.3	High	High
Wheat	3.5	High	High
Right of Way	3.5	High	High
Other Crops	1.5	High	High
Developed	1.2	High	High
Vegetables and Ground Fruit	1.0	High	High
Other Grains	0.4	High	High
Orchards and Vineyards	0.3	High	High
Corn	0.2	High	High
Golf Courses	0.03	Medium	Low
Other Row Crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.005	High	Low
Soybeans	0.002	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	27.5	High	High
Pasture	14.3	High	High
Wheat	3.5	High	High
Right of Way	3.5	High	High

Other Crops	1.5	High	High
Developed	1.2	High	High
Vegetables and Ground Fruit	1.0	High	High
Other Grains	0.4	High	High
Orchards and Vineyards	0.3	High	High
Corn	0.2	High	High
Golf Courses	0.03	High	Low
Other Row Crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.005	High	Low
Soybeans	0.002	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 259. AChE risk hypothesis; Steelhead, Snake River Basin DPS and chlorpyrifos; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	27.5	High	High
Pasture	14.3	High	High
Wheat	3.5	High	High
Right of Way	3.5	High	High
Other Crops	1.5	High	High
Developed	1.2	High	High
Vegetables and Ground Fruit	1.0	High	High
Other Grains	0.4	High	High
Orchards and Vineyards	0.3	High	High
Corn	0.2	High	High
Golf Courses	0.03	High	Low
Other Row Crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.005	High	Low
Soybeans	0.002	High	Low
Bin 3		High	High

Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 260. Direct mortality risk hypothesis; Steelhead, Snake River Basin DPS and chlorpyrifos; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	27.5	High	High
Pasture	14.3	High	High
Wheat	3.5	High	High
Right of Way	3.5	High	High
Other Crops	1.5	High	High
Developed	1.2	High	High
Vegetables and Ground Fruit	1.0	High	High
Other Grains	0.4	High	High
Orchards and Vineyards	0.3	High	High
Corn	0.2	High	High
Golf Courses	0.03	High	Low
Other Row Crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.005	High	Low
Soybeans	0.002	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 261. Growth risk hypothesis; Steelhead, Snake River Basin DPS and chlorpyrifos; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High

Mosquito Control	100	Medium	High
Managed Forest	27.5	High	High
Pasture	14.3	High	High
Wheat	3.5	High	High
Right of Way	3.5	High	High
Other Crops	1.5	High	High
Developed	1.2	High	High
Vegetables and Ground Fruit	1.0	High	High
Other Grains	0.4	High	High
Orchards and Vineyards	0.3	High	High
Corn	0.2	High	High
Golf Courses	0.03	High	Low
Other Row Crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.005	High	Low
Soybeans	0.002	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 262. Prey risk hypothesis; Steelhead, Snake River Basin DPS and chlorpyrifos; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	27.5	High	High
Pasture	14.3	High	High
Wheat	3.5	High	High
Right of Way	3.5	High	High
Other Crops	1.5	High	High
Developed	1.2	High	High
Vegetables and Ground Fruit	1.0	High	High
Other Grains	0.4	High	High
Orchards and Vineyards	0.3	High	High
Corn	0.2	High	High
Golf Courses	0.03	High	Low

Other Row Crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.005	High	Low
Soybeans	0.002	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 263. AChE risk hypothesis; Steelhead, Snake River Basin DPS and chlorpyrifos; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	27.5	High	High
Pasture	14.3	High	High
Wheat	3.5	High	High
Right of Way	3.5	High	High
Other Crops	1.5	High	High
Developed	1.2	High	High
Vegetables and Ground Fruit	1.0	High	High
Other Grains	0.4	High	High
Orchards and Vineyards	0.3	High	High
Corn	0.2	High	High
Golf Courses	0.03	High	Low
Other Row Crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.005	High	Low
Soybeans	0.002	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 264. Behavior and sensory risk hypothesis; Steelhead, Snake River Basin DPS and chlorpyrifos; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	27.5	High	High
Pasture	14.3	High	High
Wheat	3.5	High	High
Right of Way	3.5	High	High
Other Crops	1.5	High	High
Developed	1.2	High	High
Vegetables and Ground Fruit	1.0	High	High
Other Grains	0.4	High	High
Orchards and Vineyards	0.3	High	High
Corn	0.2	High	High
Golf Courses	0.03	Medium	Low
Other Row Crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.005	High	Low
Soybeans	0.002	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	27.5	High	High
Pasture	14.3	High	High
Wheat	3.5	High	High
Right of Way	3.5	High	High
Other Crops	1.5	High	High
Developed	1.2	High	High
Vegetables and Ground Fruit	1.0	High	High
Other Grains	0.4	High	High
Orchards and Vineyards	0.3	High	High
Corn	0.2	High	High
Golf Courses	0.03	High	Low

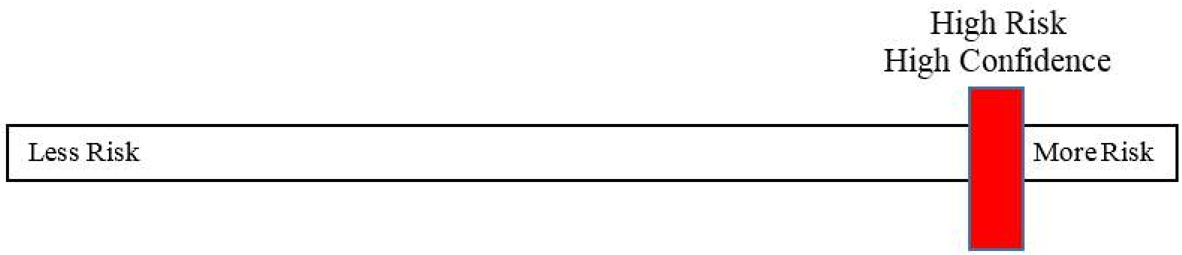
Other Row Crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.005	High	Low
Soybeans	0.002	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 265. Effects analysis summary table: Steelhead, Snake River Basin DPS and chlorpyrifos

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 53-84 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce	High	High	4-day: 53-84	**Yes**

juvenile abundance via acute lethality.			**Error! Reference source not found.**	
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day fish: 56-84 4-day invert: 54-99 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, Snake River Basin DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where chlorpyrifos achieves predicted levels. The MagTool results indicate that between 53-84 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed steelhead. The overall risk to Steelhead, Snake River Basin DPS from the effects of the action is high and the confidence associated with that risk is high.


High Risk
High Confidence
Less Risk
More Risk

12.27 Steelhead, South-Central California Coast DPS (Oncorhynchus mykiss)

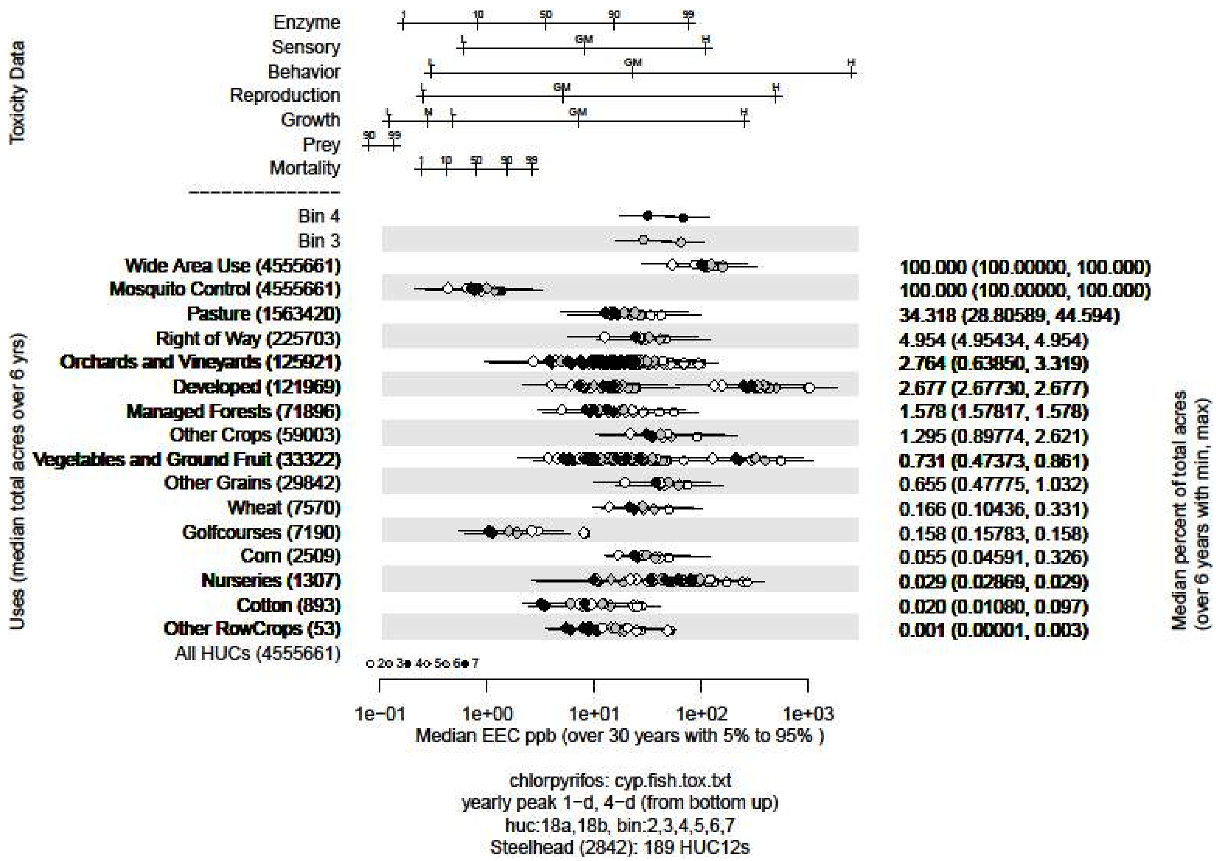


Figure 26. Effects analysis R-plot for Steelhead, South-Central California Coast DPS and chlorpyrifos

Table 266. Likelihood of exposure determination for Steelhead, South-Central California Coast DPS and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Orchards and Vineyards	2	yes	yes	yes	NA	3	High
Developed	2	yes	yes	yes	NA	3	High
Managed Forest	2	yes	yes	yes	NA	3	High
Other Crops	2	yes	yes	yes	NA	3	High
Vegetables and Ground Fruit	1	yes	yes	yes	yes	3	High
Other Grains	1	yes	yes	yes	yes	3	High
Wheat	1	yes	yes	yes	yes	3	High
Golf Courses	1	yes	yes	yes	no	3	Low
Corn	1	yes	yes	yes	yes	3	High
Nurseries	1	yes	yes	yes	no	3	Low
Cotton	1	yes	yes	yes	yes	3	High
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High
Juveniles							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Orchards and Vineyards	2	yes	yes	yes	NA	3	High
Developed	2	yes	yes	yes	NA	3	High
Managed Forest	2	yes	yes	yes	NA	3	High
Other Crops	2	yes	yes	yes	NA	3	High
Vegetables and Ground Fruit	1	yes	yes	yes	yes	3	High
Other Grains	1	yes	yes	yes	yes	3	High
Wheat	1	yes	yes	yes	yes	3	High
Golf Courses	1	yes	yes	yes	no	3	Low
Corn	1	yes	yes	yes	yes	3	High
Nurseries	1	yes	yes	yes	no	3	Low
Cotton	1	yes	yes	yes	yes	3	High
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High

Life Stage: Adults (full-range)

Table 267. Direct mortality risk hypothesis; Steelhead, South-Central California Coast DPS and chlorpyrifos; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High

Pasture	34.3	High	High
Right of Way	5.0	High	High
Orchards and Vineyards	2.8	High	High
Developed	2.3	High	High
Managed Forest	1.6	High	High
Other Crops	1.3	High	High
Vegetables and Ground Fruit	0.7	High	High
Other Grains	0.7	High	High
Wheat	0.2	High	High
Golf Courses	0.2	High	Low
Corn	0.06	High	High
Nurseries	0.03	High	Low
Cotton	0.02	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 268. Reproduction risk hypothesis; Steelhead, South-Central California Coast DPS and chlorpyrifos; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	34.3	High	High
Right of Way	5.0	High	High
Orchards and Vineyards	2.3	High	High
Developed	2.3	High	High
Managed Forest	1.6	High	High
Other Crops	1.3	High	High
Vegetables and Ground Fruit	0.7	High	High
Other Grains	0.7	High	High
Wheat	0.2	High	High
Golf Courses	0.2	Medium	Low
Corn	0.06	High	High
Nurseries	0.03	High	Low
Cotton	0.02	High	High

Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 269. Behavior and sensory risk hypothesis; Steelhead, South-Central California Coast DPS and chlorpyrifos; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	34.3	High	High
Right of Way	5.0	High	High
Orchards and Vineyards	2.3	High	High
Developed	2.3	High	High
Managed Forest	1.6	High	High
Other Crops	1.3	High	High
Vegetables and Ground Fruit	0.7	High	High
Other Grains	0.7	High	High
Wheat	0.2	High	High
Golf Courses	0.2	Medium	Low
Corn	0.06	High	High
Nurseries	0.03	High	Low
Cotton	0.02	High	High
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	34.3	High	High
Right of Way	5.0	High	High
Orchards and Vineyards	2.3	High	High
Developed	2.3	High	High
Managed Forest	1.6	High	High
Other Crops	1.3	High	High

Vegetables and Ground Fruit	0.7	High	High
Other Grains	0.7	High	High
Wheat	0.2	High	High
Golf Courses	0.2	Medium	Low
Corn	0.06	High	High
Nurseries	0.03	High	Low
Cotton	0.02	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 270. AChE risk hypothesis; Steelhead, South-Central California Coast DPS and chlorpyrifos; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Pasture	34.3	High	High
Right of Way	5.0	High	High
Orchards and Vineyards	2.3	High	High
Developed	2.3	High	High
Managed Forest	1.6	High	High
Other Crops	1.3	High	High
Vegetables and Ground Fruit	0.7	High	High
Other Grains	0.7	High	High
Wheat	0.2	High	High
Golf Courses	0.2	High	Low
Corn	0.06	High	High
Nurseries	0.03	High	Low
Cotton	0.02	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 271. Direct mortality risk hypothesis; Steelhead, South-Central California Coast DPS and chlorpyrifos; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Pasture	34.3	High	High
Right of Way	5.0	High	High
Orchards and Vineyards	2.8	High	High
Developed	2.3	High	High
Managed Forest	1.6	High	High
Other Crops	1.3	High	High
Vegetables and Ground Fruit	0.7	High	High
Other Grains	0.7	High	High
Wheat	0.2	High	High
Golf Courses	0.2	High	Low
Corn	0.06	High	High
Nurseries	0.03	High	Low
Cotton	0.02	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 272. Growth risk hypothesis; Steelhead, South-Central California Coast DPS and chlorpyrifos; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	34.3	High	High
Right of Way	5.0	High	High
Orchards and Vineyards	2.3	High	High
Developed	2.3	High	High
Managed Forest	1.6	High	High

Other Crops	1.3	High	High
Vegetables and Ground Fruit	0.7	High	High
Other Grains	0.7	High	High
Wheat	0.2	High	High
Golf Courses	0.2	Medium	Low
Corn	0.06	High	High
Nurseries	0.03	High	Low
Cotton	0.02	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 273. Prey risk hypothesis; Steelhead, South-Central California Coast DPS and chlorpyrifos; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Pasture	34.3	High	High
Right of Way	5.0	High	High
Orchards and Vineyards	2.3	High	High
Developed	2.3	High	High
Managed Forest	1.6	High	High
Other Crops	1.3	High	High
Vegetables and Ground Fruit	0.7	High	High
Other Grains	0.7	High	High
Wheat	0.2	High	High
Golf Courses	0.2	High	Low
Corn	0.06	High	High
Nurseries	0.03	High	Low
Cotton	0.02	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 274. AChE risk hypothesis; Steelhead, South-Central California Coast DPS and chlorpyrifos; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Pasture	34.3	High	High
Right of Way	5.0	High	High
Orchards and Vineyards	2.3	High	High
Developed	2.3	High	High
Managed Forest	1.6	High	High
Other Crops	1.3	High	High
Vegetables and Ground Fruit	0.7	High	High
Other Grains	0.7	High	High
Wheat	0.2	High	High
Golf Courses	0.2	High	Low
Corn	0.06	High	High
Nurseries	0.03	High	Low
Cotton	0.02	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 275. Behavior and sensory risk hypothesis; Steelhead, South-Central California Coast DPS and chlorpyrifos; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	34.3	High	High
Right of Way	5.0	High	High
Orchards and Vineyards	2.3	High	High
Developed	2.3	High	High
Managed Forest	1.6	High	High
Other Crops	1.3	High	High

Vegetables and Ground Fruit	0.7	High	High
Other Grains	0.7	High	High
Wheat	0.2	High	High
Golf Courses	0.2	Medium	Low
Corn	0.06	High	High
Nurseries	0.03	High	Low
Cotton	0.02	High	High
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	34.3	High	High
Right of Way	5.0	High	High
Orchards and Vineyards	2.3	High	High
Developed	2.3	High	High
Managed Forest	1.6	High	High
Other Crops	1.3	High	High
Vegetables and Ground Fruit	0.7	High	High
Other Grains	0.7	High	High
Wheat	0.2	High	High
Golf Courses	0.2	Medium	Low
Corn	0.06	High	High
Nurseries	0.03	High	Low
Cotton	0.02	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

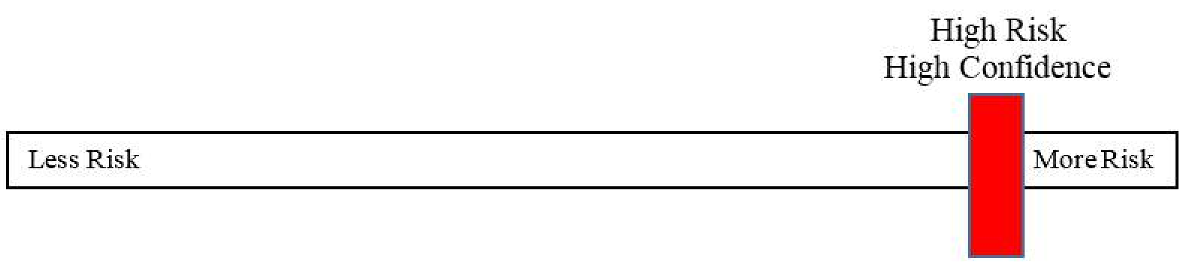
Table 276. Effects analysis summary table: Steelhead, South-Central California Coast DPS and chlorpyrifos

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				

Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 49-98 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 49-98 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day fish: 49-94 4-day invert: 49-100 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**

Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, South-Central California Coast DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where chlorpyrifos achieves predicted levels. The MagTool results indicate that between 49-98 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed steelhead. The overall risk to Steelhead, South-Central California Coast DPS from the effects of the action is high and the confidence associated with that risk is high.



12.28 Steelhead, Southern California DPS (Oncorhynchus mykiss)

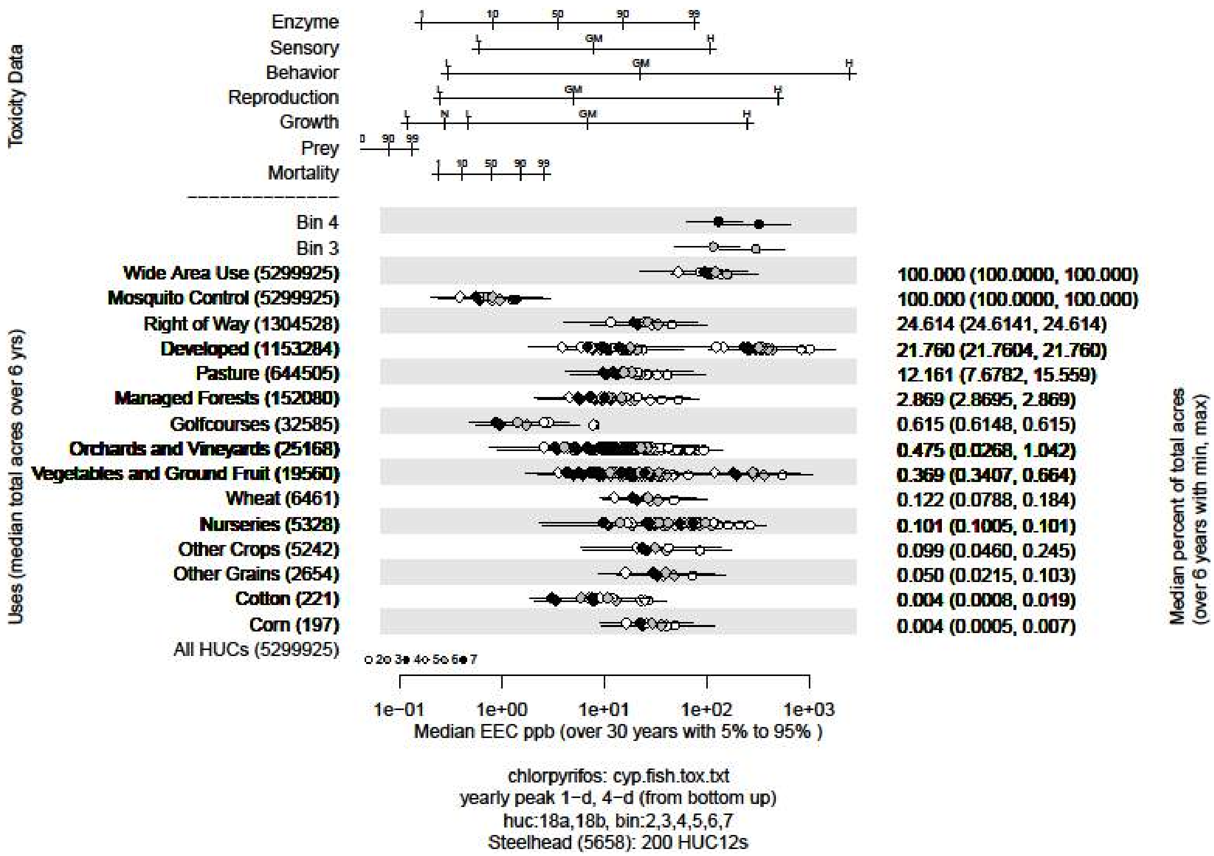


Figure 27. Effects analysis R-plot for Steelhead, Southern California DPS and chlorpyrifos

Table 277. Likelihood of exposure determination for Steelhead, Southern California DPS and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito control	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Developed	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Managed Forest	2	yes	yes	yes	NA	3	High
Golf Courses	1	yes	yes	yes	yes	3	High
Orchards and Vineyards	1	yes	yes	yes	yes	3	High
Vegetables and Ground Fruit	1	yes	yes	yes	yes	3	High
Wheat	1	yes	yes	yes	no	3	Low
Nurseries	1	yes	yes	yes	no	3	Low
Other Crops	1	yes	yes	yes	yes	3	High
Other Grains	1	yes	yes	yes	yes	3	High
Cotton	1	yes	yes	yes	yes	3	High
Corn	1	yes	yes	yes	yes	3	High
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High
Juveniles							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito control	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Developed	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Managed Forest	2	yes	yes	yes	NA	3	High
Golf Courses	1	yes	yes	yes	yes	3	High
Orchards and Vineyards	1	yes	yes	yes	yes	3	High
Vegetables and Ground Fruit	1	yes	yes	yes	yes	3	High
Wheat	1	yes	yes	yes	no	3	Low
Nurseries	1	yes	yes	yes	no	3	Low
Other Crops	1	yes	yes	yes	yes	3	High
Other Grains	1	yes	yes	yes	yes	3	High
Cotton	1	yes	yes	yes	yes	3	High
Corn	1	yes	yes	yes	yes	3	High
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High

Life Stage: Adults (full-range)

Table 278. Direct mortality risk hypothesis; Steelhead, Southern California DPS and chlorpyrifos; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito control	100	High	High
Right of Way	24.6	High	High

Developed	21.8	High	High
Pasture	12.2	High	High
Managed Forest	2.3	High	High
Golf Courses	0.6	High	High
Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High
Wheat	0.1	High	Low
Nurseries	0.1	High	Low
Other Crops	0.1	High	High
Other Grains	0.05	High	High
Cotton	0.004	High	High
Corn	0.004	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 279. Reproduction risk hypothesis; Steelhead, Southern California DPS and chlorpyrifos; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito control	100	Medium	High
Right of Way	24.6	High	High
Developed	21.8	High	High
Pasture	12.2	High	High
Managed Forest	2.3	High	High
Golf Courses	0.6	Medium	High
Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High
Wheat	0.1	High	Low
Nurseries	0.1	High	Low
Other Crops	0.1	High	High
Other Grains	0.05	High	High
Cotton	0.004	High	High
Corn	0.004	High	High
Bin 3		High	High
Bin 4		High	High

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction		
Risk	**Confidence**	
High	**High**	

Table 280. Behavior and sensory risk hypothesis; Steelhead, Southern California DPS and chlorpyrifos; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito control	100	Medium	High
Right of Way	24.6	High	High
Developed	21.8	High	High
Pasture	12.2	High	High
Managed Forest	2.3	High	High
Golf Courses	0.6	Medium	High
Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High
Wheat	0.1	High	Low
Nurseries	0.1	High	Low
Other Crops	0.1	High	High
Other Grains	0.05	High	High
Cotton	0.004	High	High
Corn	0.004	High	High
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito control	100	Medium	High
Right of Way	24.6	High	High
Developed	21.8	High	High
Pasture	12.2	High	High
Managed Forest	2.3	High	High
Golf Courses	0.6	Medium	High
Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High
Wheat	0.1	High	Low

Nurseries	0.1	High	Low
Other Crops	0.1	High	High
Other Grains	0.05	High	High
Cotton	0.004	High	High
Corn	0.004	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 281. AChE risk hypothesis; Steelhead, Southern California DPS and chlorpyrifos; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito control	100	Medium	High
Right of Way	24.6	High	High
Developed	21.8	High	High
Pasture	12.2	High	High
Managed Forest	2.3	High	High
Golf Courses	0.6	High	High
Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High
Wheat	0.1	High	Low
Nurseries	0.1	High	Low
Other Crops	0.1	High	High
Other Grains	0.05	High	High
Cotton	0.004	High	High
Corn	0.004	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 282. Direct mortality risk hypothesis; Steelhead, Southern California DPS and chlorpyrifos; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito control	100	High	High
Right of Way	24.6	High	High
Developed	21.8	High	High
Pasture	12.2	High	High
Managed Forest	2.3	High	High
Golf Courses	0.6	High	High
Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High
Wheat	0.1	High	Low
Nurseries	0.1	High	Low
Other Crops	0.1	High	High
Other Grains	0.05	High	High
Cotton	0.004	High	High
Corn	0.004	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 283. Growth risk hypothesis; Steelhead, Southern California DPS and chlorpyrifos; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito control	100	Medium	High
Right of Way	24.6	High	High
Developed	21.8	High	High
Pasture	12.2	High	High
Managed Forest	2.3	High	High
Golf Courses	0.6	Medium	High
Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High

Wheat	0.1	High	Low
Nurseries	0.1	High	Low
Other Crops	0.1	High	High
Other Grains	0.05	High	High
Cotton	0.004	High	High
Corn	0.004	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 284. Prey risk hypothesis; Steelhead, Southern California DPS and chlorpyrifos; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito control	100	High	High
Right of Way	24.6	High	High
Developed	21.8	High	High
Pasture	12.2	High	High
Managed Forest	2.3	High	High
Golf Courses	0.6	High	High
Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High
Wheat	0.1	High	Low
Nurseries	0.1	High	Low
Other Crops	0.1	High	High
Other Grains	0.05	High	High
Cotton	0.004	High	High
Corn	0.004	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 285. AChE risk hypothesis; Steelhead, Southern California DPS and chlorpyrifos; Juveniles

Endpoint: AChE

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito control	100	Medium	High
Right of Way	24.6	High	High
Developed	21.8	High	High
Pasture	12.2	High	High
Managed Forest	2.3	High	High
Golf Courses	0.6	High	High
Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High
Wheat	0.1	High	Low
Nurseries	0.1	High	Low
Other Crops	0.1	High	High
Other Grains	0.05	High	High
Cotton	0.004	High	High
Corn	0.004	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 286. Behavior and sensory risk hypothesis; Steelhead, Southern California DPS and chlorpyrifos; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito control	100	Medium	High
Right of Way	24.6	High	High
Developed	21.8	High	High
Pasture	12.2	High	High
Managed Forest	2.3	High	High
Golf Courses	0.6	Medium	High
Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High
Wheat	0.1	High	Low
Nurseries	0.1	High	Low

Other Crops	0.1	High	High
Other Grains	0.05	High	High
Cotton	0.004	High	High
Corn	0.004	High	High
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito control	100	Medium	High
Right of Way	24.6	High	High
Developed	21.8	High	High
Pasture	12.2	High	High
Managed Forest	2.3	High	High
Golf Courses	0.6	Medium	High
Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High
Wheat	0.1	High	Low
Nurseries	0.1	High	Low
Other Crops	0.1	High	High
Other Grains	0.05	High	High
Cotton	0.004	High	High
Corn	0.004	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

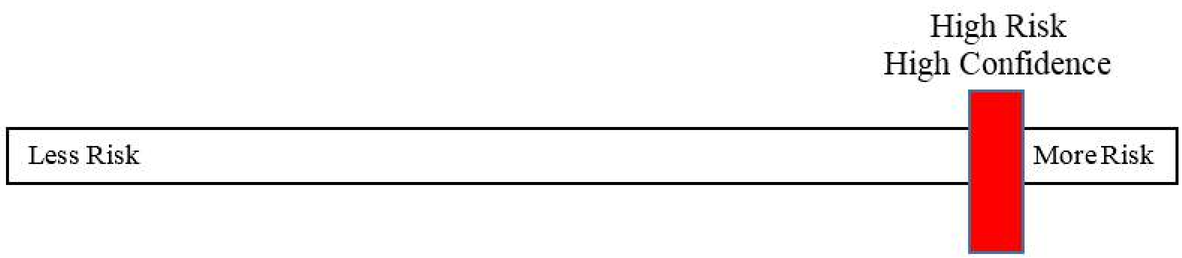
Table 287. Effects analysis summary table: Steelhead, Southern California DPS and chlorpyrifos

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 63-99 **Error! Reference source not found.**	**Yes**

Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 63-99 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day fish: 62-96 4-day invert: 63-100 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impairments to	High	High	Not Available	**Yes**

ecologically significant behaviors.				

Effects analysis summary: Adult and juvenile Steelhead, Southern California DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where chlorpyrifos achieves predicted levels. The MagTool results indicate that between 63-99 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed steelhead. The overall risk to Steelhead, Southern California DPS from the effects of the action is high and the confidence associated with that risk is high.



12.29 Steelhead, Upper Columbia River DPS (Oncorhynchus mykiss)

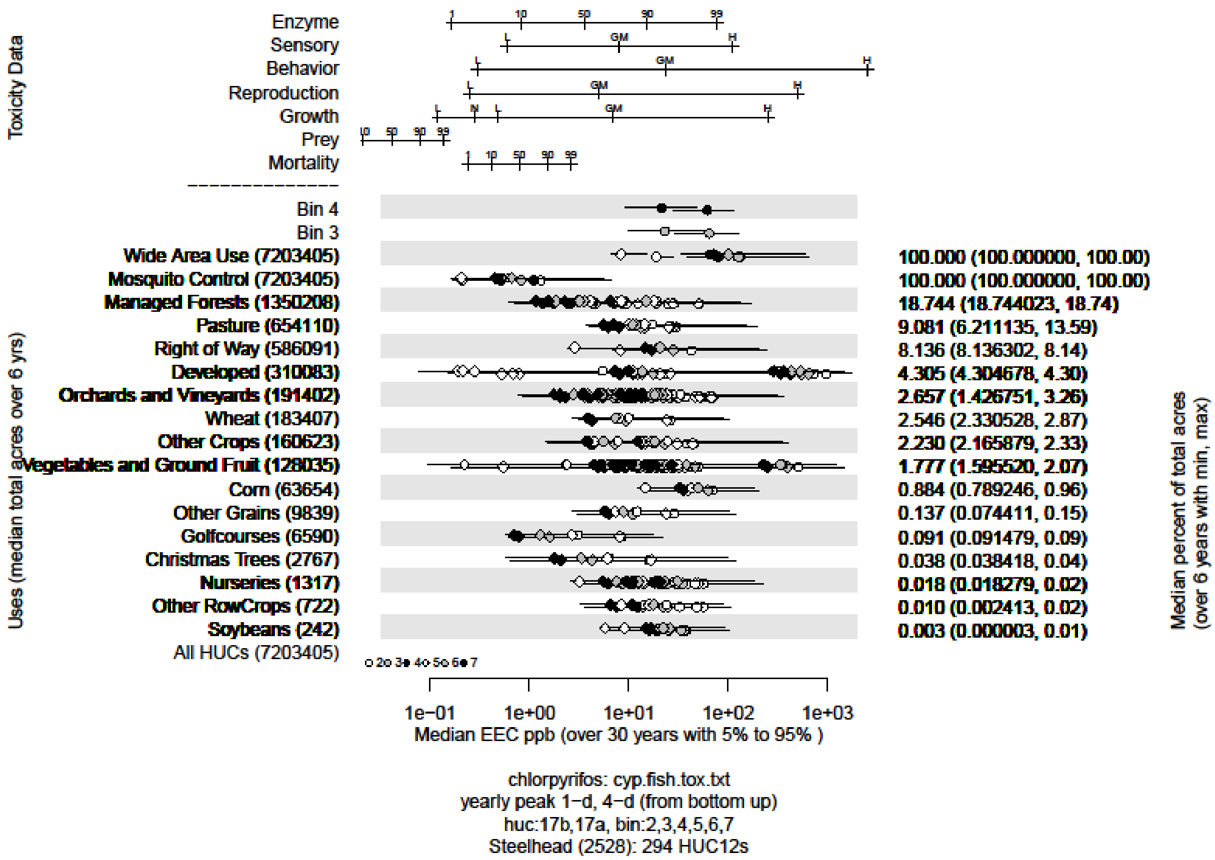


Figure 28. Effects analysis R-plot for Steelhead, Upper Columbia River DPS and chlorpyrifos

Table 288. Likelihood of exposure determination for Steelhead, Upper Columbia River DPS and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito control	3	yes	yes	yes	NA	3	High
Managed Forest	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Developed	2	yes	yes	yes	NA	3	High
Orchards and Vineyards	2	yes	yes	yes	NA	3	High
Wheat	2	yes	yes	yes	NA	3	High
Other Crops	2	yes	yes	yes	NA	3	High
Vegetables and Ground Fruit	2	yes	yes	yes	NA	3	High
Corn	1	yes	yes	yes	yes	3	High
Other Grains	1	yes	yes	yes	no	3	Low
Golf Courses	1	yes	yes	yes	no	3	Low
Christmas Trees	1	yes	yes	yes	no	3	Low
Nurseries	1	yes	yes	yes	no	3	Low
Other Row Crops	1	yes	yes	yes	no	3	Low
Soybeans	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High
Juveniles							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito control	3	yes	yes	yes	NA	3	High
Managed Forest	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Developed	2	yes	yes	yes	NA	3	High
Orchards and Vineyards	2	yes	yes	yes	NA	3	High
Wheat	2	yes	yes	yes	NA	3	High
Other Crops	2	yes	yes	yes	NA	3	High
Vegetables and Ground Fruit	2	yes	yes	yes	NA	3	High
Corn	1	yes	yes	yes	yes	3	High
Other Grains	1	yes	yes	yes	no	3	Low
Golf Courses	1	yes	yes	yes	no	3	Low
Christmas Trees	1	yes	yes	yes	no	3	Low
Nurseries	1	yes	yes	yes	no	3	Low
Other Row Crops	1	yes	yes	yes	no	3	Low
Soybeans	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High

Life Stage: Adults (full-range)

Table 289. Direct mortality risk hypothesis; Steelhead, Upper Columbia River DPS and chlorpyrifos; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High

Mosquito control	100	High	High
Managed Forest	18.7	High	High
Pasture	9.1	High	High
Right of Way	8.1	High	High
Developed	4.3	High	High
Orchards and Vineyards	2.7	High	High
Wheat	2.5	High	High
Other Crops	2.2	High	High
Vegetables and Ground Fruit	1.8	High	High
Corn	0.9	High	High
Other Grains	0.1	High	Low
Golf Courses	0.1	High	Low
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Soybeans	0.003	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 290. Reproduction risk hypothesis; Steelhead, Upper Columbia River DPS and chlorpyrifos; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito control	100	Medium	High
Managed Forest	18.7	High	High
Pasture	9.1	High	High
Right of Way	8.1	High	High
Developed	4.3	High	High
Orchards and Vineyards	2.7	High	High
Wheat	2.5	High	High
Other Crops	2.2	High	High
Vegetables and Ground Fruit	1.8	High	High
Corn	0.9	High	High
Other Grains	0.1	High	Low
Golf Courses	0.1	High	Low

Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Soybeans	0.003	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 291. Behavior and sensory risk hypothesis; Steelhead, Upper Columbia River DPS and chlorpyrifos; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito control	100	Medium	High
Managed Forest	18.7	High	High
Pasture	9.1	High	High
Right of Way	8.1	High	High
Developed	4.3	High	High
Orchards and Vineyards	2.7	High	High
Wheat	2.5	High	High
Other Crops	2.2	High	High
Vegetables and Ground Fruit	1.8	High	High
Corn	0.9	High	High
Other Grains	0.1	High	Low
Golf Courses	0.1	Medium	Low
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Soybeans	0.003	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito control	100	Medium	High
Managed Forest	18.7	High	High
Pasture	9.1	High	High

Right of Way	8.1	High	High
Developed	4.3	High	High
Orchards and Vineyards	2.7	High	High
Wheat	2.5	High	High
Other Crops	2.2	High	High
Vegetables and Ground Fruit	1.8	High	High
Corn	0.9	High	High
Other Grains	0.1	High	Low
Golf Courses	0.1	High	Low
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Soybeans	0.003	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 292. AChE risk hypothesis; Steelhead, Upper Columbia River DPS and chlorpyrifos; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito control	100	High	High
Managed Forest	18.7	High	High
Pasture	9.1	High	High
Right of Way	8.1	High	High
Developed	4.3	High	High
Orchards and Vineyards	2.7	High	High
Wheat	2.5	High	High
Other Crops	2.2	High	High
Vegetables and Ground Fruit	1.8	High	High
Corn	0.9	High	High
Other Grains	0.1	High	Low
Golf Courses	0.1	High	Low
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low

Soybeans	0.003	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 293. Direct mortality risk hypothesis; Steelhead, Upper Columbia River DPS and chlorpyrifos; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito control	100	High	High
Managed Forest	18.7	High	High
Pasture	9.1	High	High
Right of Way	8.1	High	High
Developed	4.3	High	High
Orchards and Vineyards	2.7	High	High
Wheat	2.5	High	High
Other Crops	2.2	High	High
Vegetables and Ground Fruit	1.8	High	High
Corn	0.9	High	High
Other Grains	0.1	High	Low
Golf Courses	0.1	High	Low
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Soybeans	0.003	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 294. Growth risk hypothesis; Steelhead, Upper Columbia River DPS and chlorpyrifos; Juveniles

Endpoint: Growth

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito control	100	Medium	High
Managed Forest	18.7	High	High
Pasture	9.1	High	High
Right of Way	8.1	High	High
Developed	4.3	High	High
Orchards and Vineyards	2.7	High	High
Wheat	2.5	High	High
Other Crops	2.2	High	High
Vegetables and Ground Fruit	1.8	High	High
Corn	0.9	High	High
Other Grains	0.1	High	Low
Golf Courses	0.1	High	Low
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Soybeans	0.003	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 295. Prey risk hypothesis; Steelhead, Upper Columbia River DPS and chlorpyrifos; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito control	100	High	High
Managed Forest	18.7	High	High
Pasture	9.1	High	High
Right of Way	8.1	High	High
Developed	4.3	High	High
Orchards and Vineyards	2.7	High	High
Wheat	2.5	High	High
Other Crops	2.2	High	High
Vegetables and Ground Fruit	1.8	High	High

Corn	0.9	High	High
Other Grains	0.1	High	Low
Golf Courses	0.1	High	Low
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Soybeans	0.003	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 296. AChE risk hypothesis; Steelhead, Upper Columbia River DPS and chlorpyrifos; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito control	100	High	High
Managed Forest	18.7	High	High
Pasture	9.1	High	High
Right of Way	8.1	High	High
Developed	4.3	High	High
Orchards and Vineyards	2.7	High	High
Wheat	2.5	High	High
Other Crops	2.2	High	High
Vegetables and Ground Fruit	1.8	High	High
Corn	0.9	High	High
Other Grains	0.1	High	Low
Golf Courses	0.1	High	Low
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Soybeans	0.003	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 297. Behavior and sensory risk hypothesis; Steelhead, Upper Columbia River DPS and chlorpyrifos; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito control	100	Medium	High
Managed Forest	18.7	High	High
Pasture	9.1	High	High
Right of Way	8.1	High	High
Developed	4.3	High	High
Orchards and Vineyards	2.7	High	High
Wheat	2.5	High	High
Other Crops	2.2	High	High
Vegetables and Ground Fruit	1.8	High	High
Corn	0.9	High	High
Other Grains	0.1	High	Low
Golf Courses	0.1	Medium	Low
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Soybeans	0.003	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito control	100	Medium	High
Managed Forest	18.7	High	High
Pasture	9.1	High	High
Right of Way	8.1	High	High
Developed	4.3	High	High
Orchards and Vineyards	2.7	High	High
Wheat	2.5	High	High
Other Crops	2.2	High	High
Vegetables and Ground Fruit	1.8	High	High
Corn	0.9	High	High
Other Grains	0.1	High	Low
Golf Courses	0.1	High	Low

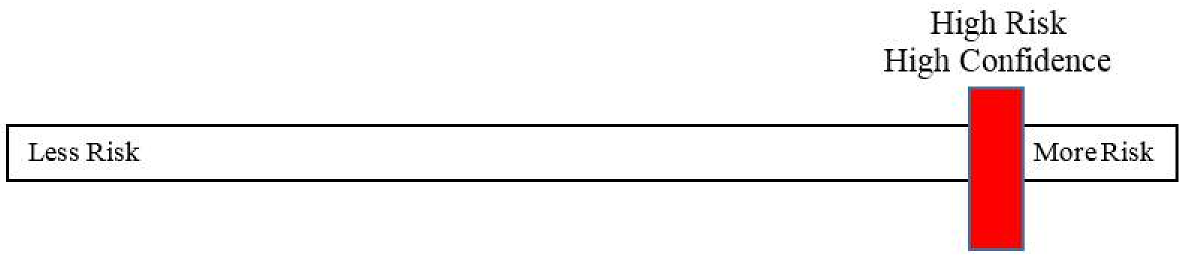
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Soybeans	0.003	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 298. Effects analysis summary table: Steelhead, Upper Columbia River DPS and chlorpyrifos

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 50-94 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce	High	High	4-day: 50-94	**Yes**

juvenile abundance via acute lethality.			**Error! Reference source not found.**	
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day fish: 48-90 4-day invert: 50-98 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, Upper Columbia River DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where chlorpyrifos achieves predicted levels. The MagTool results indicate that between 50-94 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed steelhead. The overall risk to Steelhead, Upper Columbia River DPS from the effects of the action is high and the confidence associated with that risk is high.


High Risk
High Confidence
Less Risk
More Risk

12.30 Steelhead, Upper Willamette River DPS (Oncorhynchus mykiss)

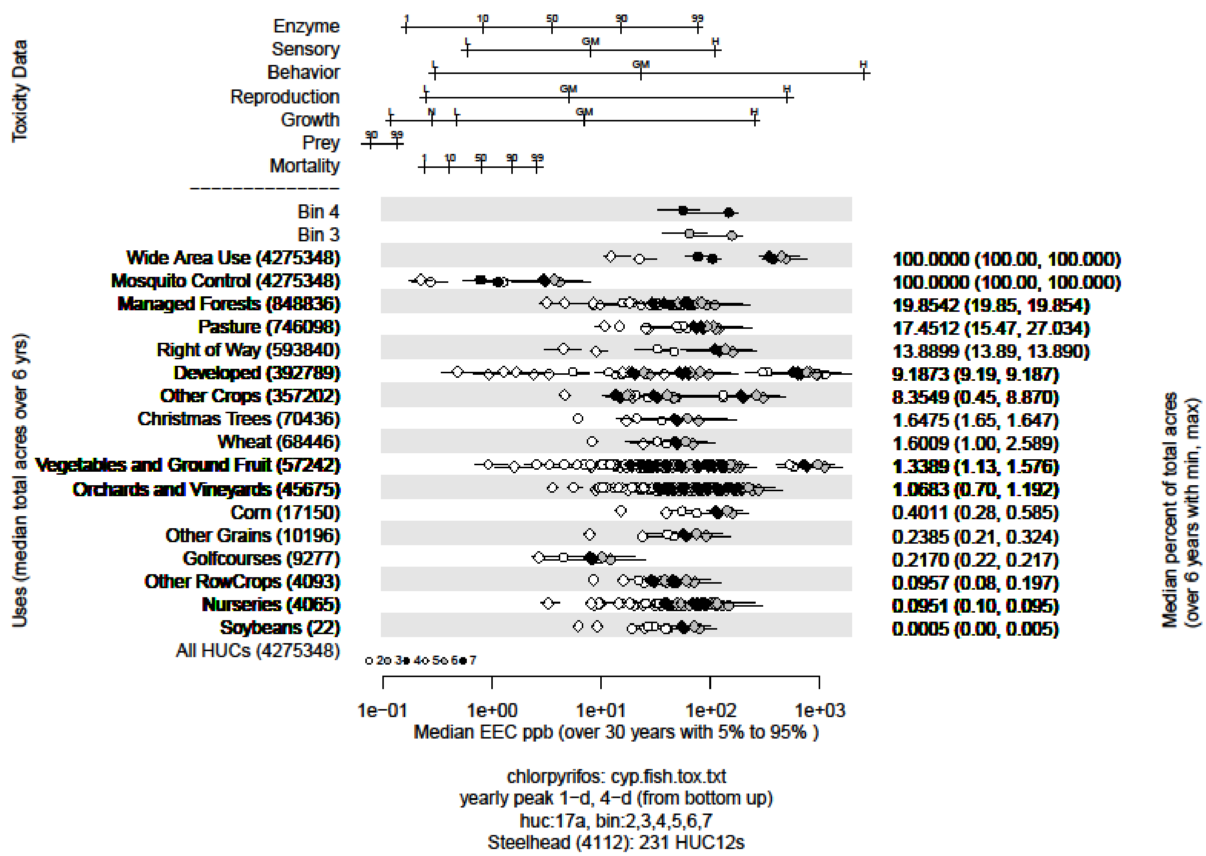


Figure 29. Effects analysis R-plot for Steelhead, Upper Willamette River DPS and chlorpyrifos

Table 299. Likelihood of exposure determination for Steelhead, Upper Willamette River DPS and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Managed Forest	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Developed	3	yes	yes	yes	NA	3	High
Other Crops	3	yes	yes	yes	NA	3	High
Christmas Trees	2	yes	yes	yes	NA	3	High
Wheat	2	yes	yes	yes	NA	3	High
Vegetables and Ground Fruit	2	yes	yes	yes	NA	3	High
Orchards and Vineyards	2	yes	yes	yes	NA	3	High
Corn	1	yes	yes	yes	yes	3	High
Other Grains	1	yes	yes	yes	yes	3	High
Golf Courses	1	yes	yes	yes	yes	3	High
Other Row Crops	1	yes	yes	yes	yes	3	High
Nurseries	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High
Juveniles							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Managed Forest	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Developed	3	yes	yes	yes	NA	3	High
Other Crops	3	yes	yes	yes	NA	3	High
Christmas Trees	2	yes	yes	yes	NA	3	High
Wheat	2	yes	yes	yes	NA	3	High
Vegetables and Ground Fruit	2	yes	yes	yes	NA	3	High
Orchards and Vineyards	2	yes	yes	yes	NA	3	High
Corn	1	yes	yes	yes	yes	3	High
Other Grains	1	yes	yes	yes	yes	3	High
Golf Courses	1	yes	yes	yes	yes	3	High
Other Row Crops	1	yes	yes	yes	yes	3	High
Nurseries	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High

Life Stage: Adults (full-range)

Table 300. Direct mortality risk hypothesis; Steelhead, Upper Willamette River DPS and chlorpyrifos; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	19.9	High	High
Pasture	17.5	High	High
Right of Way	13.9	High	High
Developed	9.2	High	High
Other Crops	8.4	High	High
Christmas Trees	1.6	High	High
Wheat	1.6	High	High
Vegetables and Ground Fruit	1.3	High	High
Orchards and Vineyards	1.1	High	High
Corn	0.4	High	High
Other Grains	0.2	High	High
Golf Courses	0.2	High	High
Other Row Crops	0.1	High	High
Nurseries	0.1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 301. Reproduction risk hypothesis; Steelhead, Upper Willamette River DPS and chlorpyrifos; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High

Mosquito Control	100	High	High
Managed Forest	19.9	High	High
Pasture	17.5	High	High
Right of Way	13.9	High	High
Developed	9.2	High	High
Other Crops	8.4	High	High
Christmas Trees	1.6	High	High
Wheat	1.6	High	High
Vegetables and Ground Fruit	1.3	High	High
Orchards and Vineyards	1.1	High	High
Corn	0.4	High	High
Other Grains	0.2	High	High
Golf Courses	0.2	High	High
Other Row Crops	0.1	High	High
Nurseries	0.1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 302. Behavior and sensory risk hypothesis; Steelhead, Upper Willamette River DPS and chlorpyrifos; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High

Mosquito Control	100	Medium	High
Managed Forest	19.9	High	High
Pasture	17.5	High	High
Right of Way	13.9	High	High
Developed	9.2	High	High
Other Crops	8.4	High	High
Christmas Trees	1.6	High	High
Wheat	1.6	High	High
Vegetables and Ground Fruit	1.3	High	High
Orchards and Vineyards	1.1	High	High
Corn	0.4	High	High
Other Grains	0.2	High	High
Golf Courses	0.2	Medium	High
Other Row Crops	0.1	High	High
Nurseries	0.1	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	19.9	High	High
Pasture	17.5	High	High
Right of Way	13.9	High	High
Developed	9.2	High	High
Other Crops	8.4	High	High

Christmas Trees	1.6	High	High
Wheat	1.6	High	High
Vegetables and Ground Fruit	1.3	High	High
Orchards and Vineyards	1.1	High	High
Corn	0.4	High	High
Other Grains	0.2	High	High
Golf Courses	0.2	High	High
Other Row Crops	0.1	High	High
Nurseries	0.1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 303. AChE risk hypothesis; Steelhead, Upper Willamette River DPS and chlorpyrifos; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	19.9	High	High
Pasture	17.5	High	High
Right of Way	13.9	High	High
Developed	9.2	High	High
Other Crops	8.4	High	High
Christmas Trees	1.6	High	High

Wheat	1.6	High	High
Vegetables and Ground Fruit	1.3	High	High
Orchards and Vineyards	1.1	High	High
Corn	0.4	High	High
Other Grains	0.2	High	High
Golf Courses	0.2	High	High
Other Row Crops	0.1	High	High
Nurseries	0.1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 304. Direct mortality risk hypothesis; Steelhead, Upper Willamette River DPS and chlorpyrifos; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	19.9	High	High
Pasture	17.5	High	High
Right of Way	13.9	High	High
Developed	9.2	High	High
Other Crops	8.4	High	High

Christmas Trees	1.6	High	High
Wheat	1.6	High	High
Vegetables and Ground Fruit	1.3	High	High
Orchards and Vineyards	1.1	High	High
Corn	0.4	High	High
Other Grains	0.2	High	High
Golf Courses	0.2	High	High
Other Row Crops	0.1	High	High
Nurseries	0.1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 305. Growth risk hypothesis; Steelhead, Upper Willamette River DPS and chlorpyrifos; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	19.9	High	High
Pasture	17.5	High	High
Right of Way	13.9	High	High
Developed	9.2	High	High
Other Crops	8.4	High	High
Christmas Trees	1.6	High	High

Wheat	1.6	High	High
Vegetables and Ground Fruit	1.3	High	High
Orchards and Vineyards	1.1	High	High
Corn	0.4	High	High
Other Grains	0.2	High	High
Golf Courses	0.2	High	High
Other Row Crops	0.1	High	High
Nurseries	0.1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 306. Prey risk hypothesis; Steelhead, Upper Willamette River DPS and chlorpyrifos; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	19.9	High	High
Pasture	17.5	High	High
Right of Way	13.9	High	High
Developed	9.2	High	High
Other Crops	8.4	High	High
Christmas Trees	1.6	High	High
Wheat	1.6	High	High

Vegetables and Ground Fruit	1.3	High	High
Orchards and Vineyards	1.1	High	High
Corn	0.4	High	High
Other Grains	0.2	High	High
Golf Courses	0.2	High	High
Other Row Crops	0.1	High	High
Nurseries	0.1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 307. AChE risk hypothesis; Steelhead, Upper Willamette River DPS and chlorpyrifos; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	19.9	High	High
Pasture	17.5	High	High
Right of Way	13.9	High	High
Developed	9.2	High	High
Other Crops	8.4	High	High
Christmas Trees	1.6	High	High
Wheat	1.6	High	High

Vegetables and Ground Fruit	1.3	High	High
Orchards and Vineyards	1.1	High	High
Corn	0.4	High	High
Other Grains	0.2	High	High
Golf Courses	0.2	High	High
Other Row Crops	0.1	High	High
Nurseries	0.1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 308. Behavior and sensory risk hypothesis; Steelhead, Upper Willamette River DPS and chlorpyrifos; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	19.9	High	High
Pasture	17.5	High	High
Right of Way	13.9	High	High
Developed	9.2	High	High
Other Crops	8.4	High	High
Christmas Trees	1.6	High	High
Wheat	1.6	High	High

Vegetables and Ground Fruit	1.3	High	High
Orchards and Vineyards	1.1	High	High
Corn	0.4	High	High
Other Grains	0.2	High	High
Golf Courses	0.2	Medium	High
Other Row Crops	0.1	High	High
Nurseries	0.1	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	19.9	High	High
Pasture	17.5	High	High
Right of Way	13.9	High	High
Developed	9.2	High	High
Other Crops	8.4	High	High
Christmas Trees	1.6	High	High
Wheat	1.6	High	High
Vegetables and Ground Fruit	1.3	High	High
Orchards and Vineyards	1.1	High	High
Corn	0.4	High	High
Other Grains	0.2	High	High
Golf Courses	0.2	High	High

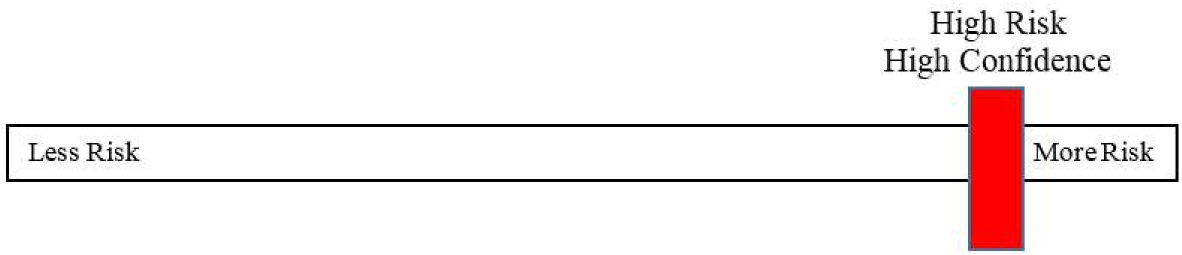
Other Row Crops	0.1	High	High
Nurseries	0.1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 309. Effects analysis summary table: Steelhead, Upper Willamette River DPS and chlorpyrifos

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 75-98 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				

Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 75-98 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day fish: 72-98 4-day invert: 75-100 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, Upper Willamette River DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where chlorpyrifos achieves predicted levels. The MagTool results indicate that between 75-98 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed steelhead. The overall risk to Steelhead, Upper Willamette River DPS from the effects of the action is high and the confidence associated with that risk is high.


High Risk
High Confidence
Less Risk
More Risk

12.31 Eulachon, Southern DPS (Thaleichthys pacificus)

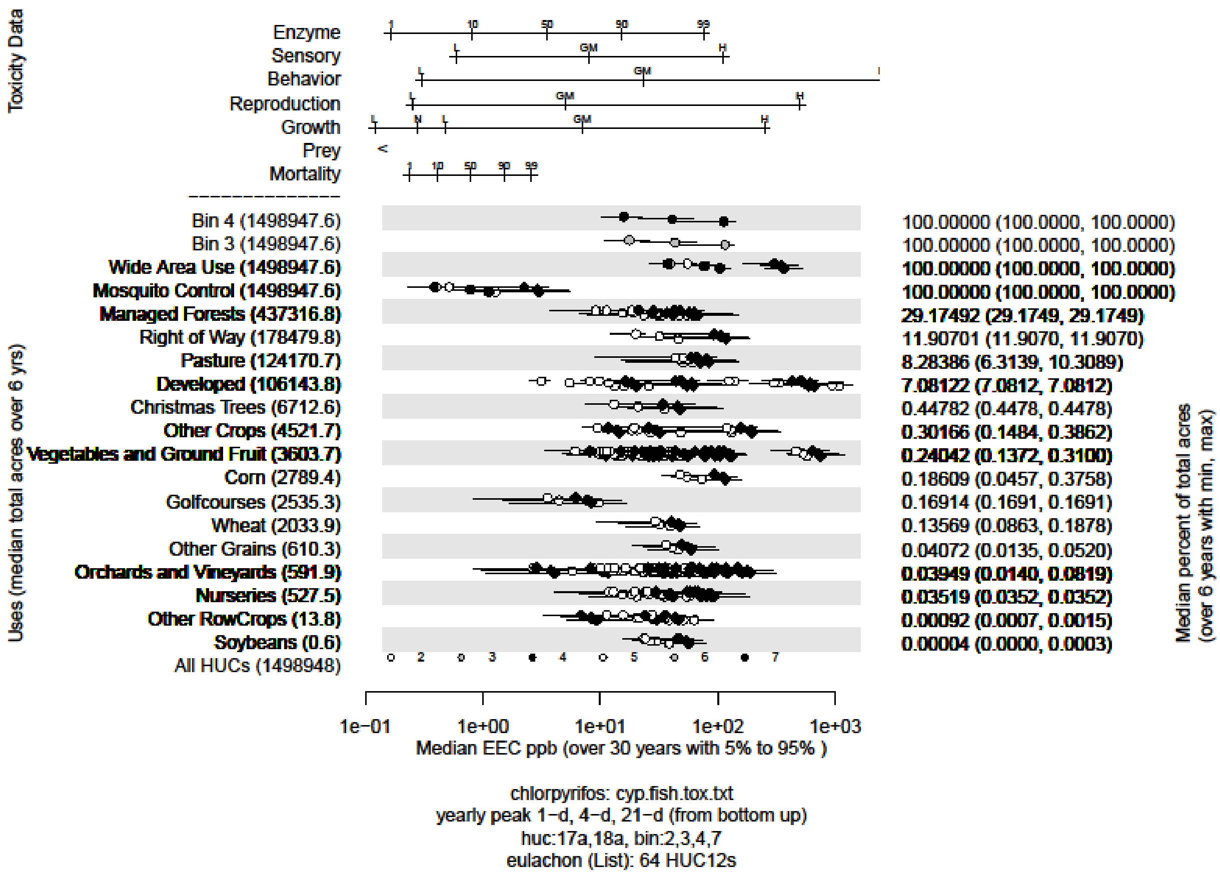


Figure 30. Effects analysis R-plot for Eulachon, Southern DPS and chlorpyrifos

Table 310. Likelihood of exposure determination for Eulachon, Southern DPS and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adult and Juvenile							
Wide Area Use	3	yes	yes	yes	NA	2	**High**
Mosquito Control	3	yes	yes	yes	NA	2	**High**
Managed Forest	3	yes	yes	yes	NA	2	**High**
Right of Way	3	yes	yes	yes	NA	2	**High**
Pasture	3	yes	yes	yes	NA	2	**High**
Developed	3	yes	yes	yes	NA	2	**High**
Christmas Tree	1	yes	yes	yes	no	2	**Low**
Other Crops	1	yes	yes	yes	no	2	**Low**
Vegetables and Ground fruit	1	yes	yes	yes	no	2	**Low**
Corn	1	yes	yes	yes	no	2	**Low**
Golf Courses	1	yes	yes	yes	no	2	**Low**
Wheat	1	yes	yes	yes	no	2	**Low**
Other Grains	1	yes	yes	yes	no	2	**Low**
Orchards and Vineyards	1	yes	yes	yes	no	2	**Low**
Nurseries	1	yes	yes	yes	no	2	**Low**
Bin 3	3	yes	yes	yes	NA	2	**High**
Bin 4	3	yes	yes	yes	NA	2	**High**

Life Stage: Juvenile and Adult (full-range)

Table 311. Direct mortality risk hypothesis; Eulachon, Southern DPS and chlorpyrifos; Adults and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	29.2	High	High
Right of Way	11.9	High	High
Pasture	8.3	High	High
Developed	7.1	High	High
Christmas Tree	.45	High	Low
Other Crops	.30	High	Low
Vegetables and Ground fruit	.24	High	Low

Corn	.19	High	Low
Golf Courses	.17	High	Low
Wheat	.14	High	Low
Other Grains	.04	High	Low
Orchards and Vineyards	.04	High	Low
Nurseries	.04	High	Low
Bin 3	100	High	High
Bin 4	100	High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile and adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 312. Prey risk hypothesis; Eulachon, Southern DPS and chlorpyrifos; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	29.2	High	High
Right of Way	11.9	High	High
Pasture	8.3	High	High
Developed	7.1	High	High
Christmas Tree	.45	High	Low
Other Crops	.30	High	Low
Vegetables and Ground fruit	.24	High	Low
Corn	.19	High	Low
Golf Courses	.17	High	Low

Wheat	.14	High	Low
Other Grains	.04	High	Low
Orchards and Vineyards	.04	High	Low
Nurseries	.04	High	Low
Bin 3	100	High	High
Bin 4	100	High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 313. Behavior and sensory risk hypothesis; Eulachon, Southern DPS and chlorpyrifos; Adults and Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	29.2	High	High
Right of Way	11.9	High	High
Pasture	8.3	High	High
Developed	7.1	High	High
Christmas Tree	.45	High	Low
Other Crops	.30	High	Low
Vegetables and Ground fruit	.24	High	Low
Corn	.19	High	Low
Golf Courses	.17	Medium	Low
Wheat	.14	High	Low

Other Grains	.04	High	Low
Orchards and Vineyards	.04	High	Low
Nurseries	.04	High	Low
Bin 3	100	High	High
Bin 4	100	High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	29.2	High	High
Right of Way	11.9	High	High
Pasture	8.3	High	High
Developed	7.1	High	High
Christmas Tree	.45	High	Low
Other Crops	.30	High	Low
Vegetables and Ground fruit	.24	High	Low
Corn	.19	High	Low
Golf Courses	.17	High	Low
Wheat	.14	High	Low
Other Grains	.04	High	Low
Orchards and Vineyards	.04	High	Low
Nurseries	.04	High	Low
Bin 3	100	High	High
Bin 4	100	High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile and adult abundance and adult productivity via impairments to ecologically significant behaviors			

Risk	Confidence	
High	**High**	

Table 314. AChE risk hypothesis; Eulachon, Southern DPS and chlorpyrifos; Adults and Juveniles

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	29.2	High	High
Right of Way	11.9	High	High
Pasture	8.3	High	High
Developed	7.1	High	High
Christmas Tree	.45	High	Low
Other Crops	.30	High	Low
Vegetables and Ground fruit	.24	High	Low
Corn	.19	High	Low
Golf Courses	.17	High	Low
Wheat	.14	High	Low
Other Grains	.04	High	Low
Orchards and Vineyards	.04	High	Low
Nurseries	.04	High	Low
Bin 3	100	High	High
Bin 4	100	High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Table 315. Growth risk hypothesis; Eulachon, Southern DPS and chlorpyrifos; Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	29.2	High	High
Right of Way	11.9	High	High
Pasture	8.3	High	High
Developed	7.1	High	High
Christmas Tree	.45	High	Low
Other Crops	.30	High	Low
Vegetables and Ground fruit	.24	High	Low
Corn	.19	High	Low
Golf Courses	.17	High	Low
Wheat	.14	High	Low
Other Grains	.04	High	Low
Orchards and Vineyards	.04	High	Low
Nurseries	.04	High	Low
Bin 3	100	High	High
Bin 4	100	High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
High	**High**		

Table 316. Reproduction risk hypothesis; Eulachon, Southern DPS and chlorpyrifos; Adults

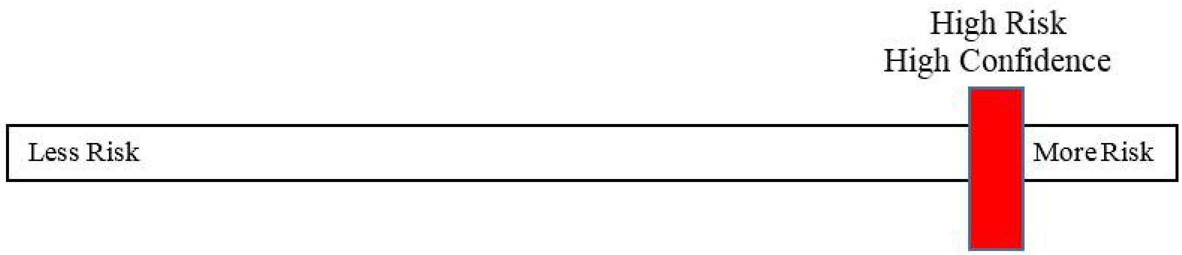
Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	29.2	High	High
Right of Way	11.9	High	High
Pasture	8.3	High	High
Developed	7.1	High	High
Christmas Tree	.45	High	Low
Other Crops	.30	High	Low
Vegetables and Ground fruit	.24	High	Low
Corn	.19	High	Low
Golf Courses	.17	Medium	Low
Wheat	.14	High	Low
Other Grains	.04	High	Low
Orchards and Vineyards	.04	High	Low
Nurseries	.04	High	Low
Bin 3	100	High	High
Bin 4	100	Medium	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 317. Effects analysis summary table: Eulachon, Southern DPS and chlorpyrifos

	R-plot Derived	**MagTool**	

Juveniles and Adults	Risk	Confidence	Range in median percent mortalities for aquatic bins	Risk Hypothesis Supported? Yes/No
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce juvenile and adult abundance via acute lethality.	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via reduction in prey availability	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce juvenile and adult abundance and adult productivity via impairments to ecologically significant behaviors	High	High	Not Available	
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Eulachon, Southern DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where chlorpyrifos achieves predicted levels. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, eulachon will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed eulachon. The overall risk to Eulachon, Southern DPS from the effects of the action is high and the confidence associated with that risk is high.


High Risk
High Confidence
Less Risk
More Risk

12.32 Green Sturgeon, Southern DPS (Acipenser medirostris)

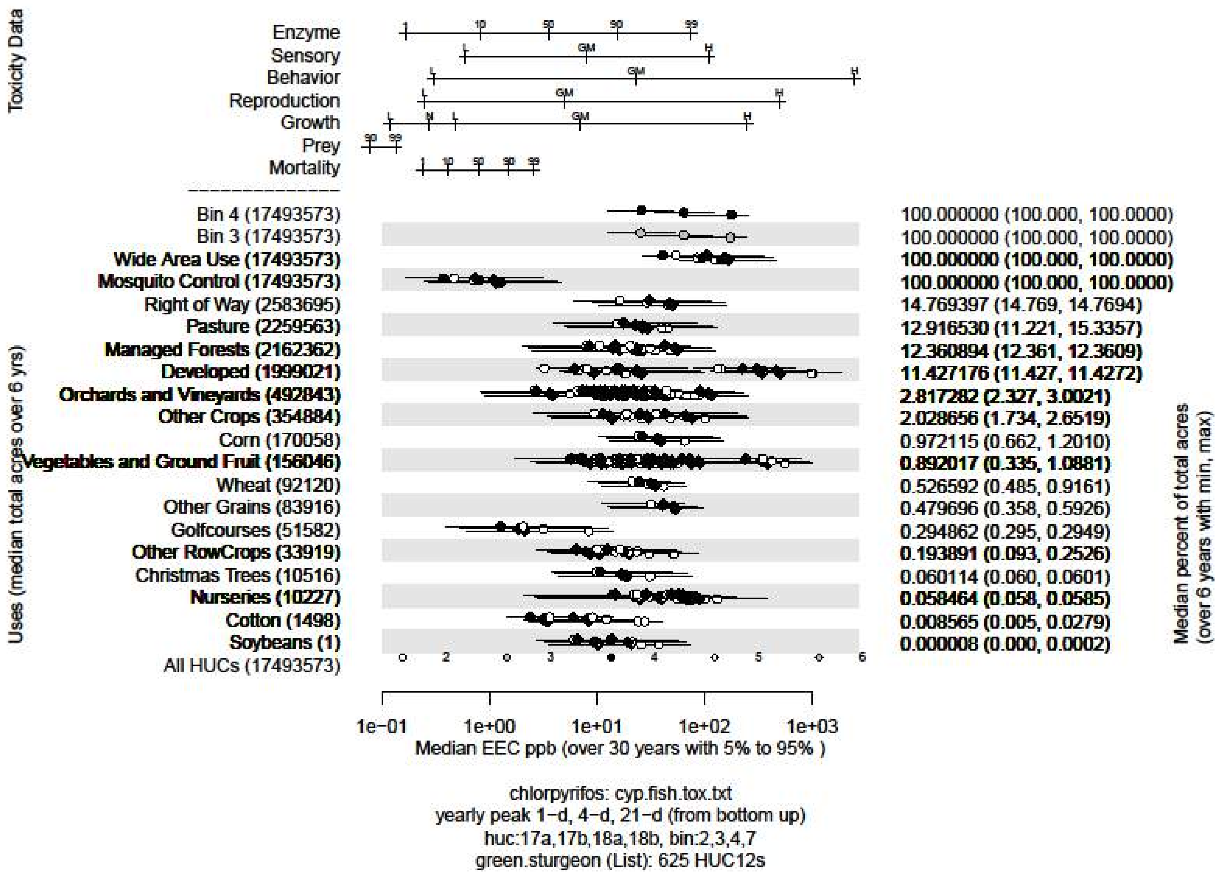


Figure 31. Effects analysis R-plot for Adult and Sub-Adult Green Sturgeon, Southern DPS and chlorpyrifos

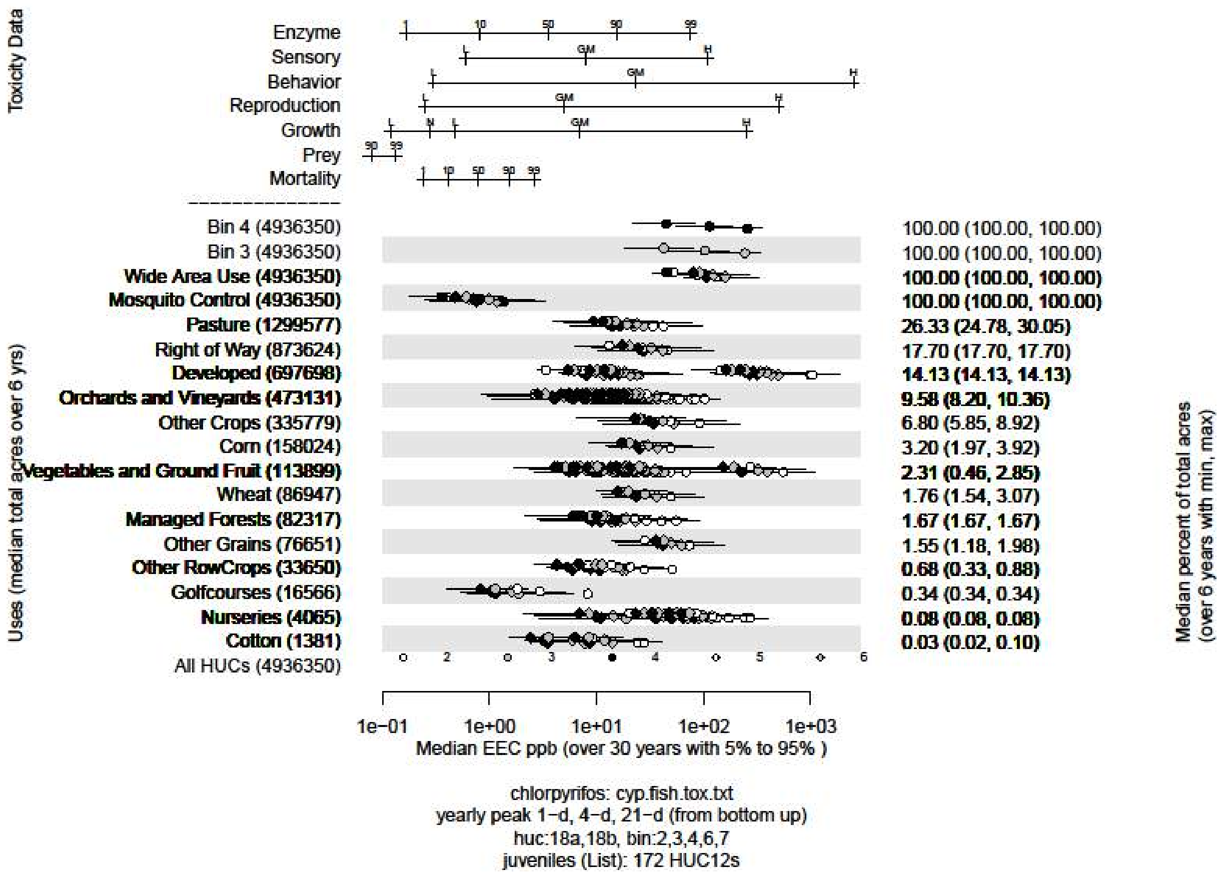


Figure 32. Effects analysis R-plot for Juvenile Green Sturgeon, Southern DPS and chlorpyrifos

Table 318. Likelihood of exposure determination for Green Sturgeon, Southern DPS and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adult and Sub-Adult							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Managed Forest	3	yes	yes	yes	NA	3	High
Developed	3	yes	yes	yes	NA	3	High
Orchards and Vineyards	2	yes	yes	yes	NA	3	High
Other Crops	2	yes	yes	yes	NA	3	High
Corn	2	yes	yes	yes	NA	3	High
Vegetables and Ground Fruit	1	yes	yes	yes	yes	3	High
Wheat	1	yes	yes	yes	yes	3	High
Other Grains	1	yes	yes	yes	yes	3	High
Golf Courses	1	yes	yes	yes	no	3	Low
Other Row Crops	1	yes	yes	yes	yes	3	High
Christmas Trees	1	yes	yes	yes	no	3	Low
Nurseries	1	yes	yes	yes	no	3	Low
Cotton	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High
Juveniles							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Developed	3	yes	yes	yes	NA	3	High
Orchards and Vineyards	3	yes	yes	yes	NA	3	High
Other Crops	3	yes	yes	yes	NA	3	High
Corn	2	yes	yes	yes	NA	3	High
Vegetables and Ground Fruit	2	yes	yes	yes	NA	3	High
Wheat	2	yes	yes	yes	NA	3	High
Managed Forest	2	yes	yes	yes	NA	3	High
Other Grains	2	yes	yes	yes	NA	3	High
Other Row Crops	1	yes	yes	yes	yes	3	High
Golf Courses	1	yes	yes	yes	no	3	Low
Nurseries	1	yes	yes	yes	no	3	Low
Cotton	1	yes	yes	yes	no	3	Low
Bin 3	3	yes	yes	yes	NA	3	High
Bin 4	3	yes	yes	yes	NA	3	High

Life Stage: Adults and Sub-Adults (full-range)

Table 319. Direct mortality risk hypothesis; Green Sturgeon, Southern DPS and chlorpyrifos; Adults and Sub-Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Wide Area Use	100	High	High
Mosquito Control	100	High	High
Right of Way	14.8	High	High
Pasture	12.9	High	High
Managed Forest	12.4	High	High
Developed	11.4	High	High
Orchards and Vineyards	2.8	High	High
Other Crops	2.0	High	High
Corn	1.0	High	High
Vegetables and Ground Fruit	0.9	High	High
Wheat	0.5	High	High
Other Grains	0.5	High	High
Golf Courses	0.3	High	Low
Other Row Crops	0.2	High	High
Christmas Trees	0.06	High	Low
Nurseries	0.06	High	Low
Cotton	0.009	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult and sub-adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 320. Reproduction risk hypothesis; Green Sturgeon, Southern DPS and chlorpyrifos; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	14.8	High	High
Pasture	12.9	High	High
Managed Forest	12.4	High	High
Developed	11.4	High	High
Orchards and Vineyards	2.8	High	High
Other Crops	2.0	High	High
Corn	1.0	High	High
Vegetables and Ground Fruit	0.9	High	High
Wheat	0.5	High	High
Other Grains	0.5	High	High
Golf Courses	0.3	High	Low
Other Row Crops	0.2	High	High
Christmas Trees	0.06	High	Low
Nurseries	0.06	High	Low
Cotton	0.009	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 321. Behavior and sensory risk hypothesis; Green Sturgeon, Southern DPS and chlorpyrifos; Adults and Sub-Adults

Endpoint: Behavior

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	14.8	High	High
Pasture	12.9	High	High
Managed Forest	12.4	High	High
Developed	11.4	High	High
Orchards and Vineyards	2.8	High	High
Other Crops	2.0	High	High
Corn	1.0	High	High
Vegetables and Ground Fruit	0.9	High	High
Wheat	0.5	High	High
Other Grains	0.5	High	High
Golf Courses	0.3	Medium	Low
Other Row Crops	0.2	High	High
Christmas Trees	0.06	High	Low
Nurseries	0.06	High	Low
Cotton	0.009	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	14.8	High	High
Pasture	12.9	High	High

Managed Forest	12.4	High	High
Developed	11.4	High	High
Orchards and Vineyards	2.8	High	High
Other Crops	2.0	High	High
Corn	1.0	High	High
Vegetables and Ground Fruit	0.9	High	High
Wheat	0.5	High	High
Other Grains	0.5	High	High
Golf Courses	0.3	High	Low
Other Row Crops	0.2	High	High
Christmas Trees	0.06	High	Low
Nurseries	0.06	High	Low
Cotton	0.009	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult and sub-adult abundance and adult productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 322. Prey risk hypothesis; Green Sturgeon, Southern DPS and chlorpyrifos; Adults and Sub-Adults

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Right of Way	14.8	High	High
Pasture	12.9	High	High

Managed Forest	12.4	High	High
Developed	11.4	High	High
Orchards and Vineyards	2.8	High	High
Other Crops	2.0	High	High
Corn	1.0	High	High
Vegetables and Ground Fruit	0.9	High	High
Wheat	0.5	High	High
Other Grains	0.5	High	High
Golf Courses	0.3	High	Low
Other Row Crops	0.2	High	High
Christmas Trees	0.06	High	Low
Nurseries	0.06	High	Low
Cotton	0.009	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult and sub-adult abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 323. AChE risk hypothesis; Green Sturgeon, Southern DPS and chlorpyrifos; Adults and Sub-Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Right of Way	14.8	High	High
Pasture	12.9	High	High

Managed Forest	12.4	High	High
Developed	11.4	High	High
Orchards and Vineyards	2.8	High	High
Other Crops	2.0	High	High
Corn	1.0	High	High
Vegetables and Ground Fruit	0.9	High	High
Wheat	0.5	High	High
Other Grains	0.5	High	High
Golf Courses	0.3	High	Low
Other Row Crops	0.2	High	High
Christmas Trees	0.06	High	Low
Nurseries	0.06	High	Low
Cotton	0.009	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles

Table 324. Direct mortality risk hypothesis; Green Sturgeon, Southern DPS and chlorpyrifos; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Pasture	26.3	High	High

Right of Way	17.7	High	High
Developed	14.1	High	High
Orchards and Vineyards	9.6	High	High
Other Crops	6.8	High	High
Corn	3.2	High	High
Vegetables and Ground Fruit	2.3	High	High
Wheat	1.8	High	High
Managed Forest	1.7	High	High
Other Grains	1.6	High	High
Other Row Crops	0.7	High	High
Golf Courses	0.3	High	Low
Nurseries	0.08	High	Low
Cotton	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 325. Growth risk hypothesis; Green Sturgeon, Southern DPS and chlorpyrifos; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	26.3	High	High
Right of Way	17.7	High	High

Developed	14.1	High	High
Orchards and Vineyards	9.6	High	High
Other Crops	6.8	High	High
Corn	3.2	High	High
Vegetables and Ground Fruit	2.3	High	High
Wheat	1.8	High	High
Managed Forest	1.7	High	High
Other Grains	1.6	High	High
Other Row Crops	0.7	High	High
Golf Courses	0.3	Medium	Low
Nurseries	0.08	High	Low
Cotton	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 326. Prey risk hypothesis; Green Sturgeon, Southern DPS and chlorpyrifos; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Pasture	26.3	High	High
Right of Way	17.7	High	High
Developed	14.1	High	High

Orchards and Vineyards	9.6	High	High
Other Crops	6.8	High	High
Corn	3.2	High	High
Vegetables and Ground Fruit	2.3	High	High
Wheat	1.8	High	High
Managed Forest	1.7	High	High
Other Grains	1.6	High	High
Other Row Crops	0.7	High	High
Golf Courses	0.3	High	Low
Nurseries	0.08	High	Low
Cotton	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 327. AChE risk hypothesis; Green Sturgeon, Southern DPS and chlorpyrifos; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	26.3	High	High
Right of Way	17.7	High	High
Developed	14.1	High	High

Orchards and Vineyards	9.6	High	High
Other Crops	6.8	High	High
Corn	3.2	High	High
Vegetables and Ground Fruit	2.3	High	High
Wheat	1.8	High	High
Managed Forest	1.7	High	High
Other Grains	1.6	High	High
Other Row Crops	0.7	High	High
Golf Courses	0.3	High	Low
Nurseries	0.08	High	Low
Cotton	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 328. Behavior and sensory risk hypothesis; Green Sturgeon, Southern DPS and chlorpyrifos; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	26.3	High	High
Right of Way	17.7	High	High
Developed	14.1	High	High

Orchards and Vineyards	9.6	High	High
Other Crops	6.8	High	High
Corn	3.2	High	High
Vegetables and Ground Fruit	2.3	High	High
Wheat	1.8	High	High
Managed Forest	1.7	High	High
Other Grains	1.6	High	High
Other Row Crops	0.7	High	High
Golf Courses	0.3	Medium	Low
Nurseries	0.08	High	Low
Cotton	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Pasture	26.3	High	High
Right of Way	17.7	High	High
Developed	14.1	High	High
Orchards and Vineyards	9.6	High	High
Other Crops	6.8	High	High
Corn	3.2	High	High
Vegetables and Ground Fruit	2.3	High	High
Wheat	1.8	High	High

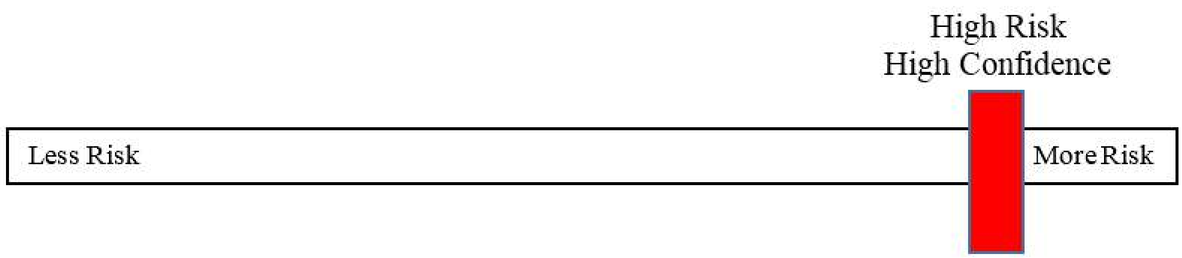
Managed Forest	1.7	High	High
Other Grains	1.6	High	High
Other Row Crops	0.7	High	High
Golf Courses	0.3	Medium	Low
Nurseries	0.08	High	Low
Cotton	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 329. Effects analysis summary table: Green Sturgeon, Southern DPS and chlorpyrifos

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults and Sub-Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce adult and sub-adult abundance via acute lethality.	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult and sub-adult abundance and adult productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Exposure to chlorpyrifos is sufficient to reduce adult and sub-adult abundance via reduction in prey availability	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Green Sturgeon, Southern DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where chlorpyrifos achieves predicted levels. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, sturgeon will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed sturgeon. The overall risk to Green Sturgeon, Southern DPS from the effects of the action is high and the confidence associated with that risk is high.



12.33 Shortnose Sturgeon (Acipenser brevirostrum)

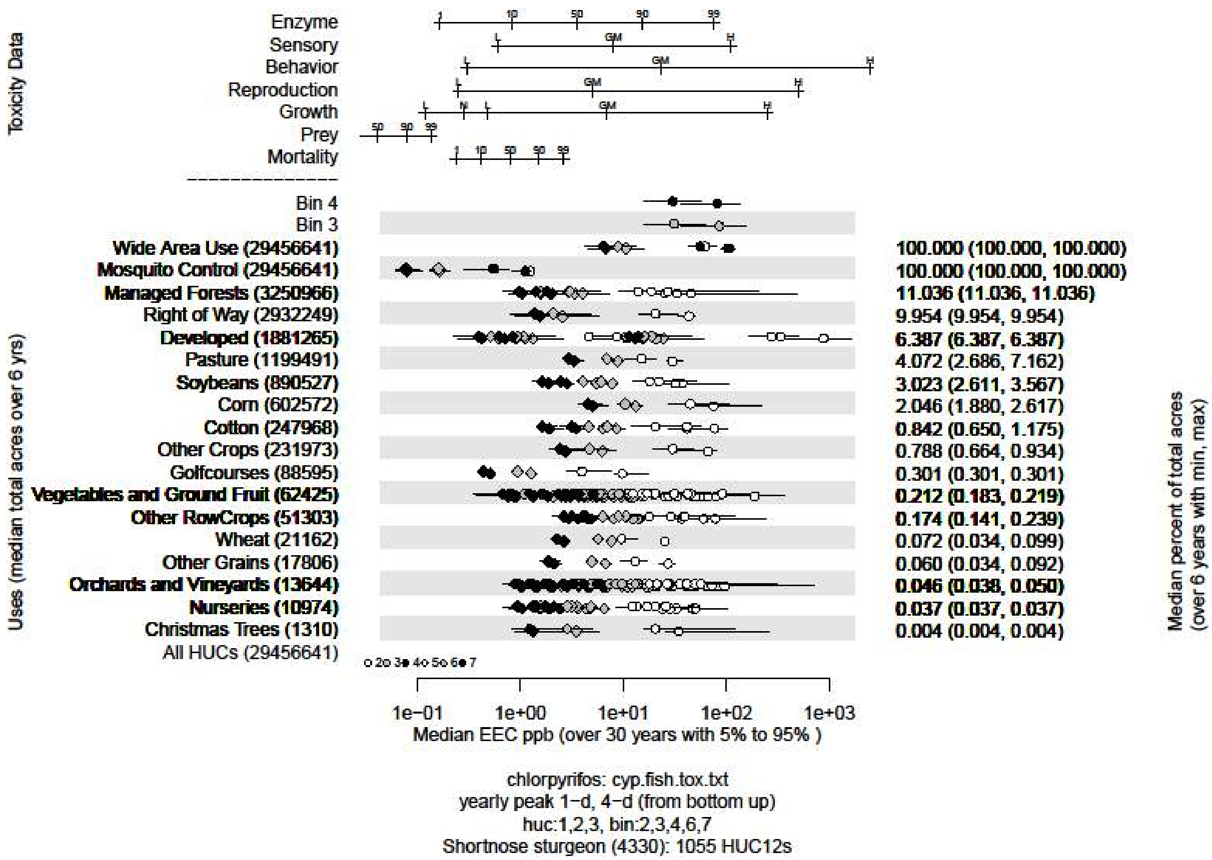


Figure 33. Effects analysis R-plot for Shortnose Sturgeon and chlorpyrifos

Table 330. Likelihood of exposure determination for Shortnose Sturgeon and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Full Range							
RoW	3	yes	yes	yes	NA	3	**High**
Developed	3	yes	yes	yes	NA	3	**High**
Managed Forest	3	yes	yes	yes	NA	3	**High**
Pasture	2	yes	yes	yes	NA	3	**High**
Golf Course	2	yes	yes	yes	NA	3	**High**
Mosquito	3	yes	yes	yes	NA	3	**High**
Wide Area	3	yes	yes	yes	NA	3	**Med**
Nursery Only							
RoW	3	yes	yes	yes	NA	3	**High**
Developed	3	yes	yes	yes	NA	3	**High**
Managed Forest	2	yes	yes	yes	NA	3	**High**
Pasture	2	yes	yes	yes	NA	3	**High**
Golf Course	1	yes	yes	yes	yes	3	**High**
Mosquito	3	yes	yes	yes	NA	3	**High**
Wide Area	3	yes	yes	yes	yes	3	**High**
Orchards and Vinyards	1	yes	yes	yes	yes	3	**High**
Othe Grain	1	yes	yes	yes	no	3	**Low**
Corn	1	yes	yes	yes	no	3	**Low**
Other Crop	1	yes	yes	yes	no	3	**Low**
Veggie	1	yes	yes	yes	no	3	**Low**

Life Stage: Juvenile and Adult (Full Range)

Table 331. Direct mortality risk hypothesis; Shortnose Sturgeon and chlorpyrifos; Adults and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	11	High	High
Right of Way	10	High	High
Developed	6.4	High	High
Pasture	4.1	High	High
Soybean	3	High	High

Corn	2	High	High
Cotton	.9	High	Low
Other Crops	.8	High	Low
Golf Courses	.3	High	Low
Vegetables and Ground Fruit	.2	High	Low
Other Row Crops	.2	High	Low
Wheat	.07	High	Low
Other Grains	.06	High	Low
Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low
Christmas Trees	.004	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 332. Prey risk hypothesis; Shortnose Sturgeon and chlorpyrifos; Adults and Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	11	High	High
Right of Way	10	High	High
Developed	6.4	High	High
Pasture	4.1	High	High

Soybean	3	High	High
Corn	2	High	High
Cotton	.9	High	Low
Other Crops	.8	High	Low
Golf Courses	.3	High	Low
Vegetables and Ground Fruit	.2	High	Low
Other Row Crops	.2	High	Low
Wheat	.07	High	Low
Other Grains	.06	High	Low
Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low
Christmas Trees	.004	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 333. Behavior and sensory risk hypothesis; Shortnose Sturgeon and chlorpyrifos; Adults and Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	11	High	High
Right of Way	10	High	High
Developed	6.4	High	High

Pasture	4.1	High	High
Soybean	3	High	High
Corn	2	High	High
Cotton	.9	High	Low
Other Crops	.8	High	Low
Golf Courses	.3	Medium	Low
Vegetables and Ground Fruit	.2	High	Low
Other Row Crops	.2	High	Low
Wheat	.07	High	Low
Other Grains	.06	High	Low
Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low
Christmas Trees	.004	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	11	High	High
Right of Way	10	High	High
Developed	6.4	High	High
Pasture	4.1	High	High
Soybean	3	High	High
Corn	2	High	High
Cotton	.9	High	Low

Other Crops	.8	High	Low
Golf Courses	.3	High	Low
Vegetables and Ground Fruit	.2	High	Low
Other Row Crops	.2	High	Low
Wheat	.07	High	Low
Other Grains	.06	High	Low
Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low
Christmas Trees	.004	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 334. AChE risk hypothesis; Shortnose Sturgeon and chlorpyrifos; Adults and Juveniles

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	11	High	High
Right of Way	10	High	High
Developed	6.4	High	High
Pasture	4.1	High	High
Soybean	3	High	High
Corn	2	High	High

Cotton	.9	High	Low
Other Crops	.8	High	Low
Golf Courses	.3	High	Low
Vegetables and Ground Fruit	.2	High	Low
Other Row Crops	.2	High	Low
Wheat	.07	High	Low
Other Grains	.06	High	Low
Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low
Christmas Trees	.004	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Table 335. Growth risk hypothesis; Shortnose Sturgeon and chlorpyrifos; Adults and Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	11	High	High
Right of Way	10	High	High
Developed	6.4	High	High
Pasture	4.1	High	High
Soybean	3	High	High

Corn	2	High	High
Cotton	.9	High	Low
Other Crops	.8	High	Low
Golf Courses	.3	Medium	Low
Vegetables and Ground Fruit	.2	High	Low
Other Row Crops	.2	High	Low
Wheat	.07	High	Low
Other Grains	.06	High	Low
Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low
Christmas Trees	.004	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
High	**High**		

Table 336. Reproduction risk hypothesis; Shortnose Sturgeon and chlorpyrifos; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	11	High	High
Right of Way	10	High	High
Developed	6.4	High	High
Pasture	4.1	High	High

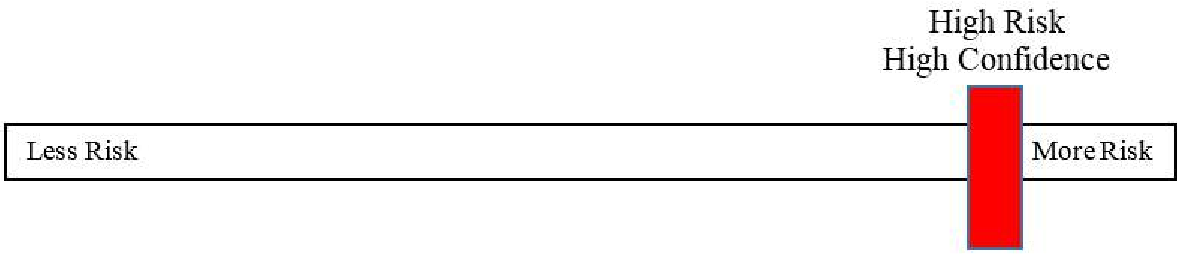
Soybean	3	High	High
Corn	2	High	High
Cotton	.9	High	Low
Other Crops	.8	High	Low
Golf Courses	.3	Medium	Low
Vegetables and Ground Fruit	.2	High	Low
Other Row Crops	.2	High	Low
Wheat	.07	High	Low
Other Grains	.06	High	Low
Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low
Christmas Trees	.004	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 337. Effects analysis summary table: Shortnose Sturgeon and chlorpyrifos

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles and Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance via acute lethality.	High	High	4-day: 29-81 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce	High	High	4-day fish: 17-78	**Yes**

adult and juvenile abundance via reduction in prey availability			4-day invert: 39-92 **Error! Reference source not found.**	
Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Shortnose Sturgeon are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where chlorpyrifos achieves predicted levels. The MagTool results indicate that between 29-81 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, sturgeon will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed sturgeon in northern regions. The overall risk to Shortnose Sturgeon from the effects of the action is high and the confidence associated with that risk is high.


High Risk
High Confidence
Less Risk
More Risk

12.34 Atlantic Sturgeon, Carolina DPS (Acipenser oxyrinchus oxyrinchus)

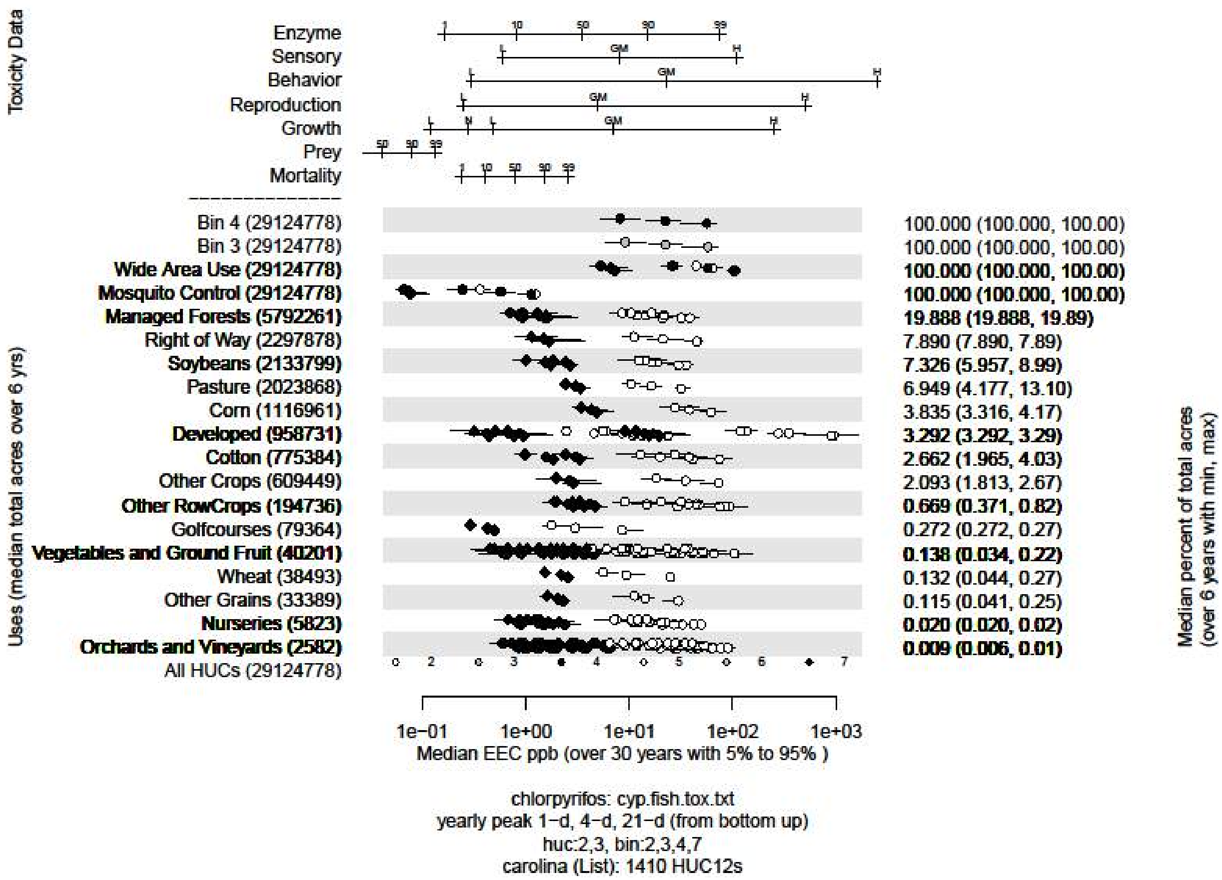


Figure 34. Effects analysis R-plot for Atlantic sturgeon, Carolina DPS and chlorpyrifos

Table 338. Likelihood of exposure determination for Atlantic sturgeon, Carolina DPS and chlorpyrifos

Adults and Juveniles	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Wide Area Use	3	yes	yes	yes	NA	3	**High**
Mosquito Control	3	yes	yes	yes	NA	3	**High**
Managed Forest	3	yes	yes	yes	NA	3	**High**
Right of Way	3	yes	yes	yes	NA	3	**High**
Soybeans	3	yes	yes	yes	NA	3	**High**
Pasture	3	yes	yes	yes	NA	3	**High**
Corn	2	yes	yes	yes	NA	3	**High**
Developed	2	yes	yes	yes	NA	3	**High**
Cotton	2	yes	yes	yes	NA	3	**High**
Other Crops	2	yes	yes	yes	NA	3	**High**
Other Row Crops	1	yes	yes	yes	no	3	**Low**
Golf Courses	1	yes	yes	yes	no	3	**Low**
Vegetables and Ground fruit	1	yes	yes	yes	no	3	**Low**
Wheat	1	yes	yes	yes	yes	3	**High**
Other Grains	1	yes	yes	yes	no	3	**Low**
Nurseries	1	yes	yes	yes	no	3	**Low**
Orchards and Vineyards	1	yes	yes	yes	no	3	**Low**
Bin 3	3	yes	yes	yes	NA	3	**High**
Bin 4	3	yes	yes	yes	NA	3	**High**

Life Stage: Juvenile and Adult

Table 339. Direct mortality risk hypothesis; Atlantic sturgeon, Carolina DPS and chlorpyrifos; Adults and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	20	High	High
Right of Way	7.9	High	High
Soybeans	7.3	High	High
Pasture	6.9	High	High
Corn	3.8	High	High

Developed	3.3	High	High
Cotton	2.7	High	High
Other Crops	2.1	High	High
Other Row Crops	.7	High	Low
Golf Courses	.3	High	Low
Vegetables and Ground fruit	.1	High	Low
Wheat	.1	High	High
Other Grains	.1	High	Low
Nurseries	.02	High	Low
Orchards and Vineyards	.009	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 340. Prey risk hypothesis; Atlantic sturgeon, Carolina DPS and chlorpyrifos; Adults and Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	20	High	High
Right of Way	7.9	High	High
Soybeans	7.3	High	High
Pasture	6.9	High	High
Corn	3.8	High	High

Developed	3.3	High	High
Cotton	2.7	High	High
Other Crops	2.1	High	High
Other Row Crops	.7	High	Low
Golf Courses	.3	High	Low
Vegetables and Ground fruit	.1	High	Low
Wheat	.1	High	High
Other Grains	.1	High	Low
Nurseries	.02	High	Low
Orchards and Vineyards	.009	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 341. Behavior and sensory risk hypothesis; Atlantic sturgeon, Carolina DPS and chlorpyrifos; Adults and Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	20	High	High
Right of Way	7.9	High	High
Soybeans	7.3	High	High
Pasture	6.9	High	High

Corn	3.8	High	High
Developed	3.3	High	High
Cotton	2.7	High	High
Other Crops	2.1	High	High
Other Row Crops	.7	High	Low
Golf Courses	.3	Medium	Low
Vegetables and Ground fruit	.1	High	Low
Wheat	.1	High	High
Other Grains	.1	High	Low
Nurseries	.02	High	Low
Orchards and Vineyards	.009	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	20	High	High
Right of Way	7.9	High	High
Soybeans	7.3	High	High
Pasture	6.9	High	High
Corn	3.8	High	High
Developed	3.3	High	High
Cotton	2.7	High	High
Other Crops	2.1	High	High
Other Row Crops	.7	High	Low

Golf Courses	.3	High	Low
Vegetables and Ground fruit	.1	High	Low
Wheat	.1	High	High
Other Grains	.1	High	Low
Nurseries	.02	High	Low
Orchards and Vineyards	.009	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 342. AChE risk hypothesis; Atlantic sturgeon, Carolina DPS and chlorpyrifos; Adults and Juveniles

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	20	High	High
Right of Way	7.9	High	High
Soybeans	7.3	High	High
Pasture	6.9	High	High
Corn	3.8	High	High
Developed	3.3	High	High
Cotton	2.7	High	High
Other Crops	2.1	High	High
Other Row Crops	.7	High	Low

Golf Courses	.3	High	Low
Vegetables and Ground fruit	.1	High	Low
Wheat	.1	High	High
Other Grains	.1	High	Low
Nurseries	.02	High	Low
Orchards and Vineyards	.009	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Table 343. Growth risk hypothesis; Atlantic sturgeon, Carolina DPS and chlorpyrifos; Adults and Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	20	High	High
Right of Way	7.9	High	High
Soybeans	7.3	High	High
Pasture	6.9	High	High
Corn	3.8	High	High
Developed	3.3	High	High
Cotton	2.7	High	High
Other Crops	2.1	High	High
Other Row Crops	.7	High	Low

Golf Courses	.3	Medium	Low
Vegetables and Ground fruit	.1	High	Low
Wheat	.1	High	High
Other Grains	.1	High	Low
Nurseries	.02	High	Low
Orchards and Vineyards	.009	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
High	**High**		

Table 344. Reproduction risk hypothesis; Atlantic sturgeon, Carolina DPS and chlorpyrifos; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	20	High	High
Right of Way	7.9	High	High
Soybeans	7.3	High	High
Pasture	6.9	High	High
Corn	3.8	High	High
Developed	3.3	High	High
Cotton	2.7	High	High
Other Crops	2.1	High	High
Other Row Crops	.7	High	Low

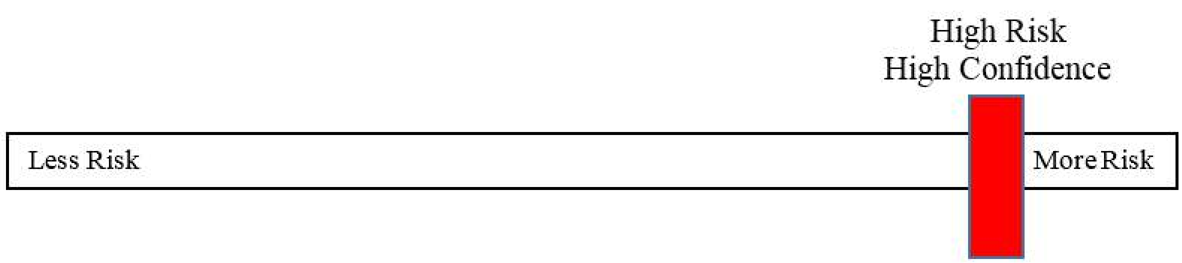
Golf Courses	.3	Medium	Low
Vegetables and Ground fruit	.1	High	Low
Wheat	.1	High	High
Other Grains	.1	High	Low
Nurseries	.02	High	Low
Orchards and Vineyards	.009	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 345. Effects analysis summary table: Atlantic sturgeon, Carolina DPS and chlorpyrifos

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles and Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance via acute lethality.	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance via reduction in prey availability	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to	High	High	Not Available	**Yes**

ecologically significant behaviors.				
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Atlantic sturgeon, Carolina DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where chlorpyrifos achieves predicted levels. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, sturgeon will likely experience more toxicity. The overall risk to Atlantic sturgeon, Carolina DPS from the effects of the action is high and the confidence associated with that risk is high.



12.35 Atlantic Sturgeon, Chesapeake Bay DPS (Acipenser oxyrinchus oxyrinchus)

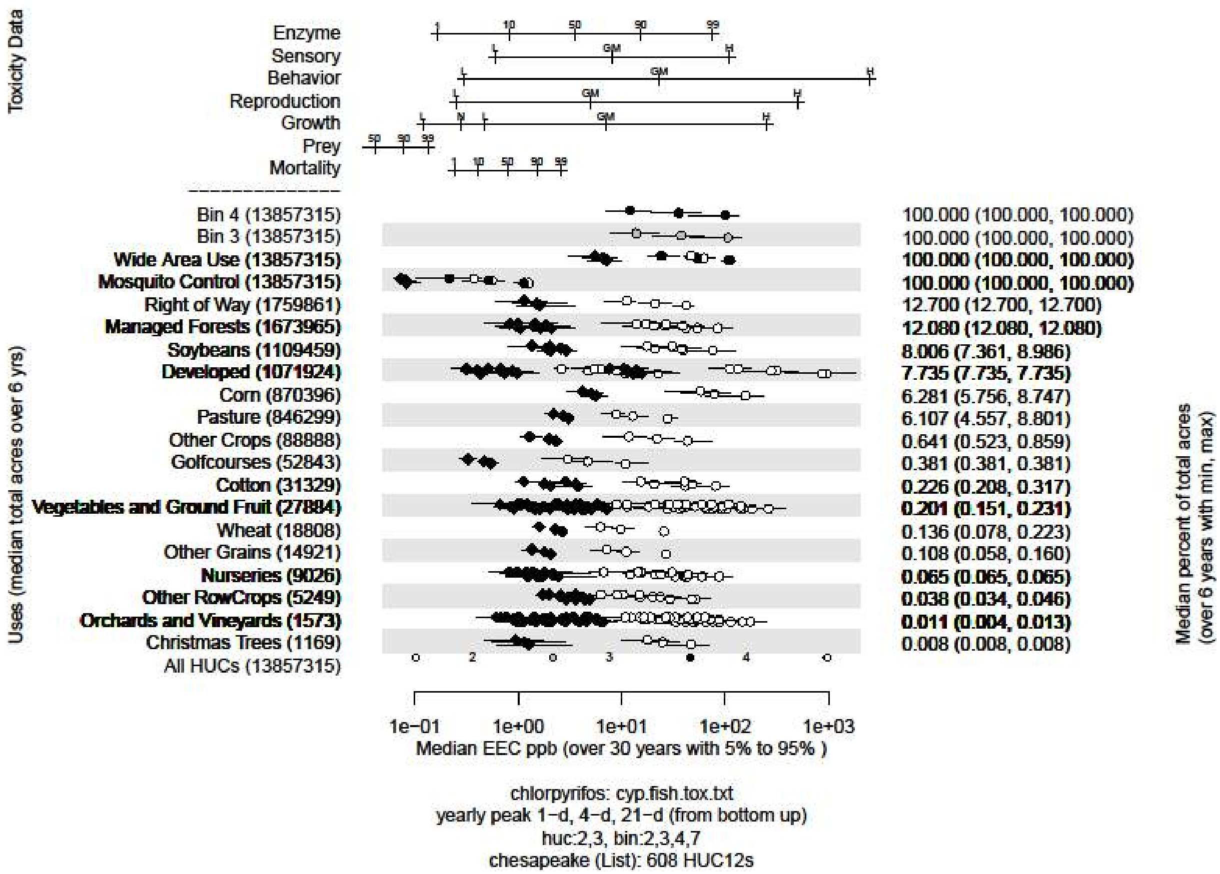


Figure 35. Effects analysis R-plot for Atlantic sturgeon, Chesapeake Bay DPS and chlorpyrifos

Table 346. Likelihood of exposure determination for Atlantic sturgeon, Chesapeake Bay DPS and chlorpyrifos

Adults and Juveniles	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Wide Area Use	3	yes	yes	yes	NA	3	**High**
Mosquito Control	3	yes	yes	yes	NA	3	**High**
Right of Way	3	yes	yes	yes	NA	3	**High**
Managed Forest	3	yes	yes	yes	NA	3	**High**
Soybean	3	yes	yes	yes	NA	3	**High**
Developed	3	yes	yes	yes	NA	3	**High**
Corn	3	yes	yes	yes	NA	3	**High**
Pasture	3	yes	yes	yes	NA	3	**High**
Other Crops	1	yes	yes	yes	no	3	**Low**
Golf Courses	1	yes	yes	yes	yes	3	**High**
Cotton	1	yes	yes	yes	yes	3	**High**
Vegetables and Ground Fruit	1	yes	yes	yes	no	3	**Low**
Wheat	1	yes	yes	yes	yes	3	**High**
Other Grains	1	yes	yes	yes	no	3	**Low**
Nurseries	1	yes	yes	yes	no	3	**Low**
Other Row Crops	1	yes	yes	yes	no	3	**Low**
Orchards and Vineyards	1	yes	yes	yes	no	3	**Low**
Christmas trees	1	yes	yes	yes	no	3	**Low**
Bin 3	3	yes	yes	yes	NA	3	**High**
Bin 4	3	yes	yes	yes	NA	3	**High**

Life Stage: Juvenile and Adult

Table 347. Direct mortality risk hypothesis; Atlantic sturgeon, Chesapeake Bay DPS and chlorpyrifos; Adults and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	High	**High**
Right of Way	12.7	High	**High**
Managed Forest	12.1	High	**High**
Soybean	8.0	High	**High**
Developed	7.7	High	**High**

Corn	6.2	High	**High**
Pasture	6.1	High	**High**
Other Crops	.6	High	**Low**
Golf Courses	.4	High	**High**
Cotton	.2	High	**High**
Vegetables and Ground Fruit	.2	High	**Low**
Wheat	.1	High	**High**
Other Grains	.1	High	**Low**
Nurseries	.1	High	**Low**
Other Row Crops	.04	High	**Low**
Orchards and Vineyards	.01	High	**Low**
Christmas trees	.01	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 348. Prey risk hypothesis; Atlantic sturgeon, Chesapeake Bay DPS and chlorpyrifos; Adults and Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	High	**High**
Right of Way	12.7	High	**High**
Managed Forest	12.1	High	**High**

Soybean	8.0	High	**High**
Developed	7.7	High	**High**
Corn	6.2	High	**High**
Pasture	6.1	High	**High**
Other Crops	.6	High	**Low**
Golf Courses	.4	High	**High**
Cotton	.2	High	**High**
Vegetables and Ground Fruit	.2	High	**Low**
Wheat	.1	High	**High**
Other Grains	.1	High	**Low**
Nurseries	.1	High	**Low**
Other Row Crops	.04	High	**Low**
Orchards and Vineyards	.01	High	**Low**
Christmas trees	.01	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 349. Behavior and sensory risk hypothesis; Atlantic sturgeon, Chesapeake Bay DPS and chlorpyrifos; Adults and Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**

Right of Way	12.7	High	**High**
Managed Forest	12.1	High	**High**
Soybean	8.0	High	**High**
Developed	7.7	High	**High**
Corn	6.2	High	**High**
Pasture	6.1	High	**High**
Other Crops	.6	High	**Low**
Golf Courses	.4	Medium	**High**
Cotton	.2	High	**High**
Vegetables and Ground Fruit	.2	High	**Low**
Wheat	.1	High	**High**
Other Grains	.1	High	**Low**
Nurseries	.1	High	**Low**
Other Row Crops	.04	High	**Low**
Orchards and Vineyards	.01	High	**Low**
Christmas trees	.01	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Right of Way	12.7	High	**High**
Managed Forest	12.1	High	**High**
Soybean	8.0	High	**High**
Developed	7.7	High	**High**

Corn	6.2	High	**High**
Pasture	6.1	High	**High**
Other Crops	.6	High	**Low**
Golf Courses	.4	High	**High**
Cotton	.2	High	**High**
Vegetables and Ground Fruit	.2	High	**Low**
Wheat	.1	High	**High**
Other Grains	.1	High	**Low**
Nurseries	.1	High	**Low**
Other Row Crops	.04	High	**Low**
Orchards and Vineyards	.01	High	**Low**
Christmas trees	.01	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 350. AChE risk hypothesis; Atlantic sturgeon, Chesapeake Bay DPS and chlorpyrifos; Adults and Juveniles

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Right of Way	12.7	High	**High**
Managed Forest	12.1	High	**High**

Soybean	8.0	High	**High**
Developed	7.7	High	**High**
Corn	6.2	High	**High**
Pasture	6.1	High	**High**
Other Crops	.6	High	**Low**
Golf Courses	.4	High	**High**
Cotton	.2	High	**High**
Vegetables and Ground Fruit	.2	High	**Low**
Wheat	.1	High	**High**
Other Grains	.1	High	**Low**
Nurseries	.1	High	**Low**
Other Row Crops	.04	High	**Low**
Orchards and Vineyards	.01	High	**Low**
Christmas trees	.01	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Table 351. Growth risk hypothesis; Atlantic sturgeon, Chesapeake Bay DPS and chlorpyrifos; Adults and Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**

Right of Way	12.7	High	**High**
Managed Forest	12.1	High	**High**
Soybean	8.0	High	**High**
Developed	7.7	High	**High**
Corn	6.2	High	**High**
Pasture	6.1	High	**High**
Other Crops	.6	High	**Low**
Golf Courses	.4	Medium	**High**
Cotton	.2	High	**High**
Vegetables and Ground Fruit	.2	High	**Low**
Wheat	.1	High	**High**
Other Grains	.1	High	**Low**
Nurseries	.1	High	**Low**
Other Row Crops	.04	High	**Low**
Orchards and Vineyards	.01	High	**Low**
Christmas trees	.01	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
High	**High**		

Table 352. Reproduction risk hypothesis; Atlantic sturgeon, Chesapeake Bay DPS and chlorpyrifos; Adults and Juveniles

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

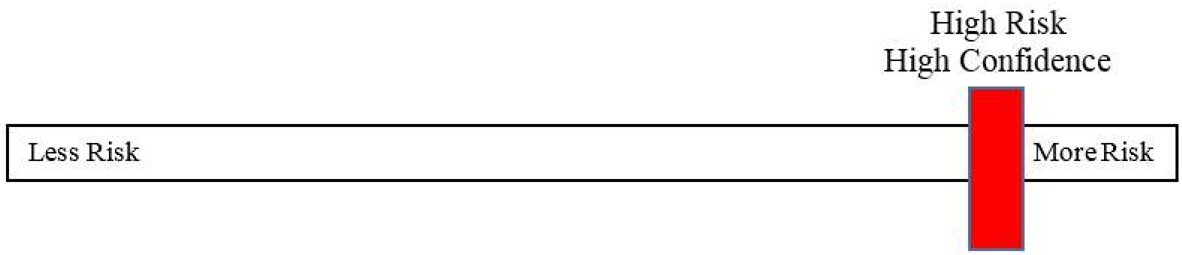
Wide Area Use	100	High	**High**
Mosquito Control	100	Medium	**High**
Right of Way	12.7	High	**High**
Managed Forest	12.1	High	**High**
Soybean	8.0	High	**High**
Developed	7.7	High	**High**
Corn	6.2	High	**High**
Pasture	6.1	High	**High**
Other Crops	.6	High	**Low**
Golf Courses	.4	Medium	**High**
Cotton	.2	High	**High**
Vegetables and Ground Fruit	.2	High	**Low**
Wheat	.1	High	**High**
Other Grains	.1	High	**Low**
Nurseries	.1	High	**Low**
Other Row Crops	.04	High	**Low**
Orchards and Vineyards	.01	High	**Low**
Christmas trees	.01	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 353. Effects analysis summary table: Atlantic sturgeon, Chesapeake Bay DPS and chlorpyrifos

	R-plot Derived	MagTool	

Juveniles and Adults	Risk	Confidence	Range in median percent mortalities for aquatic bins	Risk Hypothesis Supported? Yes/No
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance via acute lethality.	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance via reduction in prey availability	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Atlantic sturgeon, Chesapeake Bay DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where chlorpyrifos achieves predicted levels. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, sturgeon will likely experience more toxicity. The overall risk to Atlantic sturgeon, Chesapeake Bay DPS from the effects of the action is high and the confidence associated with that risk is high.


High Risk
High Confidence
Less Risk
More Risk

12.36 Atlantic Sturgeon, Gulf of Maine DPS (Acipenser oxyrinchus oxyrinchus)

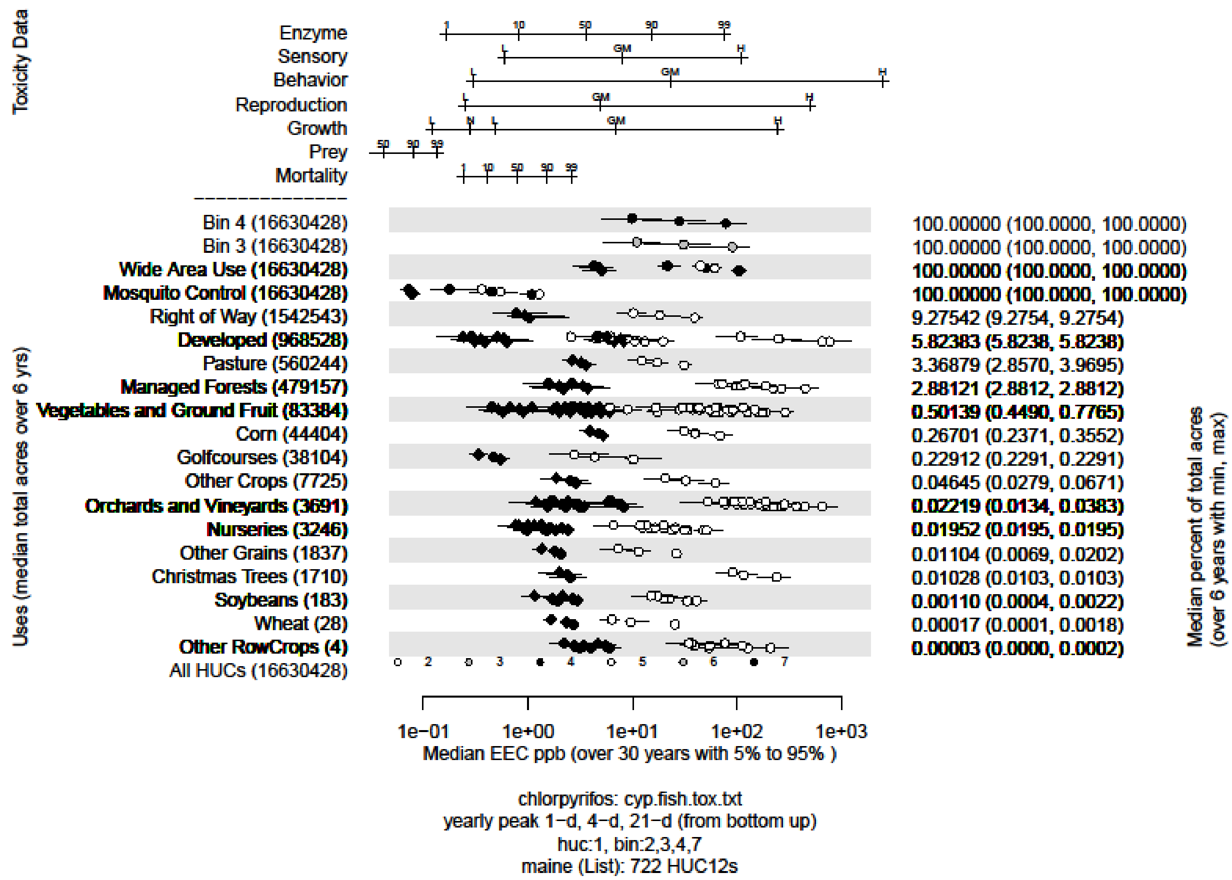


Figure 36. Effects analysis R-plot for Atlantic sturgeon, Gulf of Maine DPS and chlorpyrifos

Table 354. Likelihood of exposure determination for Atlantic sturgeon, Gulf of Maine DPS and chlorpyrifos

Adults and Juveniles	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Wide Area Use	3	yes	yes	yes	NA	3	**High**
Mosquito Control	3	yes	yes	yes	NA	3	**High**
Right of Way	3	yes	yes	yes	NA	3	**High**
Developed	3	yes	yes	yes	NA	3	**High**
Pasture	2	yes	yes	yes	NA	3	**High**
Managed forest	2	yes	yes	yes	NA	3	**High**
Vegetables and Ground Fruit	1	yes	yes	yes	no	3	**Low**
Corn	1	yes	yes	yes	no	3	**Low**
Golf Courses	1	yes	yes	yes	no	3	**Low**
Other Crops	1	yes	yes	yes	no	3	**Low**
Orchards and Vineyards	1	yes	yes	yes	no	3	**Low**
Nurseries	1	yes	yes	yes	no	3	**Low**
Other Grains	1	yes	yes	yes	no	3	**Low**
Christmas Trees	1	yes	yes	yes	no	3	**Low**
Soybeans	1	yes	yes	yes	no	3	**Low**
Bin 3	3	yes	yes	yes	NA	3	**High**
Bin 4	3	yes	yes	yes	NA	3	**High**

Life Stage: Juvenile and Adult

Table 355. Direct mortality risk hypothesis; Atlantic sturgeon, Gulf of Maine DPS and chlorpyrifos; Adults and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Right of Way	9.3	High	High
Developed	5.8	High	High
Pasture	3.4	High	High
Managed forest	2.3	High	High
Vegetables and Ground Fruit	.5	High	Low
Corn	.3	High	Low

Golf Courses	.2	High	Low
Other Crops	.05	High	Low
Orchards and Vineyards	.02	High	Low
Nurseries	.02	High	Low
Other Grains	.01	High	Low
Christmas Trees	.01	High	Low
Soybeans	.001	High	Low
Bin 3	100	High	High
Bin 4	100	High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 356. Prey risk hypothesis; Atlantic sturgeon, Gulf of Maine DPS and chlorpyrifos; Adults and Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Right of Way	9.3	High	High
Developed	5.8	High	High
Pasture	3.4	High	High
Managed forest	2.3	High	High
Vegetables and Ground Fruit	.5	High	Low
Corn	.3	High	Low
Golf Courses	.2	High	Low

Other Crops	.05	High	Low
Orchards and Vineyards	.02	High	Low
Nurseries	.02	High	Low
Other Grains	.01	High	Low
Christmas Trees	.01	High	Low
Soybeans	.001	High	Low
Bin 3	100	High	High
Bin 4	100	High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 357. Behavior and sensory risk hypothesis; Atlantic sturgeon, Gulf of Maine DPS and chlorpyrifos; Adults and Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	9.3	High	High
Developed	5.8	High	High
Pasture	3.4	High	High
Managed forest	2.3	High	High
Vegetables and Ground Fruit	.5	High	Low
Corn	.3	High	Low
Golf Courses	.2	Medium	Low
Other Crops	.05	High	Low

Orchards and Vineyards	.02	High	Low
Nurseries	.02	High	Low
Other Grains	.01	High	Low
Christmas Trees	.01	High	Low
Soybeans	.001	High	Low
Bin 3	100	High	High
Bin 4	100	High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	9.3	High	High
Developed	5.8	High	High
Pasture	3.4	High	High
Managed forest	2.3	High	High
Vegetables and Ground Fruit	.5	High	Low
Corn	.3	High	Low
Golf Courses	.2	High	Low
Other Crops	.05	High	Low
Orchards and Vineyards	.02	High	Low
Nurseries	.02	High	Low
Other Grains	.01	High	Low
Christmas Trees	.01	High	Low
Soybeans	.001	High	Low
Bin 3	100	High	High
Bin 4	100	High	High

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.		
Risk	**Confidence**	
High	**High**	

Table 358. AChE risk hypothesis; Atlantic sturgeon, Gulf of Maine DPS and chlorpyrifos; Adults and Juveniles

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	9.3	High	High
Developed	5.8	High	High
Pasture	3.4	High	High
Managed forest	2.3	High	High
Vegetables and Ground Fruit	.5	High	Low
Corn	.3	High	Low
Golf Courses	.2	High	Low
Other Crops	.05	High	Low
Orchards and Vineyards	.02	High	Low
Nurseries	.02	High	Low
Other Grains	.01	High	Low
Christmas Trees	.01	High	Low
Soybeans	.001	High	Low
Bin 3	100	High	High
Bin 4	100	High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			

Risk	Confidence	
High	**High**	

Table 359. Growth risk hypothesis; Atlantic sturgeon, Gulf of Maine DPS and chlorpyrifos; Adults and Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	9.3	High	High
Developed	5.8	High	High
Pasture	3.4	High	High
Managed forest	2.3	High	High
Vegetables and Ground Fruit	.5	High	Low
Corn	.3	High	Low
Golf Courses	.2	Medium	Low
Other Crops	.05	High	Low
Orchards and Vineyards	.02	High	Low
Nurseries	.02	High	Low
Other Grains	.01	High	Low
Christmas Trees	.01	High	Low
Soybeans	.001	High	Low
Bin 3	100	High	High
Bin 4	100	High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		

High	**High**	

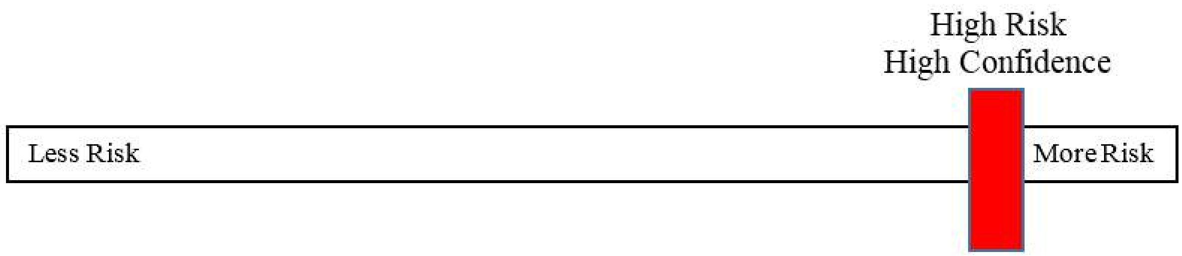
Table 360. Reproduction risk hypothesis; Atlantic sturgeon, Gulf of Maine DPS and chlorpyrifos; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	9.3	High	High
Developed	5.8	High	High
Pasture	3.4	High	High
Managed forest	2.3	High	High
Vegetables and Ground Fruit	.5	High	Low
Corn	.3	High	Low
Golf Courses	.2	High	Low
Other Crops	.05	High	Low
Orchards and Vineyards	.02	High	Low
Nurseries	.02	High	Low
Other Grains	.01	High	Low
Christmas Trees	.01	High	Low
Soybeans	.001	High	Low
Bin 3	100	High	High
Bin 4	100	High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 361. Effects analysis summary table: Atlantic sturgeon, Gulf of Maine DPS and chlorpyrifos

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Juveniles and Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance via acute lethality.	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance via reduction in prey availability	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Atlantic sturgeon, Gulf of Maine DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where chlorpyrifos achieves predicted levels. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, sturgeon will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed sturgeon. The overall risk to Atlantic sturgeon, Gulf of Maine DPS from the effects of the action is high and the confidence associated with that risk is high.



12.37 Atlantic Sturgeon, New York Bight DPS (Acipenser oxyrinchus oxyrinchus)

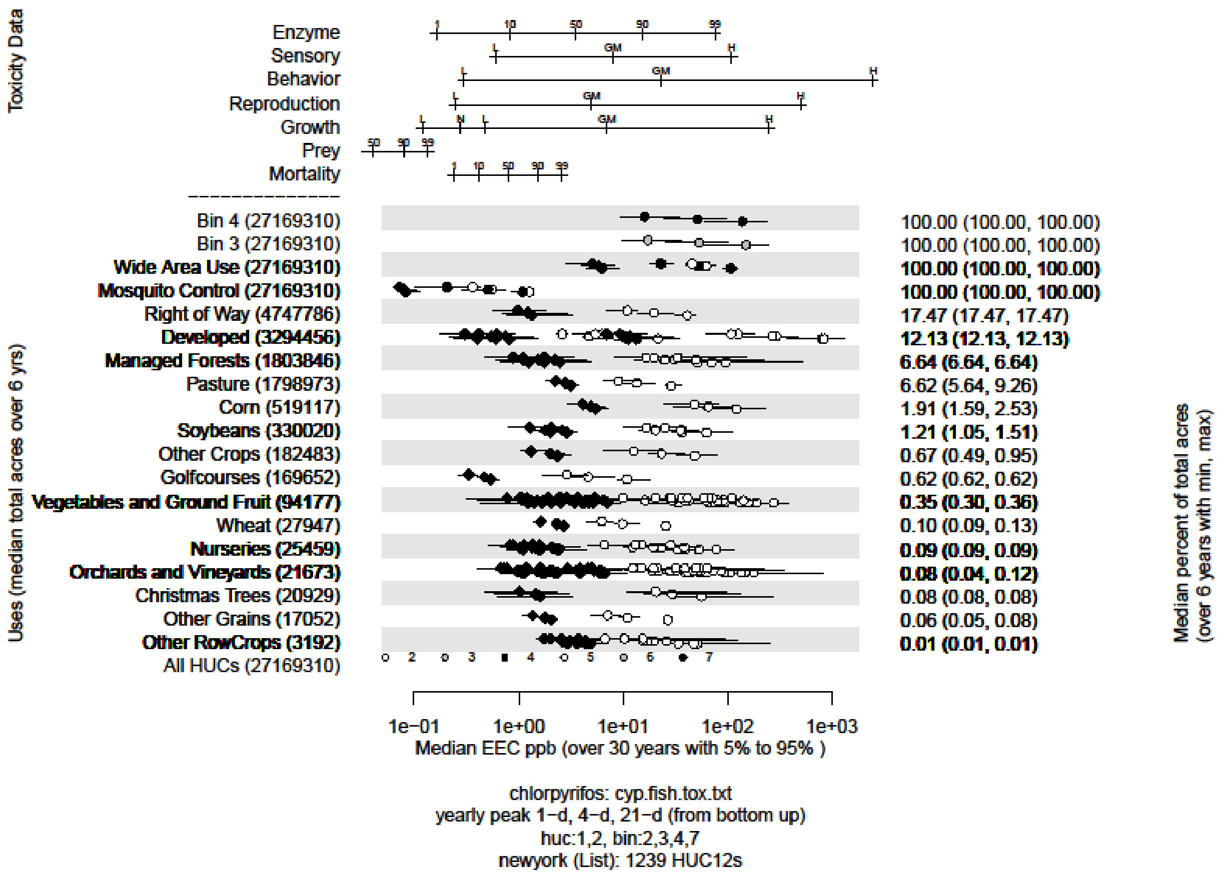


Figure 37. Effects analysis R-plot for Atlantic sturgeon, New York Bight DPS and chlorpyrifos

Table 362. Likelihood of exposure determination for Atlantic sturgeon, New York Bight DPS and chlorpyrifos

Adults and Juveniles	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Wide Area Use	3	yes	yes	yes	NA	3	**High**
Mosquito Control	3	yes	yes	yes	NA	3	**High**
Right of Way	3	yes	yes	yes	NA	3	**High**
Developed	3	yes	yes	yes	NA	3	**High**
Managed Forest	3	yes	yes	yes	NA	3	**High**
Pasture	3	yes	yes	yes	NA	3	**High**
Corn	2	yes	yes	yes	NA	3	**High**
Soybeans	2	yes	yes	yes	NA	3	**High**
Other Crops	1	yes	yes	yes	yes	3	**High**
Golf Courses	1	yes	yes	yes	yes	3	**High**
Vegetables and Ground Fruit	1	yes	yes	yes	yes	3	**High**
Wheat	1	yes	yes	yes	yes	3	**High**
Nurseries	1	yes	yes	yes	no	3	**Low**
Orchards and Vineyards	1	yes	yes	yes	yes	3	**High**
Christmas Trees	1	yes	yes	yes	no	3	**Low**
Other Grains	1	yes	yes	yes	no	3	**Low**
Other Row Crops	1	yes	yes	yes	no	3	**Low**
Bin 3	3	yes	yes	yes	NA	3	**High**
Bin 4	3	yes	yes	yes	NA	3	**High**

Life Stage: Juvenile and Adult

Table 363. Direct mortality risk hypothesis; Atlantic sturgeon, New York Bight DPS and chlorpyrifos; Adults and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Right of Way	17.5	High	High
Developed	12.1	High	High
Managed Forest	6.6	High	High
Pasture	6.6	High	High
Corn	1.9	High	High

Soybeans	1.2	High	High
Other Crops	.7	High	High
Golf Courses	.6	High	High
Vegetables and Ground Fruit	.4	High	High
Wheat	.1	High	High
Nurseries	.1	High	Low
Orchards and Vineyards	.1	High	High
Christmas Trees	.1	High	Low
Other Grains	.1	High	Low
Other Row Crops	.01	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 364. Prey risk hypothesis; Atlantic sturgeon, New York Bight DPS and chlorpyrifos; Adults and Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Right of Way	17.5	High	High
Developed	12.1	High	High
Managed Forest	6.6	High	High
Pasture	6.6	High	High

Corn	1.9	High	High
Soybeans	1.2	High	High
Other Crops	.7	High	High
Golf Courses	.6	High	High
Vegetables and Ground Fruit	.4	High	High
Wheat	.1	High	High
Nurseries	.1	High	Low
Orchards and Vineyards	.1	High	High
Christmas Trees	.1	High	Low
Other Grains	.1	High	Low
Other Row Crops	.01	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 365. Behavior and sensory risk hypothesis; Atlantic sturgeon, New York Bight DPS and chlorpyrifos; Adults and Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	17.5	High	High
Developed	12.1	High	High
Managed Forest	6.6	High	High

Pasture	6.6	High	High
Corn	1.9	High	High
Soybeans	1.2	High	High
Other Crops	.7	High	High
Golf Courses	.6	Medium	High
Vegetables and Ground Fruit	.4	High	High
Wheat	.1	High	High
Nurseries	.1	High	Low
Orchards and Vineyards	.1	High	High
Christmas Trees	.1	High	Low
Other Grains	.1	High	Low
Other Row Crops	.01	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	17.5	High	High
Developed	12.1	High	High
Managed Forest	6.6	High	High
Pasture	6.6	High	High
Corn	1.9	High	High
Soybeans	1.2	High	High
Other Crops	.7	High	High
Golf Courses	.6	High	High

Vegetables and Ground Fruit	.4	High	High
Wheat	.1	High	High
Nurseries	.1	High	Low
Orchards and Vineyards	.1	High	High
Christmas Trees	.1	High	Low
Other Grains	.1	High	Low
Other Row Crops	.01	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 366. AChE risk hypothesis; Atlantic sturgeon, New York Bight DPS and chlorpyrifos; Adults and Juveniles

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	17.5	High	High
Developed	12.1	High	High
Managed Forest	6.6	High	High
Pasture	6.6	High	High
Corn	1.9	High	High
Soybeans	1.2	High	High
Other Crops	.7	High	High

Golf Courses	.6	High	High
Vegetables and Ground Fruit	.4	High	High
Wheat	.1	High	High
Nurseries	.1	High	Low
Orchards and Vineyards	.1	High	High
Christmas Trees	.1	High	Low
Other Grains	.1	High	Low
Other Row Crops	.01	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Table 367. Growth risk hypothesis; Atlantic sturgeon, New York Bight DPS and chlorpyrifos; Adults and Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	17.5	High	High
Developed	12.1	High	High
Managed Forest	6.6	High	High
Pasture	6.6	High	High
Corn	1.9	High	High
Soybeans	1.2	High	High

Other Crops	.7	High	High
Golf Courses	.6	Medium	High
Vegetables and Ground Fruit	.4	High	High
Wheat	.1	High	High
Nurseries	.1	High	Low
Orchards and Vineyards	.1	High	High
Christmas Trees	.1	High	Low
Other Grains	.1	High	Low
Other Row Crops	.01	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
High	**High**		

Table 368. Reproduction risk hypothesis; Atlantic sturgeon, New York Bight DPS and chlorpyrifos; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	17.5	High	High
Developed	12.1	High	High
Managed Forest	6.6	High	High
Pasture	6.6	High	High
Corn	1.9	High	High
Soybeans	1.2	High	High

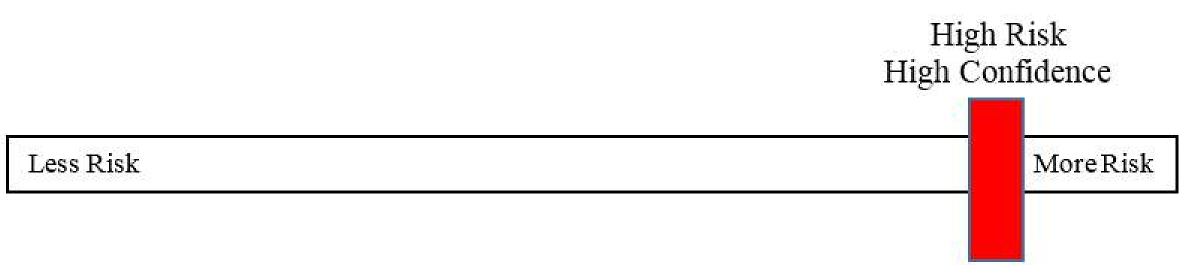
Other Crops	.7	High	High
Golf Courses	.6	Medium	High
Vegetables and Ground Fruit	.4	High	High
Wheat	.1	High	High
Nurseries	.1	High	Low
Orchards and Vineyards	.1	High	High
Christmas Trees	.1	High	Low
Other Grains	.1	High	Low
Other Row Crops	.01	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 369. Effects analysis summary table: Atlantic sturgeon, New York Bight DPS and chlorpyrifos

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles and Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance via acute lethality.	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance via reduction in prey availability	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce	High	High	Not Available	**Yes**

adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.				
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Atlantic sturgeon, New York Bight DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where chlorpyrifos achieves predicted levels. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, sturgeon will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of chlorpyrifos and mixtures containing Chlorpyrifos to exposed sturgeon. The overall risk to Atlantic sturgeon, New York Bight DPS from the effects of the action is high and the confidence associated with that risk is high.



12.38 Atlantic Sturgeon, South Atlantic DPS (Acipenser oxyrinchus oxyrinchus)

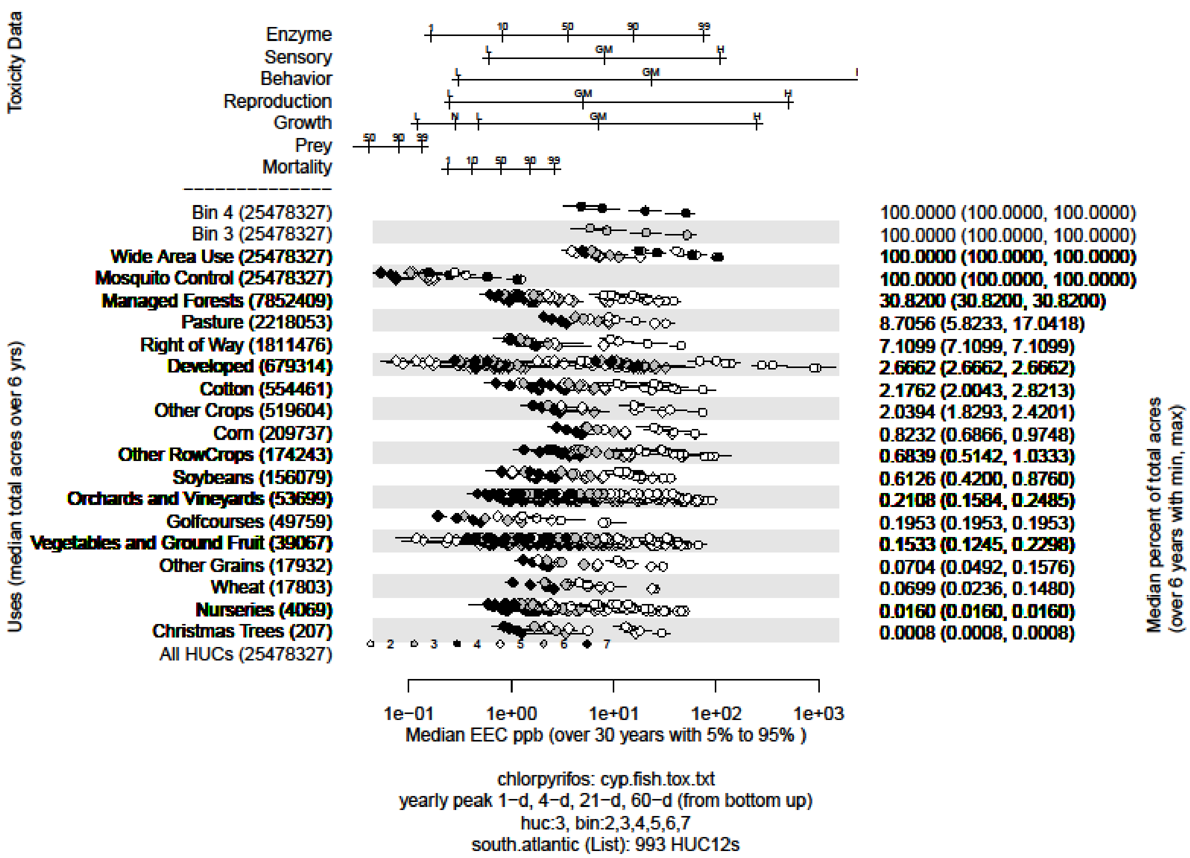


Figure 38. Effects analysis R-plot for Atlantic Sturgeon, South Atlantic DPS and chlorpyrifos

Table 370. Likelihood of exposure determination for Atlantic Sturgeon, South Atlantic DPS and chlorpyrifos

Adults and Juveniles	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Wide Area Use	3	yes	yes	yes	NA	3	**High**
Mosquito Control	3	yes	yes	yes	NA	3	**High**
Managed Forest	3	yes	yes	yes	NA	3	**High**
Pasture	3	yes	yes	yes	NA	3	**High**
Right of Way	3	yes	yes	yes	NA	3	**High**
Developed	2	yes	yes	yes	NA	3	**High**
Cotton	2	yes	yes	yes	NA	3	**High**
Other Crops	2	yes	yes	yes	NA	3	**High**
Corn	1	yes	yes	yes	yes	3	**High**
Other Row Crops	1	yes	yes	yes	yes	3	**High**
Soybeans	1	yes	yes	yes	yes	3	**High**
Orchards and Vineyards	1	yes	yes	yes	yes	3	**High**
Golf Courses	1	yes	yes	yes	no	3	**Low**
Vegetables and Ground Fruit	1	yes	yes	yes	no	3	**Low**
Other Grains	1	yes	yes	yes	no	3	**Low**
Wheat	1	yes	yes	yes	yes	3	**High**
Nurseries	1	yes	yes	yes	no	3	**Low**
Christmas Tress	1	yes	yes	yes	no	3	**Low**
Bin 3	3	yes	yes	yes	NA	3	**High**
Bin 4	3	yes	yes	yes	NA	3	**High**

Life Stage: Juvenile and Adult

Table 371. Direct mortality risk hypothesis; Atlantic Sturgeon, South Atlantic DPS and chlorpyrifos; Adults and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	30.8	High	High
Pasture	8.7	High	High
Right of Way	7.1	High	High
Developed	2.7	High	High
Cotton	2.2	High	High

Other Crops	2.0	High	High
Corn	0.8	High	High
Other Row Crops	0.7	High	High
Soybeans	0.6	High	High
Orchards and Vineyards	0.2	High	High
Golf Courses	0.2	High	Low
Vegetables and Ground Fruit	0.2	High	Low
Other Grains	.07	High	Low
Wheat	.07	High	High
Nurseries	.02	High	Low
Christmas Tress	.0008	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 372. Prey risk hypothesis; Atlantic Sturgeon, South Atlantic DPS and chlorpyrifos; Adults and Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	30.8	High	High
Pasture	8.7	High	High
Right of Way	7.1	High	High

Developed	2.7	High	High
Cotton	2.2	High	High
Other Crops	2.0	High	High
Corn	0.8	High	High
Other Row Crops	0.7	High	High
Soybeans	0.6	High	High
Orchards and Vineyards	0.2	High	High
Golf Courses	0.2	High	Low
Vegetables and Ground Fruit	0.2	High	Low
Other Grains	.07	High	Low
Wheat	.07	High	High
Nurseries	.02	High	Low
Christmas Tress	.0008	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 373. Behavior and sensory risk hypothesis; Atlantic Sturgeon, South Atlantic DPS and chlorpyrifos; Adults and Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	30.8	High	High

Pasture	8.7	High	High
Right of Way	7.1	High	High
Developed	2.7	High	High
Cotton	2.2	High	High
Other Crops	2.0	High	High
Corn	0.8	High	High
Other Row Crops	0.7	High	High
Soybeans	0.6	High	High
Orchards and Vineyards	0.2	High	High
Golf Courses	0.2	Medium	Low
Vegetables and Ground Fruit	0.2	High	Low
Other Grains	.07	High	Low
Wheat	.07	High	High
Nurseries	.02	High	Low
Christmas Tress	.0008	High	Low
Bin 3		High	High
Bin 4			High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	30.8	High	High
Pasture	8.7	High	High
Right of Way	7.1	High	High
Developed	2.7	High	High
Cotton	2.2	High	High

Other Crops	2.0	High	High
Corn	0.8	High	High
Other Row Crops	0.7	High	High
Soybeans	0.6	High	High
Orchards and Vineyards	0.2	High	High
Golf Courses	0.2	High	Low
Vegetables and Ground Fruit	0.2	High	Low
Other Grains	.07	High	Low
Wheat	.07	High	High
Nurseries	.02	High	Low
Christmas Tress	.0008	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 374. AChE risk hypothesis; Atlantic Sturgeon, South Atlantic DPS and chlorpyrifos; Adults and Juveniles

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	30.8	High	High
Pasture	8.7	High	High
Right of Way	7.1	High	High

Developed	2.7	High	High
Cotton	2.2	High	High
Other Crops	2.0	High	High
Corn	0.8	High	High
Other Row Crops	0.7	High	High
Soybeans	0.6	High	High
Orchards and Vineyards	0.2	High	High
Golf Courses	0.2	High	Low
Vegetables and Ground Fruit	0.2	High	Low
Other Grains	.07	High	Low
Wheat	.07	High	High
Nurseries	.02	High	Low
Christmas Tress	.0008	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Table 375. Growth risk hypothesis; Atlantic Sturgeon, South Atlantic DPS and chlorpyrifos; Adults and Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	30.8	High	High

Pasture	8.7	High	High
Right of Way	7.1	High	High
Developed	2.7	High	High
Cotton	2.2	High	High
Other Crops	2.0	High	High
Corn	0.8	High	High
Other Row Crops	0.7	High	High
Soybeans	0.6	High	High
Orchards and Vineyards	0.2	High	High
Golf Courses	0.2	Medium	Low
Vegetables and Ground Fruit	0.2	High	Low
Other Grains	.07	High	Low
Wheat	.07	High	High
Nurseries	.02	High	Low
Christmas Tress	.0008	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
High	**High**		

Table 376. Reproduction risk hypothesis; Atlantic Sturgeon, South Atlantic DPS and chlorpyrifos; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High

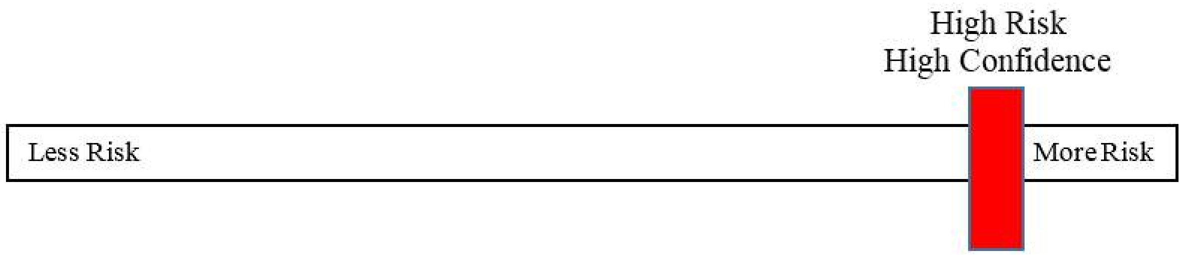
Managed Forest	30.8	High	High
Pasture	8.7	High	High
Right of Way	7.1	High	High
Developed	2.7	High	High
Cotton	2.2	High	High
Other Crops	2.0	High	High
Corn	0.8	High	High
Other Row Crops	0.7	High	High
Soybeans	0.6	High	High
Orchards and Vineyards	0.2	High	High
Golf Courses	0.2	Medium	Low
Vegetables and Ground Fruit	0.2	High	Low
Other Grains	.07	High	Low
Wheat	.07	High	High
Nurseries	.02	High	Low
Christmas Tress	.0008	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 377. Effects analysis summary table: Atlantic Sturgeon, South Atlantic DPS and chlorpyrifos

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Juveniles and Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				

Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance via acute lethality.	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance via reduction in prey availability	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Atlantic Sturgeon, South Atlantic DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to chlorpyrifos. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where chlorpyrifos achieves predicted levels. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, sturgeon will likely experience more toxicity. The overall risk to Atlantic Sturgeon, South Atlantic DPS from the effects of the action is high and the confidence associated with that risk is high.


High Risk
High Confidence
Less Risk
More Risk

12.39 Gulf Sturgeon (*Acipenser oxyrinchus desotoi*)

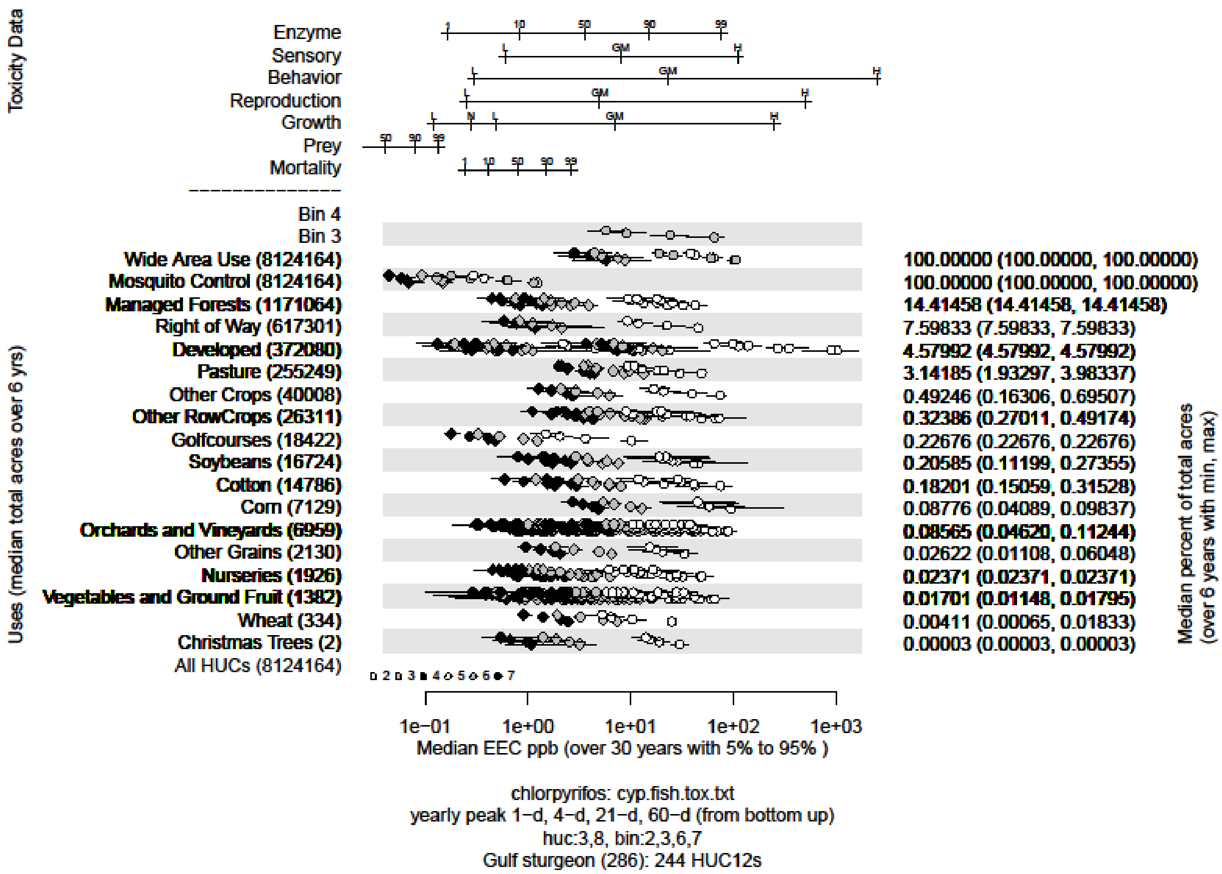


Figure 39. Effects analysis R-plot for Gulf Sturgeon and chlorpyrifos

Table 378. Likelihood of exposure determination for Gulf Sturgeon and chlorpyrifos

Adults and Juveniles	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Wide Area Use	3	yes	yes	yes	NA	3	**High**
Mosquito Control	3	yes	yes	yes	NA	3	**High**
Managed Forest	3	yes	yes	yes	NA	3	**High**
Right of Way	3	yes	yes	yes	NA	3	**High**
Developed	2	yes	yes	yes	NA	3	**High**
Pasture	2	yes	yes	yes	NA	3	**High**
Other Crops	1	yes	yes	yes	NA	3	**Low**
Other Row Crops	1	yes	yes	yes	NA	3	**Low**
Golf Courses	1	yes	yes	yes	NA	3	**Low**
Soy Beans	1	yes	yes	yes	NA	3	**Low**
Cotton	1	yes	yes	yes	NA	3	**Low**
Corn	1	yes	yes	yes	NA	3	**Low**
Orchards and Vineyards	1	yes	yes	yes	NA	3	**Low**
Other Grains	1	yes	yes	yes	NA	3	**Low**
Nurseries	1	yes	yes	yes	NA	3	**Low**
Vegetables and Ground Fruit	1	yes	yes	yes	NA	3	**Low**
Wheat	1	yes	yes	yes	NA	3	**Low**
Bin 3	3	yes	yes	yes	NA	3	**High**

Life Stage: Juvenile and Adult (Marine Environment Only)

Table 379. Direct mortality risk hypothesis; Gulf Sturgeon and chlorpyrifos; Adults and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	14.4	High	High
Right of Way	7.6	High	High
Developed	4.6	High	High
Pasture	3.1	High	High
Other Crops	.5	High	Low
Other Row Crops	.3	High	Low
Golf Courses	.2	High	Low

Soy Beans	.2	High	Low
Cotton	.18	High	Low
Corn	.09	High	Low
Orchards and Vineyards	.09	High	Low
Other Grains	.03	High	Low
Nurseries	.02	High	Low
Vegetables and Ground Fruit	.02	High	Low
Wheat	.004	High	Low
Bin 3		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance via acute lethality.			
Risk	**Confidence**		
High	**Low**		

Table 380. Prey risk hypothesis; Gulf Sturgeon and chlorpyrifos; Adults and Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	14.4	High	High
Right of Way	7.6	High	High
Developed	4.6	High	High
Pasture	3.1	High	High
Other Crops	.5	High	Low
Other Row Crops	.3	High	Low
Golf Courses	.2	High	Low
Soy Beans	.2	High	Low

Cotton	.18	High	Low
Corn	.09	High	Low
Orchards and Vineyards	.09	High	Low
Other Grains	.03	High	Low
Nurseries	.02	High	Low
Vegetables and Ground Fruit	.02	High	Low
Wheat	.004	High	Low
Bin 3		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**Low**		

Table 381. Behavior and sensory risk hypothesis; Gulf Sturgeon and chlorpyrifos; Adults and Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	14.4	High	High
Right of Way	7.6	High	High
Developed	4.6	High	High
Pasture	3.1	High	High
Other Crops	.5	High	Low
Other Row Crops	.3	High	Low
Golf Courses	.2	Medium	Low
Soy Beans	.2	High	Low
Cotton	.18	High	Low

Corn	.09	High	Low
Orchards and Vineyards	.09	High	Low
Other Grains	.03	High	Low
Nurseries	.02	High	Low
Vegetables and Ground Fruit	.02	High	Low
Wheat	.004	High	Low
Bin 3		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	14.4	High	High
Right of Way	7.6	High	High
Developed	4.6	High	High
Pasture	3.1	High	High
Other Crops	.5	High	Low
Other Row Crops	.3	High	Low
Golf Courses	.2	High	Low
Soy Beans	.2	High	Low
Cotton	.18	High	Low
Corn	.09	High	Low
Orchards and Vineyards	.09	High	Low
Other Grains	.03	High	Low
Nurseries	.02	High	Low
Vegetables and Ground Fruit	.02	High	Low

Wheat	.004	High	Low
Bin 3		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**Low**		

Table 382. AChE risk hypothesis; Gulf Sturgeon and chlorpyrifos; Adults and Juveniles

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	14.4	High	High
Right of Way	7.6	High	High
Developed	4.6	High	High
Pasture	3.1	High	High
Other Crops	.5	High	Low
Other Row Crops	.3	High	Low
Golf Courses	.2	High	Low
Soy Beans	.2	High	Low
Cotton	.18	High	Low
Corn	.09	High	Low
Orchards and Vineyards	.09	High	Low
Other Grains	.03	High	Low
Nurseries	.02	High	Low
Vegetables and Ground Fruit	.02	High	Low
Wheat	.004	High	Low

Bin 3		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Low**		

Table 383. Growth risk hypothesis; Gulf Sturgeon and chlorpyrifos; Adults and Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	14.4	High	High
Right of Way	7.6	High	High
Developed	4.6	High	High
Pasture	3.1	High	High
Other Crops	.5	High	Low
Other Row Crops	.3	High	Low
Golf Courses	.2	High	Low
Soy Beans	.2	High	Low
Cotton	.18	High	Low
Corn	.09	High	Low
Orchards and Vineyards	.09	High	Low
Other Grains	.03	High	Low
Nurseries	.02	High	Low
Vegetables and Ground Fruit	.02	High	Low
Wheat	.004	High	Low
Bin 3		High	High

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)		
Risk	**Confidence**	
High	**Low**	

Table 384. Reproduction risk hypothesis; Gulf Sturgeon and chlorpyrifos; Adults

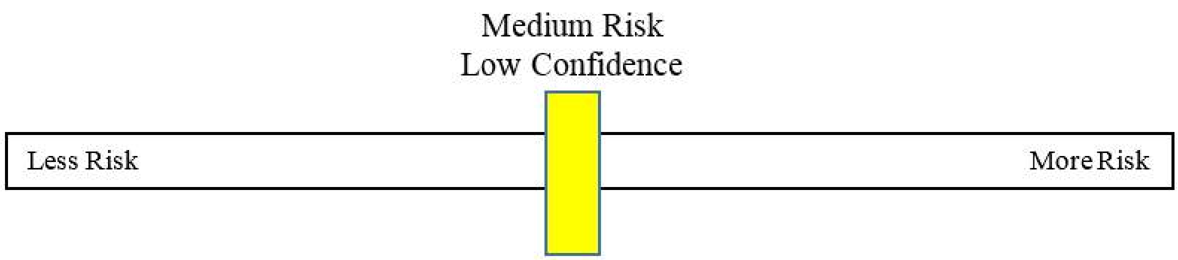
Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	14.4	High	High
Right of Way	7.6	High	High
Developed	4.6	High	High
Pasture	3.1	High	High
Other Crops	.5	High	Low
Other Row Crops	.3	High	Low
Golf Courses	.2	High	Low
Soy Beans	.2	High	Low
Cotton	.18	High	Low
Corn	.09	High	Low
Orchards and Vineyards	.09	High	Low
Other Grains	.03	High	Low
Nurseries	.02	High	Low
Vegetables and Ground Fruit	.02	High	Low
Wheat	.004	High	Low
Bin 3		High	High

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction		
Risk	**Confidence**	
High	**Low**	

Table 385. Effects analysis summary table: Gulf Sturgeon and chlorpyrifos

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Juveniles and Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance via acute lethality.	High	Low	4-day: 20-69 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance via reduction in prey availability	High	Low	4-day fish: 10-64 4-day invert: 31-79 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	Low	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Gulf Sturgeon are not anticipated to experience significant reductions in abundance or productivity (spawning adults) from exposure to chlorpyrifos in the marine environment. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, sturgeon may experience increased toxicity. If exposed to formulated products and tank mixtures containing chlorpyrifos, Gulf sturgeon may experience increased toxicity. The MagTool results indicate that between 20-69 percent of individuals within a population will die. The overall risk to Gulf Sturgeon from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted chlorpyrifos concentrations in coastal habitats.



12.40 Yelloweye Rockfish (Sebastes ruberrimus)

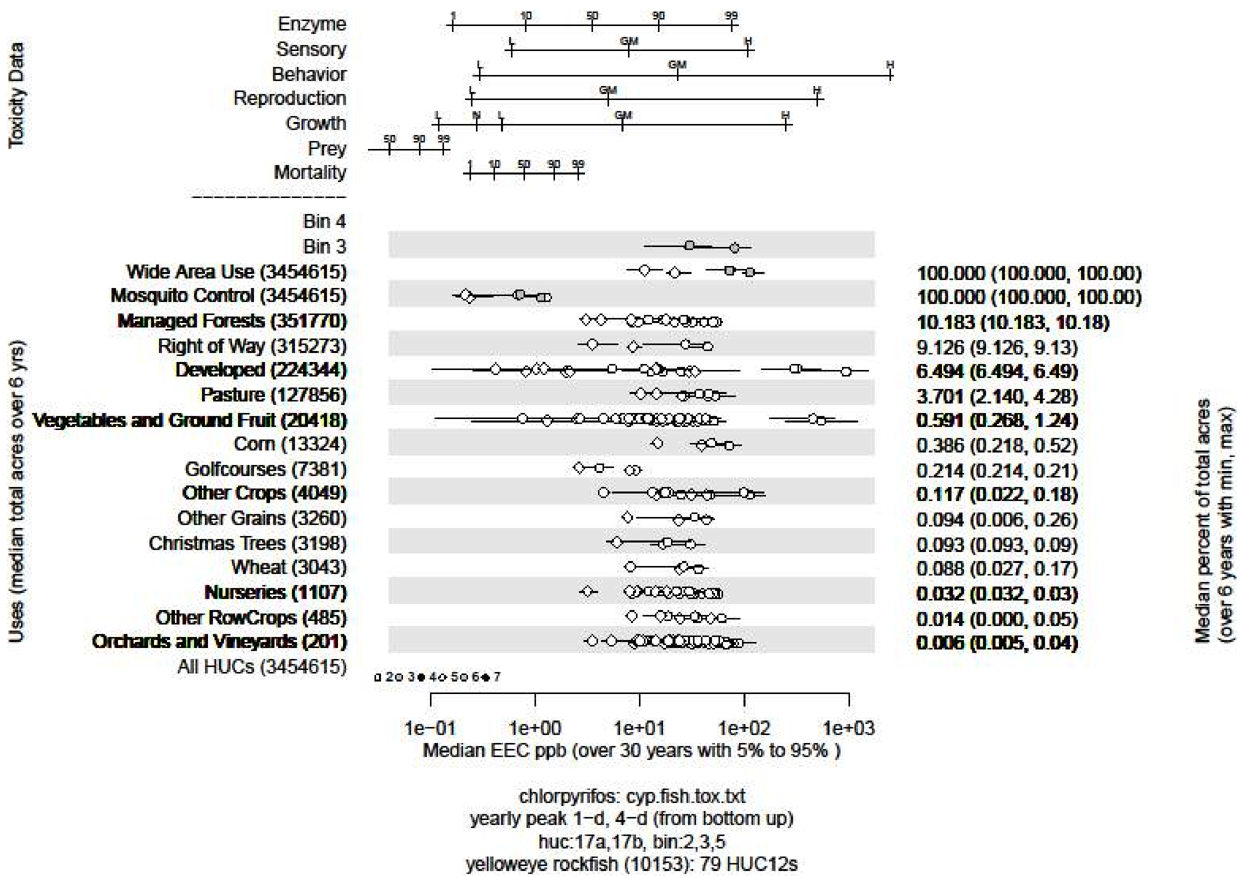


Figure 40. Effects analysis R-plot for Yelloweye Rockfish and chlorpyrifos

Table 386. Likelihood of exposure determination for Yelloweye Rockfish and chlorpyrifos

Larvae and Juveniles	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Wide Area Use	3	yes	yes	yes	NA	3	**High**
Mosquito Control	3	yes	yes	yes	NA	3	**High**
Managed Forest	3	yes	yes	yes	NA	3	**High**
Right of Way	3	yes	yes	yes	NA	3	**High**
Developed	3	yes	yes	yes	NA	3	**High**
Pasture	2	yes	yes	yes	NA	3	**High**
Vegetables and Ground Fruit	1	yes	yes	yes	NA	3	**Low**
Corn	1	yes	yes	yes	NA	3	**Low**
Golf Courses	1	yes	yes	yes	NA	3	**Low**
Other Crops	1	yes	yes	yes	NA	3	**Low**
Other Grains	1	yes	yes	yes	NA	3	**Low**
Christmas Trees	1	yes	yes	yes	NA	3	**Low**
Wheat	1	yes	yes	yes	NA	3	**Low**
Nurseries	1	yes	yes	yes	NA	3	**Low**
Other Row Crops	1	yes	yes	yes	NA	3	**Low**
Orchards and Vineyards	1	yes	yes	yes	NA	3	**Low**
Bin 3	3	yes	yes	yes	NA	3	**High**
Bin 4	3	yes	yes	yes	NA	3	**High**

Life Stage: Larvae and Juveniles

Table 387. Direct mortality risk hypothesis; Yelloweye Rockfish and chlorpyrifos; Larvae and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	10	High	High
Right of Way	9	High	High
Developed	6	High	High
Pasture	4	High	High
Vegetables and Ground Fruit	<1	High	Low
Corn	<1	High	Low

Golf Courses	<1	High	Low
Other Crops	<1	High	Low
Other Grains	<1	High	Low
Christmas Trees	<1	High	Low
Wheat	<1	High	Low
Nurseries	<1	High	Low
Other Row Crops	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce larval and juvenile abundance via acute lethality.			
Risk	**Confidence**		
High	**Low**		

Table 388. Growth risk hypothesis; Yelloweye Rockfish and chlorpyrifos; Larvae and Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	10	High	High
Right of Way	9	High	High
Developed	6	High	High
Pasture	4	High	High
Vegetables and Ground Fruit	<1	High	Low
Corn	<1	High	Low
Golf Courses	<1	Medium	Low

Other Crops	<1	High	Low
Other Grains	<1	High	Low
Christmas Trees	<1	High	Low
Wheat	<1	High	Low
Nurseries	<1	High	Low
Other Row Crops	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce larval and juvenile abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
High	**Low**		

Table 389. Prey risk hypothesis; Yelloweye Rockfish and chlorpyrifos; Larvae and Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	10	High	High
Right of Way	9	High	High
Developed	6	High	High
Pasture	4	High	High
Vegetables and Ground Fruit	<1	High	Low
Corn	<1	High	Low
Golf Courses	<1	High	Low
Other Crops	<1	High	Low

Other Grains	<1	High	Low
Christmas Trees	<1	High	Low
Wheat	<1	High	Low
Nurseries	<1	High	Low
Other Row Crops	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce larval and juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**Low**		

Table 390. AChE risk hypothesis; Yelloweye Rockfish and chlorpyrifos; Larvae and Juveniles

Endpoint: Enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	10	High	High
Right of Way	9	High	High
Developed	6	High	High
Pasture	4	High	High
Vegetables and Ground Fruit	<1	High	Low
Corn	<1	High	Low
Golf Courses	<1	High	Low
Other Crops	<1	High	Low
Other Grains	<1	High	Low

Christmas Trees	<1	High	Low
Wheat	<1	High	Low
Nurseries	<1	High	Low
Other Row Crops	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Low**		

Table 391. Behavior and sensory risk hypothesis; Yelloweye Rockfish and chlorpyrifos; Larvae and Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	10	High	High
Right of Way	9	High	High
Developed	6	High	High
Pasture	4	High	High
Vegetables and Ground Fruit	<1	High	Low
Corn	<1	High	Low
Golf Courses	<1	High	Low
Other Crops	<1	High	Low
Other Grains	<1	High	Low
Christmas Trees	<1	High	Low

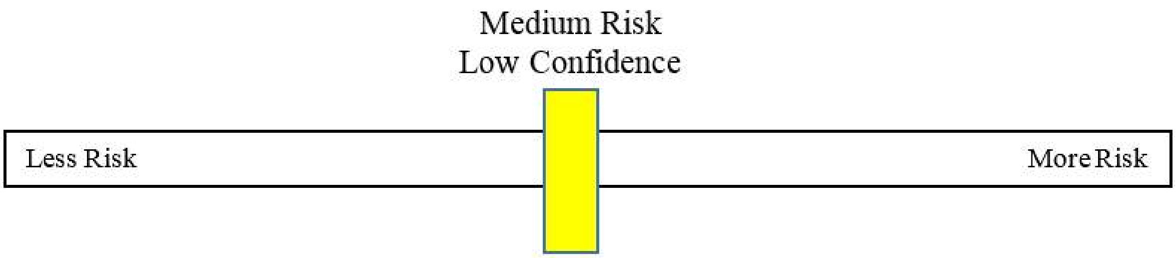
Wheat	<1	High	Low
Nurseries	<1	High	Low
Other Row Crops	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	10	High	High
Right of Way	9	High	High
Developed	6	High	High
Pasture	4	High	High
Vegetables and Ground Fruit	<1	High	Low
Corn	<1	High	Low
Golf Courses	<1	High	Low
Other Crops	<1	High	Low
Other Grains	<1	High	Low
Christmas Trees	<1	High	Low
Wheat	<1	High	Low
Nurseries	<1	High	Low
Other Row Crops	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		High	High
Bin 4		High	High

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce larval and juvenile abundance via impairments to ecologically significant behaviors.		
Risk	**Confidence**	
High	**Low**	

Table 392. Effects analysis summary table: Yelloweye Rockfish and chlorpyrifos

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Larvae and Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce larval and juvenile abundance via acute lethality.	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce larval and juvenile abundance via impacts to growth (direct toxicity)	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce larval and juvenile abundance via reduction in prey availability	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce larval and juvenile abundance via impairments to ecologically significant behaviors.	High	Low	Not Available	**Yes**

Effects analysis summary: Adult, juvenile and larval Yelloweye Rockfish are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to chlorpyrifos in the marine environment. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, rockfish may experience increased toxicity. If exposed to formulated products and tank mixtures containing chlorpyrifos, rockfish may experience increased toxicity. The overall risk to yelloweye rockfish from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted chlorpyrifos concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty in the route of exposure to adult rockfish which are typically found in deep marine habitats.



12.41 Boccacio, Puget Sound/Georgia Basin DPS (Sebastes paucispinis)

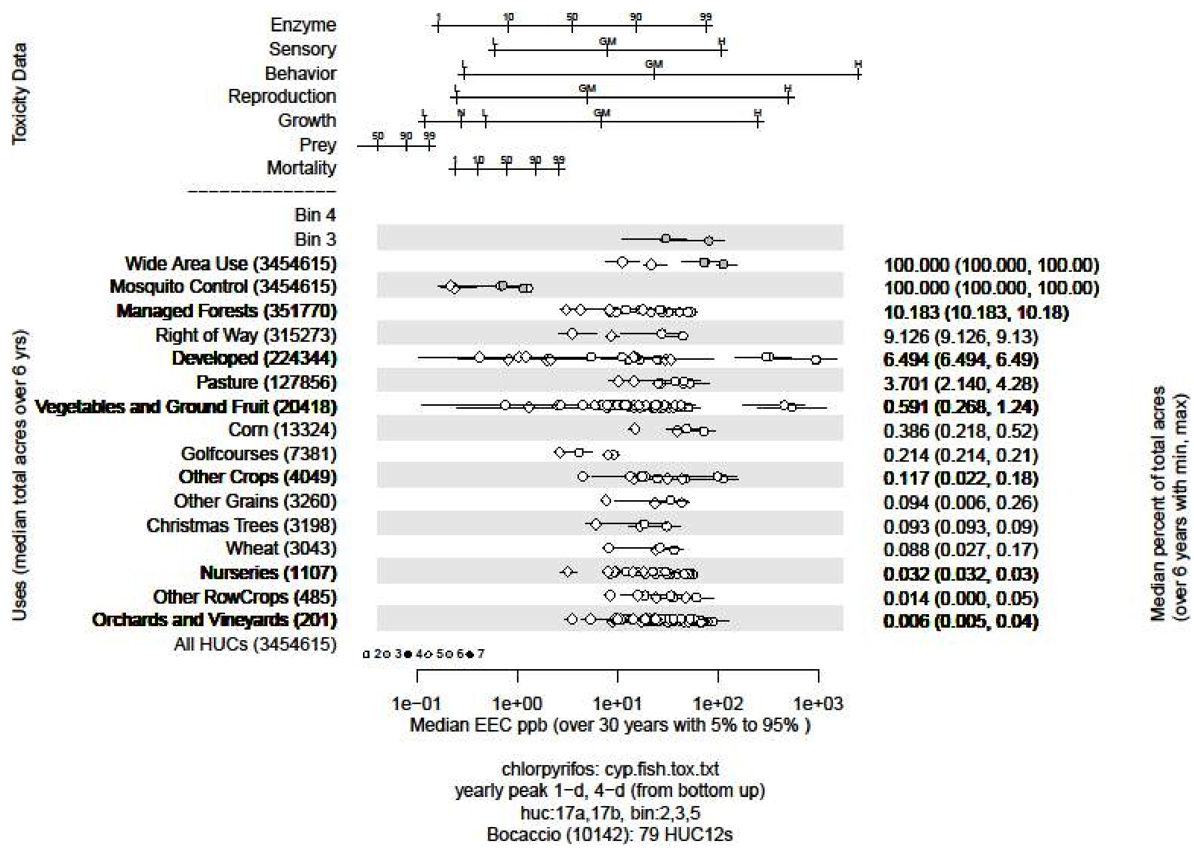


Figure 41. Effects analysis R-plot for Boccacio, Puget Sound/Georgia Basin DPS and chlorpyrifos

Table 393. Likelihood of exposure determination for Boccacio, Puget Sound/Georgia Basin DPS and chlorpyrifos

Larvae and Juveniles	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Wide Area Use	3	yes	yes	yes	NA	3	**High**
Mosquito Control	3	yes	yes	yes	NA	3	**High**
Managed Forest	3	yes	yes	yes	NA	3	**High**
Right of Way	3	yes	yes	yes	NA	3	**High**
Developed	3	yes	yes	yes	NA	3	**High**
Pasture	2	yes	yes	yes	NA	3	**High**
Vegetables and Ground Fruit	1	yes	yes	yes	no	3	**Low**
Corn	1	yes	yes	yes	no	3	**Low**
Golf Courses	1	yes	yes	yes	no	3	**Low**
Other Crops	1	yes	yes	yes	no	3	**Low**
Other Grains	1	yes	yes	yes	no	3	**Low**
Christmas Trees	1	yes	yes	yes	no	3	**Low**
Wheat	1	yes	yes	yes	no	3	**Low**
Nurseries	1	yes	yes	yes	no	3	**Low**
Other Row Crops	1	yes	yes	yes	no	3	**Low**
Orchards and Vineyards	1	yes	yes	yes	no	3	**Low**
Bin 3	3	yes	yes	yes	no	3	**High**
Bin 4	3	yes	yes	yes	no	3	**High**

Life Stage: Larvae and Juveniles

Table 394. Direct mortality risk hypothesis; Boccacio, Puget Sound/Georgia Basin DPS and chlorpyrifos; Larvae and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	10	High	High
Right of Way	9	High	High
Developed	6	High	High
Pasture	4	High	High
Vegetables and Ground Fruit	<1	High	Low

Corn	<1	High	Low
Golf Courses	<1	High	Low
Other Crops	<1	High	Low
Other Grains	<1	High	Low
Christmas Trees	<1	High	Low
Wheat	<1	High	Low
Nurseries	<1	High	Low
Other Row Crops	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce larval and juvenile abundance via acute lethality.			
Risk	**Confidence**		
High	**Low**		

Table 395. Growth risk hypothesis; Boccacio, Puget Sound/Georgia Basin DPS and chlorpyrifos; Larvae and Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	10	High	High
Right of Way	9	High	High
Developed	6	High	High
Pasture	4	High	High
Vegetables and Ground Fruit	<1	High	Low

Corn	<1	High	Low
Golf Courses	<1	Medium	Low
Other Crops	<1	High	Low
Other Grains	<1	High	Low
Christmas Trees	<1	High	Low
Wheat	<1	High	Low
Nurseries	<1	High	Low
Other Row Crops	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce larval and juvenile abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
High	**Low**		

Table 396. Prey risk hypothesis; Boccacio, Puget Sound/Georgia Basin DPS and chlorpyrifos; Larvae and Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Managed Forest	10	High	High
Right of Way	9	High	High
Developed	6	High	High
Pasture	4	High	High
Vegetables and Ground Fruit	<1	High	Low

Corn	<1	High	Low
Golf Courses	<1	High	Low
Other Crops	<1	High	Low
Other Grains	<1	High	Low
Christmas Trees	<1	High	Low
Wheat	<1	High	Low
Nurseries	<1	High	Low
Other Row Crops	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce larval and juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**Low**		

Table 397. AChE risk hypothesis; Boccacio, Puget Sound/Georgia Basin DPS and chlorpyrifos; Larvae and Juveniles

Endpoint: Enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	10	High	High
Right of Way	9	High	High
Developed	6	High	High
Pasture	4	High	High
Vegetables and Ground Fruit	<1	High	Low

Corn	<1	High	Low
Golf Courses	<1	High	Low
Other Crops	<1	High	Low
Other Grains	<1	High	Low
Christmas Trees	<1	High	Low
Wheat	<1	High	Low
Nurseries	<1	High	Low
Other Row Crops	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Low**		

Table 398. Behavior and sensory risk hypothesis; Boccacio, Puget Sound/Georgia Basin DPS and chlorpyrifos; Larvae and Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	10	High	High
Right of Way	9	High	High
Developed	6	High	High
Pasture	4	High	High
Vegetables and Ground Fruit	<1	High	Low

Corn	<1	High	Low
Golf Courses	<1	High	Low
Other Crops	<1	High	Low
Other Grains	<1	High	Low
Christmas Trees	<1	High	Low
Wheat	<1	High	Low
Nurseries	<1	High	Low
Other Row Crops	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Managed Forest	10	High	High
Right of Way	9	High	High
Developed	6	High	High
Pasture	4	High	High
Vegetables and Ground Fruit	<1	High	Low
Corn	<1	High	Low
Golf Courses	<1	High	Low
Other Crops	<1	High	Low
Other Grains	<1	High	Low
Christmas Trees	<1	High	Low
Wheat	<1	High	Low

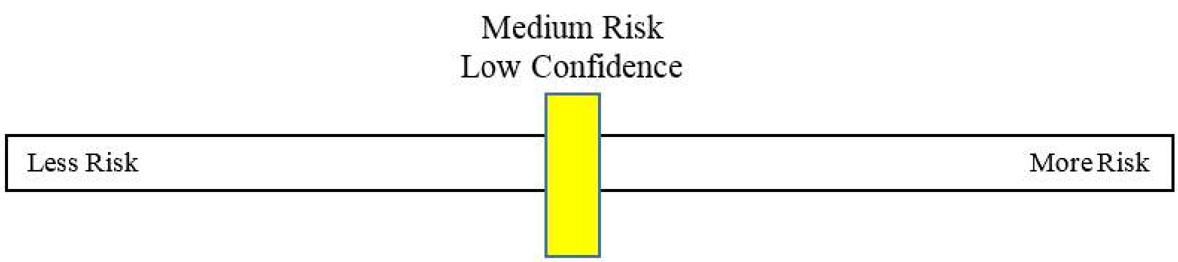
Nurseries	<1	High	Low
Other Row Crops	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce larval and juvenile abundance via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**Low**		

Table 399. Effects analysis summary table: Boccacio, Puget Sound/Georgia Basin DPS and chlorpyrifos

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Larvae and Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce larval and juvenile abundance via acute lethality.	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce larval and juvenile abundance via impacts to growth (direct toxicity)	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce larval and juvenile abundance via reduction in prey availability	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce larval and juvenile abundance via	High	Low	Not Available	**Yes**

impairments to ecologically significant behaviors.				

Effects analysis summary: Adult, juvenile and larval boccacio are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to chlorpyrifos in the marine environment. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, boccacio may experience increased toxicity. If exposed to formulated products and tank mixtures containing chlorpyrifos, boccacio may experience increased toxicity. The overall risk to boccacio from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted chlorpyrifos concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty in the route of exposure to adult boccacio which are typically found in deep marine habitats.



12.42 Gulf Grouper (Mycteroperca jordani)

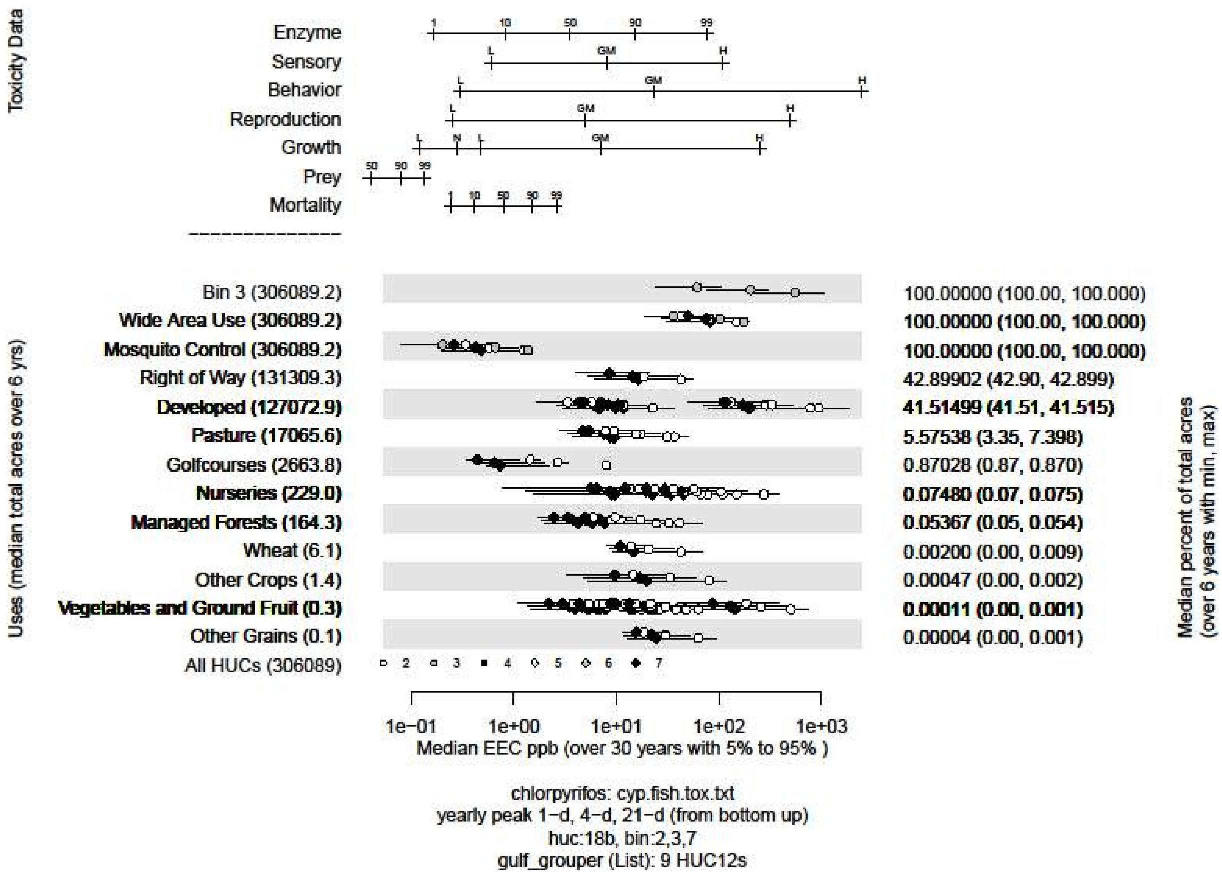


Figure 42. Effects analysis R-plot for Gulf grouper and chlorpyrifos

Table 400. Likelihood of exposure determination for Gulf grouper and chlorpyrifos

Juveniles	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range in US Territories	Likelihood of Exposure
Wide Area Use	3	yes	yes	yes	NA	3	small	**Low**
Mosquito Control	3	yes	yes	yes	NA	3	small	**Low**
Right of Way	3	yes	yes	yes	NA	3	small	**Low**
Developed	3	yes	yes	yes	NA	3	small	**Low**
Pasture	3	yes	yes	yes	no	3	small	**Low**
Golf courses	1	yes	yes	yes	no	3	small	**Low**
Nurseries	1	yes	yes	yes	no	3	small	**Low**
Managed Forest	1	yes	yes	yes	no	3	small	**Low**
Bin 3	1	yes	yes	yes	no	3	small	**Low**

Life Stage: Adult

Exposure pathway not anticipated for adult life history of this species, therefore risk hypotheses for adult life stages not evaluated.

Life Stage: Juvenile

Table 401. Direct mortality risk hypothesis; Gulf grouper and chlorpyrifos; Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Low
Mosquito Control	100	High	Low
Right of Way	43.9	High	Low
Developed	41.5	High	Low
Pasture	5.6	High	Low
Golf courses	.9	High	Low
Nurseries	<1	High	Low
Managed Forest	<1	High	Low
Bin 3		High	Low

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.		
Risk	**Confidence**	
Low	**High**	

Table 402. Prey risk hypothesis; Gulf grouper and chlorpyrifos; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Low
Mosquito Control	100	High	Low
Right of Way	43.9	High	Low
Developed	41.5	High	Low
Pasture	5.6	High	Low
Golf courses	.9	High	Low
Nurseries	<1	High	Low
Managed Forest	<1	High	Low
Bin 3		High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	**High**		

Table 403. Growth risk hypothesis; Gulf grouper and chlorpyrifos; Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Low
Mosquito Control	100	Med	Low
Right of Way	43.9	High	Low

Developed	41.5	High	Low
Pasture	5.6	High	Low
Golf courses	.9	Med	Low
Nurseries	<1	High	Low
Managed Forest	<1	High	Low
Bin 3		High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
Low	**High**		

Table 404. AChE risk hypothesis; Gulf grouper and chlorpyrifos; Juveniles

Endpoint: Enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Low
Mosquito Control	100	Med	Low
Right of Way	43.9	High	Low
Developed	41.5	High	Low
Pasture	5.6	High	Low
Golf courses	.9	Med	Low
Nurseries	<1	High	Low
Managed Forest	<1	High	Low
Bin 3		High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**High**		

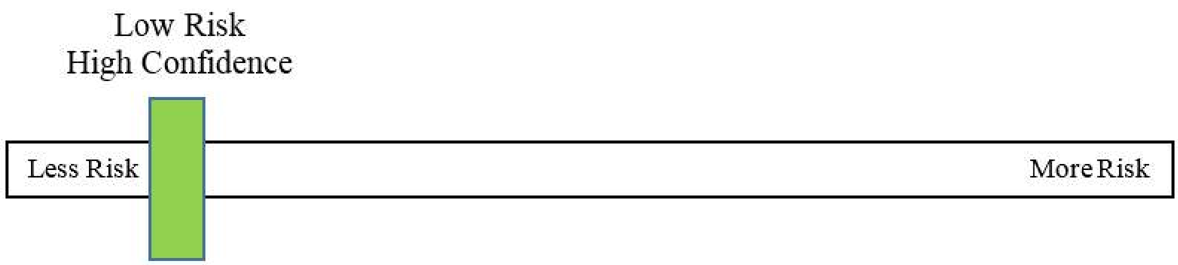
Table 405. Behavior and sensory risk hypothesis; Gulf grouper and chlorpyrifos; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Low
Mosquito Control	100	Med	Low
Right of Way	43.9	High	Low
Developed	41.5	High	Low
Pasture	5.6	High	Low
Golf courses	.9	Med	Low
Nurseries	<1	High	Low
Managed Forest	<1	High	Low
Bin 3		High	Low
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Low
Mosquito Control	100	Med	Low
Right of Way	43.9	High	Low
Developed	41.5	High	Low
Pasture	5.6	High	Low
Golf courses	.9	Med	Low
Nurseries	<1	High	Low
Managed Forest	<1	High	Low
Bin 3		High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors			
Risk	**Confidence**		
Low	**High**		

Table 406. Effects analysis summary table: Gulf grouper and chlorpyrifos

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.	Low	High	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)	Low	High	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via reduction in prey availability	Low	High	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	High	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	Low	High	Not Available	**No**

Effects analysis summary: Adult and juvenile Gulf grouper are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to chlorpyrifos in the marine environment. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, groupers may experience increased toxicity. The overall risk to Gulf grouper from the effects of the action is low and the confidence associated with that risk is high. The low risk to groupers is due primarily to the small portion of the species' range within US territories. Low risk is also attributed to uncertainty in the route of exposure to adult groupers which are typically found in deep marine habitats


Low Risk
High Confidence
Less Risk
More Risk

12.43 Nassau Grouper (Epinephelus striatus)

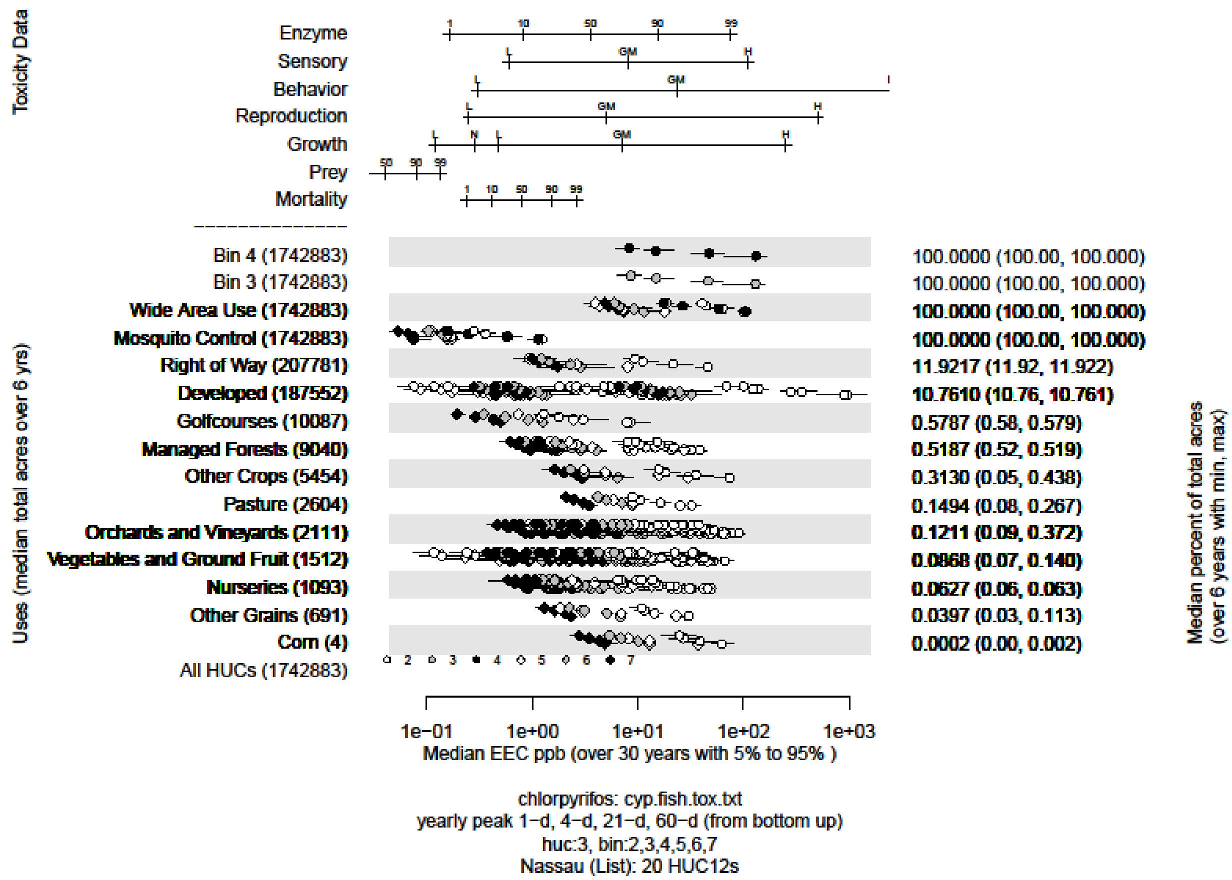


Figure 43. Effects analysis R-plot for Nassau Grouper and chlorpyrifos

Table 407. Likelihood of exposure determination for Nassau Grouper and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range within US Territories	Likelihood of Exposure
Adults and Juveniles (Florida)								
Wide Area Use	3	yes	yes	yes	NA	3	small	Low
Mosquito Control	3	yes	yes	yes	NA	3	small	Low
Right of Way	3	yes	yes	yes	NA	3	small	Low
Developed	3	yes	yes	yes	NA	3	small	Low
Golf Courses	1	yes	yes	yes	no	3	small	Low
Managed Forest	1	yes	yes	yes	no	3	small	Low
Other Crops	1	yes	yes	yes	no	3	small	Low
Pasture	1	yes	yes	yes	no	3	small	Low
Orchards and Vineyards	1	yes	yes	yes	no	3	small	Low
Vegetables and Ground fruit	1	yes	yes	yes	no	3	small	Low
Nurseries	1	yes	yes	yes	no	3	small	Low
Bin 3	1	yes	yes	yes	no	3	small	Low
Adults and Juveniles (US Territories in Caribbean)								
Crops	NA	yes	yes	yes	NA	3	small	Low
Developed	NA	yes	yes	yes	NA	3	small	Low
Mosquito Control	3	yes	yes	yes	NA	3	small	Low
Other	NA	yes	yes	yes	NA	3	small	Low

Life Stage: Adult

Table 408. Direct mortality risk hypothesis; Nassau Grouper and chlorpyrifos; Adults (Florida Coast)

Endpoint: Mortality (Florida Coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Low
Mosquito Control	100	High	Low
Right of Way	12	High	Low
Developed	10.7	High	Low
Golf Courses	>1	High	Low
Managed Forest	>1	High	Low
Other Crops	>1	High	Low
Pasture	>1	High	Low
Orchards and Vineyards	>1	High	Low

Vegetables and Ground fruit	>1	High	Low
Nurseries	>1	High	Low
Bin 3		High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**High**		

Table 409. Direct mortality risk hypothesis; Nassau Grouper and chlorpyrifos; Adults (US Territories in the Caribbean)

Endpoint: Mortality (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	100	High	Low
Other	Not Available	High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**High**		

Table 410. Reproduction risk hypothesis; Nassau Grouper and chlorpyrifos; Adults (Florida Coast)

Endpoint: Reproduction (Florida coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Low
Mosquito Control	100	Medium	Low

Right of Way	12	High	Low
Developed	10.7	High	Low
Golf Courses	>1	Medium	Low
Managed Forest	>1	High	Low
Other Crops	>1	High	Low
Pasture	>1	High	Low
Orchards and Vineyards	>1	High	Low
Vegetables and Ground fruit	>1	High	Low
Nurseries	>1	High	Low
Bin 3		High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**High**		

Table 411. Reproduction risk hypothesis; Nassau Grouper and chlorpyrifos; Adults (US Territories in the Caribbean)

Endpoint: Reproduction (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	100	Medium	Low
Other	Not Available	High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		

Low	**High**	

Table 412. AChE risk hypothesis; Nassau Grouper and chlorpyrifos; Adults (Florida Coast)

Endpoint: enzyme (Florida coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Low
Mosquito Control	100	Medium	Low
Right of Way	12	High	Low
Developed	10.7	High	Low
Golf Courses	>1	High	Low
Managed Forest	>1	High	Low
Other Crops	>1	High	Low
Pasture	>1	High	Low
Orchards and Vineyards	>1	High	Low
Vegetables and Ground fruit	>1	High	Low
Nurseries	>1	High	Low
Bin 3		High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**High**		

Table 413. AChE risk hypothesis; Nassau Grouper and chlorpyrifos; Adults (US Territories in the Caribbean)

Endpoint: Enzyme (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	100	Medium	Low
Other	Not Available	High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**High**		

Table 414. Behavior and sensory risk hypothesis; Nassau Grouper and chlorpyrifos; Adults (Florida Coast)

Endpoint: Behavior (Florida coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Low
Mosquito Control	100	Medium	Low
Right of Way	12	High	Low
Developed	10.7	High	Low
Golf Courses	>1	Medium	Low
Managed Forest	>1	High	Low
Other Crops	>1	High	Low
Pasture	>1	High	Low
Orchards and Vineyards	>1	High	Low
Vegetables and Ground fruit	>1	High	Low
Nurseries	>1	High	Low
Bin 3		High	Low
Endpoint: Sensory (Florida coast)			

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	Low
Mosquito Control	100	Medium	Low
Right of Way	12	High	Low
Developed	10.7	High	Low
Golf Courses	>1	High	Low
Managed Forest	>1	High	Low
Other Crops	>1	High	Low
Pasture	>1	High	Low
Orchards and Vineyards	>1	High	Low
Vegetables and Ground fruit	>1	High	Low
Nurseries	>1	High	Low
Bin 3		High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors			
Risk	**Confidence**		
Low	**High**		

Table 415. Behavior and sensory risk hypothesis; Nassau Grouper and chlorpyrifos; Adults (US Territories in the Caribbean)

Endpoint: Behavior (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	100	Medium	Low
Other	Not Available	Medium-High	Low
Endpoint: Sensory (HUC03 – Puerto Rico)			

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	100	Medium	Low
Other	Not Available	High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors			
Risk	**Confidence**		
Low	**High**		

Life Stage: Juvenile

Table 416. Direct mortality risk hypothesis; Nassau Grouper and chlorpyrifos; Juveniles (Florida Coast)

Endpoint: Mortality (Florida coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Low
Mosquito Control	100	High	Low
Right of Way	12	High	Low
Developed	10.7	High	Low
Golf Courses	>1	High	Low
Managed Forest	>1	High	Low
Other Crops	>1	High	Low
Pasture	>1	High	Low
Orchards and Vineyards	>1	High	Low
Vegetables and Ground fruit	>1	High	Low
Nurseries	>1	High	Low
Bin 3		High	Low

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.		
Risk	**Confidence**	
Low	**High**	

Table 417. Direct mortality risk hypothesis; Nassau Grouper and chlorpyrifos; Juveniles (US Territories in the Caribbean)

Endpoint: Mortality (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	100	High	Low
Other	Not Available	High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.			
Risk	**Confidence**		
Low	**High**		

Table 418. Prey risk hypothesis; Nassau Grouper and chlorpyrifos; Juveniles (Florida Coast)

Endpoint: Prey (Florida coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Low
Mosquito Control	100	High	Low
Right of Way	12	High	Low
Developed	10.7	High	Low
Golf Courses	>1	High	Low
Managed Forest	>1	High	Low

Other Crops	>1	High	Low
Pasture	>1	High	Low
Orchards and Vineyards	>1	High	Low
Vegetables and Ground fruit	>1	High	Low
Nurseries	>1	High	Low
Bin 3		High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	**High**		

Table 419. Prey risk hypothesis; Nassau Grouper and chlorpyrifos; Juveniles (US Territories in the Caribbean)

Endpoint: Prey (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	
Developed	Not Available	High	
Mosquito Control	Not Available	High	
Other	Other	High	
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	**High**		

Table 420. Growth risk hypothesis; Nassau Grouper and chlorpyrifos; Juveniles (Florida Coast)

Endpoint: Growth (Florida coast)

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	Low
Mosquito Control	100	Medium	Low
Right of Way	12	High	Low
Developed	10.7	High	Low
Golf Courses	>1	Medium	Low
Managed Forest	>1	High	Low
Other Crops	>1	High	Low
Pasture	>1	High	Low
Orchards and Vineyards	>1	High	Low
Vegetables and Ground fruit	>1	High	Low
Nurseries	>1	High	Low
Bin 3		High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
Low	**High**		

Table 421. Growth risk hypothesis; Nassau Grouper and chlorpyrifos; Juveniles (US Territories in the Caribbean)

Endpoint: Growth (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	100	Medium	Low
Other	Not Available	Medium-High	Low

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)		
Risk	**Confidence**	
Low	**High**	

Table 422. AChE risk hypothesis; Nassau Grouper and chlorpyrifos; Juveniles (Florida Coast)

Endpoint: Enzyme (Florida coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Low
Mosquito Control	100	Medium	Low
Right of Way	12	High	Low
Developed	10.7	High	Low
Golf Courses	>1	High	Low
Managed Forest	>1	High	Low
Other Crops	>1	High	Low
Pasture	>1	High	Low
Orchards and Vineyards	>1	High	Low
Vegetables and Ground fruit	>1	High	Low
Nurseries	>1	High	Low
Bin 3		High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**High**		

Table 423. AChE risk hypothesis; Nassau Grouper and chlorpyrifos; Juveniles (US Territories in the Caribbean)

Endpoint: Enzyme (HUC03 – Puerto Rico, Virgin Islands)

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Crops	Not Available	High	
Developed	Not Available	High	
Mosquito Control	100	Medium	
Other	Not Available	High	
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**High**		

Table 424. Behavior and sensory risk hypothesis; Nassau Grouper and chlorpyrifos; Juveniles (Florida Coast)

Endpoint: Behavior (Florida coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use		High	Low
Mosquito Control		Medium	Low
Right of Way		High	Low
Developed		High	Low
Golf Courses		Medium	Low
Managed Forest		High	Low
Other Crops		High	Low
Pasture		High	Low
Orchards and Vineyards		High	Low
Vegetables and Ground fruit		High	Low
Nurseries		High	Low

Bin 3		High	Low
Endpoint: Sensory (Florida coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use		High	Low
Mosquito Control		Medium	Low
Right of Way		High	Low
Developed		High	Low
Golf Courses		High	Low
Managed Forest		High	Low
Other Crops		High	Low
Pasture		High	Low
Orchards and Vineyards		High	Low
Vegetables and Ground fruit		High	Low
Nurseries		High	Low
Bin 3		High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors			
Risk	**Confidence**		
Low	**High**		

Table 425. Behavior and sensory risk hypothesis; Nassau Grouper and chlorpyrifos; Juveniles (US Territories in the Caribbean)

Endpoint: behavior (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	100	High	Low

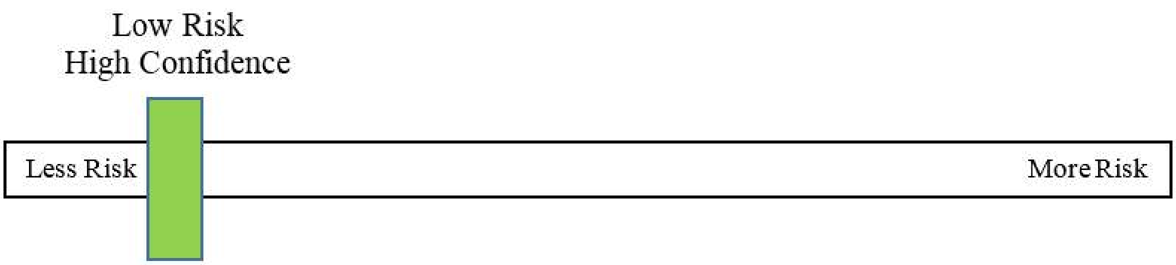
Managed Forest	Not Available	High	Low
Endpoint: sensory (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	100	High	Low
Managed Forest	Not Available	High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce productivity of populations via effects on larvae (settling, metamorphosis, mortality, etc.)			
Risk	**Confidence**		
Low	**Medium**		

Table 426. Effects analysis summary table: Nassau Grouper and chlorpyrifos

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles and Adults (Florida Coast)	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	**Low**	**High**	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction (Adult)	**Low**	**High**	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	**Low**	**High**	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to	**Low**	**High**	Not Available	**No**

ecologically significant behaviors.				
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via reduction in prey availability	**Low**	**High**	Not Available	**No**
Juveniles and Adults (HUC03 – Puerto Rico, Virgin Islands)				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	**Low**	**High**	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction (Adults)	**Low**	**High**	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	**Low**	**High**	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	**Low**	**High**	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via reduction in prey availability	**Low**	**High**	Not Available	**No**

Effects analysis summary: Adult and juvenile Nassau Grouper are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to chlorpyrifos in the marine environment. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, groupers may experience increased toxicity. The overall risk to Nassau Grouper from the effects of the action is low and the confidence associated with that risk is high. The low risk to Nassau Grouper is due primarily to the small portion of the species' range within US territories. Low risk is also attributed to uncertainty in the route of exposure to adult groupers which are typically found in deep marine habitats.


Low Risk
High Confidence
Less Risk
More Risk

12.44 Smalltooth Sawfish (Pristis pectinate)

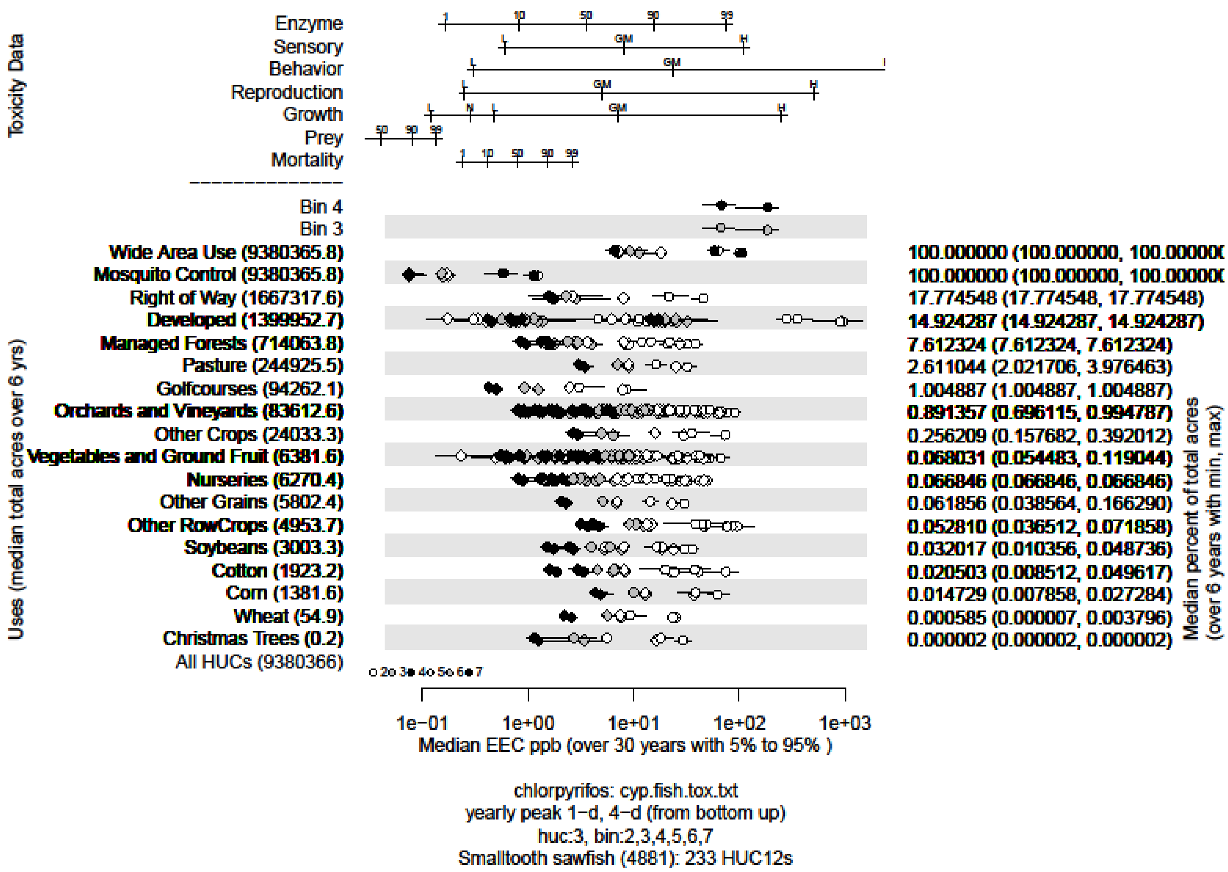


Figure 44. Effects analysis R-plot for Smalltooth sawfish and chlorpyrifos; Full Range

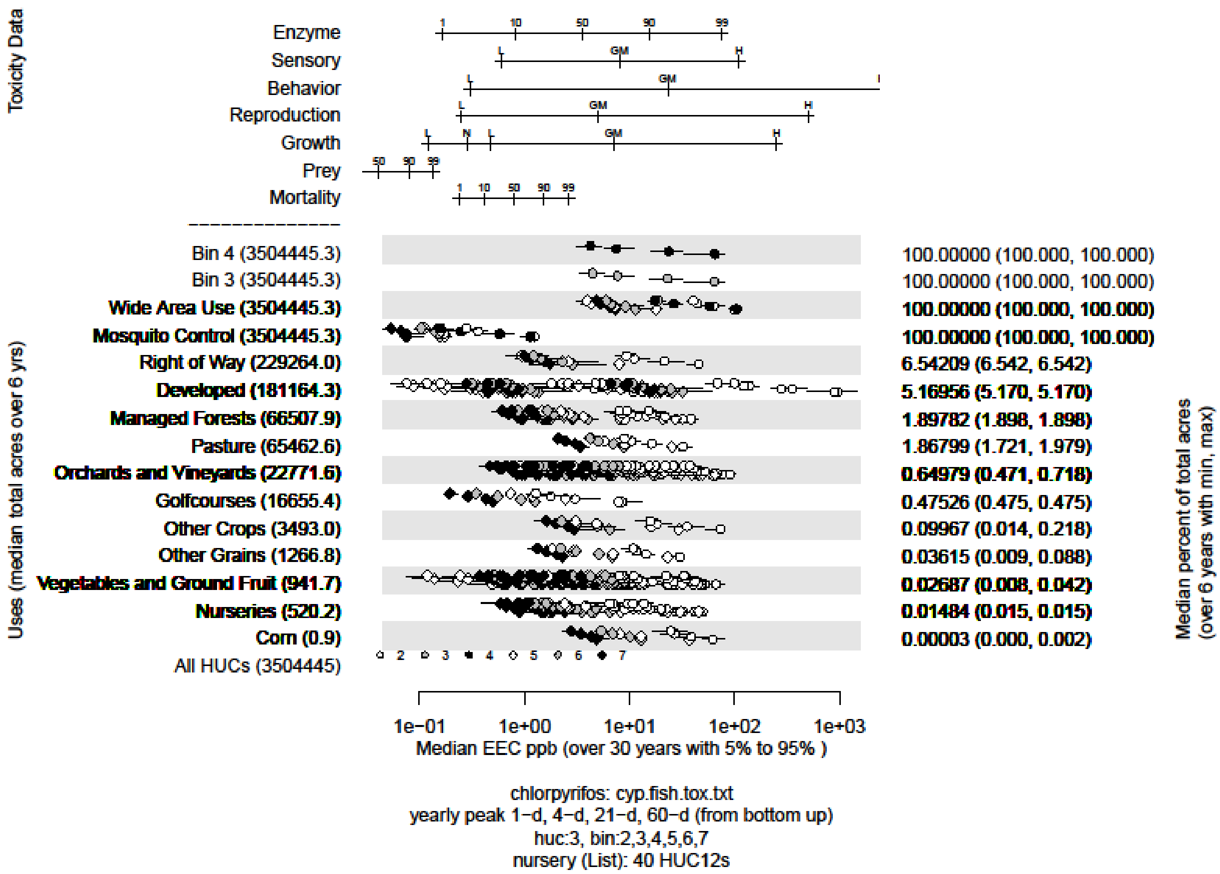


Figure 45. Effects analysis R-plot for Smalltooth sawfish and chlorpyrifos; Charlotte Harbor, Ten Thousand Islands, Everglades Nursery Areas

Table 427. Likelihood of exposure determination for Smalltooth sawfish and chlorpyrifos

	Percent Overlap	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Full Range							
RoW	3	yes	yes	yes	NA	3	**High**
Developed	3	yes	yes	yes	NA	3	**High**
Managed Forest	3	yes	yes	yes	NA	3	**High**
Pasture	2	yes	yes	yes	NA	3	**High**
Golf Course	2	yes	yes	yes	NA	3	**High**
Mosquito	3	yes	yes	yes	NA	3	**High**
Wide Area	3	yes	yes	yes	NA	3	**Med**
Nursery Only							
RoW	3	yes	yes	yes	NA	3	**High**
Developed	3	yes	yes	yes	NA	3	**High**
Managed Forest	2	yes	yes	yes	NA	3	**High**
Pasture	2	yes	yes	yes	NA	3	**High**
Golf Course	1	yes	yes	yes	yes	3	**High**
Mosquito	3	yes	yes	yes	NA	3	**High**
Wide Area	3	yes	yes	yes	yes	3	**High**
Orchards and Vinyards	1	yes	yes	yes	yes	3	**High**
Othe Grain	1	yes	yes	yes	no	3	**Low**
Corn	1	yes	yes	yes	no	3	**Low**
Other Crop	1	yes	yes	yes	no	3	**Low**
Veggie	1	yes	yes	yes	no	3	**Low**
Nursery	1	yes	yes	yes	no	3	**Low**

Adult Life Stage (Coastal Habitats - Full Species Range)

Table 428. Direct mortality risk hypothesis; Smalltooth sawfish and chlorpyrifos; Adults

Mortality (% overlap)	Effect of Exposure	Likelihood of Exposure
Managed Forest (8%)	High	High
Wide Area Use (100%)	High	High
Right of Way (18%)	High	High
Pasture (3%)	High	High
Developed (15%)	High	High
Mosquito Control (100%)	High	High

Golf Course (1%)	High	High
Bin 3	High	High
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.		
	Risk	**Confidence**
	High	**Low**

Table 429. Prey risk hypothesis; Smalltooth sawfish and chlorpyrifos; Adults

Prey (% overlap)	Effect of Exposure	Likelihood of Exposure
Managed Forest (8%)	High	High
Wide Area Use (100%)	High	High
Right of Way (18%)	High	High
Pasture (3%)	High	High
Developed (15%)	High	High
Mosquito Control (100%)	High	High
Golf Course (1%)	High	High
Bin 3	High	High
Exposure to chlorpyrifos is sufficient to reduce adult abundance via reduction in prey availability		
	Risk	**Confidence**
	High	**Low**

Table 430. AChE risk hypothesis; Smalltooth sawfish and chlorpyrifos; Adults

Enzyme - AChE(% overlap)	Effect of Exposure	Likelihood of Exposure
Managed Forest (8%)	High	High
Wide Area Use (100%)	High	High
Right of Way (18%)	High	High
Pasture (3%)	High	High
Developed (15%)	High	High
Mosquito Control (100%)	Med	High

Golf Course (1%)	High	High
Bin 3	High	High
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity		
	Risk	**Confidence**
	High	**Low**

Table 431. Behavior and sensory risk hypothesis; Smalltooth sawfish and chlorpyrifos; Adults

Sensory (% overlap)	Effect of Exposure	Likelihood of Exposure
Managed Forest (8%)	High	High
Wide Area Use (100%)	High	High
Right of Way (18%)	High	High
Pasture (3%)	High	High
Developed (15%)	High	High
Mosquito Control (100%)	Low	High
Golf Course (1%)	High	High
Bin 3	High	High
Behavior (% overlap)	**Effect of Exposure**	**Likelihood of Exposure**
Managed Forest (8%)	High	High
Wide Area Use (100%)	High	High
Right of Way (18%)	High	High
Pasture (3%)	High	High
Developed (15%)	High	High
Mosquito Control (100%)	Low	High
Golf Course (1%)	High	High
Bin 3	High	High
Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.		
	Risk	**Confidence**

	High	Low

Table 432. Reproduction risk hypothesis; Smalltooth sawfish and chlorpyrifos; Adults

Reproduction (% overlap)	**Effect of Exposure**	**Likelihood of Exposure**
Managed Forest (8%)	High	High
Wide Area Use (100%)	High	High
Right of Way (18%)	High	High
Pasture (3%)	High	High
Developed (15%)	High	High
Mosquito Control (100%)	Low	High
Golf Course (1%)	High	High
Bin 3	High	High
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction		
	Risk	**Confidence**
	High	**Low**

Juvenile and Adult Female Life Stages (Nursery Habitats)

Table 433. Direct mortality risk hypothesis; Smalltooth sawfish and chlorpyrifos; Adults and Juveniles

Mortality (% overlap)	**Effect of Exposure**	**Likelihood of Exposure**
Managed Forest (2%)	High	High
Wide Area Use (100%)	High	High
Right of Way (7%)	High	High
Pasture (2%)	High	High
Developed (5%)	High	High
Mosquito Control	High	High

(100%)		
Golf Course (<1%)	High	High
Orchards (<1%)	High	High
Other uses (<1%)	High	Low
Bin 3	High	High
Bin 4	High	High
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.		
	Risk	**Confidence**
	High	**High**

Table 434. Prey risk hypothesis; Smalltooth sawfish and chlorpyrifos; Adults and Juveniles

Juvenile Prey (% overlap)	Effect of Exposure	Likelihood of Exposure
Managed Forest (2%)	High	High
Wide Area Use (100%)	High	High
Right of Way (7%)	High	High
Pasture (2%)	High	High
Developed (5%)	High	High
Mosquito Control (100%)	High	High
Golf Course (<1%)	High	High
Orchards (<1%)	High	High
Other uses (<1%)	High	Low

Bin 3	High	High
Bin 4	High	High
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via reduction in prey availability		
	Risk	**Confidence**
	High	**High**

Table 435. AChE risk hypothesis; Smalltooth sawfish and chlorpyrifos; Adults and Juveniles

AChE (% overlap)	Effect of Exposure	Likelihood of Exposure
Managed Forest (2%)	High	High
Wide Area Use (100%)	High	High
Right of Way (7%)	High	High
Pasture (2%)	High	High
Developed (5%)	High	High
Mosquito Control (100%)	Med	High
Golf Course (<1%)	High	High
Orchards (<1%)	High	High
Other uses (<1%)	High	Low
Bin 3	High	High
Bin 4	High	High
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity		
	Risk	**Confidence**
	High	**High**

Table 436. Behavior and sensory risk hypothesis; Smalltooth sawfish and chlorpyrifos; Adults and Juveniles

Sensory (% overlap)	Effect of Exposure	Likelihood of Exposure
Managed Forest (2%)	High	High
Wide Area Use (100%)	High	High
Right of Way (7%)	High	High
Pasture (2%)	High	High
Developed (5%)	High	High
Mosquito Control (100%)	Med	High
Golf Course (<1%)	High	High
Orchards (<1%)	High	High
Other uses (<1%)	High	Low
Bin 3	High	High
Bin 4	High	High
Behavior (% overlap)	**Effect of Exposure**	**Likelihood of Exposure**
Managed Forest (2%)	High	High
Wide Area Use (100%)	High	High
Right of Way (7%)	High	High
Pasture (2%)	High	High
Developed (5%)	High	High

Mosquito Control (100%)	Med	High
Golf Course (<1%)	Med	High
Orchards (<1%)	High	High
Other uses (<1%)	High	Low
Bin 3	High	High
Bin 4	High	High
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.		
	Risk	**Confidence**
	High	**High**

Table 437. Reproduction risk hypothesis; Smalltooth sawfish and chlorpyrifos; Adults

Adult Female Reproduction	Effect of Exposure	Likelihood of Exposure
Managed Forest (2%)	High	High
Wide Area Use (100%)	High	High
Right of Way (7%)	High	High
Pasture (2%)	High	High
Developed (5%)	High	High
Mosquito Control (100%)	Med	High
Golf Course (<1%)	High	High
Orchards (<1%)	High	High

Other uses (<1%)	High	Low
Bin 3	High	High
Bin 4	High	High
Exposure to chlorpyrifos is sufficient to reduce female productivity via impairments to reproduction		
	Risk	**Confidence**
	High	**High**

Table 438. Growth risk hypothesis; Smalltooth sawfish and chlorpyrifos; Juveniles

Juvenile Growth(% overlap)	Effect of Exposure	Likelihood of Exposure
Managed Forest (2%)	High	High
Wide Area Use (100%)	High	High
Right of Way (7%)	High	High
Pasture (2%)	High	High
Developed (5%)	High	High
Mosquito Control (100%)	Med	High
Golf Course (<1%)	High	High
Orchards (<1%)	High	High
Other uses (<1%)	High	Low
Bin 3	High	High
Bin 4	High	High
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)		

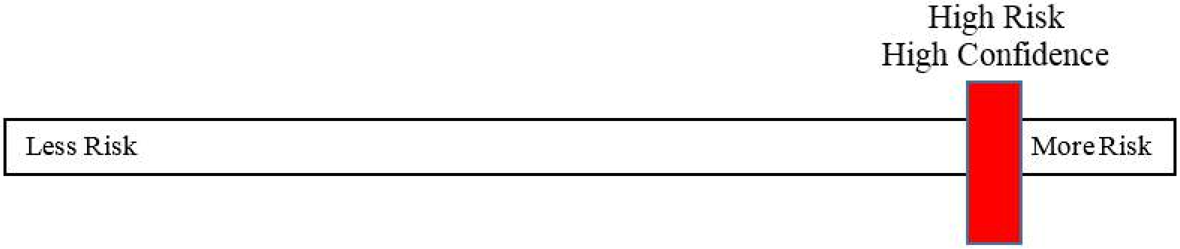
	Risk	Confidence
	High	High

Table 439. Effects analysis summary table: Smalltooth sawfish and chlorpyrifos

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Adults (Full Range)	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	Low	4-day: 33-84 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult abundance via reduction in prey availability	High	Low	4-day fish: 21-79 4-day invert: 44-97 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; mechanism of toxicity	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	Low	Not Available	**Yes**
Adult Females in Nursery Areas				
Exposure to chlorpyrifos is sufficient to reduce female productivity via impairments to reproduction	High	High	Not Available	**Yes**
Juveniles in Nursery Areas				

Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 33-84 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via reduction in prey availability	High	High	4-day fish: 21-79 4-day invert: 44-97 **Error! Reference source not found.**	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Smalltooth sawfish are anticipated to experience reduced abundance and productivity (adults) from exposure to chlorpyrifos. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where chlorpyrifos achieves predicted levels. The MagTool results indicate that between 33-84 percent of individuals within a population will die. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, sawfish will likely experience more toxicity. The overall risk to Smalltooth sawfish from the effects of the action is high and the confidence associated with that risk is high.



12.45 Black Abalone (Haliotis cracherodii)

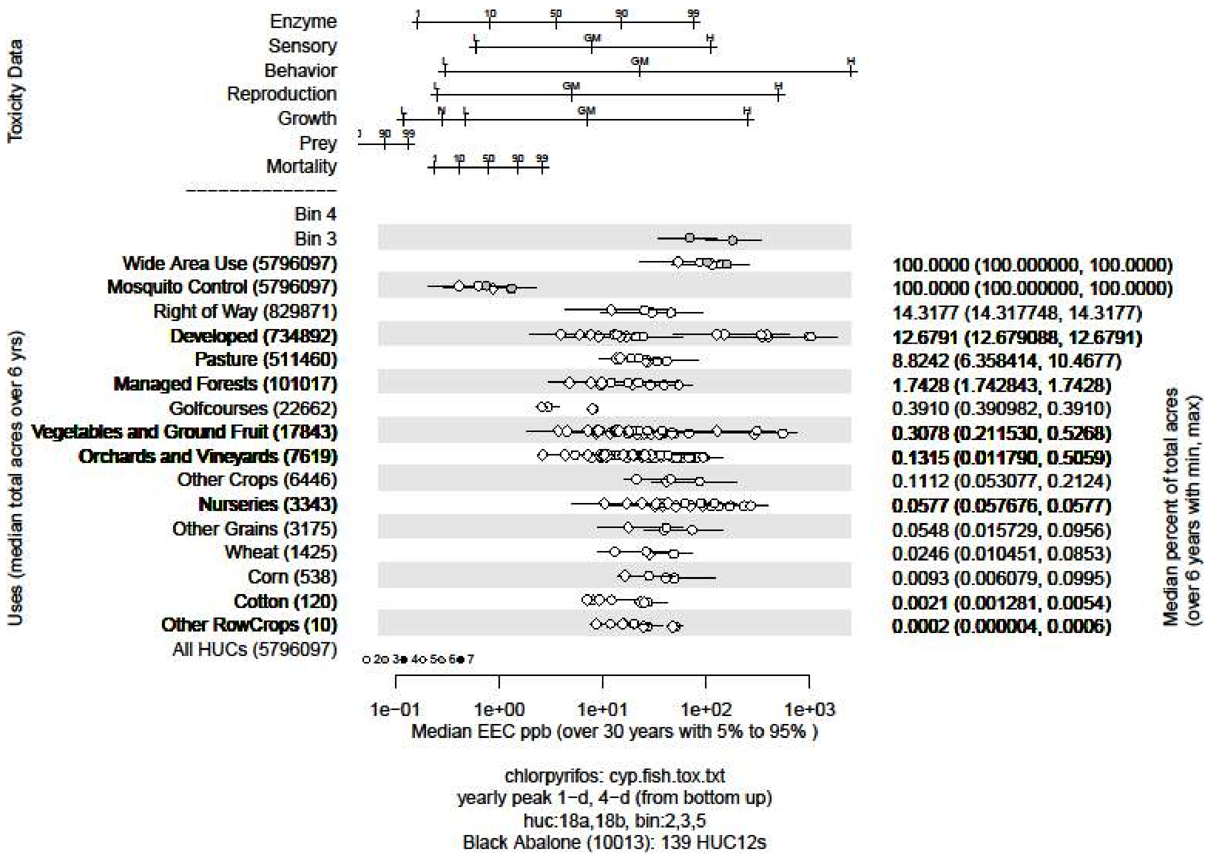


Figure 46. Effects analysis R-plot for Black abalone and chlorpyrifos

Table 440. Likelihood of exposure determination for Black abalone and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Wide Area Use	3	yes	yes	yes	NA	3	**High**
Mosquito Control	3	yes	yes	yes	NA	3	**High**
Right of Way	3	yes	yes	yes	NA	3	**High**
Developed	3	yes	yes	yes	NA	3	**High**
Pasture	3	yes	yes	yes	NA	3	**High**
Managed Forest	2	yes	yes	yes	NA	3	**High**
Golf Courses	1	yes	yes	yes	NA	3	**Low**
Vegetables and Ground Fruit	1	yes	yes	yes	NA	3	**Low**
Orchards and Vineyards	1	yes	yes	yes	NA	3	**Low**
Other Crops	1	yes	yes	yes	NA	3	**Low**
Nurseries	1	yes	yes	yes	NA	3	**Low**
Other Grains	1	yes	yes	yes	NA	3	**Low**
Wheat	1	yes	yes	yes	NA	3	**Low**
Corn	1	yes	yes	yes	NA	3	**Low**
Cotton	1	yes	yes	yes	NA	3	**Low**
Other Row Crops	1	yes	yes	yes	NA	3	**Low**
Bin 3	3	yes	yes	yes	NA	3	**High**

Life Stage: Larvae/Juvenile and Adult (full-range)

Table 441. Direct mortality risk hypothesis; Black abalone and chlorpyrifos; Larvae/Juvenile and Adult

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Right of Way	14.3	High	High
Developed	12.7	High	High
Pasture	8.8	High	High
Managed Forest	1.7	High	High
Golf Courses	0.4	High	Low
Vegetables and Ground Fruit	0.3	High	Low
Orchards and Vineyards	<1	High	Low

Other Crops	<1	High	Low
Nurseries	<1	High	Low
Other Grains	<1	High	Low
Wheat	<1	High	Low
Corn	<1	High	Low
Cotton	<1	High	Low
Other Row Crops	<1	High	Low
Bin 3		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce the abundance of larval/juvenile and adults via direct toxicity			
Risk	**Confidence**		
High	**Low**		

Table 442. Prey risk hypothesis; Black abalone and chlorpyrifos; Juvenile and Adult

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Low	High
Right of Way	14.3	Medium	High
Developed	12.7	High	High
Pasture	8.8	Medium	High
Managed Forest	1.7	Medium	High
Golf Courses	0.4	Low	Low
Vegetables and Ground Fruit	0.3	High	Low
Orchards and Vineyards	<1	Medium	Low
Other Crops	<1	High	Low
Nurseries	<1	High	Low

Other Grains	<1	Medium	Low
Wheat	<1	Medium	Low
Corn	<1	Medium	Low
Cotton	<1	Medium	Low
Other Row Crops	<1	Medium	Low
Bin 3		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce the abundance of juvenile and adults via reduction in prey availability			
Risk	**Confidence**		
High	**Low**		

Table 443. Behavior and sensory risk hypothesis; Black abalone and chlorpyrifos; Larvae/Juvenile and Adult

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Right of Way	14.3	High	High
Developed	12.7	High	High
Pasture	8.8	High	High
Managed Forest	1.7	High	High
Golf Courses	0.4	High	Low
Vegetables and Ground Fruit	0.3	High	Low
Orchards and Vineyards	<1	High	Low
Other Crops	<1	High	Low
Nurseries	<1	High	Low
Other Grains	<1	High	Low
Wheat	<1	High	Low

Corn	<1	High	Low
Cotton	<1	High	Low
Other Row Crops	<1	High	Low
Bin 3		High	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	Not Available	High
Mosquito Control	100	Not Available	High
Right of Way	14.3	Not Available	High
Developed	12.7	Not Available	High
Pasture	8.8	Not Available	High
Managed Forest	1.7	Not Available	High
Golf Courses	0.4	Not Available	Low
Vegetables and Ground Fruit	0.3	Not Available	Low
Orchards and Vineyards	<1	Not Available	Low
Other Crops	<1	Not Available	Low
Nurseries	<1	Not Available	Low
Other Grains	<1	Not Available	Low
Wheat	<1	Not Available	Low
Corn	<1	Not Available	Low
Cotton	<1	Not Available	Low
Other Row Crops	<1	Not Available	Low
Bin 3		Not Available	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce the abundance and productivity of larval/juvenile and adults via impairments to ecologically significant behaviors (e.g. prey capture, settling, metamorphosis).			
Risk	**Confidence**		

High	**Low**	

Table 444. AChE risk hypothesis; Black abalone and chlorpyrifos; Larvae/Juvenile and Adult

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Right of Way	14.3	High	High
Developed	12.7	High	High
Pasture	8.8	High	High
Managed Forest	1.7	High	High
Golf Courses	0.4	High	Low
Vegetables and Ground Fruit	0.3	High	Low
Orchards and Vineyards	<1	High	Low
Other Crops	<1	High	Low
Nurseries	<1	High	Low
Other Grains	<1	High	Low
Wheat	<1	High	Low
Corn	<1	High	Low
Cotton	<1	High	Low
Other Row Crops	<1	High	Low
Bin 3		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Low**		

Table 445. Growth risk hypothesis; Black abalone and chlorpyrifos; Larvae/Juvenile and Adult

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	14.3	High	High
Developed	12.7	High	High
Pasture	8.8	High	High
Managed Forest	1.7	High	High
Golf Courses	0.4	High	Low
Vegetables and Ground Fruit	0.3	High	Low
Orchards and Vineyards	<1	High	Low
Other Crops	<1	High	Low
Nurseries	<1	High	Low
Other Grains	<1	High	Low
Wheat	<1	High	Low
Corn	<1	High	Low
Cotton	<1	High	Low
Other Row Crops	<1	High	Low
Bin 3		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce the abundance and productivity of larval/juvenile and adults via reductions in growth (direct toxicity)			
Risk	**Confidence**		
High	**Low**		

Table 446. Reproduction risk hypothesis; Black abalone and chlorpyrifos; Adult

Endpoint: Reproduction

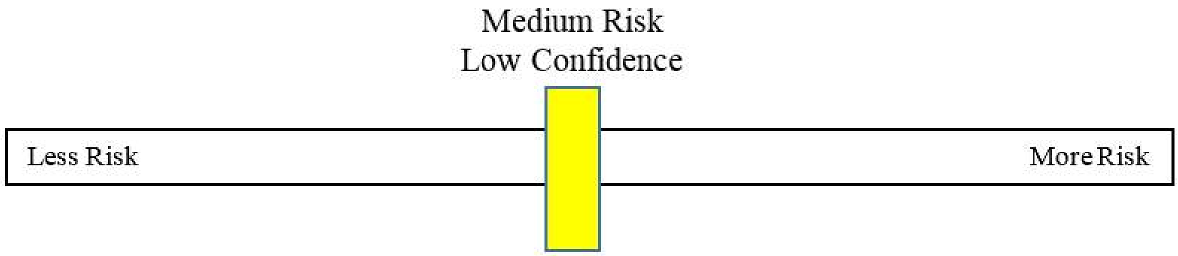
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	14.3	High	High
Developed	12.7	High	High
Pasture	8.8	High	High
Managed Forest	1.7	High	High
Golf Courses	0.4	High	Low
Vegetables and Ground Fruit	0.3	High	Low
Orchards and Vineyards	<1	High	Low
Other Crops	<1	High	Low
Nurseries	<1	High	Low
Other Grains	<1	High	Low
Wheat	<1	High	Low
Corn	<1	High	Low
Cotton	<1	High	Low
Other Row Crops	<1	High	Low
Bin 3		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce the productivity of adults via impairments to reproduction.			
Risk	**Confidence**		
High	**Low**		

Table 447. Effects analysis summary table: Black abalone and chlorpyrifos

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Larvae/Juveniles and Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				

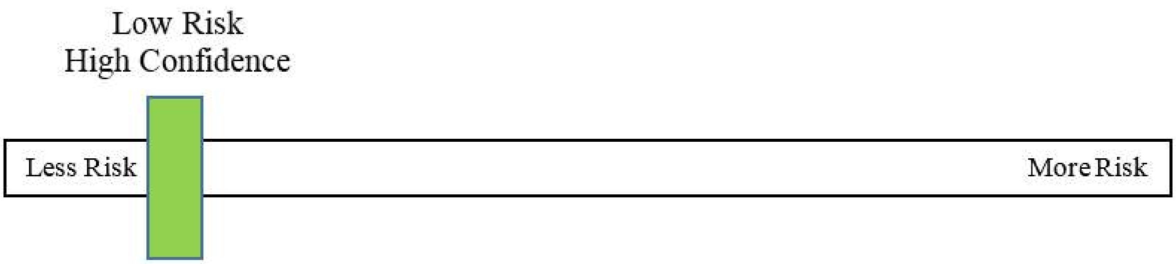
Exposure to chlorpyrifos is sufficient to reduce the abundance of larval/juvenile and adults via direct toxicity	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce the abundance of juvenile and adults via reduction in prey availability	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce the abundance and productivity of larval/juvenile and adults via impairments to ecologically significant behaviors (e.g. prey capture, settling, metamorphosis).	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce the abundance and productivity of larval/juvenile and adults via reductions in growth (direct toxicity)	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce the productivity of adults via impairments to reproduction.	High	Low	Not Available	Yes

Effects analysis summary: Adult, juvenile and larval black abalone are not anticipated to experience significant reductions in abundance and productivity (adults) from exposure to chlorpyrifos. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, abalone may experience increased toxicity. The overall risk to black abalone from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted chlorpyrifos concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the portion of the population which occupy tide-pools.



12.46 White Abalone (Haliotis sorenseni)

Effects analysis summary: Adult and juvenile white abalone are not anticipated to experience significant reductions in abundance and productivity (adults) from exposure to chlorpyrifos. The overall risk to white abalone from the effects of the action is low and the confidence associated with that risk is high. The low risk is due primarily to the proximity of white abalone habitat (marine off-shore; depths of 80-100 feet) relative to chlorpyrifos use sites.



12.47 Caribbean Corals (7 species): Orbicella franksi; Orbicella annularis; Orbicella faveolata; Mycetophyllia ferox; Acropora cervicornis; Acropora palmate; Dendrogyra cylindrus

Table 448. Likelihood of exposure determination for Caribbean corals (7 species) and chlorpyrifos

	Percent Overlap	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range within US Territories	Likelihood of Exposure
Florida Coast								
Wide Area Use	3	yes	yes	yes	NA	3	8%	High
Mosquito Control	3	yes	yes	yes	NA	3	8%	High
Right of Way	2	yes	yes	yes	NA	3	8%	High
Developed	2	yes	yes	yes	NA	3	8%	High
Golf Courses	1	yes	yes	yes	NA	3	8%	Low
Pasture	1	yes	yes	yes	NA	3	8%	Low
Managed Forest	1	yes	yes	yes	NA	3	8%	Low
Other Crops	1	yes	yes	yes	NA	3	8%	Low
Orchards and Vineyards	1	yes	yes	yes	NA	3	8%	Low
Nurseries	1	yes	yes	yes	NA	3	8%	Low
Other Grains	1	yes	yes	yes	NA	3	8%	Low
Vegetable and Ground Fruit	1	yes	yes	yes	NA	3	8%	Low
Bin 3	3	yes	yes	yes	NA	3	8%	High
US Territories in Caribbean								
Crops	NA	yes	yes	yes	NA	3	8%	Med
Developed	NA	yes	yes	yes	NA	3	8%	Med
Mosquito Control	100	yes	yes	yes	NA	3	8%	High
Managed Forest/Other	NA	yes	yes	yes	NA	3	8%	Med

Table 449. Direct mortality risk hypothesis; Caribbean corals (7 species) and chlorpyrifos; Florida Coast

Endpoint: Mortality (Southeast Florida Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Right of Way	17.3	High	High
Developed	16.1	High	High
Golf Courses	1.1	High	Low

Pasture	.3	High	Low
Managed Forest	.2	High	Low
Other Crops	.01	High	Low
Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low
Other Grains	.03	High	Low
Vegetable and Ground Fruit	.008	High	Low
Bin 3		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce the abundance of populations via direct toxicity			
Risk	**Confidence**		
High	**Low**		

Table 450. Direct mortality risk hypothesis; Caribbean corals (7 species) and chlorpyrifos; US Territories in the Caribbean

Endpoint: Mortality (HUC03; US territories in the Caribbean)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Medium
Developed	Not Available	High	Medium
Mosquito Control	Not Available	High	High
Managed Forest/Other	Not Available	High	Medium
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce the abundance of populations via direct toxicity			
Risk	**Confidence**		
High	**Low**		

Table 451. Prey risk hypothesis; Caribbean corals (7 species) and chlorpyrifos; Florida Coast

Endpoint: Prey (Southeast Florida Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Right of Way	17.3	High	High
Developed	16.1	High	High
Golf Courses	1.1	High	Low
Pasture	.3	High	Low
Managed Forest	.2	High	Low
Other Crops	.01	High	Low
Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low
Other Grains	.03	High	Low
Vegetable and Ground Fruit	.008	High	Low
Bin 3		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce the abundance of populations via reduction in prey availability			
Risk	**Confidence**		
High	**Low**		

Table 452. Prey risk hypothesis; Caribbean corals (7 species) and chlorpyrifos; US Territories in the Caribbean

Endpoint: Prey (HUC03; US territories in the Caribbean)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Medium
Developed	Not Available	High	Medium

Mosquito Control	Not Available	High	High
Managed Forest/Other	Not Available	High	Medium
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce the abundance of populations via reduction in prey availability			
Risk	**Confidence**		
High	**Low**		

Table 453. AChE risk hypothesis; Caribbean corals (7 species) and chlorpyrifos; Florida Coast

Endpoint: Enzyme (Southeast Florida Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Right of Way	17.3	High	High
Developed	16.1	High	High
Golf Courses	1.1	High	Low
Pasture	.3	High	Low
Managed Forest	.2	High	Low
Other Crops	.01	High	Low
Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low
Other Grains	.03	High	Low
Vegetable and Ground Fruit	.008	High	Low
Bin 3		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Low**		

Table 454. AChE risk hypothesis; Caribbean corals (7 species) and chlorpyrifos; US Territories in the Caribbean

Endpoint: Enzyme (HUC03; US territories in the Caribbean)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Medium
Developed	Not Available	High	Medium
Mosquito Control	Not Available	High	High
Managed Forest/Other	Not Available	High	Medium
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Low**		

Table 455. Behavior and sensory risk hypothesis; Caribbean corals (7 species) and chlorpyrifos; Florida Coast

Endpoint: Behavior (Southeast Florida Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Right of Way	17.3	High	High
Developed	16.1	High	High
Golf Courses	1.1	High	Low
Pasture	.3	High	Low
Managed Forest	.2	High	Low
Other Crops	.01	High	Low
Orchards and Vineyards	.05	High	Low

Nurseries	.04	High	Low
Other Grains	.03	High	Low
Vegetable and Ground Fruit	.008	High	Low
Bin 3		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce the abundance and productivity of populations via impairments to ecologically significant behaviors (e.g. prey capture).			
Risk	**Confidence**		
High	**Low**		

Table 456. Behavior and sensory risk hypothesis; Caribbean corals (7 species) and chlorpyrifos; US Territories in the Caribbean

Endpoint: Behavior (HUC03; US territories in the Caribbean)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Medium
Developed	Not Available	High	Medium
Mosquito Control	Not Available	High	High
Managed Forest/Other	Not Available	High	Medium
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce the abundance and productivity of populations via impairments to ecologically significant behaviors (e.g. prey capture).			
Risk	**Confidence**		
High	**Low**		

Table 457. Reproduction risk hypothesis; Caribbean corals (7 species) and chlorpyrifos; Florida Coast

Endpoint: Reproduction (Southeast Florida Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High

Mosquito Control	100	Medium	High
Right of Way	17.3	High	High
Developed	16.1	High	High
Golf Courses	1.1	High	Low
Pasture	.3	High	Low
Managed Forest	.2	High	Low
Other Crops	.01	High	Low
Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low
Other Grains	.03	High	Low
Vegetable and Ground Fruit	.008	High	Low
Bin 3		High	High
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce the productivity of populations via impairments to reproduction (e.g. spawning cues).			
Risk	**Confidence**		
High	**Low**		

Table 458. Reproduction risk hypothesis; Caribbean corals (7 species) and chlorpyrifos; US Territories in the Caribbean

Endpoint: Reproduction (HUC03; US territories in the Caribbean)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Medium
Developed	Not Available	High	Medium
Mosquito Control	Not Available	Medium	High
Managed Forest/Other	Not Available	High	Medium
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce the productivity of populations via impairments to reproduction (e.g. spawning cues).			

Risk	Confidence	
High	**Low**	

Table 459. Direct mortality, behavior, reproduction risk hypothesis; Caribbean corals (7 species) and chlorpyrifos; Florida Coast; Larvae

Endpoint: mortality (Southeast Florida Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Right of Way	17.3	High	High
Developed	16.1	High	High
Golf Courses	1.1	High	Low
Pasture	.3	High	Low
Managed Forest	.2	High	Low
Other Crops	.01	High	Low
Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low
Other Grains	.03	High	Low
Vegetable and Ground Fruit	.008	High	Low
Bin 3		High	High
Endpoint: behavior (Southeast Florida Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	High	High
Right of Way	17.3	High	High
Developed	16.1	High	High

Golf Courses	1.1	High	Low
Pasture	.3	High	Low
Managed Forest	.2	High	Low
Other Crops	.01	High	Low
Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low
Other Grains	.03	High	Low
Vegetable and Ground Fruit	.008	High	Low
Bin 3		High	High
Endpoint: reproduction (Southeast Florida Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Mosquito Control	100	Medium	High
Right of Way	17.3	High	High
Developed	16.1	High	High
Golf Courses	1.1	High	Low
Pasture	.3	High	Low
Managed Forest	.2	High	Low
Other Crops	.01	High	Low
Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low
Other Grains	.03	High	Low
Vegetable and Ground Fruit	.008	High	Low
Bin 3		High	High

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce productivity of populations via effects on larvae (settling, metamorphosis, mortality, etc.)		
Risk	**Confidence**	
High	**Low**	

Table 460. Direct mortality, behavior, reproduction risk hypothesis; Caribbean corals (7 species) and chlorpyrifos; US Territories in the Caribbean; Larvae

Endpoint: mortality (HUC03; US territories in the Caribbean)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Medium
Developed	Not Available	High	Medium
Mosquito Control	Not Available	High	High
Managed Forest	Not Available	High	Medium
Endpoint: behavior (HUC03; US territories in the Caribbean)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Medium
Developed	Not Available	High	Medium
Mosquito Control	Not Available	High	High
Managed Forest	Not Available	High	Medium
Endpoint: reproduction (HUC03; US territories in the Caribbean)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Medium
Developed	Not Available	High	Medium
Mosquito Control	Not Available	Medium	High
Managed Forest	Not Available	High	Medium
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce productivity of populations via effects on larvae (settling, metamorphosis, mortality, etc.)			
Risk	**Confidence**		

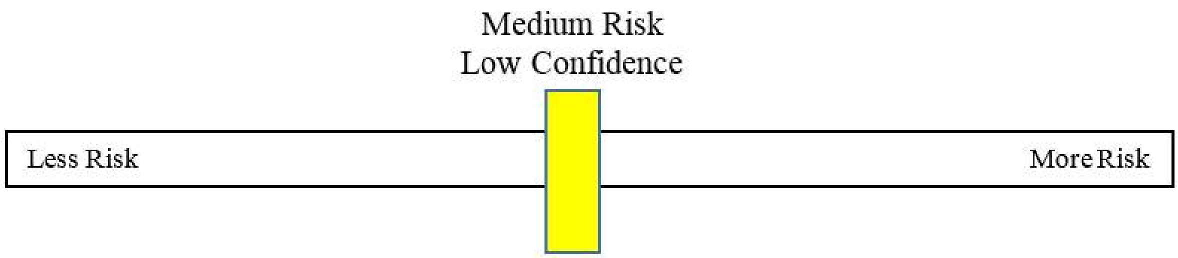
High	**Low**	

Table 461. Effects analysis summary table: Caribbean corals (7 species) and chlorpyrifos

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
(Southeast Florida Coastal HUC-12s)	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce the abundance of populations via direct toxicity	**High**	**Low**	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce the abundance of populations via reduction in prey availability	**High**	**Low**	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	**High**	**Low**	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce the abundance and productivity of populations via impairments to ecologically significant behaviors (e.g. prey capture).	**High**	**Low**	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce the productivity of populations via impairments to reproduction (e.g. spawning cues).	**High**	**Low**	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce productivity of populations via effects on larvae (settling, metamorphosis, mortality, etc.)	**High**	**Low**	Not Available	**Yes**

(HUC03; US territories in the Caribbean)				
Exposure to chlorpyrifos is sufficient to reduce the abundance of populations via direct toxicity	**High**	**Low**	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce the abundance of populations via reduction in prey availability	**High**	**Low**	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	**High**	**Low**	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce the abundance and productivity of populations via impairments to ecologically significant behaviors (e.g. prey capture).	**High**	**Low**	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce the productivity of populations via impairments to reproduction (e.g. spawning cues).	**High**	**Low**	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce productivity of populations via effects on larvae (settling, metamorphosis, mortality, etc.)	**High**	**Low**	Not Available	**Yes**

Effects analysis summary: Caribbean coral populations (7 species: Orbicella franksi; Orbicella annularis; Orbicella faveolata; Mycetophyllia ferox; Acropora cervicornis; Acropora palmate; Dendrogyra cylindrus) are not anticipated to experience significant reductions in abundance or productivity from exposure to chlorpyrifos. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, coral may experience increased toxicity. The overall risk to Caribbean corals (7 species) from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted chlorpyrifos concentrations in coastal habitats. Low confidence of risk is also attributed to the low portion of the species range within US territories.



12.48 Indo-Pacific Corals (7 species): Acropora retusa; Acropora globiceps; Seriatopora aculeate; Euphyllia paradivisa; Isopora crateriformis; Acropora jacquelineae; Acropora speciose

Table 462. Effects analysis R-plot for Indo-Pacific corals (7 species) and chlorpyrifos

	Percent Overlap	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range within US Territories	Likelihood of Exposure
Crops	NA	yes	yes	yes	NA	3	0.2 - 1.4%	Low
Developed	NA	yes	yes	yes	NA	3	0.2 - 1.4%	Low
Mosquito	NA	yes	yes	yes	NA	3	0.2 - 1.4%	Low
Managed Forest/Other	NA	yes	yes	yes	NA	3	0.2 - 1.4%	Low

Table 463. Direct mortality risk hypothesis; Indo-Pacific corals (7 species) and chlorpyrifos; Hawaii/US Territories in the Pacific

Endpoint: Mortality (HUC2: 20a/20b Hawaii and US territories in the Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	Not Available	High	Low
Managed Forest	Not Available	High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce the abundance of populations via direct toxicity			
Risk	**Confidence**		
Low	**Medium**		

Table 464. Prey risk hypothesis; Indo-Pacific corals (7 species) and chlorpyrifos; Hawaii/US Territories in the Pacific

Endpoint: Prey (HUC2: 20a/20b Hawaii and US territories in the Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	Not Available	High	Low
Managed Forest	Not Available	High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce the abundance of populations via reduction in prey availability			
Risk	**Confidence**		
Low	**Medium**		

Table 465. AChE risk hypothesis; Indo-Pacific corals (7 species) and chlorpyrifos; Hawaii/US Territories in the Pacific

Endpoint: Enzyme (HUC2: 20a/20b Hawaii and US territories in the Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	Not Available	High	Low
Managed Forest	Not Available	High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**Medium**		

Table 466. Behavior and sensory risk hypothesis; Indo-Pacific corals (7 species) and chlorpyrifos; Hawaii/US Territories in the Pacific

Endpoint: Behavior (HUC2: 20a/20b Hawaii and US territories in the Pacific)

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	Not Available	High	Low
Managed Forest	Not Available	High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce the abundance and productivity of populations via impairments to ecologically significant behaviors (e.g. prey capture).			
Risk	**Confidence**		
Low	**Medium**		

Table 467. Reproduction risk hypothesis; Indo-Pacific corals (7 species) and chlorpyrifos; Hawaii/US Territories in the Pacific

Endpoint: Reproduction (HUC2: 20a/20b Hawaii and US territories in the Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	Not Available	High	Low
Managed Forest	Not Available	High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce the productivity of populations via impairments to reproduction (e.g. spawning cues).			
Risk	**Confidence**		
Low	**Medium**		

Table 468. Direct mortality, behavior, reproduction risk hypothesis; Indo-Pacific corals (7 species) and chlorpyrifos; Hawaii/US Territories in the Pacific; larvae

Endpoint: mortality (HUC2: 20a/20b Hawaii and US territories in the Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low

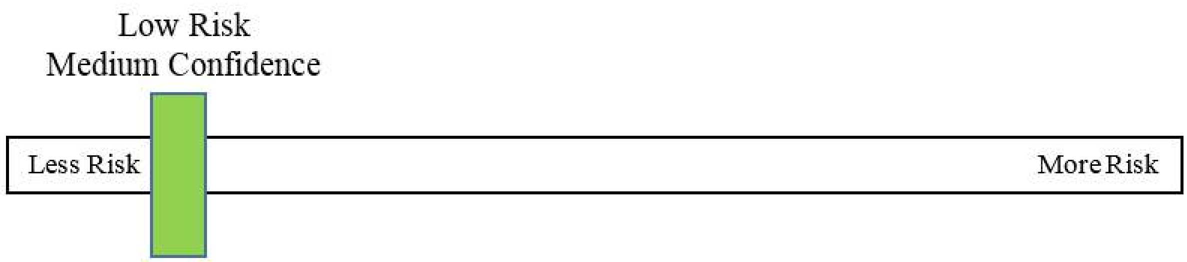
Developed	Not Available	High	Low
Mosquito Control	Not Available	High	Low
Managed Forest	Not Available	High	Low
Endpoint: behavior (HUC2: 20a/20b Hawaii and US territories in the Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	Not Available	High	Low
Managed Forest	Not Available	High	Low
Endpoint: reproduction (HUC2: 20a/20b Hawaii and US territories in the Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	Not Available	High	Low
Managed Forest	Not Available	High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce productivity of populations via effects on larvae (settling, metamorphosis, mortality, etc.)			
Risk	**Confidence**		
Low	**Medium**		

Table 469. Effects analysis summary table: Indo-Pacific corals (7 species) and chlorpyrifos

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Hawaii and US territories in the Pacific	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce the abundance of populations via direct toxicity	**Low**	**Medium**	Not Available	**No**

Exposure to chlorpyrifos is sufficient to reduce the abundance of populations via reduction in prey availability	**Low**	**Medium**	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	**Low**	**Medium**	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce the abundance and productivity of populations via impairments to ecologically significant behaviors (e.g. prey capture).	**Low**	**Medium**	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce the productivity of populations via impairments to reproduction (e.g. spawning cues).	**Low**	**Medium**	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce productivity of populations via effects on larvae (settling, metamorphosis, mortality, etc.)	**Low**	**Medium**	Not Available	**No**

Effects analysis summary: Indo-Pacific coral populations (7 species: Acropora retusa; Acropora globiceps; Seriatopora aculeate; Euphyllia paradivisa; Isopora crateriformis; Acropora jacquelineae; Acropora speciose) are not anticipated to experience significant reductions in abundance or productivity from exposure to chlorpyrifos. Where formulated products and tank mixtures containing chlorpyrifos occur in aquatic habitats, coral may experience increased toxicity. The overall risk to Indo-Pacific corals (7 species) from the effects of the action is low and the confidence associated with that risk is med. The lack in confidence is due primarily to the uncertainty in predicted chlorpyrifos concentrations in coastal habitats. Low risk is attributed primarily to the low portion of the species range within US territories.


Low Risk
Medium Confidence
Less Risk
More Risk

12.49 Green Sea Turtle, Central North Pacific DPS (Chelonia mydas)

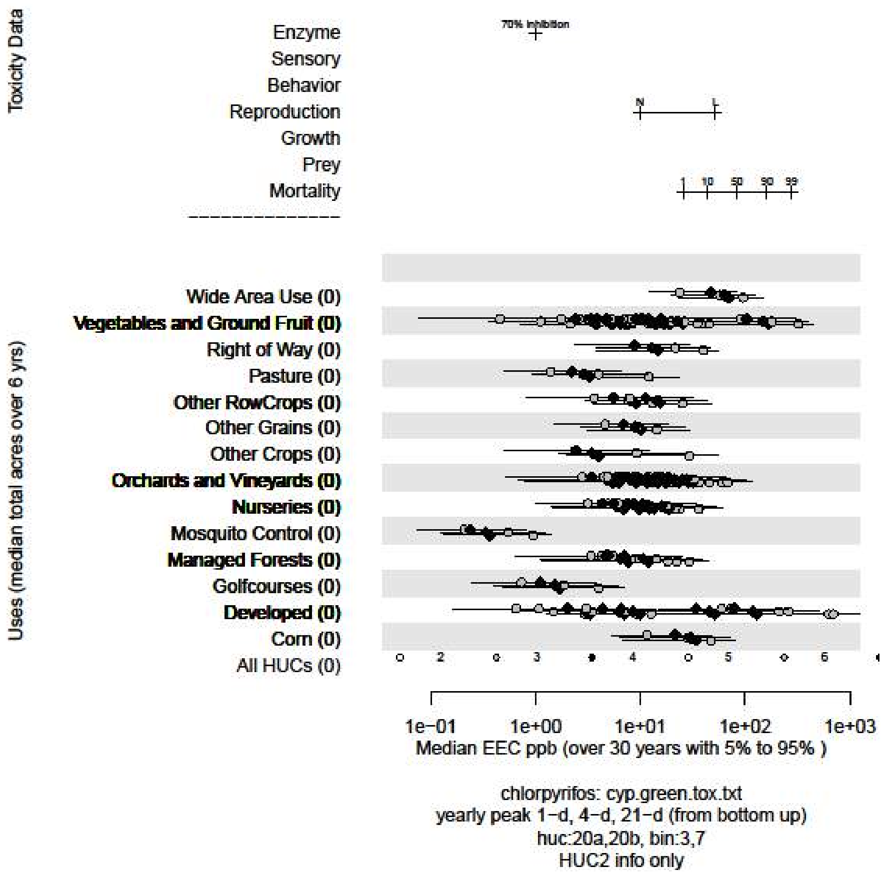


Figure 47. Effects analysis R-plot for Green sea turtle, central north pacific DPS and chlorpyrifos

Table 470. Likelihood of exposure determination for Green sea turtle, central north pacific DPS and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Wide Area Use	3	yes	yes	yes	NA	3	**High**
Vegetables and Ground Fruit	NA	yes	yes	yes	NA	3	**Med**
Right of Way	NA	yes	yes	yes	NA	3	**Med**
Pasture	NA	yes	yes	yes	NA	3	**Med**
Other Row Crops	NA	yes	yes	yes	NA	3	**Med**
Other Grains	NA	yes	yes	yes	NA	3	**Med**
Other Crops	NA	yes	yes	yes	NA	3	**Med**
Orchards and Vineyards	NA	yes	yes	yes	NA	3	**Med**
Nurseries	NA	yes	yes	yes	NA	3	**Med**
Mosquito Control	NA	yes	yes	yes	NA	3	**High**
Managed Forest	NA	yes	yes	yes	NA	3	**Med**
Golf Courses	NA	yes	yes	yes	NA	3	**Med**
Developed	NA	yes	yes	yes	NA	3	**Med**
Corn	NA	yes	yes	yes	NA	3	**Med**
Bin 3	NA	yes	yes	yes	NA	3	**Med**

Life Stage: Juveniles

Based on the life history of green turtles, hatchlings crawl to the water and swim to offshore areas where they reside for several years. Therefore juveniles are not expected to experience substantial exposure to chlorpyrifos.

Life Stage: Adults

Table 471. Direct mortality risk hypothesis; Green sea turtle, central north pacific DPS and chlorpyrifos; Adults

Endpoint: Mortality (HUC2: 20 Hawaii)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	NA	High	**High**
Vegetables and Ground Fruit	NA	High	**Medium**
Right of Way	NA	Medium	**Medium**
Pasture	NA	Low	**Medium**
Other Row Crops	NA	Medium	**Medium**

Other Grains	NA	Medium	**Medium**
Other Crops	NA	Medium	**Medium**
Orchards and Vineyards	NA	High	**Medium**
Nurseries	NA	Medium	**Medium**
Mosquito Control	NA	Low	**High**
Managed Forest	NA	Medium	**Medium**
Golf Courses	NA	Low	**Medium**
Developed	NA	High	**Medium**
Corn	NA	Medium	**Medium**
Bin 3	NA	NA	**Medium**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**Low**		

Table 472. Reproduction risk hypothesis; Green sea turtle, central north pacific DPS and chlorpyrifos; Adults

Endpoint: Reproduction (HUC2: 20 Hawaii)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	NA	High	**High**
Vegetables and Ground Fruit	NA	High	**Medium**
Right of Way	NA	Medium	**Medium**
Pasture	NA	Low	**Medium**
Other Row Crops	NA	Medium	**Medium**
Other Grains	NA	Medium	**Medium**
Other Crops	NA	Medium	**Medium**
Orchards and Vineyards	NA	High	**Medium**

Nurseries	NA	Medium	**Medium**
Mosquito Control	NA	Low	**High**
Managed Forest	NA	Medium	**Medium**
Golf Courses	NA	Low	**Medium**
Developed	NA	High	**Medium**
Corn	NA	Medium	**Medium**
Bin 3	NA	NA	**Medium**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**Low**		

Table 473. AChE risk hypothesis; Green sea turtle, central north pacific DPS and chlorpyrifos; Adults

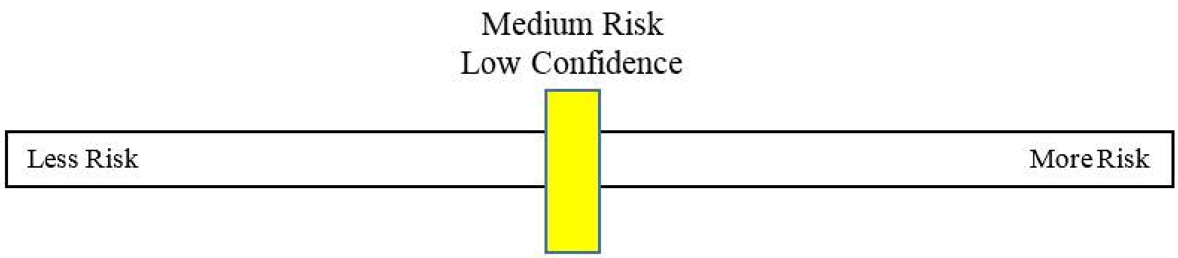
Endpoint: enzyme (HUC2: 20 Hawaii)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	NA	High	**High**
Vegetables and Ground Fruit	NA	High	**Medium**
Right of Way	NA	High	**Medium**
Pasture	NA	High	**Medium**
Other Row Crops	NA	High	**Medium**
Other Grains	NA	High	**Medium**
Other Crops	NA	High	**Medium**
Orchards and Vineyards	NA	High	**Medium**
Nurseries	NA	High	**Medium**
Mosquito Control	NA	High	**High**
Managed Forest	NA	High	**Medium**
Golf Courses	NA	High	**Medium**

Developed	NA	High	**Medium**
Corn	NA	High	**Medium**
Bin 3	NA	NA	**Medium**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Low**		

Table 474. Effects analysis summary table: Green sea turtle, central north pacific DPS and chlorpyrifos

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Low	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Green sea turtle, central north pacific DPS are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to chlorpyrifos in the marine environment. If exposed to formulated products and tank mixtures containing chlorpyrifos, sea turtles may experience increased toxicity. The overall risk to Green sea turtle, central north pacific DPS from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted chlorpyrifos concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites within the species range.


Medium Risk
Low Confidence
Less Risk
More Risk

12.50 Green Sea Turtle, Central South Pacific DPS (Chelonia mydas)

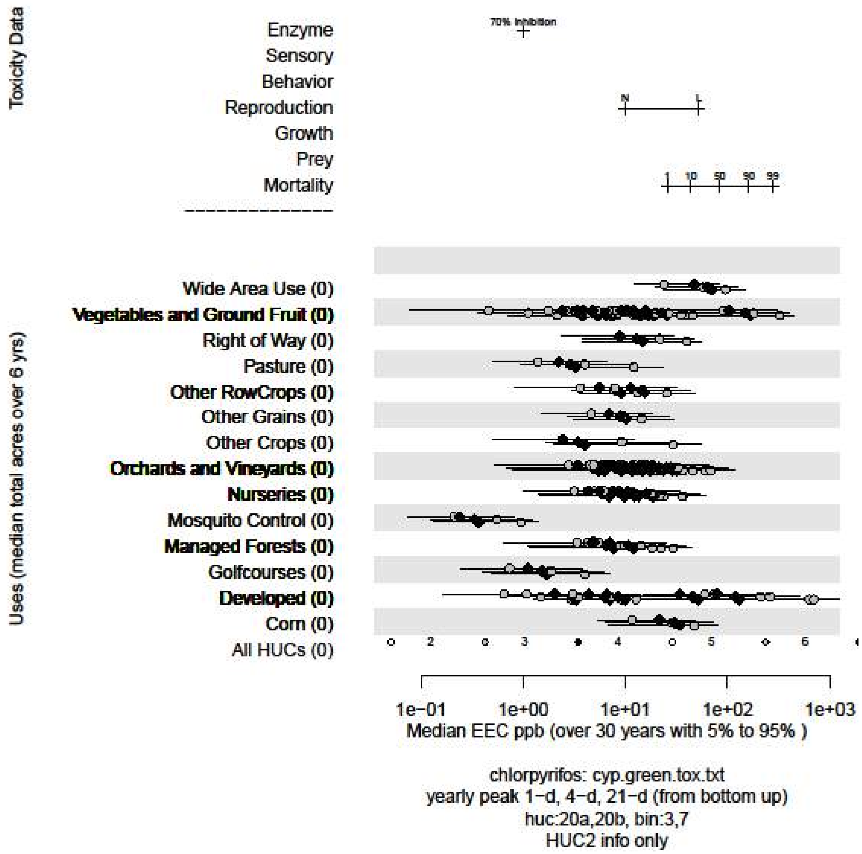


Figure 48. Effects analysis R-plot for Green sea turtle, central south pacific DPS and chlorpyrifos

Table 475. Likelihood of exposure determination for Green sea turtle, central south pacific DPS and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Wide Area Use	3	yes	yes	yes	NA	3	**High**
Vegetables and Ground Fruit	NA	yes	yes	yes	NA	3	**Med**
Right of Way	NA	yes	yes	yes	NA	3	**Med**
Pasture	NA	yes	yes	yes	NA	3	**Med**
Other Row Crops	NA	yes	yes	yes	NA	3	**Med**
Other Grains	NA	yes	yes	yes	NA	3	**Med**
Other Crops	NA	yes	yes	yes	NA	3	**Med**
Orchards and Vineyards	NA	yes	yes	yes	NA	3	**Med**
Nurseries	NA	yes	yes	yes	NA	3	**Med**
Mosquito Control	NA	yes	yes	yes	NA	3	**High**
Managed Forest	NA	yes	yes	yes	NA	3	**Med**
Golf Courses	NA	yes	yes	yes	NA	3	**Med**
Developed	NA	yes	yes	yes	NA	3	**Med**
Corn	NA	yes	yes	yes	NA	3	**Med**
Bin 3	NA	yes	yes	yes	NA	3	**Med**

Life Stage: Juveniles

Based on the life history of green turtles, hatchlings crawl to the water and swim to offshore areas where they reside for several years. Therefore juveniles are not expected to experience substantial exposure to chlorpyrifos.

Life Stage: Adults

Table 476. Direct mortality risk hypothesis; Green sea turtle, central south pacific DPS and chlorpyrifos; Adults

Endpoint: Mortality (HUC2: 20 Hawaii)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	NA	High	**High**
Vegetables and Ground Fruit	NA	High	**Medium**
Right of Way	NA	Medium	**Medium**
Pasture	NA	Low	**Medium**
Other Row Crops	NA	Medium	**Medium**

Other Grains	NA	Medium	**Medium**
Other Crops	NA	Medium	**Medium**
Orchards and Vineyards	NA	High	**Medium**
Nurseries	NA	Medium	**Medium**
Mosquito Control	NA	Low	**High**
Managed Forest	NA	Medium	**Medium**
Golf Courses	NA	Low	**Medium**
Developed	NA	High	**Medium**
Corn	NA	Medium	**Medium**
Bin 3	NA	NA	**Medium**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**Low**		

Table 477. Reproduction risk hypothesis; Green sea turtle, central south pacific DPS and chlorpyrifos; Adults

Endpoint: Reproduction (HUC2: 20 Hawaii)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	NA	High	**High**
Vegetables and Ground Fruit	NA	High	**Medium**
Right of Way	NA	Medium	**Medium**
Pasture	NA	Low	**Medium**
Other Row Crops	NA	Medium	**Medium**
Other Grains	NA	Medium	**Medium**
Other Crops	NA	Medium	**Medium**
Orchards and Vineyards	NA	High	**Medium**

Nurseries	NA	Medium	**Medium**
Mosquito Control	NA	Low	**High**
Managed Forest	NA	Medium	**Medium**
Golf Courses	NA	Low	**Medium**
Developed	NA	High	**Medium**
Corn	NA	Medium	**Medium**
Bin 3	NA	NA	**Medium**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**Low**		

Table 478. AChE risk hypothesis; Green sea turtle, central south pacific DPS and chlorpyrifos; Adults

Endpoint: enzyme (HUC2: 20 Hawaii)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	NA	High	**High**
Vegetables and Ground Fruit	NA	High	**Medium**
Right of Way	NA	High	**Medium**
Pasture	NA	High	**Medium**
Other Row Crops	NA	High	**Medium**
Other Grains	NA	High	**Medium**
Other Crops	NA	High	**Medium**
Orchards and Vineyards	NA	High	**Medium**
Nurseries	NA	High	**Medium**
Mosquito Control	NA	High	**High**
Managed Forest	NA	High	**Medium**
Golf Courses	NA	High	**Medium**

Developed	NA	High	**Medium**
Corn	NA	High	**Medium**
Bin 3	NA	NA	**Medium**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Low**		

Table 479. Effects analysis summary table: Green sea turtle, central south pacific DPS and chlorpyrifos

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Low	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Green sea turtle, central south pacific DPS are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to chlorpyrifos in the marine environment. If exposed to formulated products and tank mixtures containing chlorpyrifos, sea turtles may experience increased toxicity. The overall risk to Green sea turtle, central south pacific DPS from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted chlorpyrifos concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites with the species range.


Medium Risk
Low Confidence
Less Risk
More Risk

12.51 Green Sea Turtle, Central West Pacific DPS (Chelonia mydas)

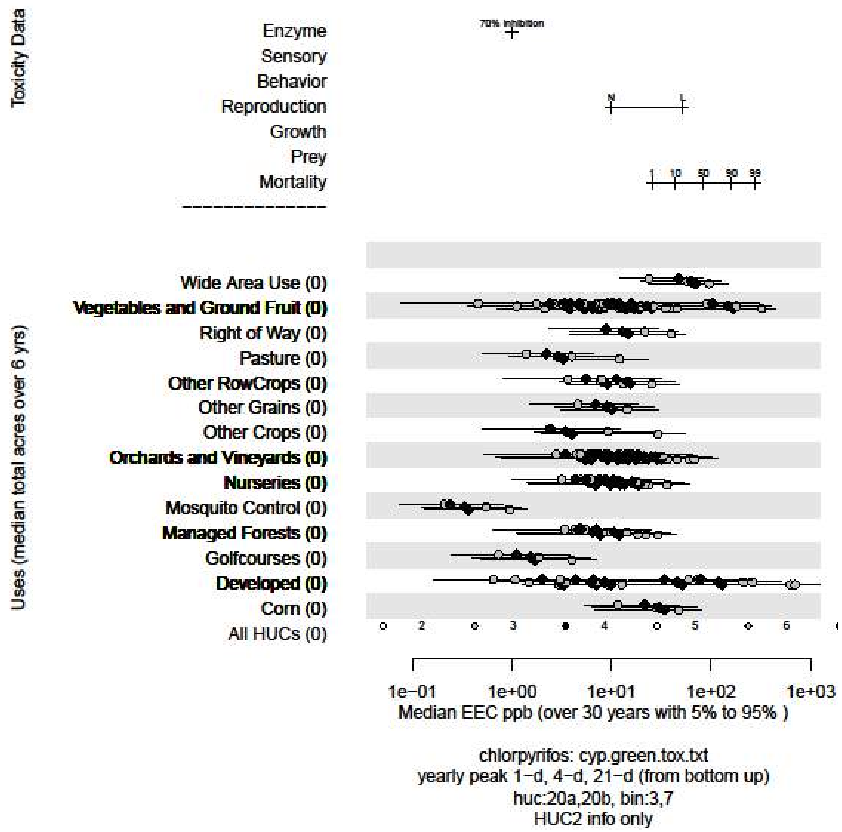


Figure 49. Effects analysis R-plot for Green sea turtle, central west pacific DPS and chlorpyrifos

Table 480. Likelihood of exposure determination for Green sea turtle, central west pacific DPS and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range within US Territories	Likelihood of Exposure
Wide Area Use	3	yes	yes	yes	NA	3	small	Low
Vegetables and Ground Fruit	NA	yes	yes	yes	NA	3	small	Low
Right of Way	NA	yes	yes	yes	NA	3	small	Low
Pasture	NA	yes	yes	yes	NA	3	small	Low
Other Row Crops	NA	yes	yes	yes	NA	3	small	Low
Other Grains	NA	yes	yes	yes	NA	3	small	Low
Other Crops	NA	yes	yes	yes	NA	3	small	Low
Orchards and Vineyards	NA	yes	yes	yes	NA	3	small	Low
Nurseries	NA	yes	yes	yes	NA	3	small	Low
Mosquito Control	NA	yes	yes	yes	NA	3	small	Low
Managed Forest	NA	yes	yes	yes	NA	3	small	Low
Golf Courses	NA	yes	yes	yes	NA	3	small	Low
Developed	NA	yes	yes	yes	NA	3	small	Low
Corn	NA	yes	yes	yes	NA	3	small	Low
Bin 3	NA	yes	yes	yes	NA	3	small	Low

Life Stage: Juveniles

Based on the life history of green turtles, hatchlings crawl to the water and swim to offshore areas where they reside for several years. Therefore juveniles are not expected to experience substantial exposure to chlorpyrifos.

Life Stage: Adults

Table 481. Direct mortality risk hypothesis; Green sea turtle, central west pacific DPS and chlorpyrifos; Adults

Endpoint: Mortality (HUC20; Guam and Mariana)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	NA	High	Low
Vegetables and Ground Fruit	NA	High	Low
Right of Way	NA	Medium	Low
Pasture	NA	Low	Low
Other Row Crops	NA	Medium	Low
Other Grains	NA	Medium	Low

Other Crops	NA	Medium	Low
Orchards and Vineyards	NA	High	Low
Nurseries	NA	Medium	Low
Mosquito Control	NA	Low	Low
Managed Forest	NA	Medium	Low
Golf Courses	NA	Low	Low
Developed	NA	High	Low
Corn	NA	Medium	Low
Bin 3	NA	NA	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**Low**		

Table 482. Reproduction risk hypothesis; Green sea turtle, central west pacific DPS and chlorpyrifos; Adults

Endpoint: Reproduction (HUC20; Guam and Mariana)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	NA	High	Low
Vegetables and Ground Fruit	NA	High	Low
Right of Way	NA	Medium	Low
Pasture	NA	Low	Low
Other Row Crops	NA	Medium	Low
Other Grains	NA	Medium	Low
Other Crops	NA	Medium	Low
Orchards and Vineyards	NA	High	Low
Nurseries	NA	Medium	Low

Mosquito Control	NA	Low	Low
Managed Forest	NA	Medium	Low
Golf Courses	NA	Low	Low
Developed	NA	High	Low
Corn	NA	Medium	Low
Bin 3	NA	NA	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**Low**		

Table 483. AChE risk hypothesis; Green sea turtle, central west pacific DPS and chlorpyrifos; Adults

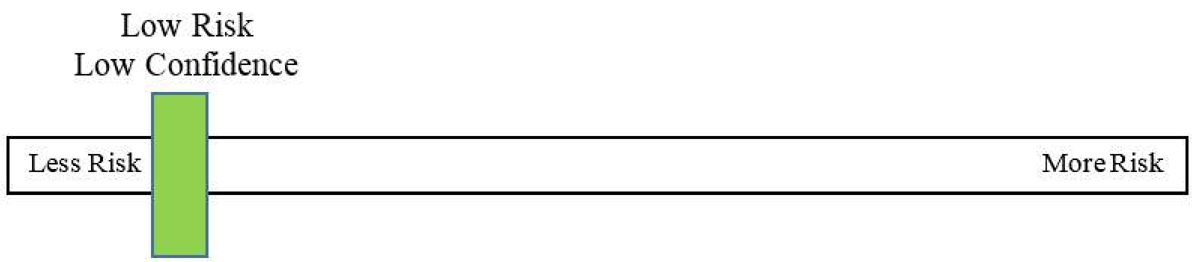
Endpoint: enzyme (HUC20; Guam and Mariana)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	NA	High	Low
Vegetables and Ground Fruit	NA	High	Low
Right of Way	NA	High	Low
Pasture	NA	High	Low
Other Row Crops	NA	High	Low
Other Grains	NA	High	Low
Other Crops	NA	High	Low
Orchards and Vineyards	NA	High	Low
Nurseries	NA	High	Low
Mosquito Control	NA	High	Low
Managed Forest	NA	High	Low
Golf Courses	NA	High	Low
Developed	NA	High	Low

Corn	NA	High	Low
Bin 3	NA	NA	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**Low**		

Table 484. Effects analysis summary table: Green sea turtle, central west pacific DPS and chlorpyrifos

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	Low	Not Available	**No**

Effects analysis summary: Adult and juvenile Green sea turtle, central west pacific DPS are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to chlorpyrifos in the marine environment. If exposed to formulated products and tank mixtures containing chlorpyrifos, sea turtles may experience increased toxicity. The overall risk to Green sea turtle, central south pacific DPS from the effects of the action is low and the confidence associated with that risk is low. The low risk is due primarily to the small portion of the species range within US territories. The lack in confidence is due primarily to the uncertainty in predicted chlorpyrifos concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites with the species range.


Low Risk
Low Confidence
Less Risk
More Risk

12.52 Green Sea Turtle, East Pacific DPS (Chelonia mydas)

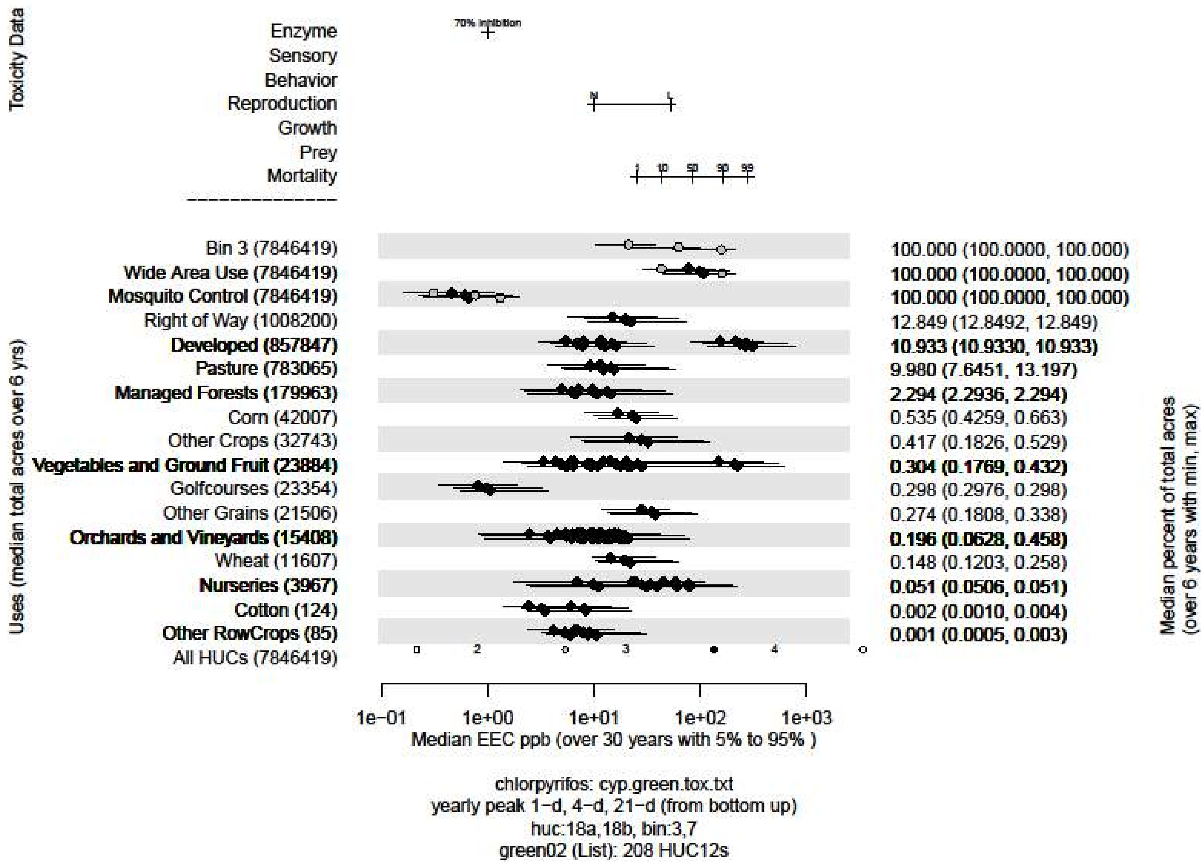


Figure 50. Effects analysis R-plot for Green sea turtle, east pacific DPS and chlorpyrifos

Table 485. Likelihood of exposure determination for Green sea turtle, east pacific DPS and chlorpyrifos

Adults	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of the Species Name in US Territories	Likelihood of Exposure
Wide Area Use	3	yes	yes	yes	NA	3	8%	**High**
Mosquito Control	3	yes	yes	yes	NA	3	8%	**High**
Right of Way	1	yes	yes	yes	NA	3	8%	Low
Developed	1	yes	yes	yes	NA	3	8%	Low
Pasture	1	yes	yes	yes	NA	3	8%	Low
Managed Forest	1	yes	yes	yes	NA	3	8%	Low
Corn	1	yes	yes	yes	NA	3	8%	Low
Other Crops	1	yes	yes	yes	NA	3	8%	Low
Vegetables and Ground Fruit	1	yes	yes	yes	NA	3	8%	Low
Golf Courses	1	yes	yes	yes	NA	3	8%	Low
Other Grains	1	yes	yes	yes	NA	3	8%	Low
Orchards and Vineyards	1	yes	yes	yes	NA	3	8%	Low
Wheat	1	yes	yes	yes	NA	3	8%	Low
Nurseries	1	yes	yes	yes	NA	3	8%	Low
Cotton	1	yes	yes	yes	NA	3	8%	Low
Other Row Crops	1	yes	yes	yes	NA	3	8%	Low
Bin 3	3	yes	yes	yes	NA	3	8%	**High**

Life Stage: Juveniles

Based on the life history of green turtles, hatchlings crawl to the water and swim to offshore areas where they reside for several years. Therefore juveniles are not expected to experience substantial exposure to chlorpyrifos.

Life Stage: Adults

Table 486. Direct mortality risk hypothesis; Green sea turtle, east pacific DPS and chlorpyrifos; Adults

Endpoint: Mortality (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Low	**High**
Right of Way	12.8	Medium	**Low**
Developed	10.9	High	**Low**
Pasture	10	Medium	**Low**
Managed Forest	2.3	Medium	**Low**

Corn	.5	Medium	**Low**
Other Crops	.4	High	**Low**
Vegetables and Ground Fruit	.3	High	**Low**
Golf Courses	.3	Low	**Low**
Other Grains	.3	High	**Low**
Orchards and Vineyards	.2	Medium	**Low**
Wheat	.1	Medium	**Low**
Nurseries	.05	High	**Low**
Cotton	.002	Low	**Low**
Other Row Crops	.001	Medium	**Low**
Bin 3	100	High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**Low**		

Table 487. Reproduction risk hypothesis; Green sea turtle, east pacific DPS and chlorpyrifos; Adults

Endpoint: Reproduction (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Low	**High**
Right of Way	12.8	Medium	**Low**
Developed	10.9	High	**Low**
Pasture	10	Medium	**Low**
Managed Forest	2.3	Medium	**Low**
Corn	.5	Medium	**Low**
Other Crops	.4	High	**Low**

Vegetables and Ground Fruit	.3	High	**Low**
Golf Courses	.3	Low	**Low**
Other Grains	.3	Medium	**Low**
Orchards and Vineyards	.2	Medium	**Low**
Wheat	.1	Medium	**Low**
Nurseries	.05	High	**Low**
Cotton	.002	Medium	**Low**
Other Row Crops	.001	Medium	**Low**
Bin 3	100	Medium	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**Low**		

Table 488. AChE risk hypothesis; Green sea turtle, east pacific DPS and chlorpyrifos; Adults

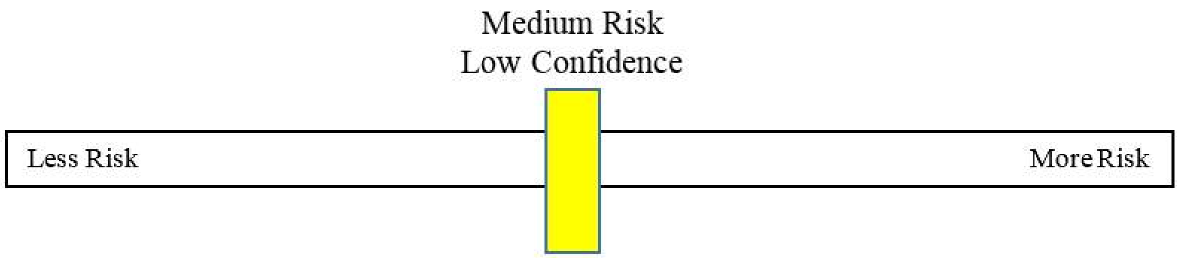
Endpoint: enzyme (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	High	**High**
Right of Way	12.8	High	**Low**
Developed	10.9	High	**Low**
Pasture	10	High	**Low**
Managed Forest	2.3	High	**Low**
Corn	.5	High	**Low**
Other Crops	.4	High	**Low**
Vegetables and Ground Fruit	.3	High	**Low**

Golf Courses	.3	High	**Low**
Other Grains	.3	High	**Low**
Orchards and Vineyards	.2	High	**Low**
Wheat	.1	High	**Low**
Nurseries	.05	High	**Low**
Cotton	.002	High	**Low**
Other Row Crops	.001	High	**Low**
Bin 3	100	High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Low**		

Table 489. Effects analysis summary table: Green sea turtle, east pacific DPS and chlorpyrifos

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Low	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Green sea turtle, east pacific DPS are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to chlorpyrifos in the marine environment. If exposed to formulated products and tank mixtures containing chlorpyrifos, sea turtles may experience increased toxicity. The overall risk to Green sea turtle, east pacific DPS from the effects of the action is medium and the confidence associated with that risk is low. The medium risk is due primarily to the small portion of the species range within US territories. The lack in confidence is due primarily to the uncertainty in predicted chlorpyrifos concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites with the species range.



12.53 Green Sea Turtle, North Atlantic DPS (Chelonia mydas)

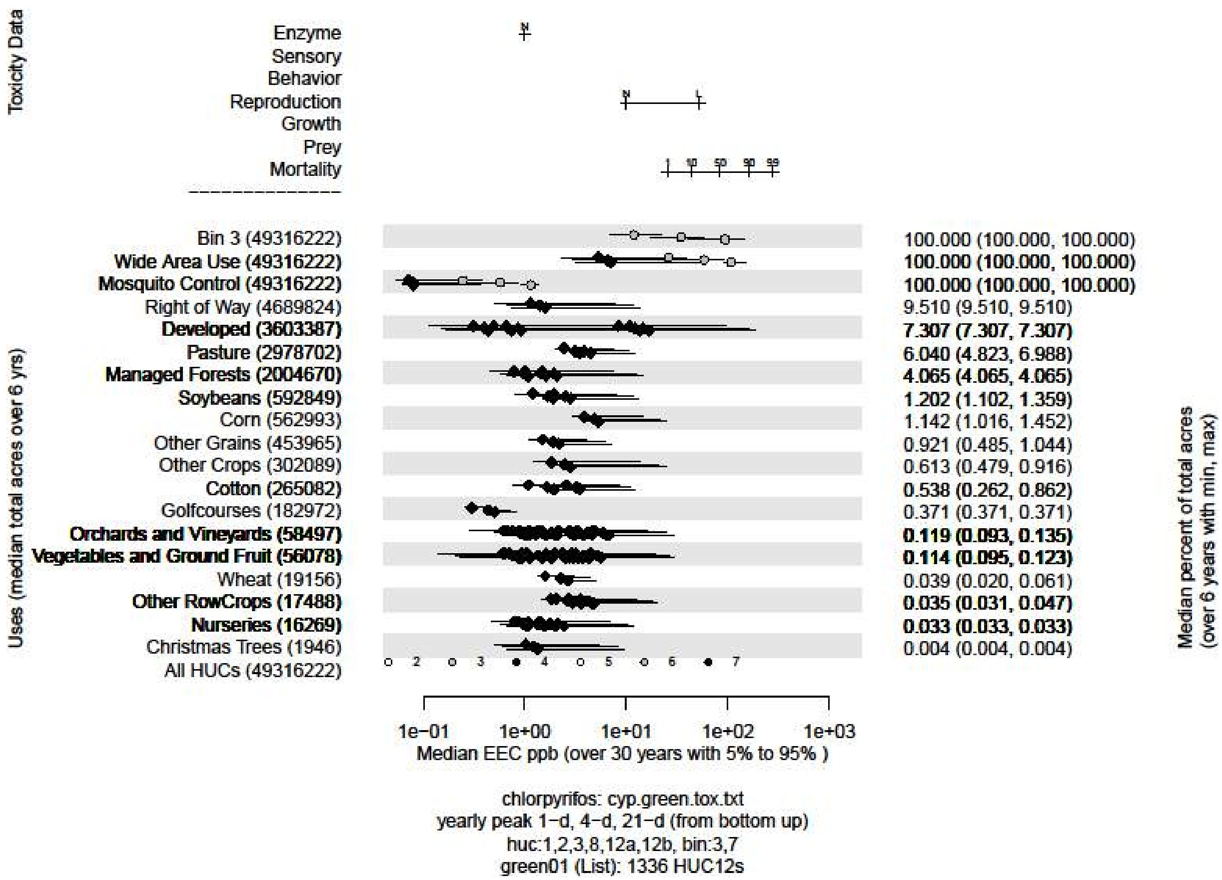


Figure 51. Effects analysis R-plot for Green sea turtle, north Atlantic DPS and chlorpyrifos

Table 490. Likelihood of exposure determination for Green sea turtle, north Atlantic DPS and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range in US Territories	Likelihood of Exposure
Adults - Atlantic Coast								
Wide Area Use	3	yes	yes	yes	NA	3	Med	**Med**
Mosquito Control	3	yes	yes	yes	NA	3	Med	**Med**
Right of Way	3	yes	yes	yes	NA	3	Med	**Med**
Developed	3	yes	yes	yes	NA	3	Med	**Med**
Pasture	3	yes	yes	yes	NA	3	Med	**Med**
Managed Forest	2	yes	yes	yes	NA	3	Med	**Med**
Soy Bean	2	yes	yes	yes	NA	3	Med	**Med**
Corn	2	yes	yes	yes	NA	3	Med	**Med**
Other Grain	1	yes	yes	yes	NA	3	Med	Low
Other Crops	1	yes	yes	yes	NA	3	Med	Low
Cotton	1	yes	yes	yes	NA	3	Med	Low
Golf Courses	1	yes	yes	yes	NA	3	Med	Low
Orchard and Vineyards	1	yes	yes	yes	NA	3	Med	Low
Vegetables anf Ground Fruit	1	yes	yes	yes	NA	3	Med	Low
Wheat	1	yes	yes	yes	NA	3	Med	Low
Other Row Crops	1	yes	yes	yes	NA	3	Med	Low
Nurseries	1	yes	yes	yes	NA	3	Med	Low
Christmas Trees	1	yes	yes	yes	NA	3	Med	Low
Bin 3	1	yes	yes	yes	NA	3	Med	Low
Adults - US Territories in Atlantic/Caribbean								
Crops	NA	yes	yes	yes	NA	3	Med	Low
Developed	NA	yes	yes	yes	NA	3	Med	Low
Mosquito Control	NA	yes	yes	yes	NA	3	Med	Low
Other	NA	yes	yes	yes	NA	3	Med	Low

Life Stage: Juveniles

Based on the life history of green turtles, hatchlings crawl to the water and swim to offshore areas where they reside for several years. Therefore juveniles are not expected to experience substantial exposure to chlorpyrifos.

Life Stage: Adults

Table 491. Direct mortality risk hypothesis; Green sea turtle, north Atlantic DPS and chlorpyrifos; Adults; Atlantic Coast

Endpoint: Mortality (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**Medium**
Mosquito Control	100	Low	**Medium**
Right of Way	9.5	Low	**Medium**

Developed	7.3	High	**Medium**
Pasture	6.0	Low	**Medium**
Managed Forest	4.1	Low	**Medium**
Soy Bean	1.2	Low	**Medium**
Corn	1.1	Low	**Medium**
Other Grain	.9	Low	**Low**
Other Crops	.6	Low	**Low**
Cotton	.5	Low	**Low**
Golf Courses	.4	Low	**Low**
Orchard and Vineyards	.1	Medium	**Low**
Vegetables anf Ground Fruit	.1	Medium	**Low**
Wheat	.04	Low	**Low**
Other Row Crops	.04	Low	**Low**
Nurseries	.03	Low	**Low**
Christmas Trees	.004	Low	**Low**
Bin 3		High	**Low**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**Low**		

Table 492. Direct mortality risk hypothesis; Green sea turtle, north Atlantic DPS and chlorpyrifos; Adults; US Territories in Atlantic

Endpoint: Mortality (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Medium-High	Low
Developed	Not Available	High	Low
Mosquito Control	100	Low	Low

Other	Not Available	Medium-High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**Low**		

Table 493. Reproduction risk hypothesis; Green sea turtle, north Atlantic DPS and chlorpyrifos; Adults; Atlantic Coast

Endpoint: Reproduction (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	Medium	**Medium**
Mosquito Control	100	Low	**Medium**
Right of Way	9.5	Low	**Medium**
Developed	7.3	High	**Medium**
Pasture	6.0	Low	**Medium**
Managed Forest	4.1	Low	**Medium**
Soy Bean	1.2	Low	**Medium**
Corn	1.1	Medium	**Medium**
Other Grain	.9	Low	**Low**
Other Crops	.6	Medium	**Low**
Cotton	.5	Low	**Low**
Golf Courses	.4	Low	**Low**
Orchard and Vineyards	.1	Medium	**Low**
Vegetables anf Ground Fruit	.1	Medium	**Low**
Wheat	.04	Low	**Low**
Other Row Crops	.04	Medium	**Low**
Nurseries	.03	Low	**Low**
Christmas Trees	.004	Low	**Low**

Bin 3		Medium	**Low**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**Low**		

Table 494. Reproduction risk hypothesis; Green sea turtle, north Atlantic DPS and chlorpyrifos; Adults; US Territories in Atlantic

Endpoint: Reproduction (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Low-Medium	Low
Developed	Not Available	High	Low
Mosquito Control	100	Low	Low
Other	Not Available	Low-Medium	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**Low**		

Table 495. AChE risk hypothesis; Green sea turtle, north Atlantic DPS and chlorpyrifos; Adults; Atlantic Coast

Endpoint: enzyme (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**Medium**
Mosquito Control	100	High	**Medium**
Right of Way	9.5	High	**Medium**
Developed	7.3	High	**Medium**
Pasture	6.0	High	**Medium**

Managed Forest	4.1	High	**Medium**
Soy Bean	1.2	High	**Medium**
Corn	1.1	High	**Medium**
Other Grain	.9	High	**Low**
Other Crops	.6	High	**Low**
Cotton	.5	High	**Low**
Golf Courses	.4	Medium	**Low**
Orchard and Vineyards	.1	High	**Low**
Vegetables anf Ground Fruit	.1	High	**Low**
Wheat	.04	High	**Low**
Other Row Crops	.04	High	**Low**
Nurseries	.03	High	**Low**
Christmas Trees	.004	High	**Low**
Bin 3		High	**Low**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Low**		

Table 496. AChE risk hypothesis; Green sea turtle, north Atlantic DPS and chlorpyrifos; Adults; US Territories in Atlantic

Endpoint: Enzyme (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Medium-High	Low
Developed	Not Available	High	Low
Mosquito Control	100	Medium	Low

Other	Not Available	High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**Low**		

Table 497. Effects analysis summary table: Green sea turtle, north Atlantic DPS and chlorpyrifos

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults (Lower 48 – Coastal HUC-12s)	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Low	Not Available	**Yes**
Adults (HUC03 – Territories in Atlantic)				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	Low	Not Available	**No**

Effects analysis summary: Adult and juvenile Green sea turtle, north Atlantic DPS are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to chlorpyrifos in the marine environment. If exposed to formulated products and tank mixtures containing chlorpyrifos, sea turtles may experience increased toxicity. The overall risk to Green sea turtle, north Atlantic DPS from the effects of the action is medium and the confidence associated with that risk is low. The medium risk is due primarily to the moderate portion of the species range within US territories. The lack in confidence is due primarily to the uncertainty in predicted chlorpyrifos concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites with the species range.

12.54 Green Sea Turtle, South Atlantic DPS (Chelonia mydas)

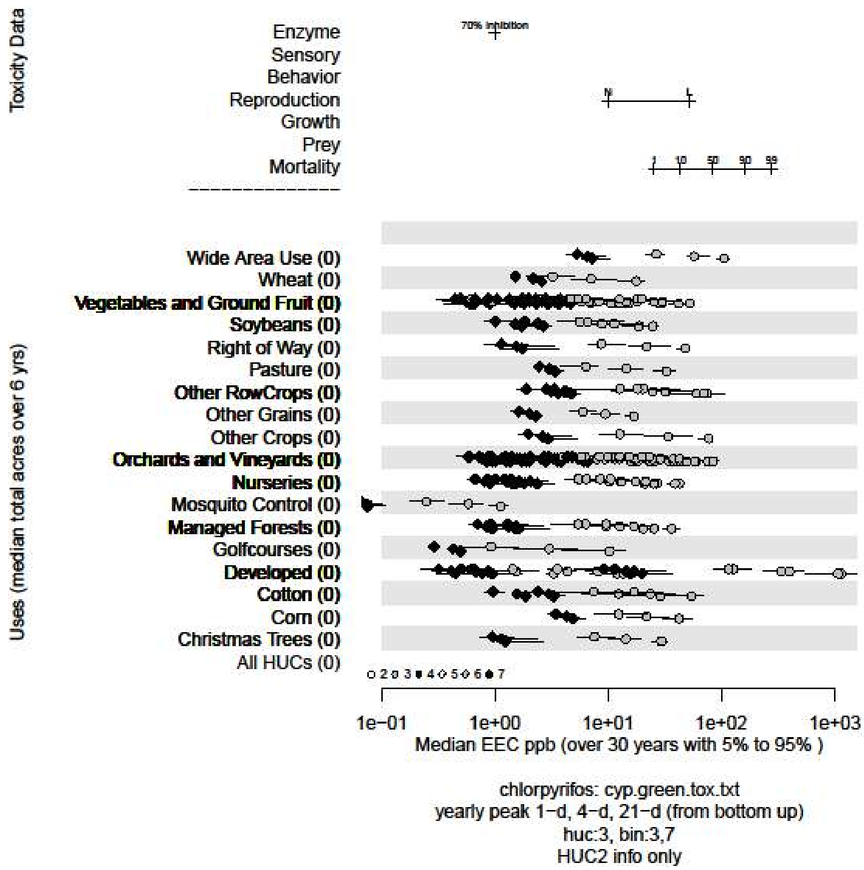


Figure 52. Effects analysis R-plot for Green sea turtle, south Atlantic DPS and chlorpyrifos

Table 498. Likelihood of exposure determination for Green sea turtle, south Atlantic DPS and chlorpyrifos

Adults	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range within US Territories	Likelihood of Exposure
Wide Area Use	3	yes	yes	yes	NA	3	small	Low
Wheat	NA	yes	yes	yes	NA	3	small	Low
Vegetables and Ground Fruit	NA	yes	yes	yes	NA	3	small	Low
Soybean	NA	yes	yes	yes	NA	3	small	Low
Right of Way	NA	yes	yes	yes	NA	3	small	Low
Pasture	NA	yes	yes	yes	NA	3	small	Low
Other Row Crops	NA	yes	yes	yes	NA	3	small	Low
Other Grains	NA	yes	yes	yes	NA	3	small	Low
Other Crops	NA	yes	yes	yes	NA	3	small	Low
Orchards and Vineyards	NA	yes	yes	yes	NA	3	small	Low
Nurseries	NA	yes	yes	yes	NA	3	small	Low
Mosquito Control	3	yes	yes	yes	NA	3	small	Low
Managed Forest	NA	yes	yes	yes	NA	3	small	Low
Golf Courses	NA	yes	yes	yes	NA	3	small	Low
Developed	NA	yes	yes	yes	NA	3	small	Low
Corn	NA	yes	yes	yes	NA	3	small	Low

Life Stage: Juveniles

Based on the life history of green turtles, hatchlings crawl to the water and swim to offshore areas where they reside for several years. Therefore juveniles are not expected to experience substantial exposure to chlorpyrifos.

Life Stage: Adults

Table 499. Direct mortality risk hypothesis; Green sea turtle, south Atlantic DPS and chlorpyrifos; Adults

Endpoint: Mortality (HUC2: 03)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	NA	High	Low
Wheat	NA	Low	Low
Vegetables and Ground Fruit	NA	Medium	Low
Soybean	NA	Medium	Low
Right of Way	NA	Medium	Low
Pasture	NA	Medium	Low
Other Row Crops	NA	High	Low

Other Grains	NA	Low	Low
Other Crops	NA	High	Low
Orchards and Vineyards	NA	High	Low
Nurseries	NA	Medium	Low
Mosquito Control	NA	Low	Low
Managed Forest	NA	Medium	Low
Golf Courses	NA	Low	Low
Developed	NA	High	Low
Corn	NA	Medium	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**Low**		

Table 500. Reproduction risk hypothesis; Green sea turtle, south Atlantic DPS and chlorpyrifos; Adults

Endpoint: Reproduction (HUC2: 03)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	NA	Medium	Low
Wheat	NA	Low	Low
Vegetables and Ground Fruit	NA	Medium	Low
Soybean	NA	Medium	Low
Right of Way	NA	Medium	Low
Pasture	NA	Low	Low
Other Row Crops	NA	Medium	Low
Other Grains	NA	Low	Low
Other Crops	NA	Medium	Low

Orchards and Vineyards	NA	Medium	Low
Nurseries	NA	Medium	Low
Mosquito Control	NA	Low	Low
Managed Forest	NA	Medium	Low
Golf Courses	NA	Low	Low
Developed	NA	High	Low
Corn	NA	Medium	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**Low**		

Table 501. AChE risk hypothesis; Green sea turtle, south Atlantic DPS and chlorpyrifos; Adults

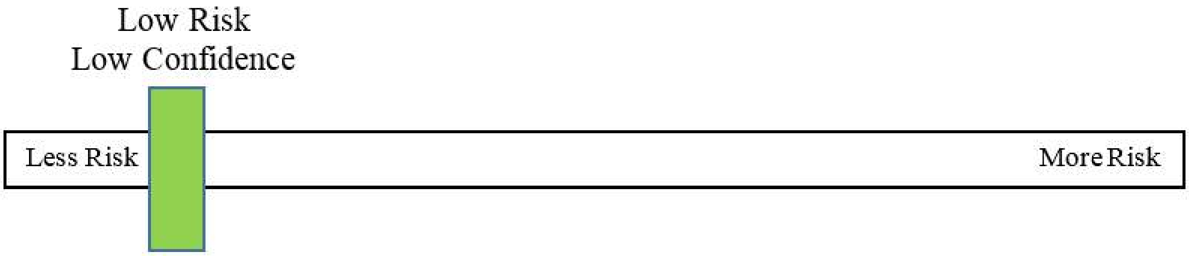
Endpoint: enzyme (HUC2: 03)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	NA	High	Low
Wheat	NA	High	Low
Vegetables and Ground Fruit	NA	High	Low
Soybean	NA	High	Low
Right of Way	NA	High	Low
Pasture	NA	High	Low
Other Row Crops	NA	High	Low
Other Grains	NA	High	Low
Other Crops	NA	High	Low
Orchards and Vineyards	NA	High	Low
Nurseries	NA	High	Low

Mosquito Control	NA	High	Low
Managed Forest	NA	High	Low
Golf Courses	NA	High	Low
Developed	NA	High	Low
Corn	NA	High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**Low**		

Table 502. Effects analysis summary table: Green sea turtle, south Atlantic DPS and chlorpyrifos

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	Low	Not Available	**No**

Effects analysis summary: Adult and juvenile Green sea turtle, south Atlantic DPS are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to chlorpyrifos in the marine environment. If exposed to formulated products and tank mixtures containing chlorpyrifos, sea turtles may experience increased toxicity. The overall risk to Green sea turtle, south Atlantic DPS from the effects of the action is low and the confidence associated with that risk is low. The low risk is due primarily to the small portion of the species range within US territories. The lack in confidence is due primarily to the uncertainty in predicted chlorpyrifos concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites with the species range.



12.55 Hawksbill Sea Turtle (Eretmochelys imbricate)

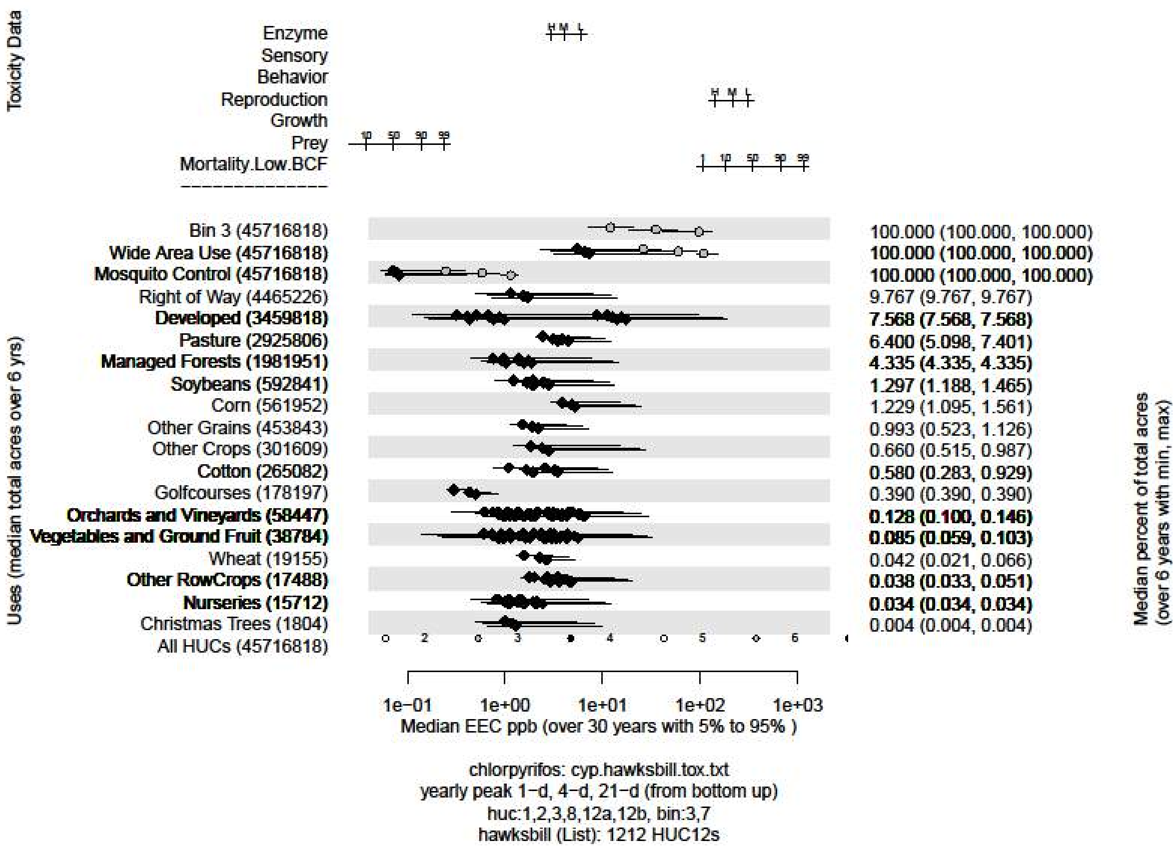


Figure 53. Effects analysis R-plot for Hawskbill sea turtle and chlorpyrifos

Table 503. Likelihood of exposure determination for Hawskbill sea turtle and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range in US Territories	Likelihood of Exposure
Lower-48 Coastal Habitats								
Wide Area Use	3	yes	yes	yes	NA	3	small	Low
Mosquito Control	3	yes	yes	yes	NA	3	small	Low
Right of Way	3	yes	yes	yes	NA	3	small	Low
Developed	3	yes	yes	yes	NA	3	small	Low
Pasture	3	yes	yes	yes	NA	3	small	Low
Managed forest	2	yes	yes	yes	NA	3	small	Low
Soybean	2	yes	yes	yes	NA	3	small	Low
Corn	2	yes	yes	yes	NA	3	small	Low
Other Grains	1	yes	yes	yes	NA	3	small	Low
Other Crops	1	yes	yes	yes	NA	3	small	Low
Cotton	1	yes	yes	yes	NA	3	small	Low
Golf Course	1	yes	yes	yes	NA	3	small	Low
Orchards and Vineyards	1	yes	yes	yes	NA	3	small	Low
Vegetables and Ground Fruit	1	yes	yes	yes	NA	3	small	Low
Wheat	1	yes	yes	yes	NA	3	small	Low
Other Row Crops	1	yes	yes	yes	NA	3	small	Low
Nurseries	1	yes	yes	yes	NA	3	small	Low
Christmas Trees	1	yes	yes	yes	NA	3	small	Low
Bin 3	1	yes	yes	yes	NA	3	small	Low
US Territories in Pacific								
Crops	NA	yes	yes	yes	NA	low	small	Low
Developed	NA	yes	yes	yes	NA	low	small	Low
Mosquito Control	NA	yes	yes	yes	NA	low	small	Low
Other	NA	yes	yes	yes	NA	low	small	Low
US Territories in Atlantic								
Crops	NA	yes	yes	yes	NA	low	small	Low
Developed	NA	yes	yes	yes	NA	low	small	Low
Mosquito Control	NA	yes	yes	yes	NA	low	small	Low
Other	NA	yes	yes	yes	NA	low	small	Low

Life Stage: Adults and Juveniles

Table 504. Direct mortality risk hypothesis; Hawskbill sea turtle and chlorpyrifos; Adults and Juveniles; Lower-48

Endpoint: Mortality (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	Med	Low
Mosquito Control	100	Low	Low
Right of Way	9.8	Med	Low
Developed	7.6	Low	Low
Pasture	6.4	Low	Low

Managed forest	4.3	Low	Low
Soybean	1.3	Low	Low
Corn	1.2	Low	Low
Other Grains	.9	Low	Low
Other Crops	.7	Low	Low
Cotton	.6	Low	Low
Golf Course	.4	Low	Low
Orchards and Vineyards	.1	Low	Low
Vegetables and Ground Fruit	.1	Low	Low
Wheat	.04	Low	Low
Other Row Crops	.03	Low	Low
Nurseries	.03	Low	Low
Christmas Trees	.004	Low	Low
Bin 3		Med	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juveniles abundance via acute lethality.			
Risk	**Confidence**		
Low	**Low**		

Table 505. Direct mortality risk hypothesis; Hawskbill sea turtle and chlorpyrifos; Adults and Juveniles; US Territories in Pacific

Endpoint: Mortality (HUC20 – Hawaii; US territories in Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Low to High	Low
Developed	Not Available	High	Low
Mosquito Control	100	Low	Low
Other	Not Available	Med to High	Low

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juveniles abundance via acute lethality.		
Risk	**Confidence**	
Low	**Low**	

Table 506. Direct mortality risk hypothesis; Hawskbill sea turtle and chlorpyrifos; Adults and Juveniles; US Territories in Atlantic

Endpoint: Mortality (HUC03 – US territories in Caribbean/Atlantic)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Low to Medium	Low
Developed	Not Available	High	Low
Mosquito Control	100	Low	Low
Other	Not Available	Low to Medium	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juveniles abundance via acute lethality.			
Risk	**Confidence**		
Low	Low		

Table 507. Prey risk hypothesis; Hawskbill sea turtle and chlorpyrifos; Adults and Juveniles; Lower-48

Endpoint: Prey (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Low
Mosquito Control	100	High	Low
Right of Way	9.8	High	Low
Developed	7.6	High	Low
Pasture	6.4	High	Low
Managed forest	4.3	High	Low
Soybean	1.3	High	Low

Corn	1.2	High	Low
Other Grains	.9	High	Low
Other Crops	.7	High	Low
Cotton	.6	High	Low
Golf Course	.4	High	Low
Orchards and Vineyards	.1	High	Low
Vegetables and Ground Fruit	.1	High	Low
Wheat	.04	High	Low
Other Row Crops	.03	High	Low
Nurseries	.03	High	Low
Christmas Trees	.004	High	Low
Bin 3		High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	**Low**		

Table 508. Prey risk hypothesis; Hawskbill sea turtle and chlorpyrifos; Adults and Juveniles; US Territories in Atlantic

Endpoint: Prey (HUC03 – US territories in Caribbean/Atlantic)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	100	High	Low
Other	Not Available	High	Low

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability		
Risk	**Confidence**	
Low	**Low**	

Table 509. Prey risk hypothesis; Hawskbill sea turtle and chlorpyrifos; Adults and Juveniles; US Territories in Pacific

Endpoint: Prey (HUC20 – Hawaii; US territories in Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	100	High	Low
Other	Not Available	High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	Low		

Table 510. AChE risk hypothesis; Hawskbill sea turtle and chlorpyrifos; Adults and Juveniles; Lower-48

Endpoint: enzyme (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Low
Mosquito Control	100	Low	Low
Right of Way	9.8	High	Low
Developed	7.6	High	Low
Pasture	6.4	High	Low
Managed forest	4.3	High	Low

Soybean	1.3	High	Low
Corn	1.2	High	Low
Other Grains	.9	High	Low
Other Crops	.7	High	Low
Cotton	.6	High	Low
Golf Course	.4	Low	Low
Orchards and Vineyards	.1	High	Low
Vegetables and Ground Fruit	.1	High	Low
Wheat	.04	High	Low
Other Row Crops	.03	High	Low
Nurseries	.03	High	Low
Christmas Trees	.004	High	Low
Bin 3		High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**Low**		

Table 511. AChE risk hypothesis; Hawskbill sea turtle and chlorpyrifos; Adults and Juveniles; US Territories in Atlantic

Endpoint: Enzyme (HUC03 – US territories in Caribbean/Atlantic)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	100	Low	Low
Other	Not Available	High	Low

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity		
Risk	**Confidence**	
Low	**Low**	

Table 512. AChE risk hypothesis; Hawskbill sea turtle and chlorpyrifos; Adults and Juveniles; US Territories in Pacific

Endpoint: Enzyme (HUC20 – Hawaii; US territories in Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	100	Low	Low
Other	Not Available	High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	Low		

Table 513. Reproduction risk hypothesis; Hawskbill sea turtle and chlorpyrifos; Adults and Juveniles; Lower-48

Endpoint: Reproduction (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	Low	Low
Mosquito Control	100	Low	Low
Right of Way	9.8	Low	Low
Developed	7.6	Low	Low
Pasture	6.4	Low	Low
Managed forest	4.3	Low	Low

Soybean	1.3	Low	Low
Corn	1.2	Low	Low
Other Grains	.9	Low	Low
Other Crops	.7	Low	Low
Cotton	.6	Low	Low
Golf Course	.4	Low	Low
Orchards and Vineyards	.1	Low	Low
Vegetables and Ground Fruit	.1	Low	Low
Wheat	.04	Low	Low
Other Row Crops	.03	Low	Low
Nurseries	.03	Low	Low
Christmas Trees	.004	Low	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**Low**		

Table 514. Reproduction risk hypothesis; Hawskbill sea turtle and chlorpyrifos; Adults and Juveniles; US Territories in Pacific

Endpoint: Reproduction (HUC20 – Hawaii; US territories in Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Low to High	Low
Developed	Not Available	High	Low
Mosquito Control	100	Low	Low
Other	Not Available	Low to Med	Low

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction		
Risk	**Confidence**	
Low	**Low**	

Table 515. Reproduction risk hypothesis; Hawskbill sea turtle and chlorpyrifos; Adults and Juveniles; US Territories in Atlantic

Endpoint: Reproduction (HUC03 – US territories in Caribbean/Atlantic)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Low	Low
Developed	Not Available	Medium	Low
Mosquito Control	100	Low	Low
Other	Not Available	Low	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	Low		

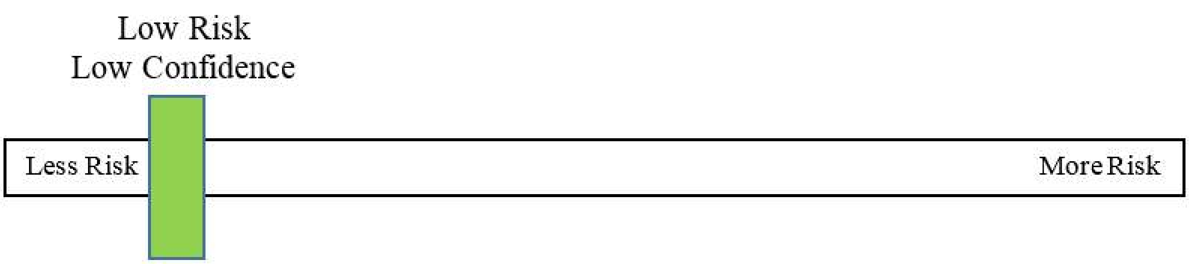
Table 516. Effects analysis summary table: Hawskbill sea turtle and chlorpyrifos

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
(Lower 48 – Coastal HUC-12s)	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**

Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability	Low	Low	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	Low	Not Available	**No**
(HUC20 – Hawaii; US territories in Pacific)				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability	Low	Low	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	Low	Not Available	**No**
(HUC03 – US territories in Caribbean/Atlantic)				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability	Low	Low	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce ChE	Low	Low	Not Available	**No**

activity; the identified mechanism of toxicity				

Effects analysis summary: Adult and juvenile hawksbill sea turtles are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to chlorpyrifos in the marine environment. If exposed to formulated products and tank mixtures containing chlorpyrifos, sea turtles may experience increased toxicity. The overall risk to hawksbill sea turtles from the effects of the action is low and the confidence associated with that risk is low. The low risk is due primarily to the small portion of the species range within US territories. The lack in confidence is due primarily to the uncertainty in predicted chlorpyrifos concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites with the species range.



12.56 Kemp's Ridley Sea Turtle (Lepidochelys kempii)

Table 517. Likelihood of exposure determination for Kemp's ridley sea turtle and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
US Lower-48							
Wide Area Use	3	yes	yes	yes	NA	3	High
Mosquito Control	3	yes	yes	yes	NA	3	High
Right of Way	3	yes	yes	yes	NA	3	High
Developed	3	yes	yes	yes	NA	3	High
Pasture	3	yes	yes	yes	NA	3	High
Managed Forest	2	yes	yes	yes	NA	3	High
Soy Bean	2	yes	yes	yes	NA	3	High
Corn	2	yes	yes	yes	NA	3	High
Other Grain	1	yes	yes	yes	NA	3	Low
Other Crops	1	yes	yes	yes	NA	3	Low
Cotton	1	yes	yes	yes	NA	3	Low
Golf Courses	1	yes	yes	yes	NA	3	Low
Orchard and Vineyards	1	yes	yes	yes	NA	3	Low
Vegetables anf Ground Fruit	1	yes	yes	yes	NA	3	Low
Wheat	1	yes	yes	yes	NA	3	Low
Other Row Crops	1	yes	yes	yes	NA	3	Low
Nurseries	1	yes	yes	yes	NA	3	Low
Christmas Trees	3	yes	yes	yes	NA	3	High
Bin 3	3	yes	yes	yes	NA	3	High
US Territories in Atlantic							
Crops	NA	yes	yes	yes	NA	3	Med
Developed	NA	yes	yes	yes	NA	3	Med
Mosquito Control	NA	yes	yes	yes	NA	3	Med
Other	NA	yes	yes	yes	NA	3	Med

Life Stage: Adults and Juveniles

Table 518. Direct mortality risk hypothesis; Kemp's ridley sea turtle and chlorpyrifos; Adults and Juveniles; US Lower-48

Endpoint: Mortality (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	Med	**High**
Mosquito Control	100	Low	**High**
Right of Way	9.5	Low	**High**
Developed	7.3	Med	**High**

Pasture	6.0	Low	**High**
Managed Forest	4.1	Low	**High**
Soy Bean	1.2	Low	**High**
Corn	1.1	Low	**High**
Other Grain	.9	Low	**Low**
Other Crops	.6	Low	**Low**
Cotton	.5	Low	**Low**
Golf Courses	.4	Low	**Low**
Orchard and Vineyards	.1	Low	**Low**
Vegetables and Ground Fruit	.1	Low	**Low**
Wheat	.04	Low	**Low**
Other Row Crops	.04	Low	**Low**
Nurseries	.03	Low	**Low**
Christmas Trees	.004	Low	**Low**
Bin 3		Med	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**Low**		

Table 519. Direct mortality risk hypothesis; Kemp's ridley sea turtle and chlorpyrifos; Adults; US Territories in Atlantic

Endpoint: Mortality (HUC03 – US territories in Caribbean/Atlantic)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Low to Medium	Medium
Developed	Not Available	High	Medium
Mosquito Control	100	Low	Medium
Other	Not Available	Low to Medium	Medium

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce juveniles abundance via acute lethality.		
Risk	**Confidence**	
High	Low	

Table 520. Prey risk hypothesis; Kemp's ridley sea turtle and chlorpyrifos; Adults and Juveniles; US Lower-48

Endpoint: Prey (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	High	**High**
Right of Way	9.5	High	**High**
Developed	7.3	High	**High**
Pasture	6.0	High	**High**
Managed Forest	4.1	High	**High**
Soy Bean	1.2	High	**High**
Corn	1.1	High	**High**
Other Grain	.9	High	**Low**
Other Crops	.6	High	**Low**
Cotton	.5	High	**Low**
Golf Courses	.4	High	**Low**
Orchard and Vineyards	.1	High	**Low**
Vegetables anf Ground Fruit	.1	High	**Low**
Wheat	.04	High	**Low**
Other Row Crops	.04	High	**Low**
Nurseries	.03	High	**Low**
Christmas Trees	.004	High	**Low**
Bin 3		High	**High**

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability		
Risk	**Confidence**	
High	**Low**	

Table 521. Prey risk hypothesis; Kemp's ridley sea turtle and chlorpyrifos; Adults; US Territories in Atlantic

Endpoint: Prey (HUC03 – US territories in Caribbean/Atlantic)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Medium
Developed	Not Available	High	Medium
Mosquito Control	100	High	Medium
Other	Not Available	High	Medium
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**Low**		

Table 522. AChE risk hypothesis; Kemp's ridley sea turtle and chlorpyrifos; Adults and Juveniles; US Lower-48

Endpoint: enzyme (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Low	**High**
Right of Way	9.5	High	**High**
Developed	7.3	High	**High**
Pasture	6.0	High	**High**
Managed Forest	4.1	High	**High**

Soy Bean	1.2	High	**High**
Corn	1.1	High	**High**
Other Grain	.9	High	**Low**
Other Crops	.6	High	**Low**
Cotton	.5	High	**Low**
Golf Courses	.4	Low	**Low**
Orchard and Vineyards	.1	High	**Low**
Vegetables and Ground Fruit	.1	High	**Low**
Wheat	.04	High	**Low**
Other Row Crops	.04	High	**Low**
Nurseries	.03	High	**Low**
Christmas Trees	.004	High	**Low**
Bin 3		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Low**		

Table 523. AChE risk hypothesis; Kemp's ridley sea turtle and chlorpyrifos; Adults; US Territories in Atlantic

Endpoint: Enzyme (HUC03 – US territories in Caribbean/Atlantic)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Medium
Developed	Not Available	High	Medium
Mosquito Control	100	Low	Medium
Other	Not Available	High	Medium

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity		
Risk	**Confidence**	
High	**Low**	

Table 524. Reproduction risk hypothesis; Kemp's ridley sea turtle and chlorpyrifos; Adults; US Territories in Atlantic

Endpoint: Reproduction (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	Low	**High**
Mosquito Control	100	Low	**High**
Right of Way	9.5	Low	**High**
Developed	7.3	Low	**High**
Pasture	6.0	Low	**High**
Managed Forest	4.1	Low	**High**
Soy Bean	1.2	Low	**High**
Corn	1.1	Low	**High**
Other Grain	.9	Low	**Low**
Other Crops	.6	Low	**Low**
Cotton	.5	Low	**Low**
Golf Courses	.4	Low	**Low**
Orchard and Vineyards	.1	Low	**Low**
Vegetables anf Ground Fruit	.1	Low	**Low**
Wheat	.04	Low	**Low**
Other Row Crops	.04	Low	**Low**
Nurseries	.03	Low	**Low**
Christmas Trees	.004	Low	**Low**
Bin 3		Low	**High**

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction		
Risk	**Confidence**	
High	**Low**	

Table 525. Reproduction risk hypothesis; Kemp's ridley sea turtle and chlorpyrifos; Adults; US Territories in Atlantic

Endpoint: Reproduction (HUC03 – US territories in Caribbean/Atlantic)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Low	Medium
Developed	Not Available	Medium	Medium
Mosquito Control	100	Low	Medium
Other	Not Available	Low	Medium
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	Low		

Table 526. Effects analysis summary table: Kemp's ridley sea turtle and chlorpyrifos

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
(Lower 48 – Coastal HUC-12s)	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	Low	Not Available	**Yes**

Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Low	Not Available	**Yes**
(HUC03 – US territories in Caribbean/Atlantic)				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Low	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Kemp's ridley sea turtles are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to chlorpyrifos in the marine environment. If exposed to formulated products and tank mixtures containing chlorpyrifos, sea turtles may experience increased toxicity. The overall risk to Kemp's ridley sea turtles from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted chlorpyrifos concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites with the species range.


Medium Risk
Low Confidence
Less Risk
More Risk

12.57 Leatherback Sea Turtle (Dermochelys coriacea)

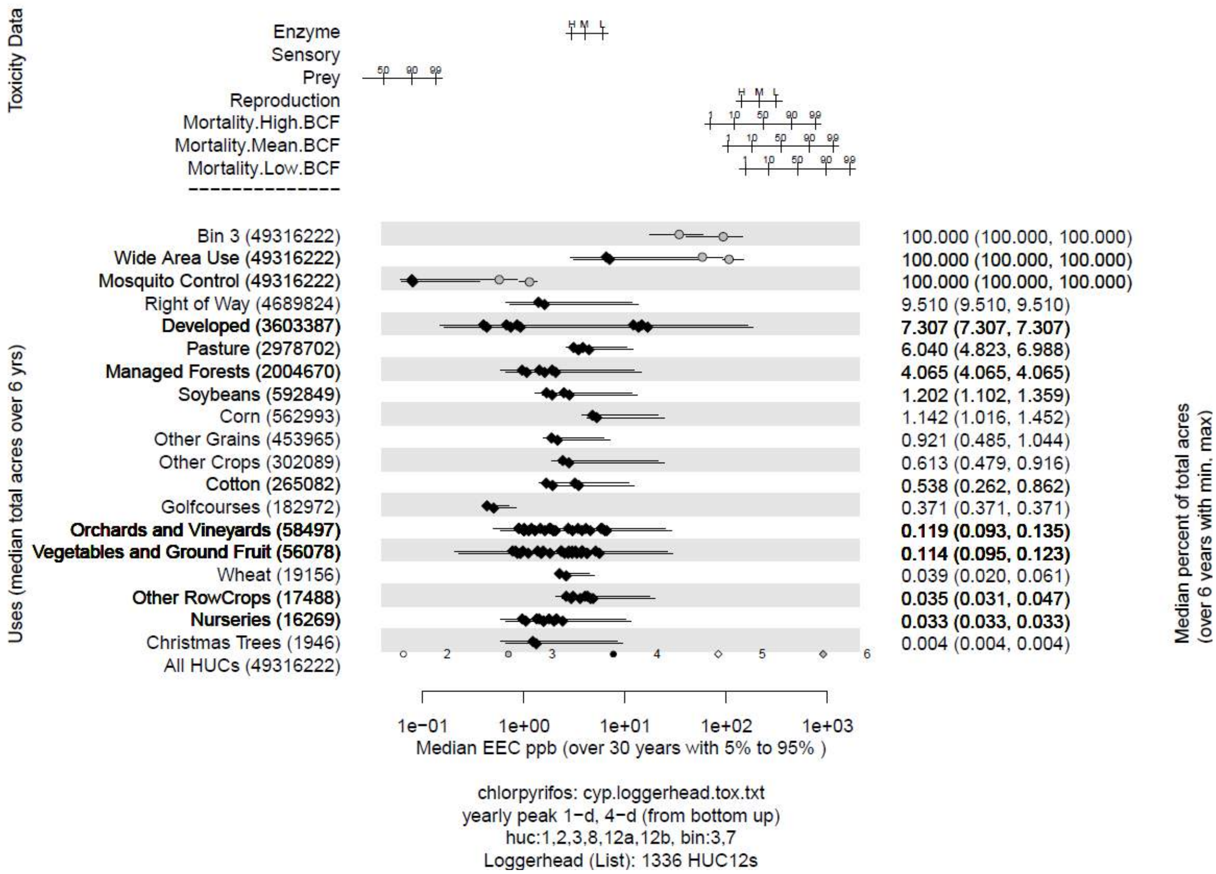


Table 527. Likelihood of exposure determination for Leatherback sea turtle and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range in US Territories	Likelihood of Exposure
US Lower-48								
Wide Area Use	3	yes	yes	yes	NA	3	Med	**Med**
Mosquito Control	3	yes	yes	yes	NA	3	Med	**Med**
Right of Way	3	yes	yes	yes	NA	3	Med	**Med**
Developed	3	yes	yes	yes	NA	3	Med	**Med**
Pasture	3	yes	yes	yes	NA	3	Med	**Med**
Managed Forset	3	yes	yes	yes	NA	3	Med	**Med**
Corn	1	yes	yes	yes	NA	3	Med	Low
Soy Bean	1	yes	yes	yes	NA	3	Med	Low
Other Grains	1	yes	yes	yes	NA	3	Med	Low
Other Crops	1	yes	yes	yes	NA	3	Med	Low
Cotton	1	yes	yes	yes	NA	3	Med	Low
Golf Courses	1	yes	yes	yes	NA	3	Med	Low
Vegetables and Ground Fruit	1	yes	yes	yes	NA	3	Med	Low
Orchards and Vineyards	1	yes	yes	yes	NA	3	Med	Low
Wheat	1	yes	yes	yes	NA	3	Med	Low
Nurseries	1	yes	yes	yes	NA	3	Med	Low
Other Row Crops	1	yes	yes	yes	NA	3	Med	Low
Christmas Trees	1	yes	yes	yes	NA	3	Med	Low
Bin 3	1	yes	yes	yes	NA	3	Med	Low
US Territories in Pacific								
Crops	NA	yes	yes	yes	NA	3	Med	Low
Developed	NA	yes	yes	yes	NA	3	Med	Low
Mosquito Control	NA	yes	yes	yes	NA	3	Med	Low
Other	NA	yes	yes	yes	NA	3	Med	Low
US Territories in Atlantic								
Crops	NA	yes	yes	yes	NA	3	Med	Low
Developed	NA	yes	yes	yes	NA	3	Med	Low
Mosquito Control	NA	yes	yes	yes	NA	3	Med	Low
Other	NA	yes	yes	yes	NA	3	Med	Low

Life Stage: Juveniles

Based on the life history of leatherback turtles, hatchlings crawl to the water and swim to offshore areas where they reside for several years. Therefore juveniles are not expected to experience substantial exposure to chlorpyrifos.

Life Stage: Adults

Table 528. Direct mortality risk hypothesis; Leatherback sea turtle and chlorpyrifos; Adults; US Lower-48

Endpoint: Mortality (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**Med**
Mosquito Control	100	Low	**Med**
Right of Way	9.6	Med	**Med**

Developed	7.4	High	**Med**
Pasture	6.2	Low	**Med**
Managed Forest	5.1	Med	**Med**
Corn	.9	Med	**Low**
Soy Bean	.9	Low	**Low**
Other Grains	.7	Low	**Low**
Other Crops	.5	Med	**Low**
Cotton	.4	Low	**Low**
Golf Courses	.4	Low	**Low**
Vegetables and Ground Fruit	.1	High	**Low**
Orchards and Vineyards	.1	Med	**Low**
Wheat	.05	Low	**Low**
Nurseries	.03	Med	**Low**
Other Row Crops	.03	Low	**Low**
Christmas Trees	.009	Low	**Low**
Bin 3			**Low**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**Low**		

Table 529. Direct mortality risk hypothesis; Leatherback sea turtle and chlorpyrifos; Adults; US Territories in Pacific

Endpoint: Mortality (HUC20 – Hawaii; US territories in Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Low to High	Low
Developed	Not Available	High	Low

Mosquito Control	100	Low	Low
Other	Not Available	Med to High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**Low**		

Table 530. Direct mortality risk hypothesis; Leatherback sea turtle and chlorpyrifos; Adults; US Territories in Atlantic

Endpoint: Mortality (HUC03 – US territories in Caribbean/Atlantic)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Low to Medium	Low
Developed	Not Available	High	Low
Mosquito Control	100	Low	Low
Other	Not Available	Low to Medium	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	Low		

Table 531. Reproduction risk hypothesis; Leatherback sea turtle and chlorpyrifos; Adults; US Lower-48

Endpoint: Reproduction (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**Med**
Mosquito Control	100	Low	**Med**
Right of Way	9.6	Low	**Med**
Developed	7.4	High	**Med**
Pasture	6.2	Low	**Med**

Managed Forest	5.1	Low	**Med**
Corn	.9	Low	**Low**
Soy Bean	.9	Low	**Low**
Other Grains	.7	Low	**Low**
Other Crops	.5	Med	**Low**
Cotton	.4	Low	**Low**
Golf Courses	.4	Low	**Low**
Vegetables and Ground Fruit	.1	High	**Low**
Orchards and Vineyards	.1	Med	**Low**
Wheat	.05	Low	**Low**
Nurseries	.03	Low	**Low**
Other Row Crops	.03	Low	**Low**
Christmas Trees	.009	Low	**Low**
Bin 3		Low	**Low**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**Low**		

Table 532. Reproduction risk hypothesis; Leatherback sea turtle and chlorpyrifos; Adults; US Territories in Pacific

Endpoint: Reproduction (HUC20 – Hawaii; US territories in Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Low to High	Low
Developed	Not Available	High	Low
Mosquito Control	100	Low	Low

Other	Not Available	Low to Med	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	Low		

Table 533. Reproduction risk hypothesis; Leatherback sea turtle and chlorpyrifos; Adults; US Territories in Atlantic

Endpoint: Reproduction (HUC03 – US territories in Caribbean/Atlantic)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Low	Low
Developed	Not Available	Medium	Low
Mosquito Control	100	Low	Low
Other	Not Available	Low	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	Low		

Table 534. AChE risk hypothesis; Leatherback sea turtle and chlorpyrifos; Adults; US Lower-48

Endpoint: enzyme (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**Med**
Mosquito Control	100	Med	**Med**
Right of Way	9.6	High	**Med**
Developed	7.4	High	**Med**
Pasture	6.2	High	**Med**

Managed Forest	5.1	High	**Med**
Corn	.9	High	**Low**
Soy Bean	.9	High	**Low**
Other Grains	.7	High	**Low**
Other Crops	.5	High	**Low**
Cotton	.4	High	**Low**
Golf Courses	.4	High	**Low**
Vegetables and Ground Fruit	.1	High	**Low**
Orchards and Vineyards	.1	High	**Low**
Wheat	.05	High	**Low**
Nurseries	.03	High	**Low**
Other Row Crops	.03	High	**Low**
Christmas Trees	.009	High	**Low**
Bin 3		High	**Low**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Low**		

Table 535. AChE risk hypothesis; Leatherback sea turtle and chlorpyrifos; Adults; US Territories in Pacific

Endpoint: Enzyme (HUC20 – Hawaii; US territories in Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	100	Low	Low
Other	Not Available	High	Low

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity		
Risk	**Confidence**	
Low	Low	

Table 536. AChE risk hypothesis; Leatherback sea turtle and chlorpyrifos; Adults; US Territories in Atlantic

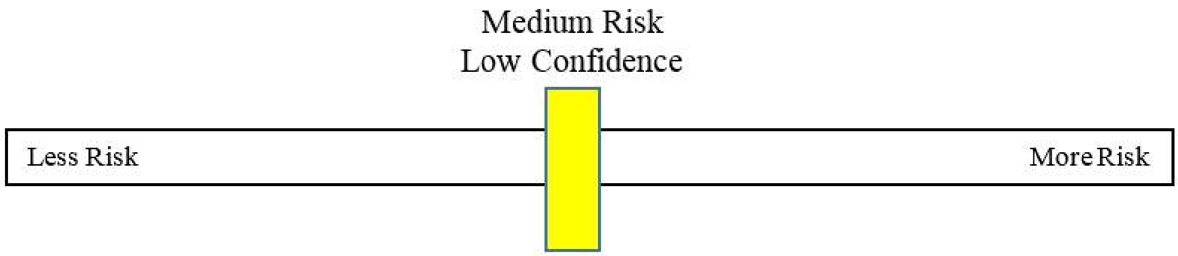
Endpoint: Enzyme (HUC03 – US territories in Caribbean/Atlantic)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	100	Low	Low
Other	Not Available	High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	Low		

Table 537. Effects analysis summary table: Leatherback sea turtle and chlorpyrifos

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
(Lower 48 – Coastal HUC-12s)	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	Low	Not Available	**Yes**

Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Low	Not Available	**Yes**
(HUC03 – US territories in Caribbean/Atlantic)				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	Low	Not Available	**No**
(HUC20 – Hawaii; US territories in Pacific)				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	Low	Not Available	**No**

Effects analysis summary: Adult and juvenile leatherback sea turtles are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to chlorpyrifos in the marine environment. If exposed to formulated products and tank mixtures containing chlorpyrifos, sea turtles may experience increased toxicity. The overall risk to leatherback sea turtles from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted chlorpyrifos concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites with the species range.


Medium Risk
Low Confidence
Less Risk
More Risk

12.58 Loggerhead Sea Turtle, North Pacific Ocean DPS (Caretta caretta)

Effects analysis summary: Adult and juvenile loggerhead sea turtle, North Pacific Ocean DPS are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to chlorpyrifos in the marine environment. If exposed to formulated products and tank mixtures containing chlorpyrifos, sea turtles may experience increased toxicity. The overall risk to loggerhead sea turtle, North Pacific DPS from the effects of the action is low and the confidence associated with that risk is high. Low risk is due primarily to the small portion of the species range within US territories and the species utilization of off-shore habitats.

12.58.1.1 Loggerhead Sea Turtle, Northwest Atlantic Ocean DPS (Caretta caretta)

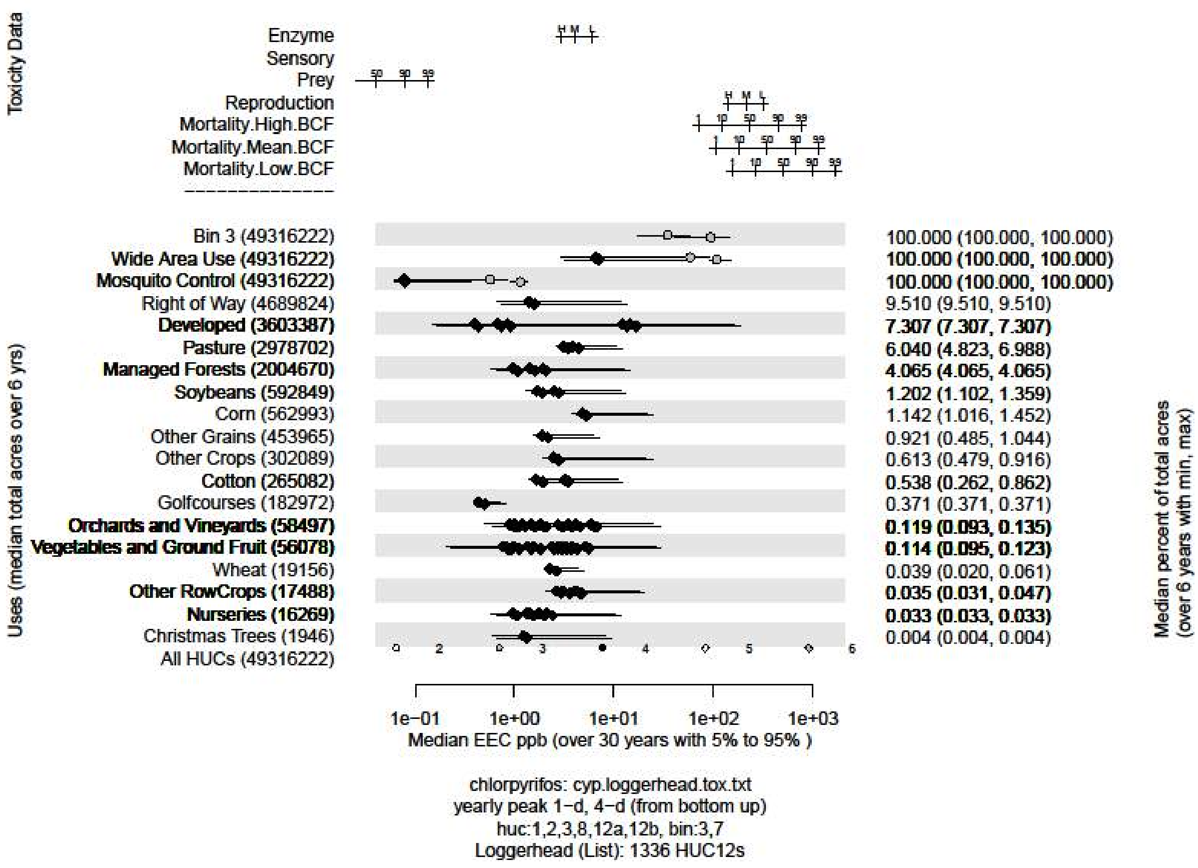


Figure 54. Effects analysis R-plot for Loggerhead sea turtle, northwest Atlantic Ocean DPS and chlorpyrifos

Table 538. Likelihood of exposure determination for Loggerhead sea turtle, northwest Atlantic Ocean DPS and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
US Lower-48							
Wide Area Use	3	yes	yes	yes	NA	3	**High**
Mosquito Control	3	yes	yes	yes	NA	3	**High**
Right of Way	3	yes	yes	yes	NA	3	**High**
Developed	3	yes	yes	yes	NA	3	**High**
Pasture	3	yes	yes	yes	NA	3	**High**
Managed Forest	2	yes	yes	yes	NA	3	**High**
Soy Bean	2	yes	yes	yes	NA	3	**High**
Corn	2	yes	yes	yes	NA	3	**High**
Other Grain	1	yes	yes	yes	NA	3	**Low**
Other Crops	1	yes	yes	yes	NA	3	**Low**
Cotton	1	yes	yes	yes	NA	3	**Low**
Golf Courses	1	yes	yes	yes	NA	3	**Low**
Orchard and Vineyards	1	yes	yes	yes	NA	3	**Low**
Vegetables anf Ground Fruit	1	yes	yes	yes	NA	3	**Low**
Wheat	1	yes	yes	yes	NA	3	**Low**
Other Row Crops	1	yes	yes	yes	NA	3	**Low**
Nurseries	1	yes	yes	yes	NA	3	**Low**
Christmas Trees	1	yes	yes	yes	NA	3	**Low**
Bin 3	3	yes	yes	yes	NA	3	**High**
US Territories in Atlanitc							
Crops	NA	yes	yes	yes	NA	3	**Med**
Developed	NA	yes	yes	yes	NA	3	**Med**
Mosquito Control	NA	yes	yes	yes	NA	3	**Med**
Other	NA	yes	yes	yes	NA	3	**Med**

Life Stage: Adults and Juveniles

Table 539. Direct mortality risk hypothesis; Loggerhead sea turtle, northwest Atlantic Ocean DPS and chlorpyrifos; Adults and Juveniles; US Lower-48

Endpoint: Mortality (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	Medium	**High**
Mosquito Control	100	Low	**High**
Right of Way	9.5	Low	**High**
Developed	7.3	Medium	**High**
Pasture	6.0	Low	**High**

Managed Forest	4.1	Low	**High**
Soy Bean	1.2	Low	**High**
Corn	1.1	Low	**High**
Other Grain	.9	Low	**Low**
Other Crops	.6	Low	**Low**
Cotton	.5	Low	**Low**
Golf Courses	.4	Low	**Low**
Orchard and Vineyards	.1	Low	**Low**
Vegetables anf Ground Fruit	.1	Low	**Low**
Wheat	.04	Low	**Low**
Other Row Crops	.04	Low	**Low**
Nurseries	.03	Low	**Low**
Christmas Trees	.004	Low	**Low**
Bin 3		Medium	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**Low**		

Table 540. Direct mortality risk hypothesis; Loggerhead sea turtle, northwest Atlantic Ocean DPS and chlorpyrifos; Adults and Juveniles; US Territories in Atlantic

Endpoint: Mortality (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Low to Medium	Medium
Developed	Not Available	High	Medium
Mosquito Control	100	Low	Medium
Other	Not Available	Low to Medium	Medium

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.		
Risk	**Confidence**	
High	**Low**	

Table 541. Prey risk hypothesis; Loggerhead sea turtle, northwest Atlantic Ocean DPS and chlorpyrifos; Adults and Juveniles; US Lower-48

Endpoint: Prey (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	High	**High**
Right of Way	9.5	High	**High**
Developed	7.3	High	**High**
Pasture	6.0	High	**High**
Managed Forest	4.1	High	**High**
Soy Bean	1.2	High	**High**
Corn	1.1	High	**High**
Other Grain	.9	High	**Low**
Other Crops	.6	High	**Low**
Cotton	.5	High	**Low**
Golf Courses	.4	High	**Low**
Orchard and Vineyards	.1	High	**Low**
Vegetables anf Ground Fruit	.1	High	**Low**
Wheat	.04	High	**Low**
Other Row Crops	.04	High	**Low**
Nurseries	.03	High	**Low**
Christmas Trees	.004	High	**Low**
Bin 3		High	**High**

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability		
Risk	**Confidence**	
High	**Low**	

Table 542. Prey risk hypothesis; Loggerhead sea turtle, northwest Atlantic Ocean DPS and chlorpyrifos; Adults and Juveniles; US Territories in Atlantic

Endpoint: Prey (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Medium
Developed	Not Available	High	Medium
Mosquito Control	100	High	Medium
Other	Not Available	High	Medium
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**Low**		

Table 543. AChE risk hypothesis; Loggerhead sea turtle, northwest Atlantic Ocean DPS and chlorpyrifos; Adults and Juveniles; US Lower-48

Endpoint: enzyme (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	**High**
Mosquito Control	100	Low	**High**
Right of Way	9.5	High	**High**
Developed	7.3	High	**High**
Pasture	6.0	High	**High**
Managed Forest	4.1	High	**High**

Soy Bean	1.2	High	**High**
Corn	1.1	High	**High**
Other Grain	.9	High	**Low**
Other Crops	.6	High	**Low**
Cotton	.5	High	**Low**
Golf Courses	.4	Low	**Low**
Orchard and Vineyards	.1	High	**Low**
Vegetables anf Ground Fruit	.1	High	**Low**
Wheat	.04	High	**Low**
Other Row Crops	.04	High	**Low**
Nurseries	.03	High	**Low**
Christmas Trees	.004	High	**Low**
Bin 3		High	**High**
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Low**		

Table 544. AChE risk hypothesis; Loggerhead sea turtle, northwest Atlantic Ocean DPS and chlorpyrifos; Adults and Juveniles; US Territories in Atlantic

Endpoint: Enzyme (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Medium
Developed	Not Available	High	Medium
Mosquito Control	100	Low	Medium
Other	Not Available	High	Medium

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity		
Risk	**Confidence**	
High	**Low**	

Table 545. Reproduction risk hypothesis; Loggerhead sea turtle, northwest Atlantic Ocean DPS and chlorpyrifos; Adults; US Lower-48

Endpoint: Reproduction (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	Low	**High**
Mosquito Control	100	Low	**High**
Right of Way	9.5	Low	**High**
Developed	7.3	Low	**High**
Pasture	6.0	Low	**High**
Managed Forest	4.1	Low	**High**
Soy Bean	1.2	Low	**High**
Corn	1.1	Low	**High**
Other Grain	.9	Low	**Low**
Other Crops	.6	Low	**Low**
Cotton	.5	Low	**Low**
Golf Courses	.4	Low	**Low**
Orchard and Vineyards	.1	Low	**Low**
Vegetables anf Ground Fruit	.1	Low	**Low**
Wheat	.04	Low	**Low**
Other Row Crops	.04	Low	**Low**
Nurseries	.03	Low	**Low**
Christmas Trees	.004	Low	**Low**
Bin 3		Low	**High**

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction		
Risk	Confidence	
High	Low	

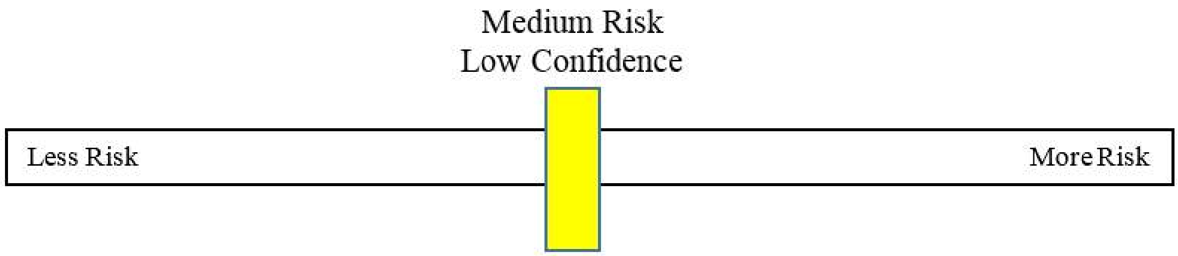
Table 546. Reproduction risk hypothesis; Loggerhead sea turtle, northwest Atlantic Ocean DPS and chlorpyrifos; Adults; US Territories in Atlantic

Endpoint: Reproduction (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Low	Medium
Developed	Not Available	Medium	Medium
Mosquito Control	100	Low	Medium
Other	Not Available	Low	Medium
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**Low**		

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
(Lower 48 – Coastal HUC-12s)	Risk	Confidence	Range in median percent mortalities for aquatic bins	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce	High	Low	Not Available	

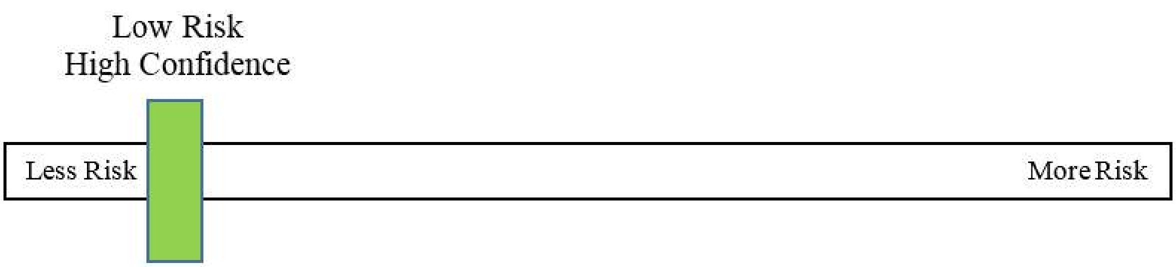
Juvenile abundance via reduction in prey availability				
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Low	Not Available	**Yes**
(HUC03 – US territories in Caribbean/Atlantic)				
Exposure to chlorpyrifos is sufficient to reduce adult abundance via acute lethality.	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce Juvenile abundance via reduction in prey availability	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Low	Not Available	**Yes**

Effects analysis summary: Adult and juvenile loggerhead sea turtles, northwest Atlantic Ocean DPS are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to chlorpyrifos in the marine environment. If exposed to formulated products and tank mixtures containing chlorpyrifos, sea turtles may experience increased toxicity. The overall risk to loggerhead sea turtles from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted chlorpyrifos concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites with the species range.


Medium Risk
Low Confidence
Less Risk
More Risk

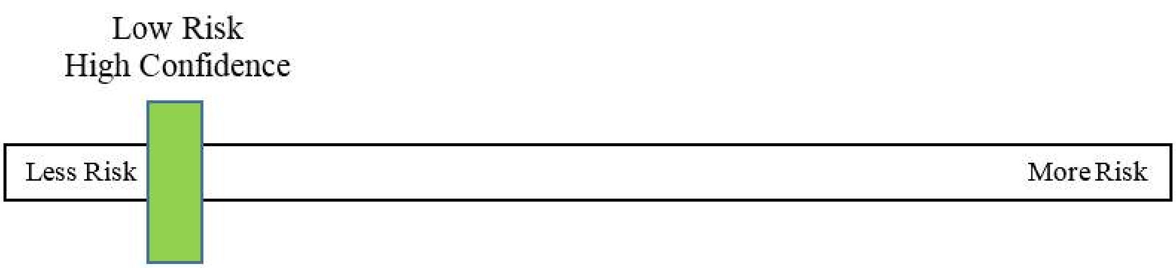
12.59 Olive Ridley Sea Turtle, Mexico's Pacific Coast Breeding Colonies (Lepidochelys olivacea)

Effects analysis summary: Adult and juvenile Olive ridley sea turtles within Mexico's Pacific breeding colonies are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to chlorpyrifos in the marine environment. If exposed to formulated products and tank mixtures containing chlorpyrifos, sea turtles may experience increased toxicity. The overall risk to Mexico's Pacific coast breeding colonies of Olive ridley sea turtles is low and the confidence associated with that risk is high. Low risk is due primarily to the small portion of the species range within US territories and the species' utilization of off-shore habitats.



12.60 Olive Ridley Sea Turtle, All Other Areas (Lepidochelys olivacea)

Effects analysis summary: Adult and juvenile Olive ridley sea turtles (all areas outside of Mexico's Pacific breeding colonies) are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to chlorpyrifos in the marine environment. If exposed to formulated products and tank mixtures containing chlorpyrifos, sea turtles may experience increased toxicity. The overall risk to Olive ridley sea turtles (all areas outside of Mexico's Pacific coast breeding colonies) is low and the confidence associated with that risk is high. Low risk is due primarily to the small portion of the species range within US territories and the species' utilization of off-shore habitats.



12.61 Killer Whale, Southern Resident DPS (Orcinus orca)

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via reduction in prey availability (primarily salmonids and other fish)

Table 547. Prey Risk Hypothesis; Killer Whale, Southern Resident DPS; Adults and Juveniles

Endpoint: Prey			
Prey Species	**DPS**	**Biological Opinion Conclusion (Jeopardy/No jeopardy)**	
Chum Salmon (Oncorhynchus keta)			
Chum	Hood Canal summer-run	Jeopardy	
Chum	Lower Columbia R.	Jeopardy	
Chinook Salmon (Oncorhynchus tshawytscha)			
Chinook	California coastal	Jeopardy	
Chinook	Central Valley spring-run	Jeopardy	
Chinook	Lower Columbia River	Jeopardy	
Chinook	Puget Sound	Jeopardy	
Chinook	Sacramento R winter-run	Jeopardy	
Chinook	Snake River fall-run	Jeopardy	
Chinook	Snake River spring/summer	Jeopardy	
Chinook	Upper Col. R. spring-run	Jeopardy	
Chinook	Upper Willamette River	Jeopardy	
Population Model: Chinook, ocean-type		***Population Model: Chinook, stream-type***	
Portion of juveniles exposed to chlorpyrifos EECs; 0.75-100 µg/l	*Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles*	*Portion of juveniles exposed to chlorpyrifos EECs; 0.75-100 µg/l*	*Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles*
25%	*1-12% (13-23)*	*25%*	*1-11% (5-18)*
50%	*1-23% (13-26)*	*50%*	*1-21% (5-22)*
75%	*2-35% (13-24)*	*75%*	*2-31% (4-21)*

100%	*3-97% (13-0)*	*100%*	*2-97% (4-0)*
Coho Salmon (Oncorhynchus kisutch)			
Coho	Central California coast	Jeopardy	
Coho	Lower Columbia River	Jeopardy	
Coho	Oregon coast	Jeopardy	
Coho	SONC	Jeopardy	
Population Model: Coho Salmon			
Portion of juveniles exposed to chlorpyrifos EECs; 0.75-100 µg/l		*Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles*	
25%		1-14% (8-23)	
50%		1-27% (8-28)	
75%		2-40% (7-27)	
100%		3-99% (7-0)	
Sockeye Salmon (Oncorhynchus nerka)			
Sockeye	Ozette Lake	Jeopardy	
Sockeye	Snake R	Jeopardy	
Population Model: Sockeye Salmon			
Portion of juveniles exposed to chlorpyrifos EECs; 0.75-100 µg/l		*Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles*	
25%		*1-11% (8-19)*	
50%		*1-20% (8-22)*	
75%		*2-29% (8-20)*	
100%		*2-97% (8-0)*	
Steelhead	California C. Valley	Jeopardy	
Steelhead	CCC	Jeopardy	
Steelhead	LC River	Jeopardy	
Steelhead	MC River	Jeopardy	
Steelhead	Northern California	Jeopardy	

Steelhead	Puget Sound	Jeopardy
Steelhead	Snake River Basin	Jeopardy
Steelhead	South-Central California coast	Jeopardy
Steelhead	Southern California	Jeopardy
Steelhead	Upper Columbia River	Jeopardy
Steelhead	Upper Willamette River	Jeopardy
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via reduction in prey availability (primarily salmonids and other fish)		
Risk	**Confidence**	
High	**High**	

Effects analysis summary:

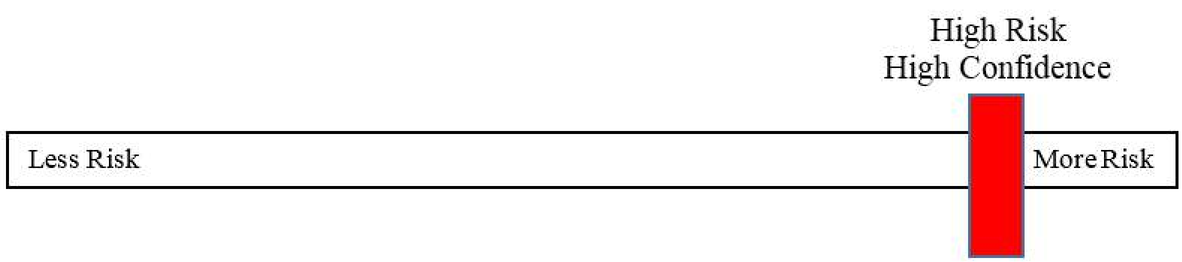
Adult and juvenile Killer whales (southern resident DPS) are anticipated to experience reduced abundance via reductions in prey from exposure to chlorpyrifos. The primary dietary item of the southern resident killer whale is salmon (predominantly Chinook). Chinook salmon populations have declined due to degradation of habitat, hydrology issues, harvest, and hatchery introgression; such reductions may require an increase in foraging effort. In addition, these prey contain environmental pollutants. These contaminants become concentrated at higher trophic levels and may lead to immune suppression or reproductive impairment. The overall risk to Killer whale, southern resident DPS from the effects of the action is high and the confidence associated with that risk is high.

The National Marine Fisheries Service (NMFS) qualitatively evaluated long-term effects on the Southern Residents from the anticipated appreciable reduction in the likelihood of survival and recovery of all 28 Pacific salmon Evolutionarily Significant Units (ESUs)/Distinct Population Segments (DPSs), and in particular, the nine Chinook salmon ESUs. We assessed the likelihood for localized depletions, and long-term implications for Southern Residents' survival and recovery, resulting from the increased risk of extinction of all listed Chinook salmon ESUs. In this way, NMFS can determine whether the increased likelihood of extinction of prey species is also likely to appreciably reduce the likelihood of survival and recovery of Southern Residents.

A reduction in prey would occur over time as abundance declined for the nine ESUs of Chinook salmon, along with the decline of lesser preferred prey ESUs/DPSs of other listed salmon. The continued depletion of these ESUs would also preclude the potential for their future recovery to healthy, more substantial numbers. Fewer populations contributing to Southern Residents' prey base will reduce the representation of diversity in life histories, resiliency in withstanding stochastic events, and redundancy to ensure there is a margin of safety for the salmon and Southern Residents to withstand catastrophic events.

The long-term reduction of the nine ESUs of Chinook salmon and other listed salmon and steelhead can lead to nutritional stress in the whales. Nutritional stress can lead to reduced body size and condition of individuals and can also lower reproductive and survival rates. Prey sharing would distribute more evenly the effects of prey limitation across individuals of the population that would otherwise be the case. Therefore, poor nutrition from the reduction of prey could contribute to additional mortality in this population. Food scarcity could also cause whales to draw on fat stores, mobilizing contaminants stored in their fat and affecting reproduction and immune function.

Differences in adult salmon life histories and locations of their natal streams likely affect the distribution of salmon across the Southern Residents' coastal range. The continued decline and potential extinction of the nine ESUs of Chinook salmon and other listed salmonids, and consequent interruption in the geographic continuity of salmon-bearing watersheds in the Southern Residents' coastal range, is likely to alter the distribution of migrating salmon and increase the likelihood of localized depletions in prey. This would have adverse effects on the Southern Residents' ability to meet their energy needs. A fundamental change in the prey base originating from the whales' geographic range is likely to result in Southern Residents abandoning areas in search of more abundant prey or expending substantial effort to find depleted prey resources. This potential increase in energy demands should have the same effect on an animal's energy budget as reductions in available energy, such as one would expect from reductions in prey.



12.62 Steller Sea Lion, Western DPS (Eumetopias jubatus)

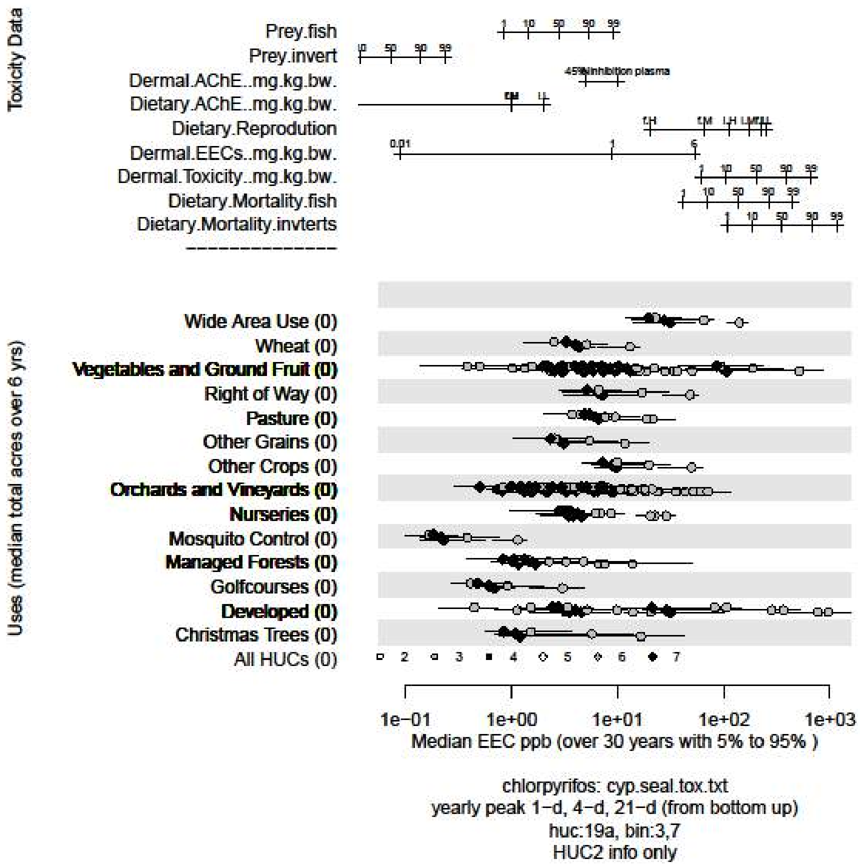


Figure 55. Effects analysis R-plot for Steller sea lion (western DPS) and chlorpyrifos

Table 548. Likelihood of exposure determination for Steller sea lion (western DPS) and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Wide Area Use	NA	yes	yes	yes	NA	3	High
Wheat	NA	yes	yes	yes	NA	3	Low
Vegetables and Ground Fruit	NA	yes	yes	yes	NA	3	Low
Right of Way	NA	yes	yes	yes	NA	3	Low
Pasture	NA	yes	yes	yes	NA	3	Low
Other Grains	NA	yes	yes	yes	NA	3	Low
Other Crops	NA	yes	yes	yes	NA	3	Low
Orchards and Vineyards	NA	yes	yes	yes	NA	3	Low
Nurseries	NA	yes	yes	yes	NA	3	Low
Mosquito Control	NA	yes	yes	yes	NA	3	High
Managed Forest	NA	yes	yes	yes	NA	3	Med
Golf Courses	NA	yes	yes	yes	NA	3	Low
Developed	NA	yes	yes	yes	NA	3	Low
Christmas Trees	NA	yes	yes	yes	NA	3	Low

Life Stage: Juvenile and Adult (full-range)

Table 549. Direct mortality (dietary: inverts) risk hypothesis; Steller sea lion (western DPS) and chlorpyrifos; Adults and Juveniles

Endpoint: Mortality (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	Medium	High
Wheat	Unknown	Low	Low
Vegetables and Ground Fruit	Unknown	High	Low
Right of Way	Unknown	Low	Low
Pasture	Unknown	Low	Low
Other Grains	Unknown	Low	Low
Other Crops	Unknown	Low	Low
Orchards and Vineyards	Unknown	Medium	Low
Nurseries	Unknown	Low	Low
Mosquito Control	100	Low	High

Managed Forest	Unknown	Low	Medium
Golf Courses	Unknown	Low	Low
Developed	Unknown	High	Low
Christmas Trees	Unknown	Low	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via dietary aquatic exposure (inverts)			
Risk	**Confidence**		
Medium	**Low**		

Table 550. Direct mortality (dietary: fish) risk hypothesis; Steller sea lion (western DPS) and chlorpyrifos; Adults and Juveniles

Endpoint: Mortality (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Wheat	Unknown	Low	Low
Vegetables and Ground Fruit	Unknown	High	Low
Right of Way	Unknown	Medium	Low
Pasture	Unknown	Low	Low
Other Grains	Unknown	Low	Low
Other Crops	Unknown	Medium	Low
Orchards and Vineyards	Unknown	Medium	Low
Nurseries	Unknown	Low	Low
Mosquito Control	100	Low	High
Managed Forest	Unknown	Medium	Medium
Golf Courses	Unknown	Low	Low
Developed	Unknown	High	Low
Christmas Trees	Unknown	Low	Low

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via dietary aquatic exposure (fish)		
Risk	**Confidence**	
High	**Low**	

Table 551. Direct mortality (dermal) risk hypothesis; Steller sea lion (western DPS) and chlorpyrifos; Adults and Juveniles

Endpoint: Mortality (dermal)			
Application Rate	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
0.01 – 6.0 lbs a.i./acre	NA	Low	Medium
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via dermal exposure			
Risk	**Confidence**		
Low	**High**		

Table 552. Prey (inverts) risk hypothesis; Steller sea lion (western DPS) and chlorpyrifos; Adults and Juveniles

Endpoint: Prey (inverts)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Wheat	Unknown	High	Low
Vegetables and Ground Fruit	Unknown	High	Low
Right of Way	Unknown	High	Low
Pasture	Unknown	High	Low
Other Grains	Unknown	High	Low
Other Crops	Unknown	High	Low
Orchards and Vineyards	Unknown	High	Low
Nurseries	Unknown	High	Low

Mosquito Control	100	High	High
Managed Forest	Unknown	High	Medium
Golf Courses	Unknown	High	Low
Developed	Unknown	High	Low
Christmas Trees	Unknown	High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via reduction in prey availability (aquatic inverts)			
Risk	**Confidence**		
High	**Low**		

Table 553. Prey (fish) risk hypothesis; Steller sea lion (western DPS) and chlorpyrifos; Adults and Juveniles

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Wheat	Unknown	High	Low
Vegetables and Ground Fruit	Unknown	High	Low
Right of Way	Unknown	High	Low
Pasture	Unknown	High	Low
Other Grains	Unknown	High	Low
Other Crops	Unknown	High	Low
Orchards and Vineyards	Unknown	High	Low
Nurseries	Unknown	High	Low
Mosquito Control	100	Medium	High
Managed Forest	Unknown	High	Medium
Golf Courses	Unknown	High	Low
Developed	Unknown	High	Low
Christmas Trees	Unknown	High	Low

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via reduction in prey availability (fish)		
Risk	**Confidence**	
High	**Low**	

Table 554. AChE (dietary) risk hypothesis; Steller sea lion (western DPS) and chlorpyrifos; Adults and Juveniles

Endpoint: AChE (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Wheat	Unknown	High	Low
Vegetables and Ground Fruit	Unknown	High	Low
Right of Way	Unknown	High	Low
Pasture	Unknown	High	Low
Other Grains	Unknown	High	Low
Other Crops	Unknown	High	Low
Orchards and Vineyards	Unknown	High	Low
Nurseries	Unknown	High	Low
Mosquito Control	100	High	High
Managed Forest	Unknown	High	Medium
Golf Courses	Unknown	High	Low
Developed	Unknown	High	Low
Christmas Trees	Unknown	High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity via dietary exposure (inverts and fish); the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Low**		

Table 555. AChE (dermal) risk hypothesis; Steller sea lion (western DPS) and chlorpyrifos; Adults and Juveniles

Endpoint: AChE (dermal)			
Application Rate	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
< 1 lbs a.i. /acre	NA	Low to Medium	Low to Medium
> 1.0 lbs a.i. /acre	NA	High	Low to Medium
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity via dermal exposure; the identified mechanism of toxicity			
Risk	**Confidence**		
Medium	**Medium**		

Table 556. Reproduction (dietary) risk hypothesis; Steller sea lion (western DPS) and chlorpyrifos; Adults

Endpoint: Reproduction (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	High
Wheat	Unknown	Low	Low
Vegetables and Ground Fruit	Unknown	High	Low
Right of Way	Unknown	Medium	Low
Pasture	Unknown	Medium	Low
Other Grains	Unknown	Medium	Low
Other Crops	Unknown	Medium	Low
Orchards and Vineyards	Unknown	High	Low
Nurseries	Unknown	Medium	Low
Mosquito Control	100	Low	High
Managed Forest	Unknown	Medium	Medium
Golf Courses	Unknown	Low	Low
Developed	Unknown	High	Low

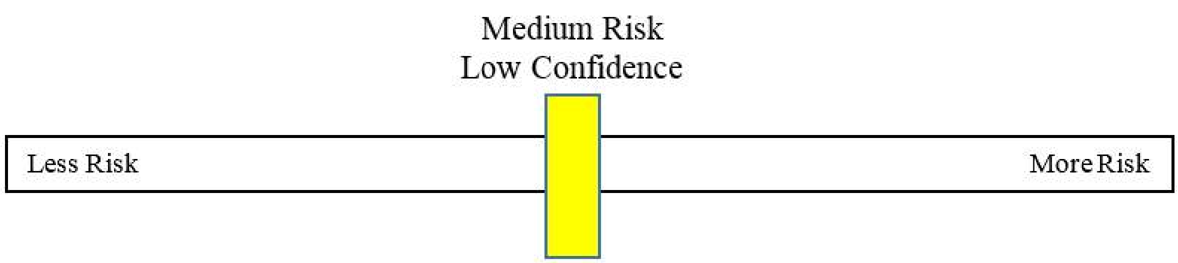
Christmas Trees	Unknown	Medium	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction via dietary exposure (fish)			
Risk	**Confidence**		
High	**Low**		

Table 557. Effects analysis summary table: Steller sea lion (western DPS) and chlorpyrifos

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Adults and Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce abundance via dietary aquatic exposure (inverts)	Medium	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce abundance via dietary aquatic exposure (fish)	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce abundance via dermal exposure	Low	High	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce abundance via reduction in prey availability (aquatic inverts)	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce abundance via reduction in prey availability (fish)	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity via dietary exposure (inverts and fish); the identified mechanism of toxicity	High	Low	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity via dermal	Medium	Medium	Not Available	**Yes**

exposure; the identified mechanism of toxicity				
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction via dietary exposure (fish)	High	Low	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steller sea lion (western DPS) are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to chlorpyrifos in the marine environment. If exposed to formulated products and tank mixtures containing chlorpyrifos, sea lions may experience increased toxicity. The overall risk to Steller sea lion (western DPS) from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted chlorpyrifos concentrations in coastal habitats.



12.63 Guadalupe Fur Seal (Arctocephalus townsendi)

12.63.1.1 Guadalupe Fur Seal (Arctocephalus townsendi)

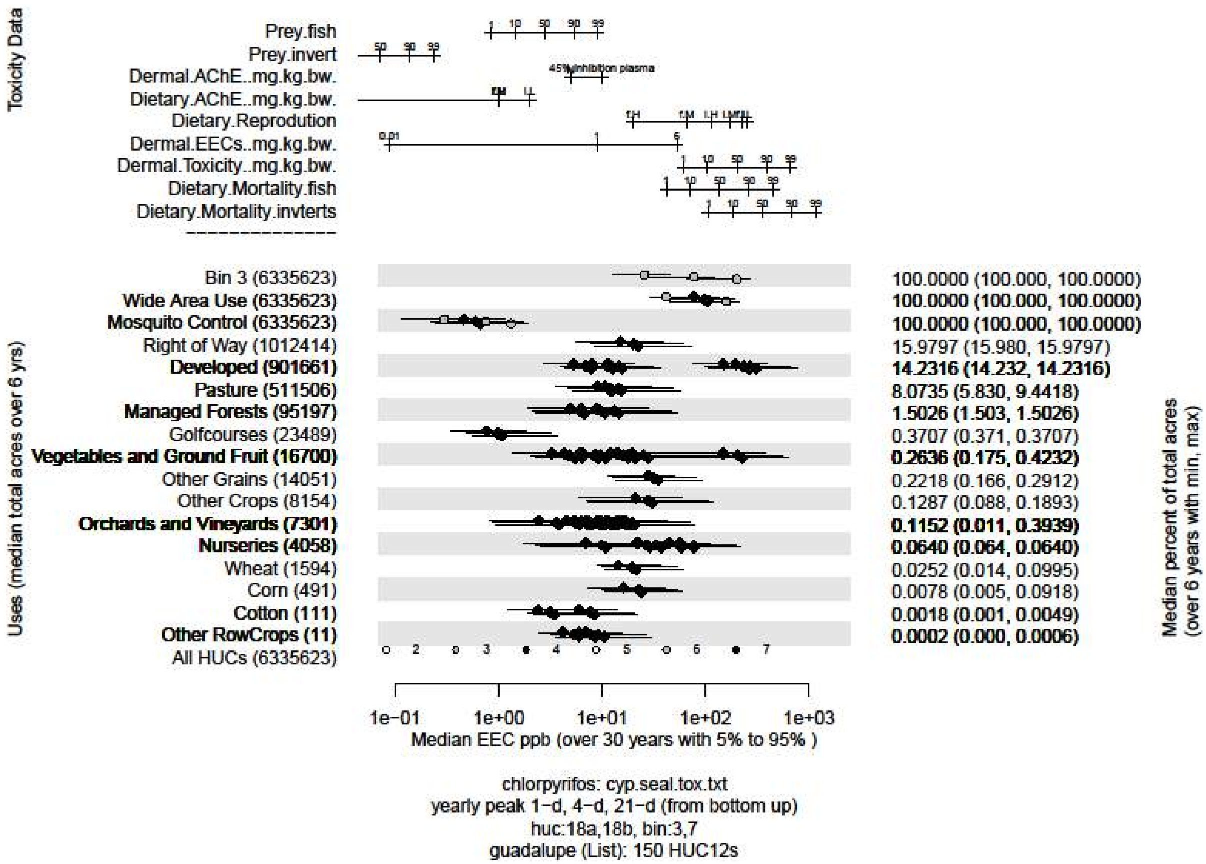


Figure 56. Effects analysis R-plot for Guadalupe fur seal and chlorpyrifos

Table 558. Likelihood of exposure determination for Guadalupe fur seal and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range within US Territories	Likelihood of Exposure
Wide Area Use	3	yes	yes	yes	NA	unknown	small	**Low**
Mosquito Control	3	yes	yes	yes	NA	unknown	small	**Low**
Right of Way	3	yes	yes	yes	NA	unknown	small	**Low**
Developed	3	yes	yes	yes	NA	unknown	small	**Low**
Pasture	3	yes	yes	yes	NA	unknown	small	**Low**
Managed Forest	2	yes	yes	yes	NA	unknown	small	**Low**
Golf Courses	1	yes	yes	yes	no	unknown	small	**Low**
Vegetables and Ground Fruit	1	yes	yes	yes	no	unknown	small	**Low**
Other Grains	1	yes	yes	yes	no	unknown	small	**Low**
Other Crops	1	yes	yes	yes	no	unknown	small	**Low**
Orchards and Vineyards	1	yes	yes	yes	no	unknown	small	**Low**
Nurseries	1	yes	yes	yes	no	unknown	small	**Low**
Wheat	1	yes	yes	yes	no	unknown	small	**Low**
Corn	1	yes	yes	yes	no	unknown	small	**Low**
Cotton	1	yes	yes	yes	no	unknown	small	**Low**
Bin3	1	yes	yes	yes	no	unknown	small	**Low**

Life Stage: Juvenile and Adult (full-range)

Table 559. Direct mortality (dietary – inverts) risk hypothesis; Guadalupe fur seal and chlorpyrifos; Adults and Juveniles

Endpoint: Mortality (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	Medium	Low
Mosquito Control	100	Low	Low
Right of Way	16	Low	Low
Developed	14.4	High	Low
Pasture	8.1	Low	Low
Managed Forest	1.5	Low	Low
Golf Courses	.4	Low	Low
Vegetables and Ground Fruit	.3	High	Low
Other Grains	.2	Low	Low

Other Crops	.1	Medium	Low
Orchards and Vineyards	.1	Low	Low
Nurseries	.06	Medium	Low
Wheat	.02	Low	Low
Corn	.008	Low	Low
Cotton	.002	Low	Low
Bin3		Medium	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via dietary aquatic exposure (inverts)			
Risk	**Confidence**		
Low	**Medium**		

Table 560. Direct mortality (dietary – fish) risk hypothesis; Guadalupe fur seal and chlorpyrifos; Adults and Juveniles

Endpoint: Mortality (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Low
Mosquito Control	100	Low	Low
Right of Way	16	Medium	Low
Developed	14.4	High	Low
Pasture	8.1	Medium	Low
Managed Forest	1.5	Medium	Low
Golf Courses	.4	Low	Low
Vegetables and Ground Fruit	.3	High	Low
Other Grains	.2	Medium	Low
Other Crops	.1	Medium	Low
Orchards and Vineyards	.1	Medium	Low

Nurseries	.06	High	Low
Wheat	.02	Medium	Low
Corn	.008	Medium	Low
Cotton	.002	Low	Low
Bin3		High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via dietary aquatic exposure (fish)			
Risk	**Confidence**		
Low	**Medium**		

Table 561. Direct mortality (dermal) risk hypothesis; Guadalupe fur seal and chlorpyrifos; Adults and Juveniles

Endpoint: Mortality (dermal)			
Application Rate	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
0.01 – 6.0 lbs a.i./acre	Not applicable	Low	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via dermal exposure			
Risk	**Confidence**		
Low	**Medium**		

Table 562. Prey (inverts) risk hypothesis; Guadalupe fur seal and chlorpyrifos; Adults and Juveniles

Endpoint: Prey (inverts)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Low
Mosquito Control	100	High	Low
Right of Way	16	High	Low
Developed	14.4	High	Low
Pasture	8.1	High	Low

Managed Forest	1.5	High	Low
Golf Courses	.4	High	Low
Vegetables and Ground Fruit	.3	High	Low
Other Grains	.2	High	Low
Other Crops	.1	High	Low
Orchards and Vineyards	.1	High	Low
Nurseries	.06	High	Low
Wheat	.02	High	Low
Corn	.008	High	Low
Cotton	.002	High	Low
Bin3		High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via reduction in prey availability (aquatic inverts)			
Risk	**Confidence**		
Low	**Medium**		

Table 563. Prey (fish) risk hypothesis; Guadalupe fur seal and chlorpyrifos; Adults and Juveniles

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Low
Mosquito Control	100	Medium	Low
Right of Way	16	High	Low
Developed	14.4	High	Low
Pasture	8.1	High	Low
Managed Forest	1.5	High	Low
Golf Courses	.4	High	Low

Vegetables and Ground Fruit	.3	High	Low
Other Grains	.2	High	Low
Other Crops	.1	High	Low
Orchards and Vineyards	.1	High	Low
Nurseries	.06	High	Low
Wheat	.02	High	Low
Corn	.008	High	Low
Cotton	.002	High	Low
Bin3		High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via reduction in prey availability (fish)			
Risk	**Confidence**		
Low	**Medium**		

Table 564. AChE (dietary) risk hypothesis; Guadalupe fur seal and chlorpyrifos; Adults and Juveniles

Endpoint: AChE (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Low
Mosquito Control	100	High	Low
Right of Way	16	High	Low
Developed	14.4	High	Low
Pasture	8.1	High	Low
Managed Forest	1.5	High	Low
Golf Courses	.4	High	Low
Vegetables and Ground Fruit	.3	High	Low
Other Grains	.2	High	Low

Other Crops	.1	High	Low
Orchards and Vineyards	.1	High	Low
Nurseries	.06	High	Low
Wheat	.02	High	Low
Corn	.008	High	Low
Cotton	.002	High	Low
Bin3		High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity via dietary exposure (inverts and fish); the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**Medium**		

Table 565. AChE (dermal) risk hypothesis; Guadalupe fur seal and chlorpyrifos; Adults and Juveniles

Endpoint: AChE (dermal)			
Application Rate	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
< 1 lbs a.i. /acre	Not Applicable	Medium	Low
> 1.0 lbs a.i. /acre	Not Applicable	High	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity via dermal exposure; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**Medium**		

Table 566. Reproduction (dietary) risk hypothesis; Guadalupe fur seal and chlorpyrifos; Adults

Endpoint: Reproduction (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Low
Mosquito Control	100	Low	Low

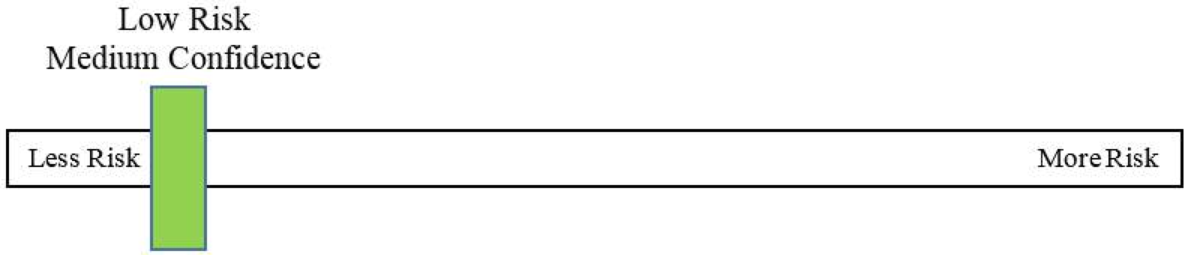
Right of Way	16	Medium	Low
Developed	14.4	High	Low
Pasture	8.1	Medium	Low
Managed Forest	1.5	Medium	Low
Golf Courses	.4	Low	Low
Vegetables and Ground Fruit	.3	High	Low
Other Grains	.2	Medium	Low
Other Crops	.1	Medium	Low
Orchards and Vineyards	.1	Medium	Low
Nurseries	.06	High	Low
Wheat	.02	Medium	Low
Corn	.008	Medium	Low
Cotton	.002	Low	Low
Bin3		Medium	Low
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction via dietary exposure (fish)			
Risk	**Confidence**		
Low	**Medium**		

Table 567. Effects analysis summary table: Guadalupe fur seal and chlorpyrifos

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults and Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce abundance via dietary aquatic exposure (inverts)	**Low**	**Medium**	Not Available	**No**

Exposure to chlorpyrifos is sufficient to reduce abundance via dietary aquatic exposure (fish)	**Low**	**Medium**	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce abundance via dermal exposure	**Low**	**Medium**	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce abundance via reduction in prey availability (aquatic inverts)	**Low**	**Medium**	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce abundance via reduction in prey availability (fish)	**Low**	**Medium**	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce ChE activity via dietary exposure (inverts and fish); the identified mechanism of toxicity	**Low**	**Medium**	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce ChE activity via dermal exposure; the identified mechanism of toxicity	**Low**	**Medium**	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction via dietary exposure (fish)	**Low**	**Medium**	Not Available	**No**

Effects analysis summary: Adult and juvenile Guadalupe fur seals are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to chlorpyrifos in the marine environment. If exposed to formulated products and tank mixtures containing chlorpyrifos, fur seals may experience increased toxicity. The overall risk to Guadalupe fur seals from the effects of the action is low and the confidence associated with that risk is medium. The Low risk is due primarily to the small portion of the species' range within US territories. The lack in confidence is due primarily to the uncertainty in predicted chlorpyrifos concentrations in coastal habitats.



12.64 Hawaiian Monk Seal (Monachus schauinslandi)

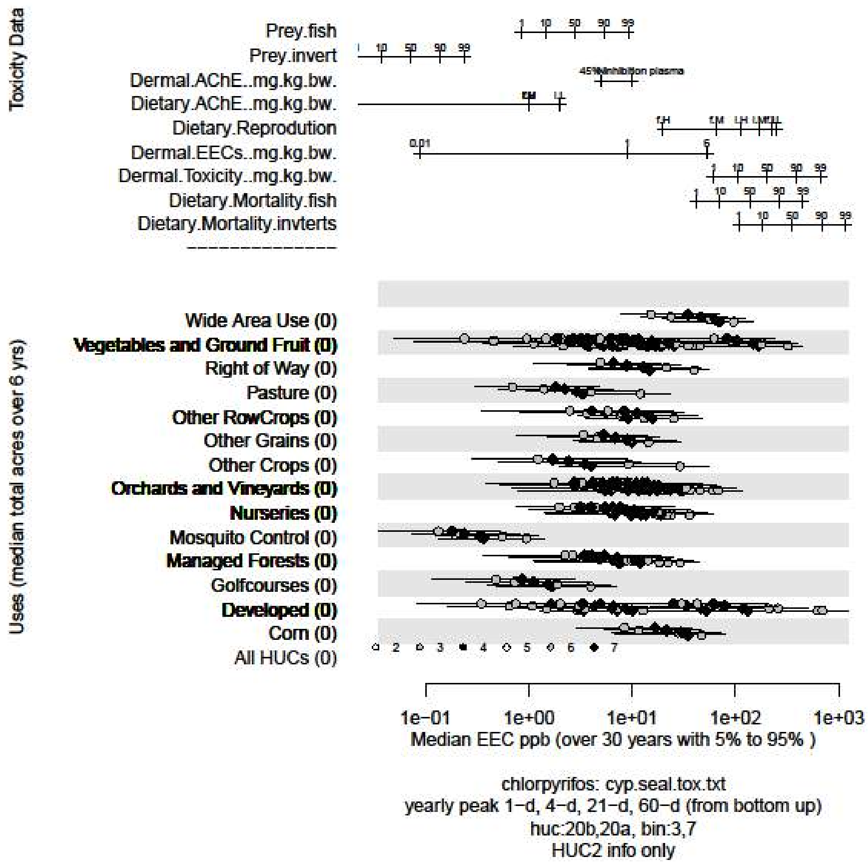


Figure 57. Effects analysis R-plot for Hawaiian monk seal and chlorpyrifos

Table 568. Likelihood of exposure determination for Hawaiian monk seal and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Wide Area Use	NA	yes	yes	yes	NA	3	**Med**
Vegetables and Ground Fruit	NA	yes	yes	yes	NA	3	**Med**
Right of Way	NA	yes	yes	yes	NA	3	**Med**
Pasture	NA	yes	yes	yes	NA	3	**Med**
Other Row Crops	NA	yes	yes	yes	NA	3	**Med**
Other Grains	NA	yes	yes	yes	NA	3	**Med**
Other Crops	NA	yes	yes	yes	NA	3	**Med**
Orchards and Vineyards	NA	yes	yes	yes	NA	3	**Med**
Nurseries	NA	yes	yes	yes	NA	3	**Med**
Mosquito Control	NA	yes	yes	yes	NA	3	**Med**
Managed Forest	NA	yes	yes	yes	NA	3	**Med**
Golf Courses	NA	yes	yes	yes	NA	3	**Med**
Developed	NA	yes	yes	yes	NA	3	**Med**
Corn	NA	yes	yes	yes	NA	3	**Med**

Life Stage: Juvenile and Adult (full-range)

Table 569. Direct mortality (dietary – fish) risk hypothesis; Hawaiian monk seal and chlorpyrifos; Adults and Juveniles

Endpoint: Mortality (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Medium
Vegetables and Ground Fruit	Unknown	High	Medium
Right of Way	Unknown	Medium	Medium
Pasture	Unknown	Low	Medium
Other Row Crops	Unknown	Medium	Medium
Other Grains	Unknown	Low	Medium
Other Crops	Unknown	Medium	Medium
Orchards and Vineyards	Unknown	Medium	Medium
Nurseries	Unknown	Medium	Medium

Mosquito Control	100	Low	Medium
Managed Forest	Unknown	Medium	Medium
Golf Courses	Unknown	Low	Medium
Developed	Unknown	High	Medium
Corn	Unknown	Medium	Medium
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via dietary aquatic exposure (fish)			
Risk	**Confidence**		
High	**Low**		

Table 570. Direct mortality (dermal) risk hypothesis; Hawaiian monk seal and chlorpyrifos; Adults and Juveniles

Endpoint: Mortality (dermal)			
Application Rate	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
0.01 – 6.0 lbs a.i./acre	Unknown	Low	Medium
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via dermal exposure			
Risk	**Confidence**		
Low	**Medium**		

Table 571. Prey (inverts) risk hypothesis; Hawaiian monk seal and chlorpyrifos; Adults and Juveniles

Endpoint: Prey (inverts)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Medium
Vegetables and Ground Fruit	Unknown	High	Medium
Right of Way	Unknown	High	Medium
Pasture	Unknown	High	Medium
Other Row Crops	Unknown	High	Medium

Other Grains	Unknown	High	Medium
Other Crops	Unknown	High	Medium
Orchards and Vineyards	Unknown	High	Medium
Nurseries	Unknown	High	Medium
Mosquito Control	100	High	Medium
Managed Forest	Unknown	High	Medium
Golf Courses	Unknown	High	Medium
Developed	Unknown	High	Medium
Corn	Unknown	High	Medium
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via reduction in prey availability (aquatic inverts)			
Risk	**Confidence**		
High	**Low**		

Table 572. Prey (fish) risk hypothesis; Hawaiian monk seal and chlorpyrifos; Adults and Juveniles

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Medium
Vegetables and Ground Fruit	Unknown	High	Medium
Right of Way	Unknown	High	Medium
Pasture	Unknown	High	Medium
Other Row Crops	Unknown	High	Medium
Other Grains	Unknown	High	Medium
Other Crops	Unknown	High	Medium
Orchards and Vineyards	Unknown	High	Medium
Nurseries	Unknown	High	Medium

Mosquito Control	100	Medium	Medium
Managed Forest	Unknown	High	Medium
Golf Courses	Unknown	High	Medium
Developed	Unknown	High	Medium
Corn	Unknown	High	Medium
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce abundance via reduction in prey availability (fish)			
Risk	**Confidence**		
High	**Low**		

Table 573. AChE (dietary) risk hypothesis; Hawaiian monk seal and chlorpyrifos; Adults and Juveniles

Endpoint: AChE (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Medium
Vegetables and Ground Fruit	Unknown	High	Medium
Right of Way	Unknown	High	Medium
Pasture	Unknown	High	Medium
Other Row Crops	Unknown	High	Medium
Other Grains	Unknown	High	Medium
Other Crops	Unknown	High	Medium
Orchards and Vineyards	Unknown	High	Medium
Nurseries	Unknown	High	Medium
Mosquito Control	100	High	Medium
Managed Forest	Unknown	High	Medium
Golf Courses	Unknown	High	Medium
Developed	Unknown	High	Medium
Corn	Unknown	High	Medium

Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity via dietary exposure (inverts and fish); the identified mechanism of toxicity		
Risk	**Confidence**	
High	**Low**	

Table 574. AChE (dermal) risk hypothesis; Hawaiian monk seal and chlorpyrifos; Adults and Juveniles

Endpoint: AChE (dermal)			
Application Rate	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
0.01 – <1 lbs a.i. /acre	Unknown	Low	Medium
1.0 – 6.0 lbs a.i. /acre	Unknown	High	Medium
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce ChE activity via dermal exposure; the identified mechanism of toxicity			
Risk	**Confidence**		
Medium	**Medium**		

Table 575. Reproduction (dietary) risk hypothesis; Hawaiian monk seal and chlorpyrifos; Adults

Endpoint: Reproduction (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	High	Medium
Vegetables and Ground Fruit	Unknown	High	Medium
Right of Way	Unknown	Medium	Medium
Pasture	Unknown	Medium	Medium
Other Row Crops	Unknown	Medium	Medium
Other Grains	Unknown	Medium	Medium
Other Crops	Unknown	Medium	Medium
Orchards and Vineyards	Unknown	High	Medium
Nurseries	Unknown	Medium	Medium

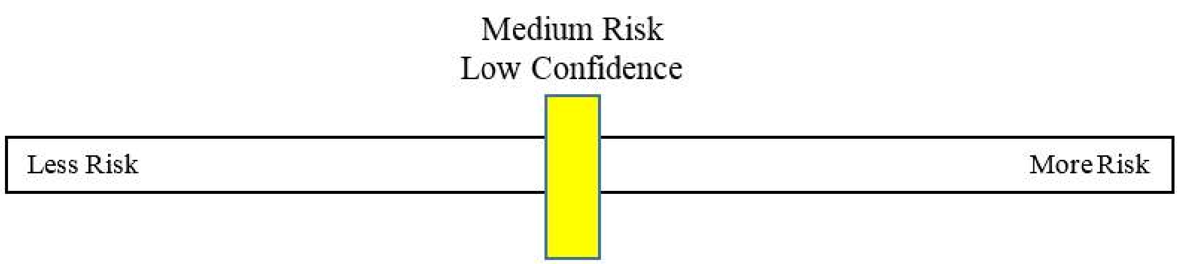
Mosquito Control	100	Low	Medium
Managed Forest	Unknown	Medium	Medium
Golf Courses	Unknown	Low	Medium
Developed	Unknown	High	Medium
Corn	Unknown	High	Medium
Risk Hypothesis: Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction via dietary exposure (fish)			
Risk	**Confidence**		
High	**Low**		

Table 576. Effects analysis summary table: Hawaiian monk seal and chlorpyrifos

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported?**
Adults and Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	**Yes/No**
Risk Hypothesis				
Exposure to chlorpyrifos is sufficient to reduce abundance via dietary aquatic exposure (fish)	**High**	**Low**	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce abundance via dermal exposure	**Low**	**Medium**	Not Available	**No**
Exposure to chlorpyrifos is sufficient to reduce abundance via reduction in prey availability (aquatic inverts)	**High**	**Low**	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce abundance via reduction in prey availability (fish)	**High**	**Low**	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce ChE activity via dietary	**High**	**Low**	Not Available	**Yes**

exposure (inverts and fish); the identified mechanism of toxicity				
Exposure to chlorpyrifos is sufficient to reduce ChE activity via dermal exposure; the identified mechanism of toxicity	**Medium**	**Medium**	Not Available	**Yes**
Exposure to chlorpyrifos is sufficient to reduce adult productivity via impairments to reproduction via dietary exposure (fish)	**High**	**Low**	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Hawaiian monk seals are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to chlorpyrifos in the marine environment. If exposed to formulated products and tank mixtures containing chlorpyrifos, fur seals may experience increased toxicity. The overall risk to Hawaiian monk seals from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted chlorpyrifos concentrations in coastal habitats.



12.65 Johnson's Seagrass (Halophila johnsonii)

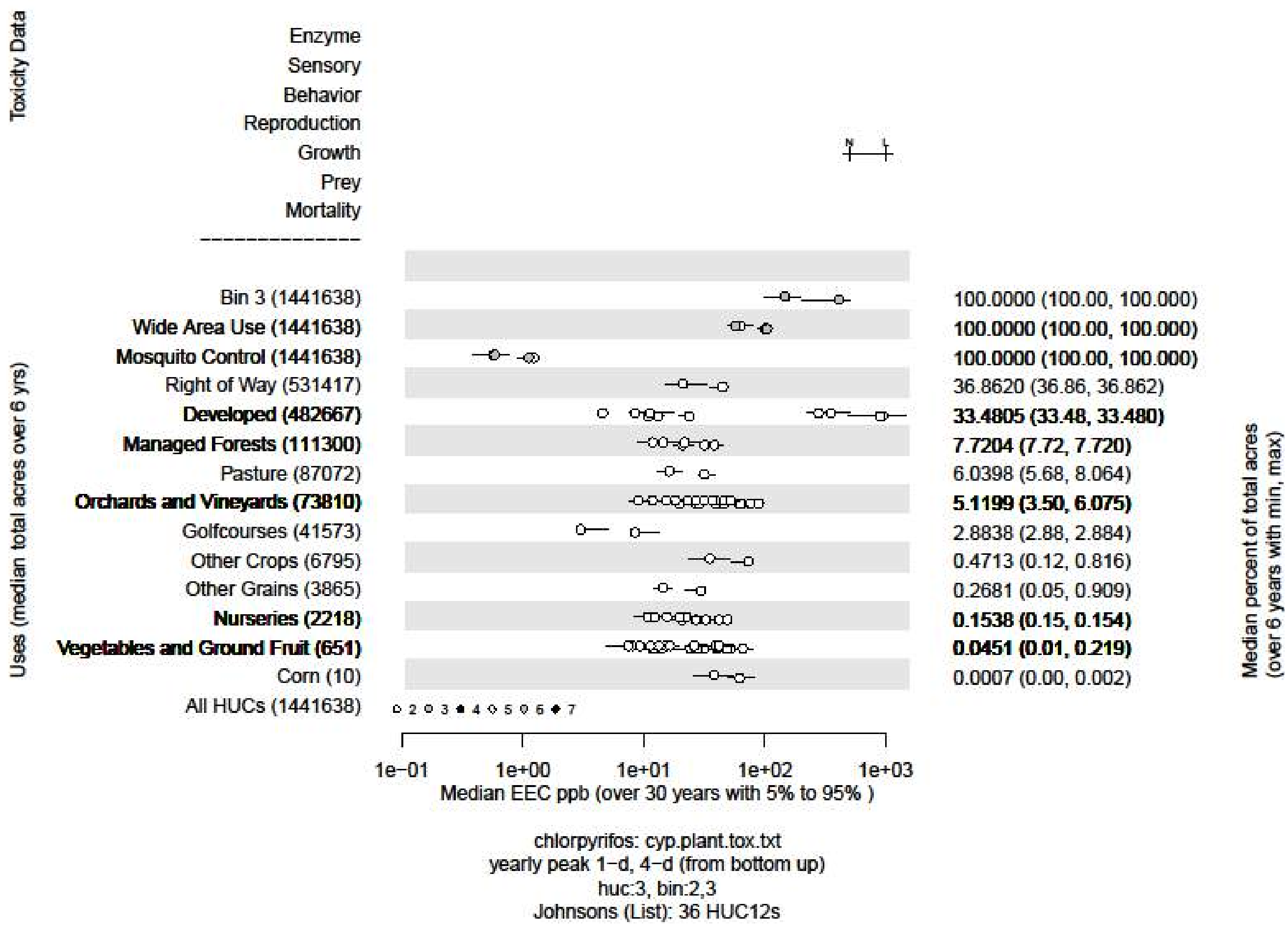


Figure 58. Effects analysis R-plot for Johnson's seagrass and chlorpyrifos

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Wide Area Use	3	yes	yes	yes	NA	3	**High**
Mosquito Control	3	yes	yes	yes	NA	3	**High**
Right of Way	3	yes	yes	yes	NA	3	**High**
Developed	3	yes	yes	yes	NA	3	**High**
Managed Forest	3	yes	yes	yes	NA	3	**High**
Pasture	3	yes	yes	yes	NA	3	**High**
Orchards and Vineyards	3	yes	yes	yes	NA	3	**High**
Golf Courses	2	yes	yes	yes	NA	3	**High**
Other Crops	1	yes	yes	yes	no	3	**Low**
Other Grains	1	yes	yes	yes	no	3	**Low**
Nurseries	1	yes	yes	yes	no	3	**Low**
Vegetables and Ground Fruit	1	yes	yes	yes	no	3	**Low**
Bin 3	3	yes	yes	yes	NA	3	**High**
Bin 4	3	yes	yes	yes	NA	3	**High**

Figure 59. Likelihood of exposure determination for Johnson's seagrass and chlorpyrifos

Table 577. Direct mortality risk hypothesis; Johnson's seagrass and chlorpyrifos

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	NA	High
Mosquito Control	100	NA	High
Right of Way	37	NA	High
Developed	33	NA	High
Managed Forest	8	NA	High
Pasture	6	NA	High
Orchards and Vineyards	5	NA	High
Golf Courses	3	NA	High
Other Crops	<1	NA	Low
Other Grains	<1	NA	Low
Nurseries	<1	NA	Low

Vegetables and Ground Fruit	<1	NA	Low
Bin 3		NA	High
Risk Hypothesis: Exposure to the pesticide is sufficient to reduce abundance via direct mortality.			
Risk	**Confidence**		
NA	**NA**		

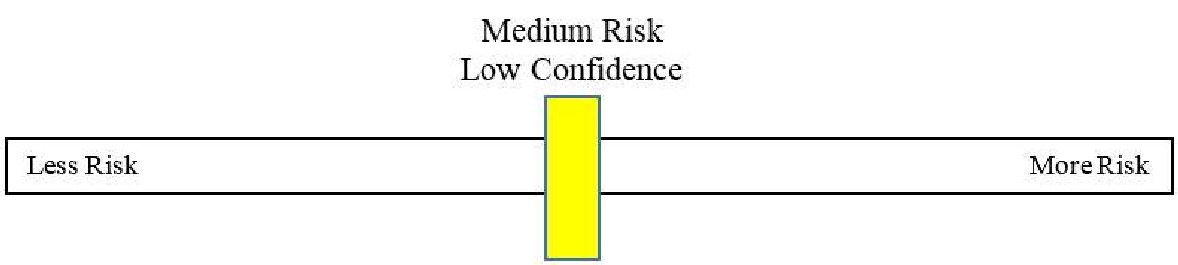
Table 578. Growth risk hypothesis; Johnson's seagrass and chlorpyrifos

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100	Low	High
Mosquito Control	100	Low	High
Right of Way	37	Low	High
Developed	33	High	High
Managed Forest	8	Low	High
Pasture	6	Low	High
Orchards and Vineyards	5	Low	High
Golf Courses	3	Low	High
Other Crops	<1	Low	Low
Other Grains	<1	Low	Low
Nurseries	<1	Low	Low
Vegetables and Ground Fruit	<1	Low	Low
Bin 3		Medium	High
Risk Hypothesis: Exposure to the pesticides is sufficient to reduce abundance via impacts to growth.			
Risk	**Confidence**		
High	**Low**		

Table 579. Effects analysis summary table: Johnson's seagrass and chlorpyrifos

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported?** Yes/No
Adults (Lower 48 – Coastal HUC-12s)	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to the pesticide is sufficient to reduce abundance via direct mortality.	**NA**	**NA**	Not Available	**No**
Exposure to the pesticides is sufficient to reduce abundance via impacts to growth.	**High**	**Low**	Not Available	**Yes**

Effects analysis summary: Johnson's seagrass is not anticipated to experience significant reductions in abundance or productivity from exposure to chlorpyrifos in the marine environment. The overall risk to Johnson's seagrass from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted chlorpyrifos concentrations in coastal habitats.



CHAPTER 13

DIAZINON SPECIES EFFECTS ANALYSIS

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13 Diazinon Effects Analysis

13.1 Introduction

See Chapters 3 (Approach to the Assessment) and 11 (Effects Analysis Introduction) for descriptions of the methods and information used in this section. In this section we integrate the exposure and response information to evaluate the likelihood of adverse effects from stressors of the action at the population and species level. The information is organized by species. Within each species section the information is presented in the following order:

1. R- Plots figures: Demonstrate the relationship between geographically-specific exposure distributions and assessment measures (response distributions). These figures also convey the prevalence of registered use sites within the species range (example **Figure 1**).
2. Likelihood of exposure tables: Tables summarizing assessment of likelihood of exposure to each pesticide use that occurs within the species range (example **Table 1**).
3. Risk Hypotheses Tables: tables for each risk hypothesis summarizing risk and confidence associated with each registered use that occurs within the species range (example **Table 2**).
4. Final effects analysis table and narrative summary: Each species sections concludes with a Table indicating which risk hypotheses were supported and associated narrative summary of overall risk of the action to the species (example **Table 5**). Where applicable, the effects analysis table includes MagTool and/or Pacific salmon population model output. MagTool and population model output is also provided in appendix A: MagTool Results, and appendix B: Pacific Salmon Population Modeling.

13.2 Atlantic Salmon (Salmo salar)

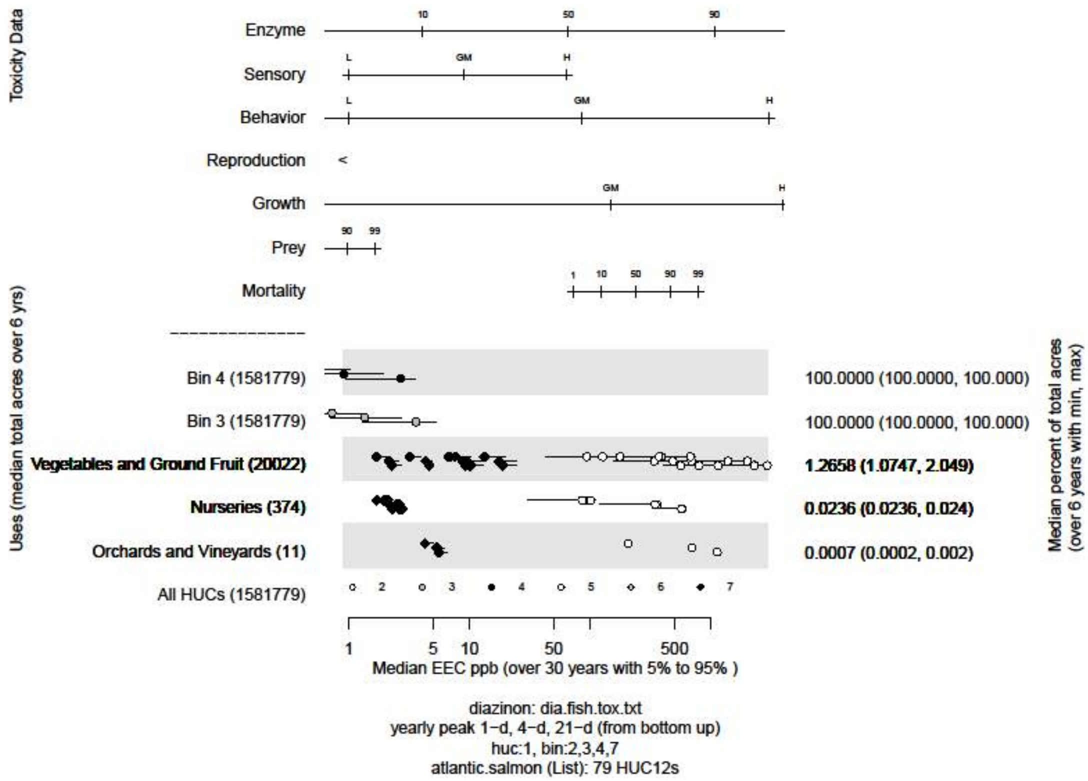


Figure 1. Effects analysis R-plot for Atlantic salmon (coastal marine habitat) and diazinon

Table 1. Likelihood of exposure determination for Atlantic salmon (coastal marine habitat) and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Vegetables and Ground Fruit	2	yes	no	yes	NA	2	**Med**
Nurseries	1	yes	no	yes	NA	2	**Low**
Bin 3	2	yes	no	yes	NA	2	**Med**
Bin 4	2	yes	no	yes	NA	2	**Med**

Life Stage: Juvenile and Adult (Marine Environment Only)

Table 2.Direct mortality risk hypothesis; Atlantic salmon and diazinon

Endpoint: Mortality (Marine Environment Only)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.3	High	Medium
Nurseries	.02	High	Low
Bin 3		Low	Medium
Bin 4		Low	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult and juvenile abundance via acute lethality.			
Risk	**Confidence**		
High	**Low**		

Table 3. Behavior and sensory risk hypothesis; Atlantic salmon and Diazinon

Endpoint: Behavior (Marine Environment Only)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.3	High	Medium
Nurseries	.02	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Endpoint: Sensory (Marine Environment Only)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.3	High	Medium
Nurseries	.02	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**Low**		

Table 4. AChE risk hypothesis; Atlantic salmon and diazinon

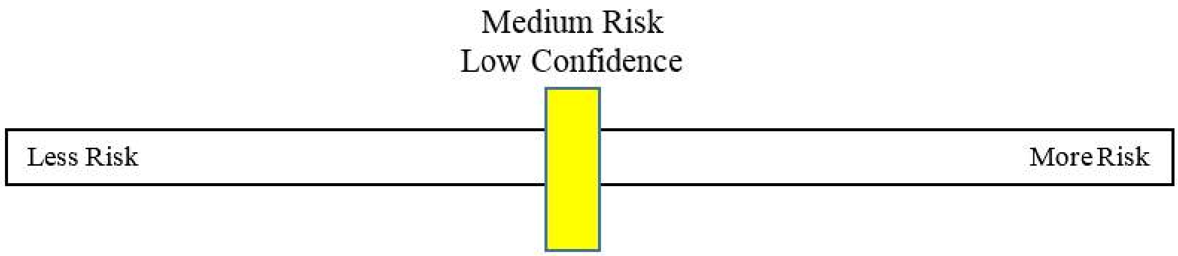
Endpoint: enzyme (Marine Environment Only)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.3	High	Medium
Nurseries	.02	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium

Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity		
Risk	**Confidence**	
High	**Low**	

Table 5. Effects analysis summary table: Atlantic salmon and diazinon

	R-plot Derived		MagTool Range in median percent mortalities for aquatic bins	Risk Hypothesis Supported? Yes/No
Juveniles and Adults (Marine Environment Only)	**Risk**	**Confidence**		
Exposure to diazinon is sufficient to reduce adult and juvenile abundance via acute lethality.	**High**	**Low**	**Not Available**	**Yes**
Exposure to diazinon is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.	**High**	**Low**	**Not Available**	**Yes**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	**High**	**Low**	**Not Available**	**Yes**

Effects analysis summary: Atlantic salmon are not anticipated to experience significant reductions in abundance or productivity (spawning adults) from exposure to diazinon in the marine environment. If exposed to formulated products and tank mixtures containing diazinon, Atlantic salmon may experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed Atlantic salmon. The overall risk to Atlantic salmon from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted diazinon concentrations in coastal habitats. Low confidence of risk is also attributed to lack of information regarding duration of residency of Atlantic salmon in the coastal marine environment within US waters.


Medium Risk
Low Confidence
Less Risk
More Risk

13.3 Chum salmon, Columbia River ESU (Oncorhynchus keta)

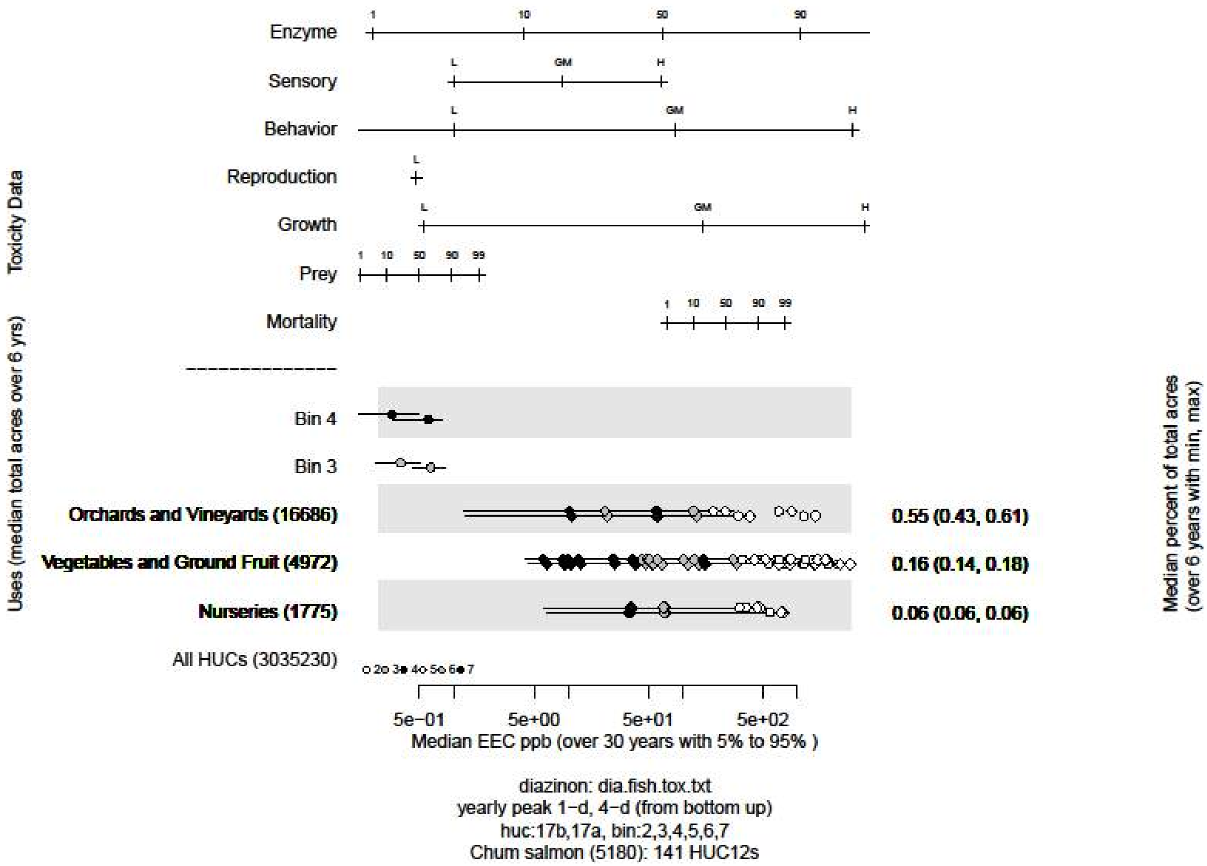


Figure 2. Effects analysis R-plot for Columbia River ESU chum salmon and diazinon

Table 6. Likelihood of exposure determination for Columbia River ESU chum salmon and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Orchards and Vineyards	1	yes	no	yes	no	2	Low
Vegetables and Ground Fruit	1	yes	no	yes	no	2	Low
Nurseries	1	yes	no	yes	no	2	Low
Bin 3	1	yes	no	yes	no	2	Low
Bin 4	1	yes	no	yes	no	2	Low

Life Stage: Juvenile and Adult (full range)

Table 7. Direct mortality risk hypothesis; Columbia River ESU chum salmon and diazinon

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Nurseries	>1	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile and adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**High**		

Table 8. Prey risk hypothesis; Columbia River ESU chum salmon and diazinon

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Nurseries	>1	High	Low
Bin 3		High	Low
Bin 4		High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	**High**		

Table 9. Behavior and sensory risk hypothesis; Columbia River ESU chum salmon and diazinon

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Nurseries	>1	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Orchards and Vineyards	1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Nurseries	>1	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile and adult abundance and adult productivity via impairments to ecologically significant behaviors			
Risk	**Confidence**		
Low	**High**		

Table 10. AChE risk hypothesis; Columbia River ESU chum salmon and diazinon

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Nurseries	>1	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**High**		

Table 11. Growth risk hypothesis; Columbia River ESU chum salmon and diazinon

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Nurseries	>1	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
Low	**High**		

Table 12. Reproduction risk hypothesis; Columbia River ESU chum salmon and diazinon

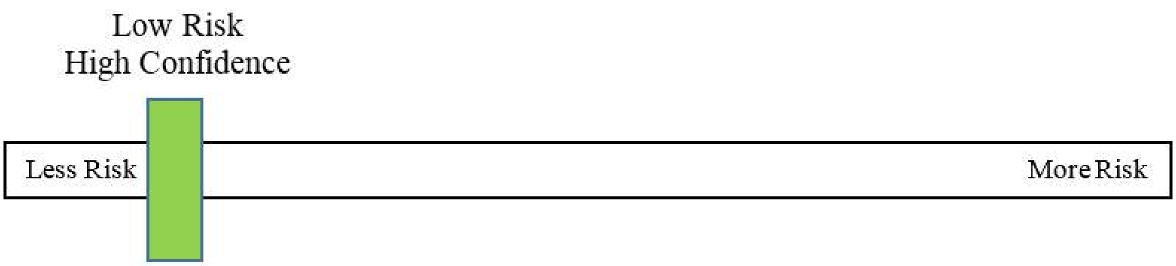
Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Nurseries	>1	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**High**		

Table 13. Effects analysis summary table: Columbia River ESU chum salmon and diazinon

	R-plot Derived		**MagTool**	**Population Model**	**Risk**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	**Population Model Results**	**Hypothesis Supported? Yes/No**
Risk Hypothesis					
Exposure to diazinon is sufficient to reduce juvenile and adult abundance via acute lethality.	Low	High	4-day: 0-1	Not Applicable	No
Exposure to diazinon is sufficient to reduce juvenile abundance via reduction in prey availability	Low	High	4-day fish: 0-1 4-day invert: 1-7		No
Exposure to diazinon is sufficient to reduce juvenile and adult abundance and adult productivity via impairments to ecologically significant behaviors	Low	High	Not Available	Not Applicable	No
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	High	Not Available		No
Exposure to diazinon is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)	Low	High	Not Available	Not Applicable	No

Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Low	High	Not Available	Not Applicable	No

Effects analysis summary: Adult and juvenile Columbia River ESU chum salmon are not anticipated to experience significant reductions in abundance or productivity (spawning adults) from exposure to diazinon. The MagTool results indicate that between 0-1 percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, chum may experience increased toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed chum. The overall risk to Columbia River ESU chum salmon from the effects of the action is low and the confidence associated with that risk is high.



13.4 Chum Salmon, Hood Canal summer-run ESU (Oncorhynchus keta)

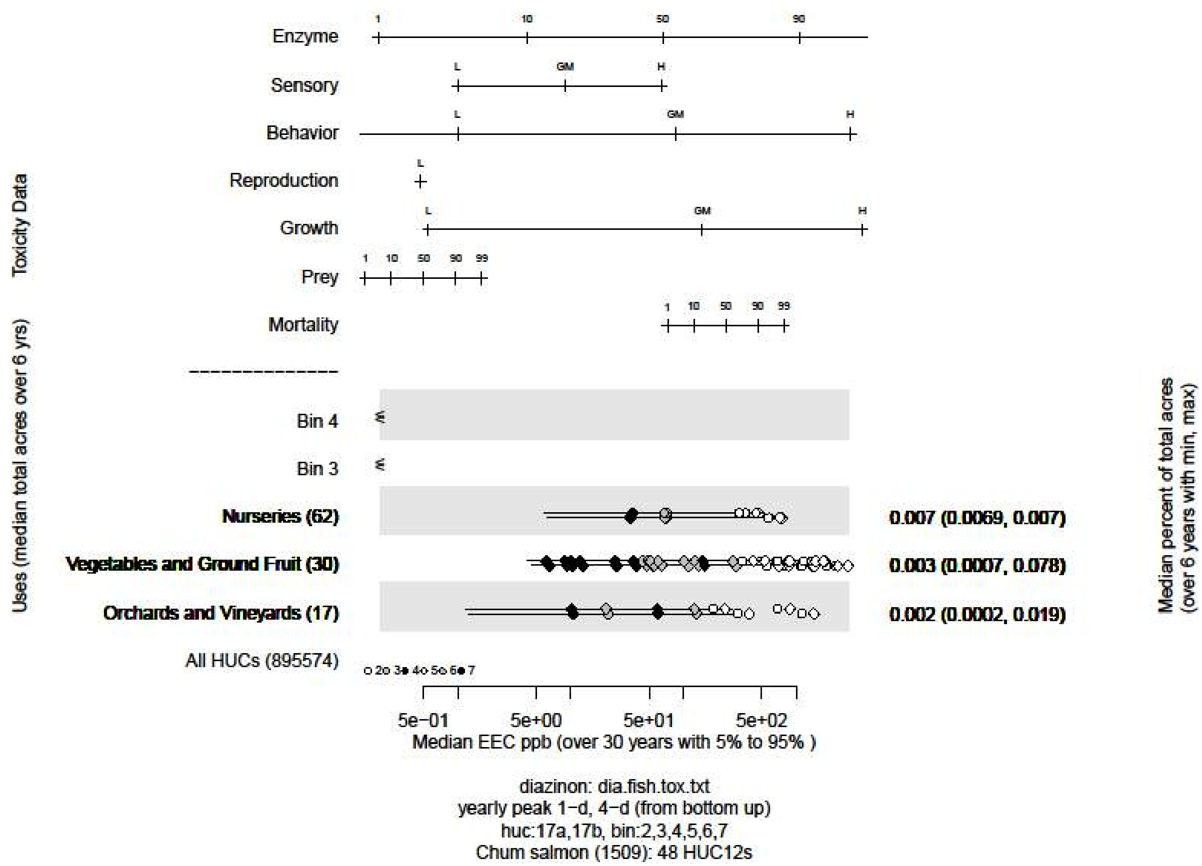


Figure 3. Effects analysis R-plot for Hood Canal summer-run ESU chum salmon and diazinon

Table 14. Likelihood of exposure determination for Hood Canal summer-run ESU chum salmon and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Nurseries	1	yes	no	yes	no	2	**Low**
Vegetables and Ground Fruit	1	yes	no	yes	no	2	**Low**
Orchards and Vineyards	1	yes	no	yes	no	2	**Low**
Bin 3	1	yes	no	yes	NA	2	**Low**
Bin 4	1	yes	no	yes	NA	2	**Low**

Life Stage: Juvenile and Adult (full-range)

Table 15. Direct mortality risk hypothesis; Hood Canal summer-run chum salmon and diazinon

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Nurseries	<1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile and adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**High**		

Table 16. Prey risk hypothesis; Hood Canal summer-run chum salmon and diazinon

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Nurseries	<1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	**High**		

Table 17. Behavior and sensory risk hypothesis; Hood Canal summer-run chum salmon and diazinon

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Nurseries	<1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Endpoint: Sensory			

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Nurseries	<1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile and adult abundance and adult productivity via impairments to ecologically significant behaviors			
Risk	**Confidence**		
Low	**High**		

Table 18. AChE risk hypothesis; Hood Canal summer-run chum salmon and diazinon

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Nurseries	<1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**High**		

Table 19. Growth risk hypothesis; Hood Canal summer-run chum salmon and diazinon

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Nurseries	<1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
Low	**High**		

Table 20. Reproduction risk hypothesis; Hood Canal summer-run chum salmon and diazinon

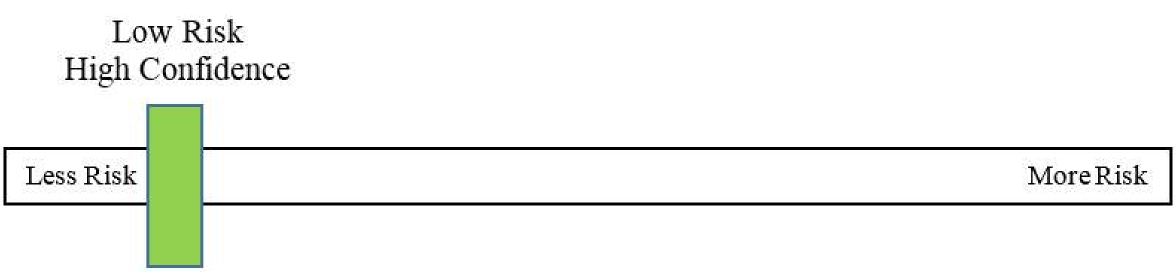
Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Nurseries	<1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**High**		

Table 21. Effects analysis summary table: Hood Canal summer-run ESU chum salmon and diazinon

	R-plot Derived		**MagTool**	**Population Model Results**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to diazinon is sufficient to reduce juvenile and adult abundance via acute lethality.	Low	High	4-day: 0	Not Applicable	No
Exposure to diazinon is sufficient to reduce juvenile abundance via reduction in prey availability	Low	High	4-day fish: 0 4-day invert: 0	Not Applicable	No
Exposure to diazinon is sufficient to reduce juvenile and adult abundance and adult productivity via impairments to ecologically significant behaviors	Low	High	Not Available		No
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	High	Not Available		No
Exposure to diazinon is sufficient to reduce juvenile	Low	High	Not Available	Not Applicable	No

abundance via impacts to growth (direct toxicity)					
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Low	High	Not Available	Not Applicable	No

Effects analysis summary: Adult and juvenile Hood Canal summer-run ESU chum salmon are not anticipated to experience significant reductions in abundance or productivity (spawning adults) from exposure to diazinon. The MagTool results indicate that 0 percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, chum may experience increased toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed chum. The overall risk to Hood Canal summer-run ESU chum from the effects of the action is low and the confidence associated with that risk is high.



13.5 Chinook, California Coastal (Oncorhynchus tshawytscha)

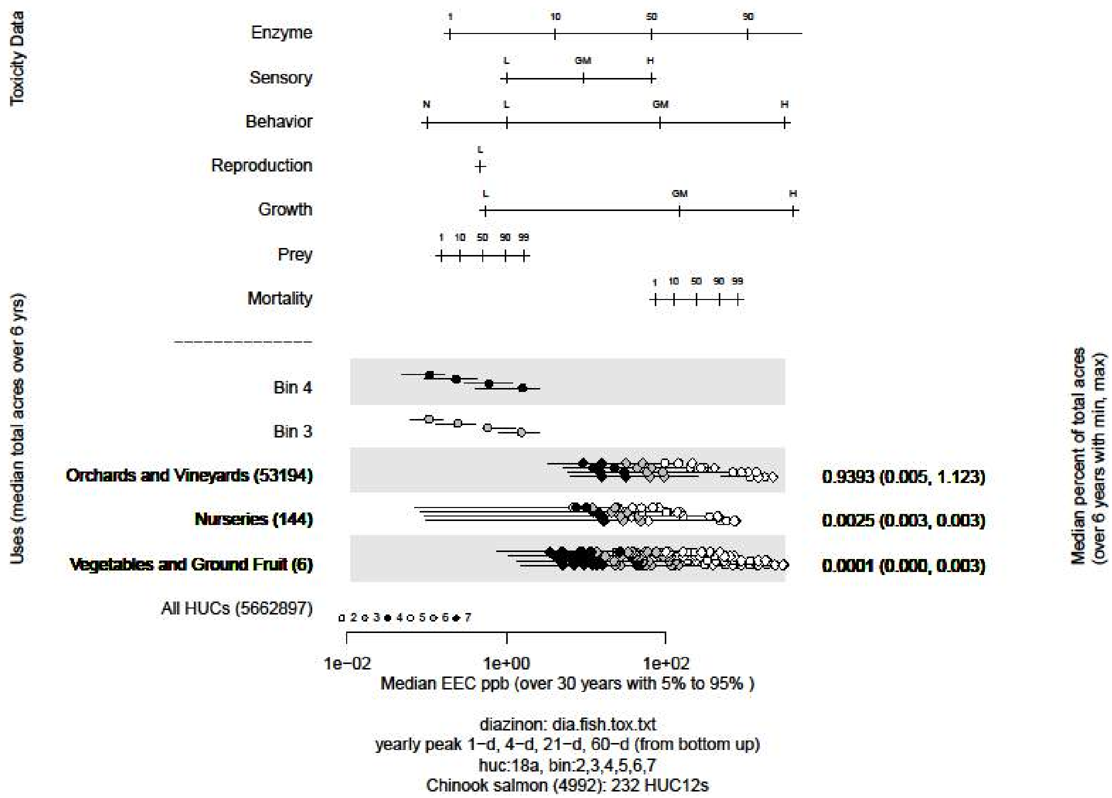


Figure 4. Effects analysis R-plot for California Coastal ESU chinook and diazinon

Table 22. Likelihood of exposure determination for California Coastal ESU Chinook salmon and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Orchards and Vineyards	1	yes	no	yes	yes	3	**High**
Nurseries	1	yes	no	yes	no	3	**Low**
Vegetables and Ground Fruit	1	yes	no	yes	no	3	**Low**
Bin 3	1	yes	no	yes	NA	3	**Low**
Bin 4	1	yes	no	yes	NA	3	**Low**
Juveniles							
Orchards and Vineyards	1	yes	no	yes	yes	3	**High**
Nurseries	1	yes	no	yes	no	3	**Low**
Vegetables and Ground Fruit	1	yes	no	yes	no	3	**Low**
Bin 3	1	yes	no	yes	NA	3	**Low**
Bin 4	1	yes	no	yes	NA	3	**Low**

Life Stage: Adults (full-range)

Table 23. Direct mortality risk hypothesis; Adult California Coastal Chinook salmon and diazinon

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.9	High	**High**
Nurseries	0.002	High	**Low**
Vegetables and Ground Fruit	0.0001	High	**Low**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to spawning streams of the Russian River population. This population has been determined essential to the recovery of the ESU per the 2016 Coastal Multispecies Recovery Plan.	
High	**Medium**		

Table 24. Reproduction risk hypothesis; Adult California Coastal Chinook salmon and diazinon

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.9	High	**High**
Nurseries	0.002	High	**Low**

Vegetables and Ground Fruit	0.0001	High	**Low**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to spawning streams of the Russian River population. This population has been determined essential to the recovery of the ESU per the 2016 Coastal Multispecies Recovery Plan.	
High	**Medium**		

Table 25. Behavior and sensory risk hypothesis; Adult California Coastal Chinook salmon and diazinon

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.9	High	**High**
Nurseries	0.002	High	**Low**
Vegetables and Ground Fruit	0.0001	High	**Low**
Bin 3		Medium	**Low**
Bin 4		Medium	**Low**
Endpoint: Sensory			**High**
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.9	High	**High**
Nurseries	0.002	High	**Low**
Vegetables and Ground Fruit	0.0001	High	**Low**
Bin 3		Medium	**Low**
Bin 4		Medium	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to spawning streams of the Russian River population. This population has been determined essential to the recovery of the ESU per the 2016 Coastal Multispecies Recovery Plan.	
High	**Medium**		

Table 26. AChE risk hypothesis; Adult California Coastal Chinook salmon and diazinon

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Orchards and Vineyards	0.9	High	**High**
Nurseries	0.002	High	**Low**
Vegetables and Ground Fruit	0.0001	High	**Low**
Bin 3		Medium	**Low**
Bin 4		Medium	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to spawning streams of the Russian River population. This population has been determined essential to the recovery of the ESU per the 2016 Coastal Multispecies Recovery Plan.	
High	**Medium**		

Life Stage: Juveniles (full-range)

Table 27. Direct mortality risk hypothesis; Juvenile California Coastal Chinook salmon and diazinon

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	0.9	High	High
Nurseries	0.002	High	Low
Vegetables and Ground Fruit	0.0001	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence	High density of orchards and vineyards use sites proximal to spawning streams of the Russian River population. This population has been determined essential to the recovery of the ESU per the 2016 Coastal Multispecies Recovery Plan.	
High	Medium		

Table 28. Growth risk hypothesis; Juvenile California Coastal Chinook salmon and diazinon

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	0.9	High	High
Nurseries	0.002	High	Low
Vegetables and Ground Fruit	0.0001	High	Low
Bin 3		Low	Low
Bin 4		Low	Low

Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)		
Risk	Confidence	High density of orchards and vineyards use sites proximal to spawning streams of the Russian River population. This population has been determined essential to the recovery of the ESU per the 2016 Coastal Multispecies Recovery Plan.
High	Medium	

Table 29. Prey risk hypothesis; Juvenile California Coastal Chinook salmon and diazinon

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.9	High	**High**
Nurseries	0.002	High	**Low**
Vegetables and Ground Fruit	0.0001	High	**Low**
Bin 3		High	**Low**
Bin 4		High	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to spawning streams of the Russian River population. This population has been determined essential to the recovery of the ESU per the 2016 Coastal Multispecies Recovery Plan.	
High	**Medium**		

Table 30. AChE risk hypothesis; Juvenile California Coastal Chinook salmon and diazinon

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	0.9	High	High
Nurseries	0.002	High	Low
Vegetables and Ground Fruit	0.0001	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence	High density of orchards and vineyards use sites proximal to spawning streams of the Russian River population. This population has been determined essential to the recovery of the ESU per the 2016 Coastal Multispecies Recovery Plan.	
High	Medium		

Table 31. Behavior and sensory risk hypothesis; Juvenile California Coastal Chinook salmon and diazinon

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.9	High	**High**
Nurseries	0.002	High	**Low**
Vegetables and Ground Fruit	0.0001	High	**Low**
Bin 3		Medium	**Low**
Bin 4		Medium	**Low**
Endpoint: Sensory			**High**
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.9	High	**High**
Nurseries	0.002	High	**Low**
Vegetables and Ground Fruit	0.0001	High	**Low**
Bin 3		Medium	**Low**
Bin 4		Medium	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juveniles abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to spawning streams of the Russian River population. This population has been determined essential to the recovery of the ESU per the 2016 Coastal Multispecies Recovery Plan.	
High	**Medium**		

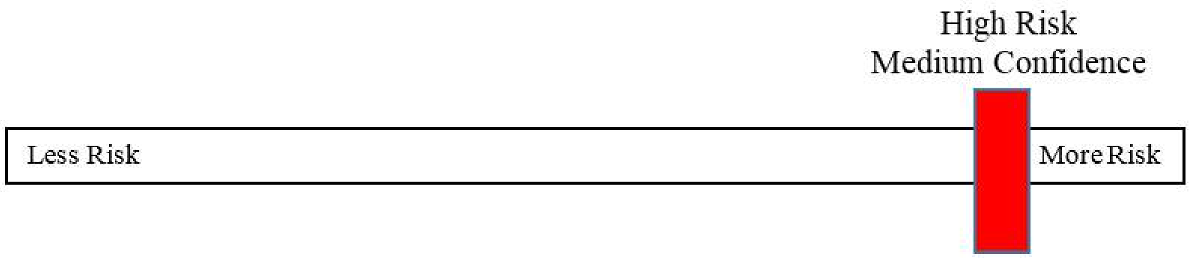
Table 32. Effects analysis summary table: California Coastal ESU Chinook salmon and diazinon

	R-plot Derived		**MagTool**	**Population Model Results: Chinook Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	High	Medium	4-day: 0-1	Not Applicable	Yes
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	High	Medium	Not Available	Not Applicable	Yes

Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	Medium	Not Available	Not Applicable	Yes
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Medium	Not Available	Not Applicable	Yes
	R-plot Derived		**MagTool**	**Population Model Results**	**Risk**
Life Stage: Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities of aquatic bins**		**Hypothesis Supported? Yes/No**
Risk Hypothesis					
Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.	High	Medium	4-day: 0-1	**Ocean-Type Chinook** Portion of juveniles exposed to diazinon estimated environmental concentrations (EECs); 100-2000 µg/l / Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles 25% / 0-12% (13-23) 50% / 1-23% (13-26) 75% / 1-35% (13-24) 100% / 1-86% (13-2) **Stream-Type Chinook** Portion of juveniles exposed to diazinon EECs; 100-2000 µg/l / Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles 25% / 0-11% (4-18)	Yes

				50% 0-20% (4-21) 75% 1-31% (4-21) 100% 1-84% (4-1)	
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	Medium	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**	Yes
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	High	Medium	4-day invert: 1-8	**Ocean-Type Chinook:** 3-24% (8-10)	Yes
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Medium	Not Available	**Stream-Type Chinook:** 2-23% (3-5)	Yes
Exposure to diazinon is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	Medium	Not Available	Not Applicable	Yes

Effects analysis summary: Adult and juvenile California Coastal Chinook salmon are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to diazinon. Population modelling results indicate that diazinon-induced mortality to juveniles may lead to severe reductions in lambda up to 86%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 0-1 percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, Chinook will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed Chinook. The overall risk to California Coastal Chinook salmon from the effects of the action is high and the confidence associated with that risk is medium. High risk is due to the proximity of orchards and vineyards use sites to the spawning streams of the Russian River population. Uses associated with the orchards and vineyards GIS layer are approved for use at times when individuals of this population are present. This population has been determined essential to the recovery of the ESU per the 2016 Coastal Multispecies Recovery Plan.


High Risk
Medium Confidence
Less Risk
More Risk

13.6 Chinook Salmon, Central Valley spring-run ESU (Oncorhynchus tshawytscha)

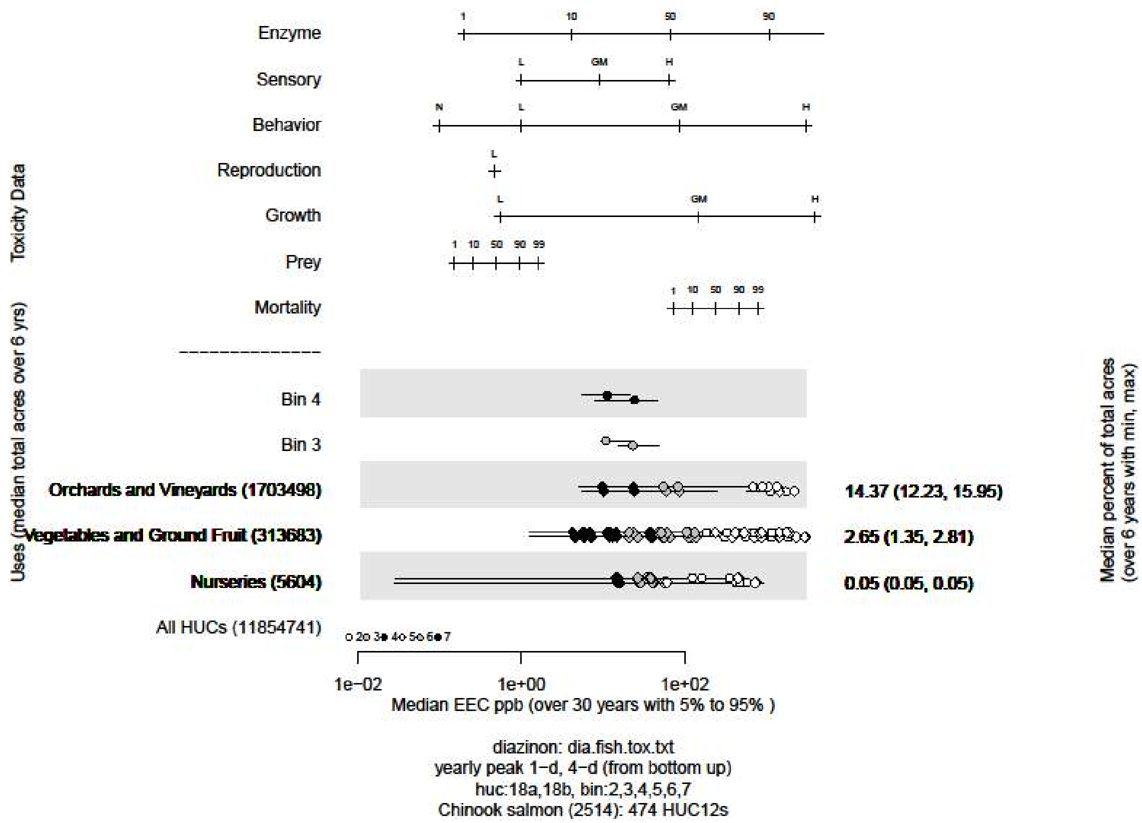


Figure 5. Effects analysis R-plot for Chinook salmon, Central Valley spring-run ESU and diazinon

Table 33. Likelihood of exposure determination for Chinook salmon, Central Valley spring-run ESU and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Orchards and Vineyards	3	yes	no	yes	NA	3	**High**
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	**Med**
Nurseries	1	yes	no	no	NA	3	**Low**
Bin 3	3	yes	no	yes	NA	3	**High**
Bin 4	3	yes	no	yes	NA	3	**High**
Juveniles							
Orchards and Vineyards	3	yes	no	yes	NA	3	**High**
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	**Med**
Nurseries	1	yes	no	no	NA	3	**Low**
Bin 3	3	yes	no	yes	NA	3	**High**
Bin 4	3	yes	no	yes	NA	3	**High**

Life Stage: Adults (full-range)

Table 34. Direct mortality risk hypothesis; Adult Chinook salmon, Central Valley spring-run ESU and diazinon

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	14.4	High	**High**
Vegetables and Ground Fruit	2.7	High	**Medium**
Nurseries	0.05	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 35. Reproduction risk hypothesis; Adult Chinook salmon, Central Valley spring-run ESU and diazinon

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	14.4	High	**High**

Vegetables and Ground Fruit	2.7	High	**Medium**
Nurseries	0.05	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 36. Behavior and sensory risk hypothesis; Adult Chinook salmon, Central Valley spring-run ESU and diazinon

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	14.4	High	**High**
Vegetables and Ground Fruit	2.7	High	**Medium**
Nurseries	0.05	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	14.4	High	**High**
Vegetables and Ground Fruit	2.7	High	**Medium**
Nurseries	0.05	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 37. AChE risk hypothesis; Adult Chinook salmon, Central Valley spring-run ESU and diazinon

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	14.4	High	**High**
Vegetables and Ground Fruit	2.7	High	**Medium**

Nurseries	0.05	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 38. Direct mortality risk hypothesis; Juvenile Chinook salmon, Central Valley spring-run ESU and diazinon

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	14.4	High	High
Vegetables and Ground Fruit	2.7	High	Medium
Nurseries	0.05	High	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 39. Growth risk hypothesis; Juvenile Chinook salmon, Central Valley spring-run ESU and diazinon

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	14.4	High	High
Vegetables and Ground Fruit	2.7	High	Medium
Nurseries	0.05	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 40. Prey risk hypothesis; Juvenile Chinook salmon, Central Valley spring-run ESU and diazinon

Endpoint: Prey

Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	14.4	High	**High**
Vegetables and Ground Fruit	2.7	High	**Medium**
Nurseries	0.05	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 41. AChE risk hypothesis; Juvenile Chinook salmon, Central Valley spring-run ESU and diazinon

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	14.4	High	High
Vegetables and Ground Fruit	2.7	High	Medium
Nurseries	0.05	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 42. Behavior and sensory risk hypothesis; Juvenile Chinook salmon, Central Valley spring-run ESU and diazinon

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	14.4	High	High
Vegetables and Ground Fruit	2.7	High	Medium
Nurseries	0.05	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Orchards and Vineyards	14.4	High	High
Vegetables and Ground Fruit	2.7	High	Medium
Nurseries	0.05	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

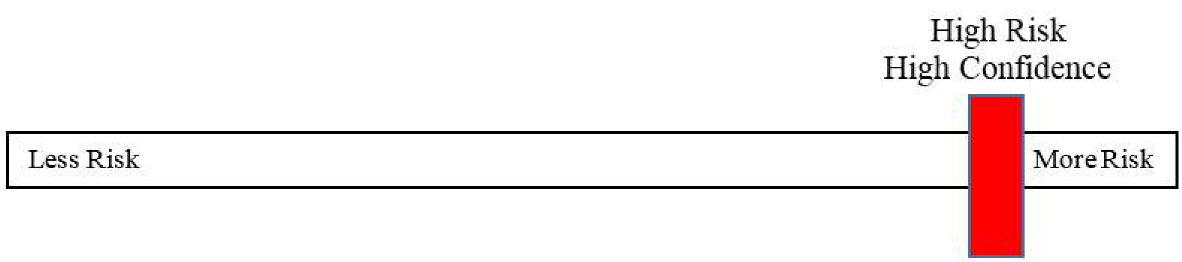
Table 43. Effects analysis summary table: Chinook salmon, Central Valley spring-run ESU and diazinon

	R-plot Derived		**MagTool**	**Population Model Results: Chinook Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 1-17	Not Applicable	Yes
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable	Yes
Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	Yes
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	Not Applicable	Yes
	R-plot Derived		**MagTool**	**Population Model Results**	**Risk Hypothesis Supported?**
Life Stage: Juveniles	**Risk**	**Confidence**			

			Range in median percent mortalities of aquatic bins		Yes/No
Risk Hypothesis					
Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 1-17	**Ocean-Type Chinook** Portion of juveniles exposed to diazinon EECs; 100-2000 µg/l — Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles 25% — 0-12% (13-23) 50% — 1-23% (13-26) 75% — 1-35% (13-24) 100% — 1-86% (13-2) **Stream-Type Chinook** Portion of juveniles exposed to diazinon EECs; 100-2000 µg/l — Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles 25% — 0-11% (4-18) 50% — 0-20% (4-21) 75% — 1-31% (4-21) 100% — 1-84% (4-1)	Yes
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**	Yes
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day invert: 17-65	**Ocean-Type Chinook:** 3-24% (8-10)	Yes
Exposure to diazinon is sufficient to	High	High	Not Available		Yes

reduce ChE activity; the identified mechanism of toxicity				**Stream-Type Chinook:** 2-23% (3-5)	
Exposure to diazinon is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	**Yes**

Effects analysis summary: Adult and juvenile Central Valley spring-run Chinook salmon are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to diazinon. Population modelling results indicate that diazinon-induced mortality to juveniles may lead to severe reductions in lambda up to 86%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 1-17 percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, Chinook will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed Chinook. The overall risk to Central Valley spring-run Chinook salmon from the effects of the action is high and the confidence associated with that risk is high.



13.7 Chinook Salmon, Lower Columbia River ESU (Oncorhynchus tshawytscha)

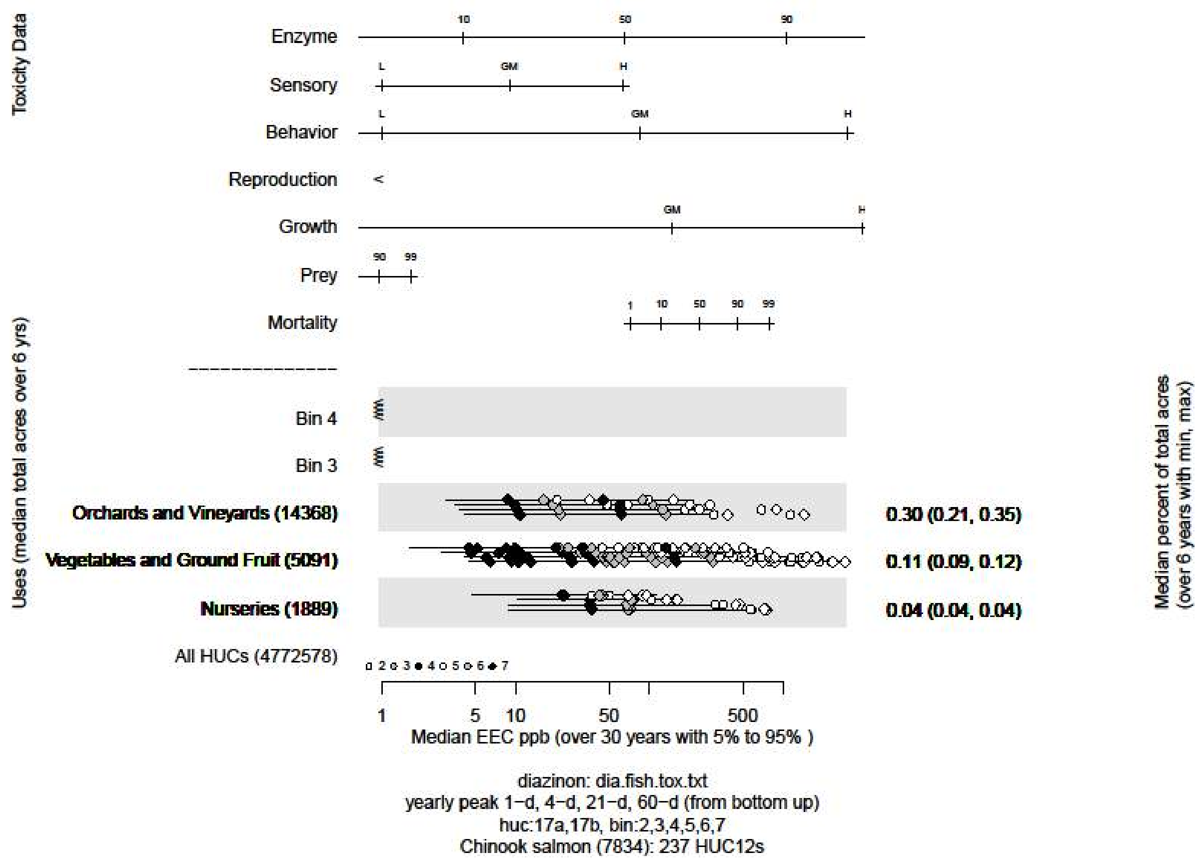


Figure 6. Effects analysis R-plot for Lower Columbia River ESU, Chinook salmon and diazinon

Table 44. Likelihood of exposure determination for Lower Columbia River ESU, Chinook salmon and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Orchards and Vineyards	1	yes	no	yes	yes	3	**High**
Vegetables and Ground Fruit	1	yes	no	yes	yes	3	**High**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	1	yes	no	yes	NA	3	**Low**
Bin 4	1	yes	no	yes	NA	3	**Low**
Juveniles							
Orchards and Vineyards	1	yes	no	yes	yes	3	**High**
Vegetables and Ground Fruit	1	yes	no	yes	yes	3	**High**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	1	yes	no	yes	NA	3	**Low**
Bin 4	1	yes	no	yes	NA	3	**Low**

Life Stage: Adults (full-range)

Table 45. Direct mortality risk hypothesis; Adult Chinook salmon, Lower Columbia River ESU and diazinon

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.3	High	High
Vegetables and Ground Fruit	0.1	High	High
Nurseries	0.04	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to White Salmon population spawning areas and migratory corridor. This population has been determined essential to the recovery of the ESU per the 2013 Lower Columbia River Recovery Plan for Salmon and Steelhead. In addition, high density of vegetables and ground fruit use sites proximal to the migration corridor at Sauvie Island, Oregon (all populations utilize this migratory corridor).	
High	**High**		

Table 46. Reproduction risk hypothesis; Adult Chinook salmon, Lower Columbia River ESU and diazinon

Endpoint: Reproduction

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	0.3	High	High
Vegetables and Ground Fruit	0.1	High	High
Nurseries	0.04	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to White Salmon population spawning areas and migratory corridor. This population has been determined essential to the recovery of the ESU per the 2013 Lower Columbia River Recovery Plan for Salmon and Steelhead. In addition, high density of vegetables and ground fruit use sites proximal to the migration corridor at Sauvie Island, Oregon (all populations utilize this migratory corridor).	
High	**High**		

Table 47. Behavior and sensory risk hypothesis; Adult Chinook salmon, Lower Columbia River ESU and diazinon

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.3	High	High
Vegetables and Ground Fruit	0.1	High	High
Nurseries	0.04	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.3	High	High
Vegetables and Ground Fruit	0.1	High	High
Nurseries	0.04	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		

High	**High**	High density of orchards and vineyards use sites proximal to White Salmon population spawning areas and migratory corridor. This population has been determined essential to the recovery of the ESU per the 2013 Lower Columbia River Recovery Plan for Salmon and Steelhead. In addition, high density of vegetables and ground fruit use sites proximal to the migration corridor at Sauvie Island, Oregon (all populations utilize this migratory corridor).

Table 48. AChE risk hypothesis; Adult Chinook salmon, Lower Columbia River ESU and diazinon

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.3	High	High
Vegetables and Ground Fruit	0.1	High	High
Nurseries	0.04	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to White Salmon population spawning areas and migratory corridor. This population has been determined essential to the recovery of the ESU per the 2013 Lower Columbia River Recovery Plan for Salmon and Steelhead. In addition, high density of vegetables and ground fruit use sites proximal to the migration corridor at Sauvie Island, Oregon (all populations utilize this migratory corridor).	
High	**High**		

Life Stage: Juveniles (full-range)

Table 49. Direct mortality risk hypothesis; Juvenile Chinook salmon, Lower Columbia River ESU and diazinon

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	0.3	High	High
Vegetables and Ground Fruit	0.1	High	High

Nurseries	0.04	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence	High density of orchards and vineyards use sites proximal to White Salmon population spawning areas and migratory corridor. This population has been determined essential to the recovery of the ESU per the 2013 Lower Columbia River Recovery Plan for Salmon and Steelhead. In addition, high density of vegetables and ground fruit use sites proximal to the migration corridor at Sauvie Island, Oregon (all populations utilize this migratory corridor).	
High	High		

Table 50. Growth risk hypothesis; Juvenile Chinook salmon, Lower Columbia River ESU and diazinon

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	0.3	High	High
Vegetables and Ground Fruit	0.1	High	High
Nurseries	0.04	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence	High density of orchards and vineyards use sites proximal to White Salmon population spawning areas and migratory corridor. This population has been determined essential to the recovery of the ESU per the 2013 Lower Columbia River Recovery Plan for Salmon and Steelhead. In addition, high density of vegetables and ground fruit use sites proximal to the migration corridor at Sauvie Island, Oregon (all populations utilize this migratory corridor).	
High	High		

Table 51. Prey risk hypothesis; Juvenile Chinook salmon, Lower Columbia River ESU and diazinon

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.3	High	High

Vegetables and Ground Fruit	0.1	High	High
Nurseries	0.04	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to White Salmon population spawning areas and migratory corridor. This population has been determined essential to the recovery of the ESU per the 2013 Lower Columbia River Recovery Plan for Salmon and Steelhead. In addition, high density of vegetables and ground fruit use sites proximal to the migration corridor at Sauvie Island, Oregon (all populations utilize this migratory corridor).	
High	**High**		

Table 52. AChE risk hypothesis; Juvenile Chinook salmon, Lower Columbia River ESU and diazinon

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	0.3	High	High
Vegetables and Ground Fruit	0.1	High	High
Nurseries	0.04	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence	High density of orchards and vineyards use sites proximal to White Salmon population spawning areas and migratory corridor. This population has been determined essential to the recovery of the ESU per the 2013 Lower Columbia River Recovery Plan for Salmon and Steelhead. In addition, high density of vegetables and ground fruit use sites proximal to the migration corridor at Sauvie Island, Oregon (all populations utilize this migratory corridor).	
High	High		

Table 53. Behavior and sensory risk hypothesis; Juvenile Chinook salmon, Lower Columbia River ESU and diazinon

Endpoint: Behavior

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	0.3	High	High
Vegetables and Ground Fruit	0.1	High	High
Nurseries	0.04	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.3	High	High
Vegetables and Ground Fruit	0.1	High	High
Nurseries	0.04	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to White Salmon population spawning areas and migratory corridor. This population has been determined essential to the recovery of the ESU per the 2013 Lower Columbia River Recovery Plan for Salmon and Steelhead. In addition, high density of vegetables and ground fruit use sites proximal to the migration corridor at Sauvie Island, Oregon (all populations utilize this migratory corridor).	
High	**High**		

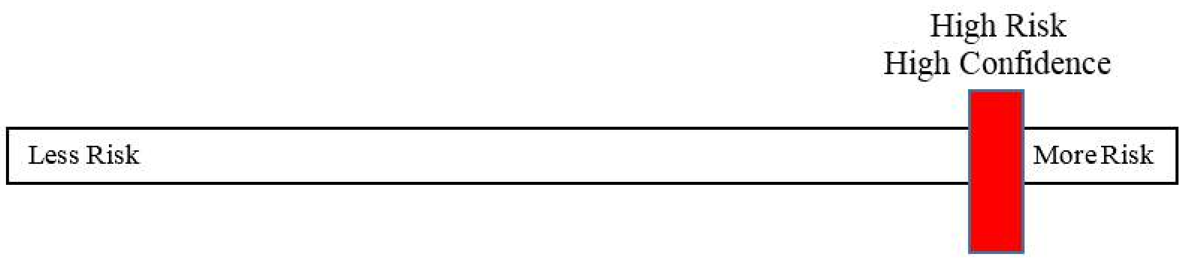
Table 54. Effects analysis summary table: Chinook salmon, Lower Columbia River ESU and diazinon

	R-plot Derived		MagTool	Population Model Results: Chinook Salmon	Risk Hypothesis Supported? Yes/No
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 0	Not Applicable	Yes
Exposure to diazinon is sufficient to reduce adult	High	High	Not Available	Not Applicable	Yes

productivity via impairments to reproduction					
Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	Yes
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	Not Applicable	Yes
	R-plot Derived		**MagTool**	**Population Model Results**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities of aquatic bins**		
Risk Hypothesis					
Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 0	**Ocean-Type Chinook** Portion of juveniles exposed to diazinon EECs; 100-2000 µg/l / Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles 25% / 0-12% (13-23) 50% / 1-23% (13-26) 75% / 1-35% (13-24) 100% / 1-86% (13-2) **Stream-Type Chinook** Portion of juveniles exposed to diazinon EECs; 100-2000 µg/l / Mean percent reduction (STD) in a population's intrinsic growth, lambda, from	Yes

					death of juveniles	
				25% 50% 75% 100%	0-11% (4-18) 0-20% (4-21) 1-31% (4-21) 1-84% (4-1)	
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**		Yes
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day invert: 4-5	**Ocean-Type Chinook:** 3-24% (8-10) **Stream-Type Chinook:** 2-23% (3-5)		Yes
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available			Yes
Exposure to diazinon is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable		Yes

Effects analysis summary: Adult and juvenile Chinook salmon, Lower Columbia River ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to diazinon. Population modelling results indicate that diazinon-induced mortality to juveniles may lead to severe reductions in lambda up to 86%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that 0 percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, Chinook will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed Chinook. The overall risk to Chinook salmon, Lower Columbia River ESU from the effects of the action is high and the confidence associated with that risk is high. High risk is due to the proximity of orchard and vineyard use sites to the White Salmon population's spawning streams and migratory corridor, as well as vegetable and ground fruit use sites in proximity to the migratory corridor near Sauvie Island, Oregon. Uses associated with the orchards and vineyards GIS layer are approved for use at times when individuals of the While Salmon population are present. This population has been determined essential to the recovery of the ESU per the 2013 Lower Columbia River Recovery Plan for Salmon and Steelhead.



13.8 Chinook Salmon, Puget Sound ESU (Oncorhynchus tshawytscha)

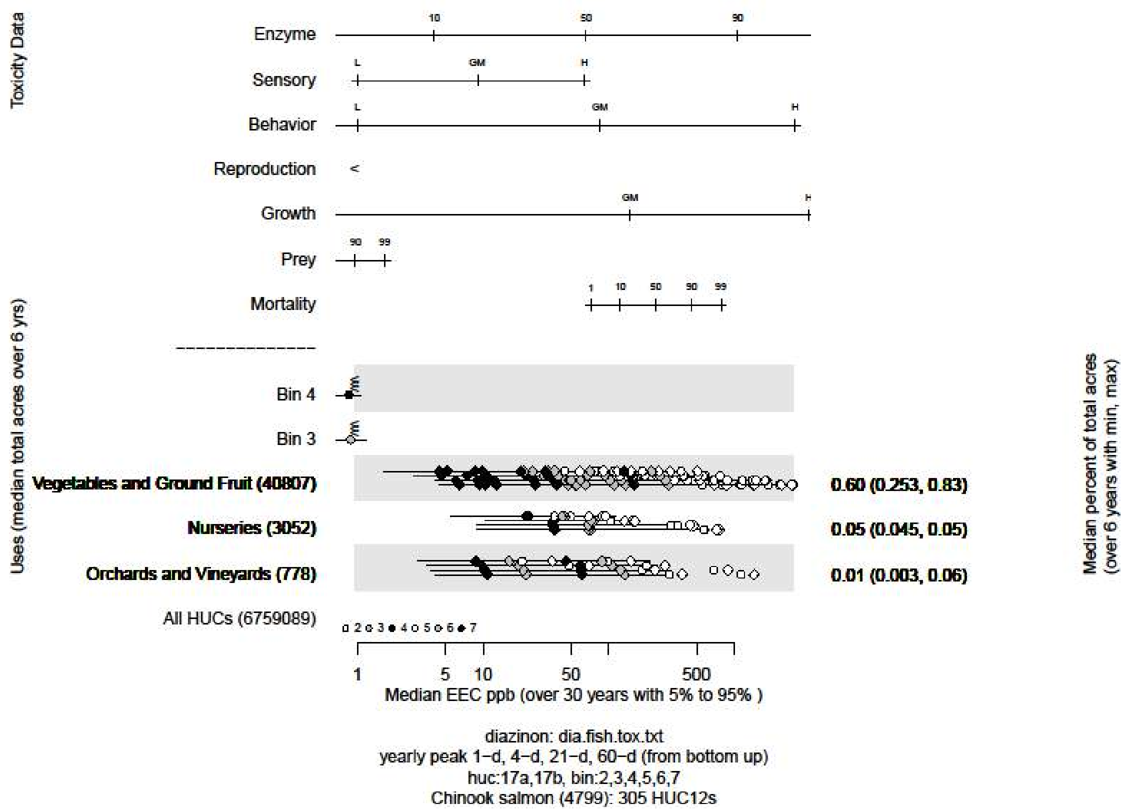


Figure 7. Effects analysis R-plot for Chinook salmon, Puget Sound ESU and diazinon

Table 55. Likelihood of exposure determination for Chinook salmon, Puget Sound ESU and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Vegetables and Ground Fruit	1	yes	no	yes	yes	3	**High**
Nurseries	1	yes	no	yes	no	3	**Low**
Orchards and Vineyards	1	yes	no	yes	no	3	**Low**
Bin 3	1	yes	no	yes	NA	3	**Low**
Bin 4	1	yes	no	yes	NA	3	**Low**
Juveniles							
Vegetables and Ground Fruit	1	yes	no	yes	yes	3	**High**
Nurseries	1	yes	no	yes	no	3	**Low**
Orchards and Vineyards	1	yes	no	yes	no	3	**Low**
Bin 3	1	yes	no	yes	NA	3	**Low**
Bin 4	1	yes	no	yes	NA	3	**Low**

Life Stage: Adults (full-range)

Table 56. Direct mortality risk hypothesis; Chinook salmon, Puget Sound ESU and diazinon; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.6	High	**High**
Nurseries	0.05	High	**Low**
Orchards and Vineyards	0.01	High	**Low**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**	High density of vegetables and ground fruit use sites proximal to the Nooksack populations (middle fork, north fork, and south fork), the upper and lower Skagit populations, and the Sauk population. These populations have been determined essential to the recovery of the ESU per the 2007 Puget Sound Chinook Recovery Plan.	
High	**Medium**		

Table 57. Reproduction risk hypothesis; Chinook salmon, Puget Sound ESU and diazinon; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Vegetables and Ground Fruit	0.6	High	**High**
Nurseries	0.05	High	**Low**
Orchards and Vineyards	0.01	High	**Low**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**	High density of vegetables and ground fruit use sites proximal to the Nooksack populations (middle fork, north fork, and south fork), the upper and lower Skagit populations, and the Sauk population. These populations have been determined essential to the recovery of the ESU per the 2007 Puget Sound Chinook Recovery Plan.	
High	**Medium**		

Table 58. Behavior and sensory risk hypothesis; Chinook salmon, Puget Sound ESU and diazinon; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.6	High	**High**
Nurseries	0.05	High	**Low**
Orchards and Vineyards	0.01	High	**Low**
Bin 3		Medium	**Low**
Bin 4		Medium	**Low**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.6	High	**High**
Nurseries	0.05	High	**Low**
Orchards and Vineyards	0.01	High	**Low**
Bin 3		Medium	**Low**
Bin 4		Medium	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**	High density of vegetables and ground fruit use sites proximal to the Nooksack populations (middle fork, north fork, and south fork), the upper and lower Skagit populations, and the Sauk population. These populations have been determined essential to the recovery of the ESU	
High	**Medium**		

		per the 2007 Puget Sound Chinook Recovery Plan.

Table 59. AChE risk hypothesis; Chinook salmon, Puget Sound ESU and diazinon; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.6	High	**High**
Nurseries	0.05	High	**Low**
Orchards and Vineyards	0.01	High	**Low**
Bin 3		Medium	**Low**
Bin 4		Medium	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**	High density of vegetables and ground fruit use sites proximal to the Nooksack populations (middle fork, north fork, and south fork), the upper and lower Skagit populations, and the Sauk population. These populations have been determined essential to the recovery of the ESU per the 2007 Puget Sound Chinook Recovery Plan.	
High	**Medium**		

Life Stage: Juveniles (full-range)

Table 60. Direct mortality risk hypothesis; Chinook salmon, Puget Sound ESU and diazinon; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	0.6	High	High
Nurseries	0.05	High	Low
Orchards and Vineyards	0.01	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence	High density of vegetables and ground fruit use sites proximal to the Nooksack populations (middle fork, north fork, and south fork), the upper and lower Skagit populations, and the Sauk population. These populations have been determined essential to the recovery of the ESU	
High	Medium		

		per the 2007 Puget Sound Chinook Recovery Plan.

Table 61. Growth risk hypothesis; Chinook salmon, Puget Sound ESU and diazinon; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	0.6	High	High
Nurseries	0.05	High	Low
Orchards and Vineyards	0.01	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence	High density of vegetables and ground fruit use sites proximal to the Nooksack populations (middle fork, north fork, and south fork), the upper and lower Skagit populations, and the Sauk population. These populations have been determined essential to the recovery of the ESU per the 2007 Puget Sound Chinook Recovery Plan.	
High	Medium		

Table 62. Prey risk hypothesis; Chinook salmon, Puget Sound ESU and diazinon; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.6	High	**High**
Nurseries	0.05	High	**Low**
Orchards and Vineyards	0.01	High	**Low**
Bin 3		Medium	**Low**
Bin 4		Medium	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**	High density of vegetables and ground fruit use sites proximal to the Nooksack populations (middle fork, north fork, and south fork), the upper and lower Skagit populations, and the Sauk population. These populations have been determined essential to the recovery of the ESU per the 2007 Puget Sound Chinook Recovery Plan.	
High	**Medium**		

Table 63. AChE risk hypothesis; Chinook salmon, Puget Sound ESU and diazinon; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	0.6	High	High
Nurseries	0.05	High	Low
Orchards and Vineyards	0.01	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence	High density of vegetables and ground fruit use sites proximal to the Nooksack populations (middle fork, north fork, and south fork), the upper and lower Skagit populations, and the Sauk population. These populations have been determined essential to the recovery of the ESU per the 2007 Puget Sound Chinook Recovery Plan.	
High	Medium		

Table 64. Behavior and sensory risk hypothesis; Chinook salmon, Puget Sound ESU and diazinon; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.6	High	**High**
Nurseries	0.05	High	**Low**
Orchards and Vineyards	0.01	High	**Low**
Bin 3		Medium	**Low**
Bin 4		Medium	**Low**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.6	High	**High**
Nurseries	0.05	High	**Low**
Orchards and Vineyards	0.01	High	**Low**
Bin 3		Medium	**Low**
Bin 4		Medium	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			

Risk	Confidence	
High	**Medium**	High density of vegetables and ground fruit use sites proximal to the Nooksack populations (middle fork, north fork, and south fork), the upper and lower Skagit populations, and the Sauk population. These populations have been determined essential to the recovery of the ESU per the 2007 Puget Sound Chinook Recovery Plan.

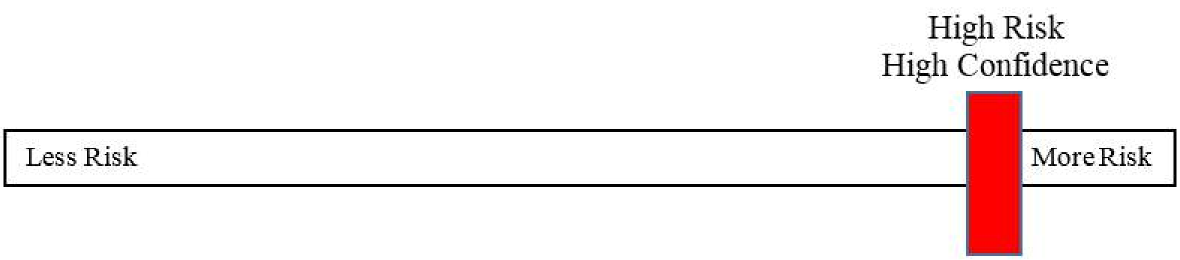
Table 65. Effects analysis summary table: Chinook salmon, Puget Sound ESU and diazinon

	R-plot Derived		**MagTool**	**Population Model Results: Chinook Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	High	Medium	4-day: 0-1	Not Applicable	Yes
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	High	Medium	Not Available	Not Applicable	Yes
Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	Medium	Not Available	Not Applicable	Yes
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Medium	Not Available	Not Applicable	Yes
	R-plot Derived		**MagTool**	**Population Model Results**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities of aquatic bins**		
Risk Hypothesis					
	High	Medium	4-day:	**Ocean-Type Chinook**	Yes

Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			0-1	Portion of juveniles exposed to diazinon EECs; 100-2000 µg/l	Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles	
				25% 50% 75% 100%	0-12% (13-23) 1-23% (13-26) 1-35% (13-24) 1-86% (13-2)	
				Stream-Type Chinook		
				Portion of juveniles exposed to diazinon EECs; 100-2000 µg/l	Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles	
				25% 50% 75% 100%	0-11% (4-18) 0-20% (4-21) 1-31% (4-21) 1-84% (4-1)	
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	Medium	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**		Yes
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	High	Medium	4-day invert: 1-6	**Ocean-Type Chinook:** 3-24% (8-10)		Yes
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Medium	Not Available	**Stream-Type Chinook:** 2-23% (3-5)		Yes

Exposure to diazinon is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	Medium	Not Available	Not Applicable	**Yes**

Effects analysis summary: Adult and juvenile Chinook salmon, Puget Sound ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to diazinon. Population modelling results indicate that diazinon-induced mortality to juveniles may lead to severe reductions in lambda up to 86%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 0-1 percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, Chinook will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed Chinook. The overall risk to Chinook salmon, Puget Sound ESU from the effects of the action is high and the confidence associated with that risk is medium. High risk is due to the proximity of vegetables and ground fruit use sites to the Nooksack populations (middle fork, north fork, and south fork), the upper and lower Skagit populations, and the Sauk population. Uses associated with the vegetables and ground fruit GIS layer are approved for use at times when individuals of these populations are present. These populations have been determined essential to the recovery of the ESU per the 2007 Puget Sound Chinook Recovery Plan.



13.9 Chinook Salmon, Sacramento River winter-run (Oncorhynchus tshawytscha)

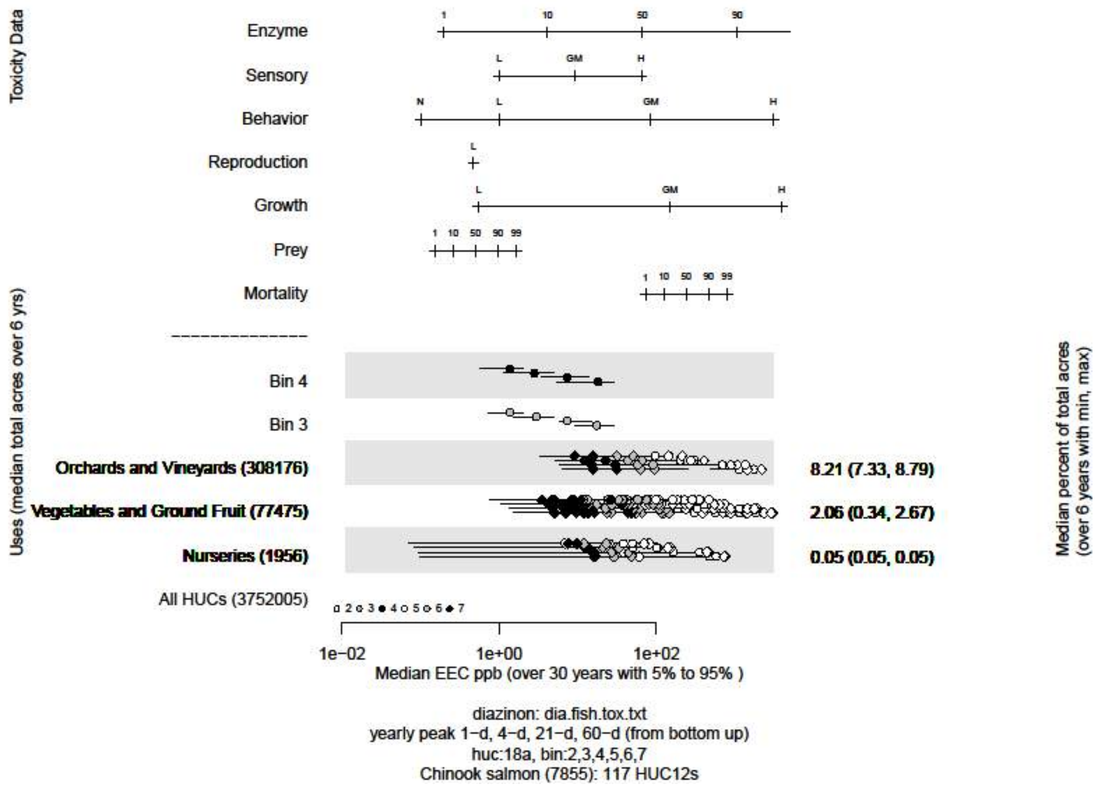


Figure 8. Effects analysis R-plot for Chinook salmon, Sacramento River winter-run ESU and diazinon

Table 66. Likelihood of exposure determination for Chinook salmon, Sacramento River winter-run ESU and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Orchards and Vineyards	3	yes	no	yes	NA	3	**High**
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	**Med**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	3	yes	no	yes	NA	3	**High**
Bin 4	3	yes	no	yes	NA	3	**High**
Juveniles							
Orchards and Vineyards	3	yes	no	yes	NA	3	**High**
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	**Med**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	3	yes	no	yes	NA	3	**High**
Bin 4	3	yes	no	yes	NA	3	**High**

Life Stage: Adults (full-range)

Table 67. Direct mortality risk hypothesis; Chinook salmon, Sacramento River winter-run ESU and diazinon; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	8.2	High	**High**
Vegetables and Ground Fruit	2.1	High	**Medium**
Nurseries	0.05	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 68. Reproduction risk hypothesis; Chinook salmon, Sacramento River winter-run ESU and diazinon; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	8.2	High	**High**

Vegetables and Ground Fruit	2.1	High	**Medium**
Nurseries	0.05	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 69. Behavior and sensory risk hypothesis; Chinook salmon, Sacramento River winter-run ESU and diazinon; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	8.2	High	**High**
Vegetables and Ground Fruit	2.1	High	**Medium**
Nurseries	0.05	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	8.2	High	**High**
Vegetables and Ground Fruit	2.1	High	**Medium**
Nurseries	0.05	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 70. AChE risk hypothesis; Chinook salmon, Sacramento River winter-run ESU and diazinon; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	8.2	High	**High**
Vegetables and Ground Fruit	2.1	High	**Medium**

Nurseries	0.05	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 71. Direct mortality risk hypothesis; Chinook salmon, Sacramento River winter-run ESU and diazinon; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	8.2	High	High
Vegetables and Ground Fruit	2.1	High	Medium
Nurseries	0.05	High	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 72. Growth risk hypothesis; Chinook salmon, Sacramento River winter-run ESU and diazinon; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	8.2	High	High
Vegetables and Ground Fruit	2.1	High	Medium
Nurseries	0.05	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 73. Prey risk hypothesis; Chinook salmon, Sacramento River winter-run ESU and diazinon; Juveniles

Endpoint: Prey

Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	8.2	High	**High**
Vegetables and Ground Fruit	2.1	High	**Medium**
Nurseries	0.05	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 74. AChE risk hypothesis; Chinook salmon, Sacramento River winter-run ESU and diazinon; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	8.2	High	High
Vegetables and Ground Fruit	2.1	High	Medium
Nurseries	0.05	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 75. Behavior and sensory risk hypothesis; Chinook salmon, Sacramento River winter-run ESU and diazinon; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	8.2	High	**High**
Vegetables and Ground Fruit	2.1	High	**Medium**
Nurseries	0.05	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Orchards and Vineyards	8.2	High	**High**
Vegetables and Ground Fruit	2.1	High	**Medium**
Nurseries	0.05	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

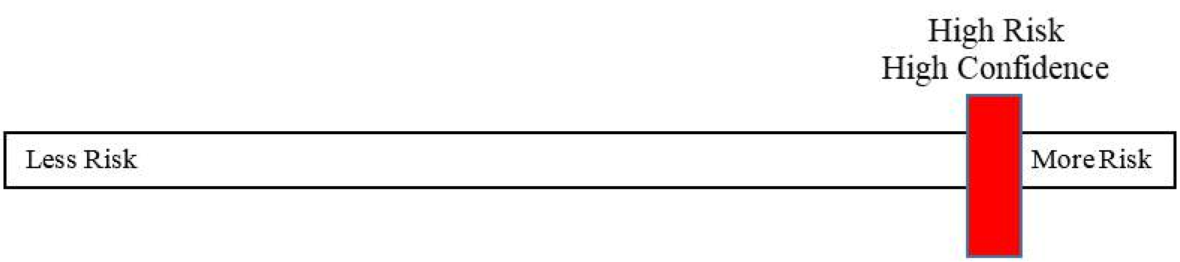
Table 76. Effects analysis summary table: Chinook salmon, Sacramento River winter-run ESU and diazinon

	R-plot Derived		**MagTool**	**Population Model Results: Chinook Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 1-10	Not Applicable	Yes
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable	Yes
Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	Yes
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	Not Applicable	Yes
	R-plot Derived		**MagTool**	**Population Model Results**	**Risk Hypothesis Supported?**
Life Stage: Juveniles	**Risk**	**Confidence**			

			Range in median percent mortalities of aquatic bins		**Yes/No**
Risk Hypothesis					
Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 1-10	**Ocean-Type Chinook** Portion of juveniles exposed to diazinon EECs; 100-2000 µg/l | Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles 25% | 0-12% (13-23) 50% | 1-23% (13-26) 75% | 1-35% (13-24) 100% | 1-86% (13-2) **Stream-Type Chinook** Portion of juveniles exposed to diazinon EECs; 100-2000 µg/l | Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles 25% | 0-11% (4-18) 50% | 0-20% (4-21) 75% | 1-31% (4-21) 100% | 1-84% (4-1)	Yes
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**	Yes
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day invert: 10-60	**Ocean-Type Chinook:** 3-24% (8-10)	Yes
Exposure to diazinon is sufficient to	High	High	Not Available		Yes

reduce ChE activity; the identified mechanism of toxicity				**Stream-Type Chinook:** 2-23% (3-5)	
Exposure to diazinon is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	**Yes**

Effects analysis summary: Adult and juvenile Chinook salmon, Sacramento River winter-run ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to diazinon. Population modelling results indicate that diazinon-induced mortality to juveniles may lead to severe reductions in lambda up to 86%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 1-10 percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, Chinook will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed Chinook. The overall risk to Chinook salmon, Sacramento River winter-run ESU from the effects of the action is high and the confidence associated with that risk is high.



13.10 Chinook Salmon, Snake River fall-run ESU (Oncorhynchus tshawytscha)

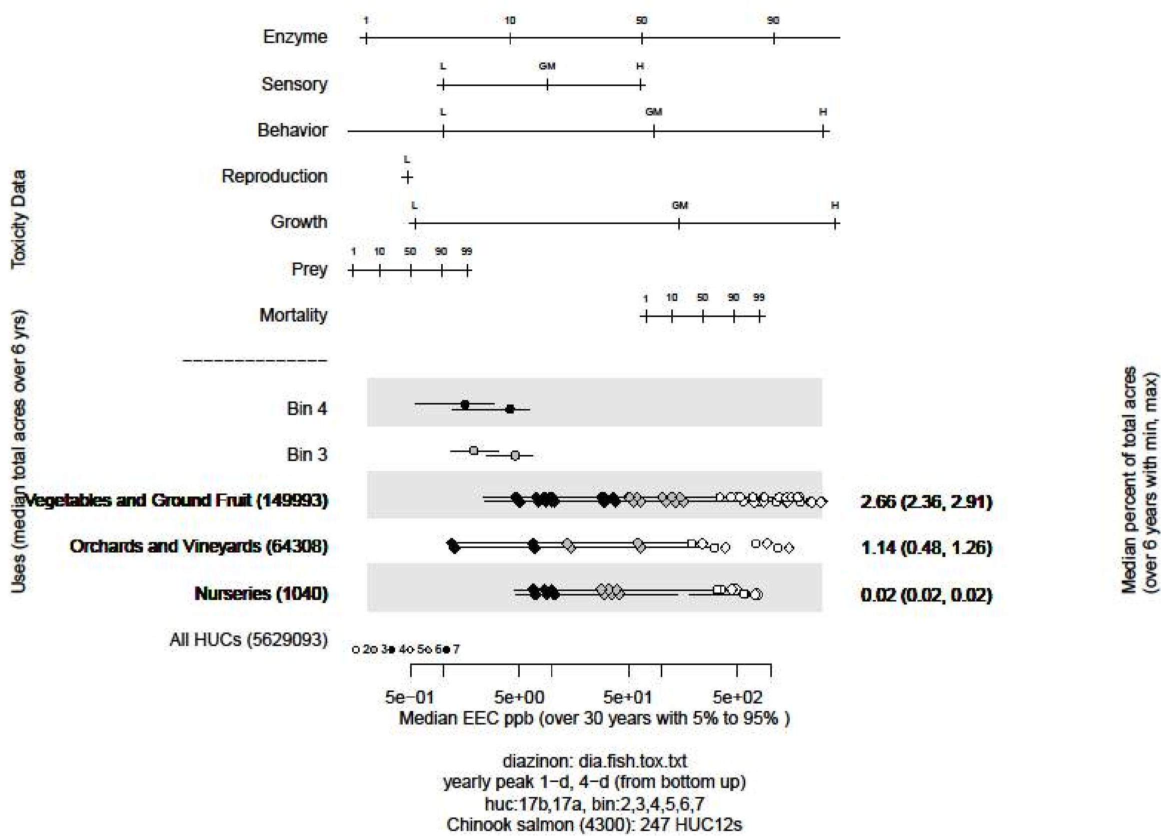


Figure 9. Effects analysis R-plot for Chinook salmon, Snake River fall-run ESU and diazinon

Table 77. Likelihood of exposure determination for Chinook salmon, Snake River fall-run ESU and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	**Med**
Orchards and Vineyards	2	yes	no	yes	NA	3	**Med**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	2	yes	no	yes	NA	3	**Med**
Bin 4	2	yes	no	yes	NA	3	**Med**
Juveniles							
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	**Med**
Orchards and Vineyards	2	yes	no	yes	NA	3	**Med**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	2	yes	no	yes	NA	3	**Med**
Bin 4	2	yes	no	yes	NA	3	**Med**

Life Stage: Adults (full-range)

Table 78. Direct mortality risk hypothesis; Chinook salmon, Snake River fall-run ESU and diazinon; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	2.7	High	**Medium**
Orchards and Vineyards	1.1	High	**Medium**
Nurseries	0.02	High	**Low**
Bin 3		Low	**Medium**
Bin 4		Low	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 79. Reproduction risk hypothesis; Chinook salmon, Snake River fall-run ESU and diazinon; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	2.7	High	**Medium**
Orchards and Vineyards	1.1	High	**Medium**
Nurseries	0.02	High	**Low**
Bin 3		High	**Medium**

Bin 4		High	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 80. Behavior and sensory risk hypothesis; Chinook salmon, Snake River fall-run ESU and diazinon; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	2.7	High	**Medium**
Orchards and Vineyards	1.1	High	**Medium**
Nurseries	0.02	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	2.7	High	**Medium**
Orchards and Vineyards	1.1	High	**Medium**
Nurseries	0.02	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 81. AChE risk hypothesis; Chinook salmon, Snake River fall-run ESU and diazinon; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	2.7	High	**Medium**
Orchards and Vineyards	1.1	High	**Medium**
Nurseries	0.02	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**

Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity		
Risk	**Confidence**	
High	**High**	

Life Stage: Juveniles (full-range)

Table 82. Direct mortality risk hypothesis; Chinook salmon, Snake River fall-run ESU and diazinon; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	2.7	High	Medium
Orchards and Vineyards	1.1	High	Medium
Nurseries	0.02	High	Low
Bin 3		Low	Medium
Bin 4		Low	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 83. Growth risk hypothesis; Chinook salmon, Snake River fall-run ESU and diazinon; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	2.7	High	Medium
Orchards and Vineyards	1.1	High	Medium
Nurseries	0.02	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 84. Prey risk hypothesis; Chinook salmon, Snake River fall-run ESU and diazinon; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	2.7	High	**Medium**

Orchards and Vineyards	1.1	High	**Medium**
Nurseries	0.02	High	**Low**
Bin 3		High	**Medium**
Bin 4		High	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 85. AChE risk hypothesis; Chinook salmon, Snake River fall-run ESU and diazinon; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	2.7	High	Medium
Orchards and Vineyards	1.1	High	Medium
Nurseries	0.02	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 86. Behavior and sensory risk hypothesis; Chinook salmon, Snake River fall-run ESU and diazinon; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	2.7	High	**Medium**
Orchards and Vineyards	1.1	High	**Medium**
Nurseries	0.02	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	2.7	High	**Medium**
Orchards and Vineyards	1.1	High	**Medium**
Nurseries	0.02	High	**Low**

Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

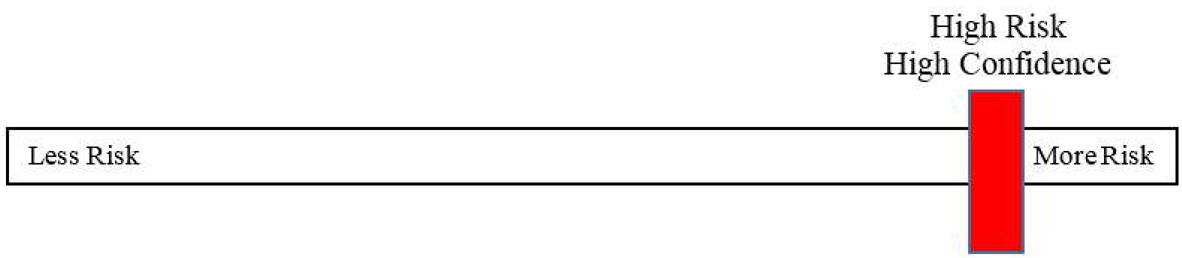
Table 87. Effects analysis summary table: Chinook salmon, Snake River fall-run ESU and diazinon

	R-plot Derived		**MagTool**	**Population Model Results: Chinook Salmon**		**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**			
Risk Hypothesis						
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: Pending	Not Applicable		Yes
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable		Yes
Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable		Yes
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	Not Applicable		Yes
	R-plot Derived		**MagTool**	**Population Model Results**		**Risk Hypothesis Supported? Yes/No**
Life Stage: Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities of aquatic bins**			
Risk Hypothesis						
Exposure to diazinon is sufficient to reduce juvenile	High	High	4-day: Pending	**Ocean-Type Chinook**		Yes
				Portion of juveniles	Mean percent reduction	

abundance via acute lethality.				exposed to diazinon EECs; 100-2000 µg/l | (STD) in a population's intrinsic growth, lambda, from death of juveniles 25% | 0-12% (13-23) 50% | 1-23% (13-26) 75% | 1-35% (13-24) 100% | 1-86% (13-2) **Stream-Type Chinook** Portion of juveniles exposed to diazinon EECs; 100-2000 µg/l | Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles 25% | 0-11% (4-18) 50% | 0-20% (4-21) 75% | 1-31% (4-21) 100% | 1-84% (4-1)	
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**	Yes
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day invert: Pending	**Ocean-Type Chinook:** 3-24% (8-10) **Stream-Type Chinook:** 2-23% (3-5)	Yes
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available		Yes
Exposure to diazinon is sufficient to reduce juvenile	High	High	Not Available	Not Applicable	**Yes**

abundance via impairments to ecologically significant behaviors.					

Effects analysis summary: Adult and juvenile Chinook salmon, Snake River fall-run ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to diazinon. Population modelling results indicate that diazinon-induced mortality to juveniles may lead to severe reductions in lambda up to 86%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between [pending] percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, Chinook will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed Chinook. The overall risk to Chinook salmon, Snake River fall-run ESU from the effects of the action is high and the confidence associated with that risk is high.



13.11 Chinook Salmon, Snake River spring/summer-run ESU (Oncorhynchus tshawytscha)

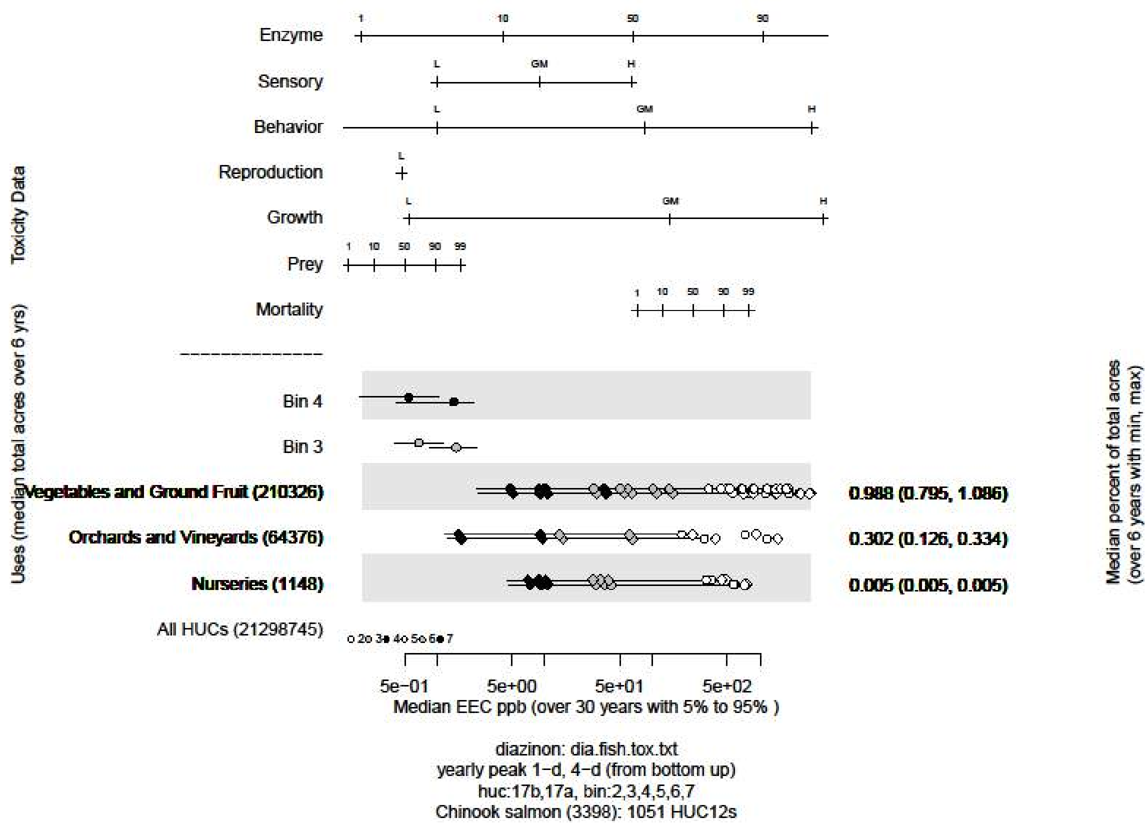


Figure 10. Effects analysis R-plot for Chinook salmon, Snake River spring/summer-run ESU and diazinon

Table 88. Likelihood of exposure determination for Chinook salmon, Snake River spring/summer-run ESU and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	**Med**
Orchards and Vineyards	1	yes	no	yes	yes	3	**High**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	2	yes	no	yes	NA	3	**Med**
Bin 4	2	yes	no	yes	NA	3	**Med**
Juveniles							
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	**Med**
Orchards and Vineyards	1	yes	no	yes	yes	3	**High**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	2	yes	no	yes	NA	3	**Med**
Bin 4	2	yes	no	yes	NA	3	**Med**

Life Stage: Adults (full-range)

Table 89. Direct mortality risk hypothesis; Chinook salmon, Snake River spring/summer-run ESU and diazinon; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.0	High	**Medium**
Orchards and Vineyards	0.3	High	**High**
Nurseries	0.005	High	**Low**
Bin 3		Low	**Medium**
Bin 4		Low	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to the migratory corridor at the confluence of the Snake and Columbia rivers as well as at the confluence of the Yakima and Columbia rivers. All populations of this ESU utilize this migratory corridor.	
High	**High**		

Table 90. Reproduction risk hypothesis; Chinook salmon, Snake River spring/summer-run ESU and diazinon; Adults

Endpoint: Reproduction

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	1.0	High	**Medium**
Orchards and Vineyards	0.3	High	**High**
Nurseries	0.005	High	**Low**
Bin 3		High	**Medium**
Bin 4		Low	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to the migratory corridor at the confluence of the Snake and Columbia rivers as well as at the confluence of the Yakima and Columbia rivers. All populations of this ESU utilize this migratory corridor.	
High	**High**		

Table 91. Behavior and sensory risk hypothesis; Chinook salmon, Snake River spring/summer-run ESU and diazinon; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.0	High	**Medium**
Orchards and Vineyards	0.3	High	**High**
Nurseries	0.005	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.0	High	**Medium**
Orchards and Vineyards	0.3	High	**High**
Nurseries	0.005	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to the migratory corridor at the confluence of the Snake and Columbia rivers as well as at the confluence of the Yakima and	
High	**High**		

		Columbia rivers. All populations of this ESU utilize this migratory corridor.

Table 92. AChE risk hypothesis; Chinook salmon, Snake River spring/summer-run ESU and diazinon; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.0	High	**Medium**
Orchards and Vineyards	0.3	High	**High**
Nurseries	0.005	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to the migratory corridor at the confluence of the Snake and Columbia rivers as well as at the confluence of the Yakima and Columbia rivers. All populations of this ESU utilize this migratory corridor.	
High	**High**		

Life Stage: Juveniles (full-range)

Table 93. Direct mortality risk hypothesis; Chinook salmon, Snake River spring/summer-run ESU and diazinon; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	1.0	High	Medium
Orchards and Vineyards	0.3	High	High
Nurseries	0.005	High	Low
Bin 3		Low	Medium
Bin 4		Low	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence	High density of orchards and vineyards use sites proximal to the migratory corridor at the confluence of the Snake and Columbia rivers as well as at the confluence of the Yakima and Columbia rivers. All populations of this ESU utilize this migratory corridor.	
High	High		

Table 94. Growth risk hypothesis; Chinook salmon, Snake River spring/summer-run ESU and diazinon; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	1.0	High	Medium
Orchards and Vineyards	0.3	High	High
Nurseries	0.005	High	Low
Bin 3		Low	Medium
Bin 4		Low	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence	High density of orchards and vineyards use sites proximal to the migratory corridor at the confluence of the Snake and Columbia rivers as well as at the confluence of the Yakima and Columbia rivers. All populations of this ESU utilize this migratory corridor.	
High	High		

Table 95. Prey risk hypothesis; Chinook salmon, Snake River spring/summer-run ESU and diazinon; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.0	High	**Medium**
Orchards and Vineyards	0.3	High	**High**
Nurseries	0.005	High	**Low**
Bin 3		High	**Medium**
Bin 4		High	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to the migratory corridor at the confluence of the Snake and Columbia rivers as well as at the confluence of the Yakima and Columbia rivers. All populations of this ESU utilize this migratory corridor.	
High	**High**		

Table 96. AChE risk hypothesis; Chinook salmon, Snake River spring/summer-run ESU and diazinon; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	1.0	High	Medium
Orchards and Vineyards	0.3	High	High
Nurseries	0.005	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence	High density of orchards and vineyards use sites proximal to the migratory corridor at the confluence of the Snake and Columbia rivers as well as at the confluence of the Yakima and Columbia rivers. All populations of this ESU utilize this migratory corridor.	
High	High		

Table 97. Behavior and sensory risk hypothesis; Chinook salmon, Snake River spring/summer-run ESU and diazinon; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.0	High	**Medium**
Orchards and Vineyards	0.3	High	**High**
Nurseries	0.005	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.0	High	**Medium**
Orchards and Vineyards	0.3	High	**High**
Nurseries	0.005	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to the migratory corridor at the	
High	**High**		

		confluence of the Snake and Columbia rivers as well as at the confluence of the Yakima and Columbia rivers. All populations of this ESU utilize this migratory corridor.

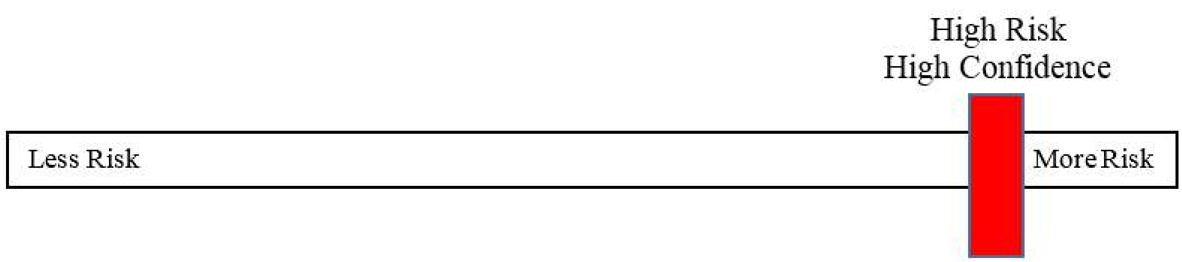
Table 98. Effects analysis summary table: Chinook salmon, Snake River spring/summer-run ESU and diazinon

	R-plot Derived		MagTool	Population Model Results: Chinook Salmon		Risk Hypothesis Supported? Yes/No
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**			
Risk Hypothesis						
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 0-1	Not Applicable		Yes
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable		Yes
Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable		Yes
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	Not Applicable		Yes
	R-plot Derived		**MagTool**	**Population Model Results**		**Risk Hypothesis Supported? Yes/No**
Life Stage: Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities of aquatic bins**			
Risk Hypothesis						
Exposure to diazinon is sufficient to reduce juvenile	High	High	4-day: 0-1	**Ocean-Type Chinook**		Yes
				Portion of juveniles exposed to	Mean percent reduction (STD) in a	

abundance via acute lethality.				diazinon EECs; 100-2000 µg/l / population's intrinsic growth, lambda, from death of juveniles 25% — 0-12% (13-23) 50% — 1-23% (13-26) 75% — 1-35% (13-24) 100% — 1-86% (13-2) **Stream-Type Chinook** Portion of juveniles exposed to diazinon EECs; 100-2000 µg/l / Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles 25% — 0-11% (4-18) 50% — 0-20% (4-21) 75% — 1-31% (4-21) 100% — 1-84% (4-1)	
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**	Yes
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day invert: 1-11	**Ocean-Type Chinook:** 3-24% (8-10)	Yes
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Stream-Type Chinook:** 2-23% (3-5)	Yes
Exposure to diazinon is sufficient to reduce juvenile abundance via	High	High	Not Available	Not Applicable	**Yes**

impairments to ecologically significant behaviors.					

Effects analysis summary: Adult and juvenile Chinook salmon, Snake River spring/summer-run ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to diazinon. Population modelling results indicate that diazinon-induced mortality to juveniles may lead to severe reductions in lambda up to 86%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 0-1 percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, Chinook will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed Chinook. The overall risk to Chinook salmon, Snake River spring/summer-run ESU from the effects of the action is high and the confidence associated with that risk is high. High risk is due, in part, to the proximity of orchards and vineyards use sites to the migratory corridor at the confluence of the Snake and Columbia rivers as well as at the confluence of the Yakima and Columbia rivers. All populations of this ESU utilize this migratory corridor.



13.12 Chinook salmon, Upper Columbia River spring-run ESU (Oncorhynchus tshawytscha)

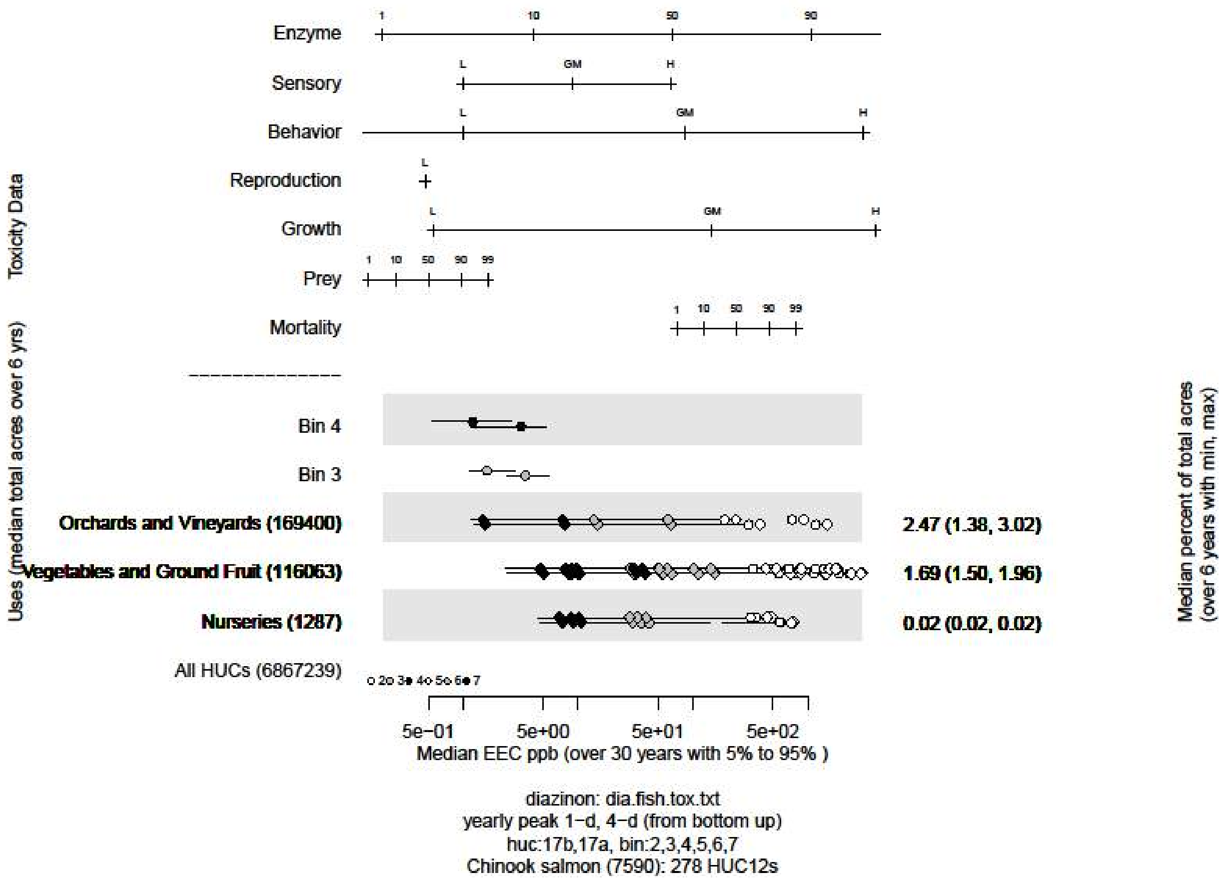


Figure 11. Effects analysis R-plot for Chinook salmon, upper Columbia spring-run ESU and diazinon

Table 99. Likelihood of exposure determination for Chinook salmon, upper Columbia spring-run ESU and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Orchards and Vineyards	2	yes	no	yes	NA	3	**Med**
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	**Med**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	2	yes	no	yes	NA	3	**Med**
Bin 4	2	yes	no	yes	NA	3	**Med**
Juveniles							
Orchards and Vineyards	2	yes	no	yes	NA	3	**Med**
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	**Med**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	2	yes	no	yes	NA	3	**Med**
Bin 4	2	yes	no	yes	NA	3	**Med**

Life Stage: Adults (full-range)

Table 100. Direct mortality risk hypothesis; Chinook salmon, upper Columbia spring-run ESU and diazinon; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.5	High	**Medium**
Vegetables and Ground Fruit	1.7	High	**Medium**
Nurseries	0.02	High	**Low**
Bin 3		Low	**Medium**
Bin 4		Low	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 101. Reproduction risk hypothesis; Chinook salmon, upper Columbia spring-run ESU and diazinon; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.5	High	**Medium**

Vegetables and Ground Fruit	1.7	High	**Medium**
Nurseries	0.02	High	**Low**
Bin 3		High	**Medium**
Bin 4		High	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 102. Behavior and sensory risk hypothesis; Chinook salmon, upper Columbia spring-run ESU and diazinon; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.5	High	**Medium**
Vegetables and Ground Fruit	1.7	High	**Medium**
Nurseries	0.02	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.5	High	**Medium**
Vegetables and Ground Fruit	1.7	High	**Medium**
Nurseries	0.02	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 103. AChE risk hypothesis; Chinook salmon, upper Columbia spring-run ESU and diazinon; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.5	High	**Medium**
Vegetables and Ground Fruit	1.7	High	**Medium**

Nurseries	0.02	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 104. Direct mortality risk hypothesis; Chinook salmon, upper Columbia spring-run ESU and diazinon; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	2.5	High	Medium
Vegetables and Ground Fruit	1.7	High	Medium
Nurseries	0.02	High	Low
Bin 3		Low	Medium
Bin 4		Low	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 105. Growth risk hypothesis; Chinook salmon, upper Columbia spring-run ESU and diazinon; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	2.5	High	Medium
Vegetables and Ground Fruit	1.7	High	Medium
Nurseries	0.02	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 106. Prey risk hypothesis; Chinook salmon, upper Columbia spring-run ESU and diazinon; Juveniles

Endpoint: Prey

Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.5	High	**Medium**
Vegetables and Ground Fruit	1.7	High	**Medium**
Nurseries	0.02	High	**Low**
Bin 3		High	**Medium**
Bin 4		High	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 107. AChE risk hypothesis; Chinook salmon, upper Columbia spring-run ESU and diazinon; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	2.5	High	Medium
Vegetables and Ground Fruit	1.7	High	Medium
Nurseries	0.02	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 108. Behavior and sensory risk hypothesis; Chinook salmon, upper Columbia spring-run ESU and diazinon; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.5	High	**Medium**
Vegetables and Ground Fruit	1.7	High	**Medium**
Nurseries	0.02	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Orchards and Vineyards	2.5	High	**Medium**
Vegetables and Ground Fruit	1.7	High	**Medium**
Nurseries	0.02	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juveniles abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

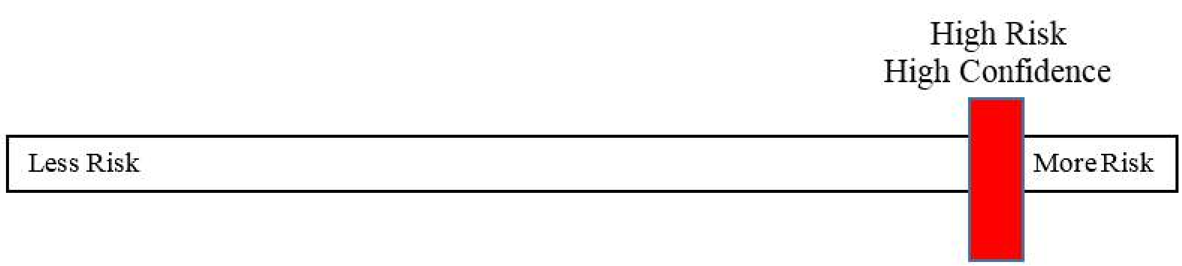
Table 109. Effects analysis summary table: Chinook salmon, upper Columbia spring-run ESU and diazinon

	R-plot Derived		**MagTool**	**Population Model Results: Chinook Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 0-4	Not Applicable	Yes
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable	Yes
Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	Yes
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	Not Applicable	Yes
	R-plot Derived		**MagTool**	**Population Model Results**	**Risk Hypothesis Supported?**
Life Stage: Juveniles	**Risk**	**Confidence**			

			Range in median percent mortalities of aquatic bins			Yes/No
Risk Hypothesis						
Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 0-4	**Ocean-Type Chinook**		Yes
				Portion of juveniles exposed to diazinon EECs; 100-2000 µg/l	Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles	
				25%	0-12% (13-23)	
				50%	1-23% (13-26)	
				75%	1-35% (13-24)	
				100%	1-86% (13-2)	
				Stream-Type Chinook		
				Portion of juveniles exposed to diazinon EECs; 100-2000 µg/l	Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles	
				25%	0-11% (4-18)	
				50%	0-20% (4-21)	
				75%	1-31% (4-21)	
				100%	1-84% (4-1)	
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**		Yes
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day invert: 4-29	**Ocean-Type Chinook:** 3-24% (8-10)		Yes
Exposure to diazinon is sufficient to	High	High	Not Available			Yes

reduce ChE activity; the identified mechanism of toxicity				**Stream-Type Chinook:** 2-23% (3-5)	
Exposure to diazinon is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	**Yes**

Effects analysis summary: Adult and juvenile Chinook salmon, upper Columbia spring-run ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to diazinon. Population modelling results indicate that diazinon-induced mortality to juveniles may lead to severe reductions in lambda up to 86%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 0-4 percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, Chinook will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed Chinook. The overall risk to Chinook salmon, upper Columbia spring-run ESU from the effects of the action is high and the confidence associated with that risk is high.



13.13 Chinook Salmon, Upper Willamette River ESU (Oncorhynchus tshawytscha)

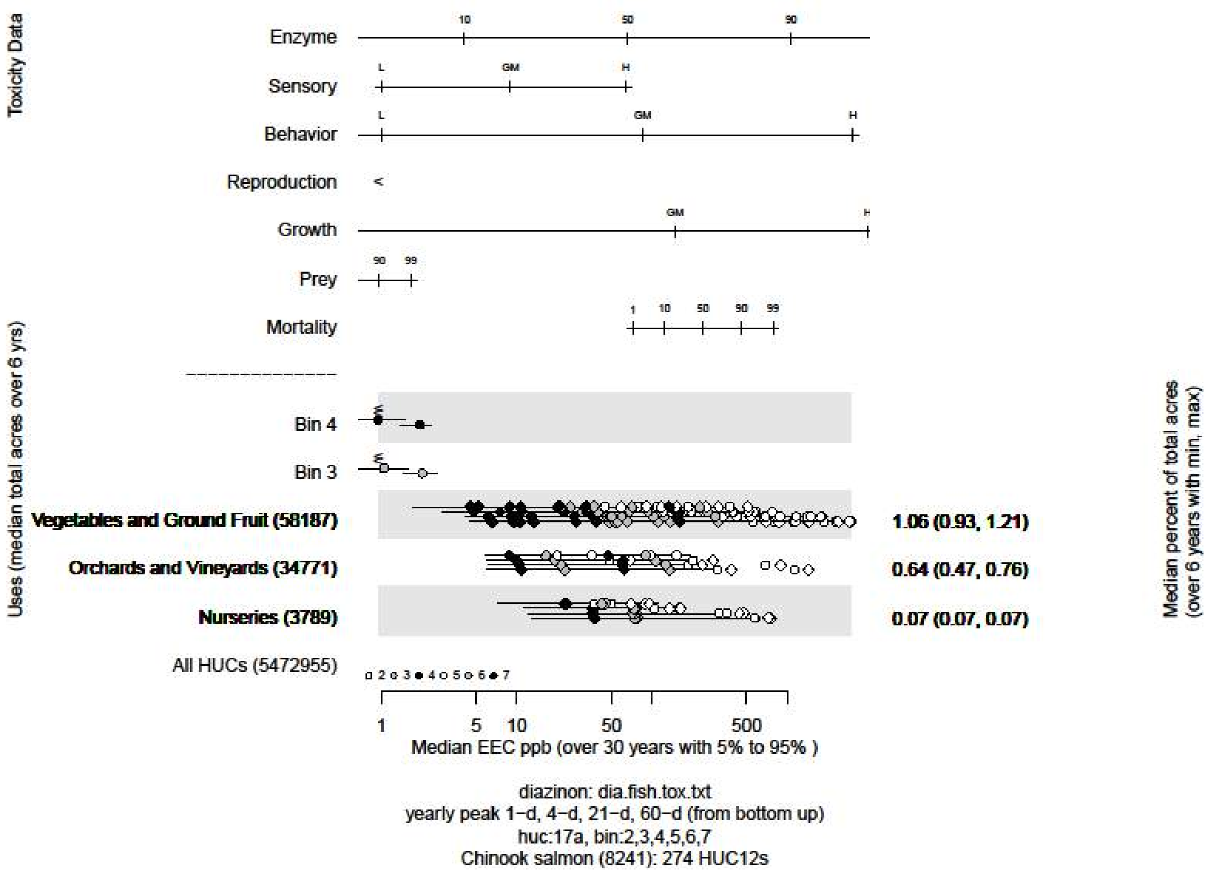


Figure 12. Effects analysis R-plot for Chinook salmon, upper Willamette River ESU and diazinon

Table 110. Likelihood of exposure determination for Chinook salmon, upper Willamette River ESU and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	**Med**
Orchards and Vineyards	1	yes	no	yes	yes	3	**High**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	2	yes	no	yes	NA	3	**Med**
Bin 4	2	yes	no	yes	NA	3	**Med**
Juveniles							
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	**Med**
Orchards and Vineyards	1	yes	no	yes	yes	3	**High**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	2	yes	no	yes	NA	3	**Med**
Bin 4	2	yes	no	yes	NA	3	**Med**

Life Stage: Adults (full-range)

Table 111. Direct mortality risk hypothesis; Chinook salmon, upper Willamette River ESU and diazinon; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.1	High	**Medium**
Orchards and Vineyards	0.6	High	**High**
Nurseries	0.07	High	**Low**
Bin 3		Low	**Medium**
Bin 4		Low	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to spawning streams of the Molalla, North Santiam, McKenzie, and middle-fork Willamette populations. These populations have been determined essential to the recovery of the ESU per the 2011 Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead.	
High	**High**		

Table 112. Reproduction risk hypothesis; Chinook salmon, upper Willamette River ESU and diazinon; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.1	High	**Medium**
Orchards and Vineyards	0.6	High	**High**
Nurseries	0.07	High	**Low**
Bin 3		High	**Medium**
Bin 4		High	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to spawning streams of the Molalla, North Santiam, McKenzie, and middle-fork Willamette populations. These populations have been determined essential to the recovery of the ESU per the 2011 Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead.	
High	**High**		

Table 113. Behavior and sensory risk hypothesis; Chinook salmon, upper Willamette River ESU and diazinon; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.1	High	**Medium**
Orchards and Vineyards	0.6	High	**High**
Nurseries	0.07	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.1	High	**Medium**
Orchards and Vineyards	0.6	High	**High**
Nurseries	0.07	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**

Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.		
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to spawning streams of the Molalla, North Santiam, McKenzie, and middle-fork Willamette populations. These populations have been determined essential to the recovery of the ESU per the 2011 Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead.
High	**High**	

Table 114. AChE risk hypothesis; Chinook salmon, upper Willamette River ESU and diazinon; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.1	High	**Medium**
Orchards and Vineyards	0.6	High	**High**
Nurseries	0.07	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to spawning streams of the Molalla, North Santiam, McKenzie, and middle-fork Willamette populations. These populations have been determined essential to the recovery of the ESU per the 2011 Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead.	
High	**High**		

Life Stage: Juveniles (full-range)

Table 115. Direct mortality risk hypothesis; Chinook salmon, upper Willamette River ESU and diazinon; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	1.1	High	Medium
Orchards and Vineyards	0.6	High	High
Nurseries	0.07	High	Low
Bin 3		Low	Medium

Bin 4		Low	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence	High density of orchards and vineyards use sites proximal to spawning streams of the Molalla, North Santiam, McKenzie, and middle-fork Willamette populations. These populations have been determined essential to the recovery of the ESU per the 2011 Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead.	
High	High		

Table 116. Growth risk hypothesis; Chinook salmon, upper Willamette River ESU and diazinon; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	1.1	High	Medium
Orchards and Vineyards	0.6	High	High
Nurseries	0.07	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence	High density of orchards and vineyards use sites proximal to spawning streams of the Molalla, North Santiam, McKenzie, and middle-fork Willamette populations. These populations have been determined essential to the recovery of the ESU per the 2011 Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead.	
High	High		

Table 117. Prey risk hypothesis; Chinook salmon, upper Willamette River ESU and diazinon; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.1	High	**Medium**
Orchards and Vineyards	0.6	High	**High**
Nurseries	0.07	High	**Low**
Bin 3		High	**Medium**
Bin 4		High	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			

Risk	**Confidence**	High density of orchards and vineyards use sites proximal to spawning streams of the Molalla, North Santiam, McKenzie, and middle-fork Willamette populations. These populations have been determined essential to the recovery of the ESU per the 2011 Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead.
High	**High**	

Table 118. AChE risk hypothesis; Chinook salmon, upper Willamette River ESU and diazinon; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	1.1	High	Medium
Orchards and Vineyards	0.6	High	High
Nurseries	0.07	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence	High density of orchards and vineyards use sites proximal to spawning streams of the Molalla, North Santiam, McKenzie, and middle-fork Willamette populations. These populations have been determined essential to the recovery of the ESU per the 2011 Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead.	
High	High		

Table 119. Behavior and sensory risk hypothesis; Chinook salmon, upper Willamette River ESU and diazinon; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.1	High	**Medium**
Orchards and Vineyards	0.6	High	**High**
Nurseries	0.07	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Vegetables and Ground Fruit	1.1	High	**Medium**
Orchards and Vineyards	0.6	High	**High**
Nurseries	0.07	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to spawning streams of the Molalla, North Santiam, McKenzie, and middle-fork Willamette populations. These populations have been determined essential to the recovery of the ESU per the 2011 Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead.	
High	**High**		

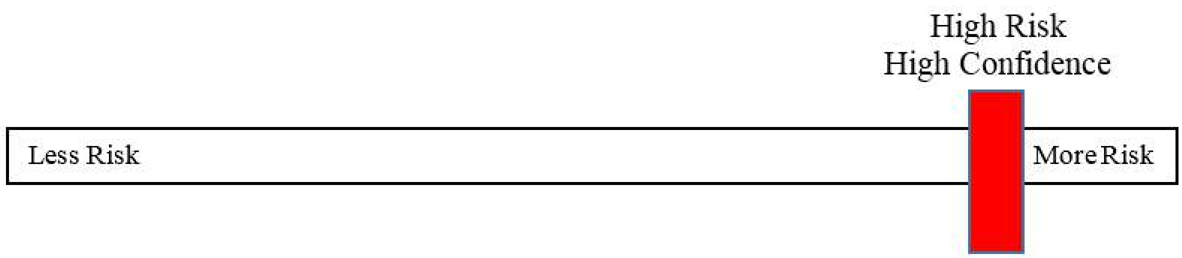
Table 120. Effects analysis summary table: Chinook salmon, upper Willamette River ESU and diazinon

	R-plot Derived		**MagTool**	**Population Model Results: Chinook Salmon**	**Risk Hypothesis Supported?** Yes/No
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 0-2	Not Applicable	Yes
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable	Yes
Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	Yes
Exposure to diazinon is sufficient to	High	High	Not Available	Not Applicable	Yes

reduce ChE activity; the identified mechanism of toxicity					
	R-plot Derived		**MagTool**	**Population Model Results**	**Risk**
Life Stage: Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities of aquatic bins**		**Hypothesis Supported? Yes/No**
Risk Hypothesis					
Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 0-2	**Ocean-Type Chinook** Portion of juveniles exposed to diazinon EECs; 100-2000 µg/l / Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles 25% — 0-12% (13-23) 50% — 1-23% (13-26) 75% — 1-35% (13-24) 100% — 1-86% (13-2) **Stream-Type Chinook** Portion of juveniles exposed to diazinon EECs; 100-2000 µg/l / Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles 25% — 0-11% (4-18) 50% — 0-20% (4-21) 75% — 1-31% (4-21) 100% — 1-84% (4-1)	Yes
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**	Yes
Exposure to diazinon is sufficient to	High	High	4-day invert: 4-29		Yes

reduce Juvenile abundance via reduction in prey availability				**Ocean-Type Chinook:** 3-24% (8-10)	
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Stream-Type Chinook:** 2-23% (3-5)	Yes
Exposure to diazinon is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	**Yes**

Effects analysis summary: Adult and juvenile Chinook salmon, upper Willamette River ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to diazinon. Population modelling results indicate that diazinon-induced mortality to juveniles may lead to severe reductions in lambda up to 86%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 0-4 percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, Chinook will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed Chinook. The overall risk to Chinook salmon, upper Willamette River ESU from the effects of the action is high and the confidence associated with that risk is high. High risk is due to the proximity of orchards and vineyards use sites to spawning streams of the Molalla, North Santiam, McKenzie, and middle-fork Willamette populations. Uses associated with the orchards and vineyards GIS layer are approved for use at times when individuals of these populations are present. These populations have been determined essential to the recovery of the ESU per the 2011 Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead.


High Risk
High Confidence
Less Risk
More Risk

13.14 Coho Salmon, Central California Coast ESU (Oncorhynchus kisutch)

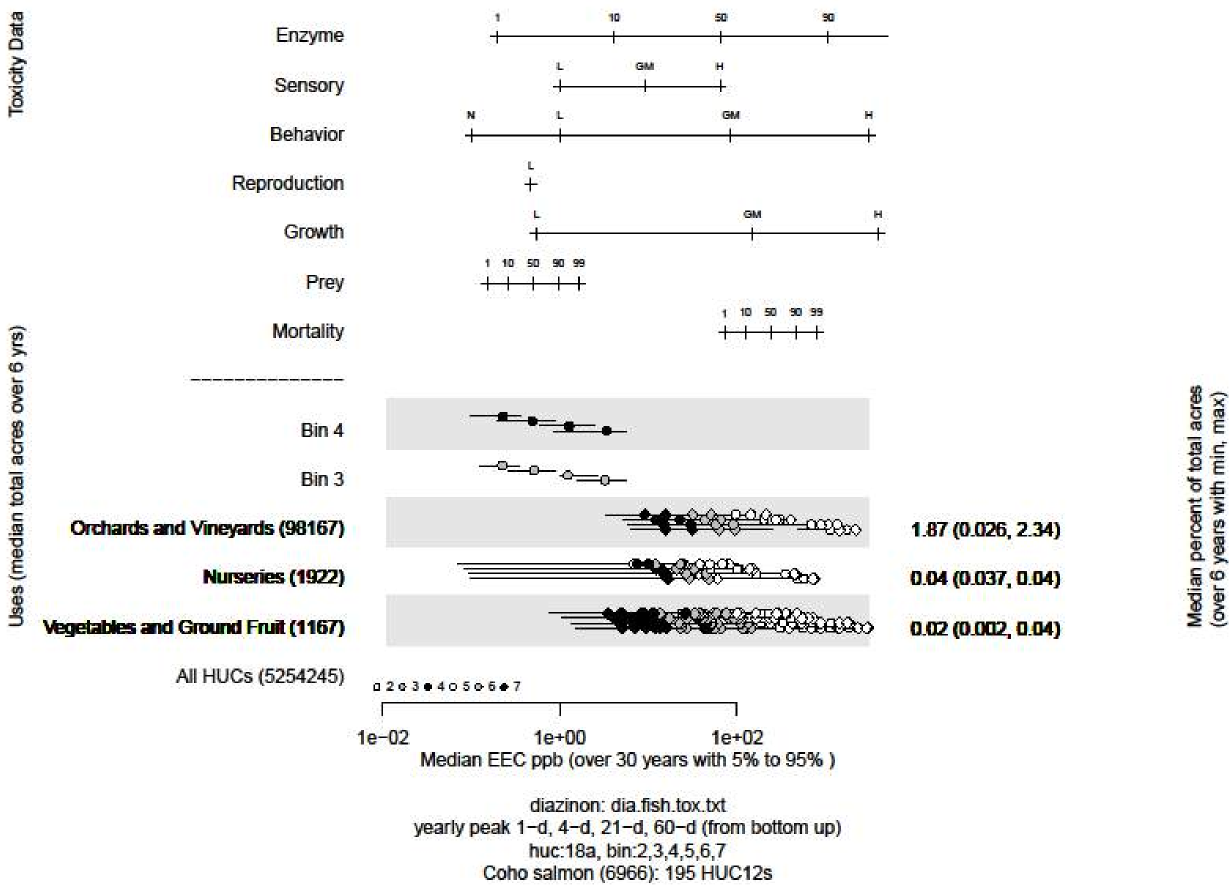


Figure 13. Effects analysis R-plot for Coho salmon, Central California Coast ESU and diazinon

Table 121. Likelihood of exposure determination for Coho salmon, Central California Coast ESU and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Orchards and Vineyards	2	yes	no	yes	NA	3	**Med**
Nurseries	1	yes	no	yes	NA	3	**Low**
Vegetables and ground fruit	1	yes	no	yes	NA	3	**Low**
Bin 3	2	yes	no	yes	NA	3	**Med**
Bin 4	2	yes	no	yes	NA	3	**Med**
Juveniles							
Orchards and Vineyards	2	yes	no	yes	NA	3	**Med**
Nurseries	1	yes	no	yes	NA	3	**Low**
Vegetables and ground fruit	1	yes	no	yes	NA	3	**Low**
Bin 3	2	yes	no	yes	NA	3	**Med**
Bin 4	2	yes	no	yes	NA	3	**Med**

Life Stage: Adults (full-range)

Table 122. Direct mortality risk hypothesis; Coho salmon, Central California Coast ESU and diazinon; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	1.9	High	**Medium**
Nurseries	0.04	High	**Low**
Vegetables and ground fruit	0.02	High	**Low**
Bin 3		Low	**Medium**
Bin 4		Low	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**Medium**		

Table 123. Reproduction risk hypothesis; Coho salmon, Central California Coast ESU and diazinon; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	1.9	High	**Medium**

Nurseries	0.04	High	**Low**
Vegetables and ground fruit	0.02	High	**Low**
Bin 3		High	**Medium**
Bin 4		High	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**Medium**		

Table 124. Behavior and sensory risk hypothesis; Coho salmon, Central California Coast ESU and diazinon; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	1.9	High	**Medium**
Nurseries	0.04	High	**Low**
Vegetables and ground fruit	0.02	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Endpoint: Sensory			**Medium**
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	1.9	High	**Medium**
Nurseries	0.04	High	**Low**
Vegetables and ground fruit	0.02	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**Medium**		

Table 125. AChE risk hypothesis; Coho salmon, Central California Coast ESU and diazinon; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	1.9	High	**Medium**
Nurseries	0.04	High	**Low**

Vegetables and ground fruit	0.02	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Medium**		

Life Stage: Juveniles (full-range)

Table 126. Direct mortality risk hypothesis; Coho salmon, Central California Coast ESU and diazinon; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	1.9	High	Medium
Nurseries	0.04	High	Low
Vegetables and ground fruit	0.02	High	Low
Bin 3		Low	Medium
Bin 4		Low	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	Medium		

Table 127. Growth risk hypothesis; Coho salmon, Central California Coast ESU and diazinon; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	1.9	High	Medium
Nurseries	0.04	Medium	Low
Vegetables and ground fruit	0.02	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	Medium		

Table 128. Prey risk hypothesis; Coho salmon, Central California Coast ESU and diazinon; Juveniles

Endpoint: Prey

Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	1.9	High	**Medium**
Nurseries	0.04	High	**Low**
Vegetables and ground fruit	0.02	High	**Low**
Bin 3		High	**Medium**
Bin 4		High	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**Medium**		

Table 129. AChE risk hypothesis; Coho salmon, Central California Coast ESU and diazinon; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	1.9	High	Medium
Nurseries	0.04	High	Low
Vegetables and ground fruit	0.02	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	Medium		

Table 130. Behavior and sensory risk hypothesis; Coho salmon, Central California Coast ESU and diazinon; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	1.9	High	**Medium**
Nurseries	0.04	High	**Low**
Vegetables and ground fruit	0.02	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Endpoint: Sensory			**Medium**
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Orchards and Vineyards	1.9	High	**Medium**
Nurseries	0.04	High	**Low**
Vegetables and ground fruit	0.02	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**Medium**		

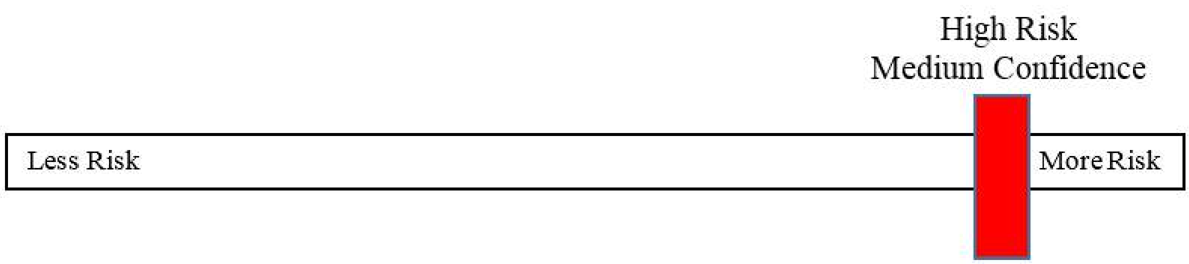
Table 131. Effects analysis summary table: Coho salmon, Central California Coast ESU and diazinon

	R-plot Derived		**MagTool**	**Population Model Results: Coho Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	High	Medium	4-day: 0-2	Not Applicable	Yes
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	High	Medium	Not Available	Not Applicable	Yes
Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	Medium	Not Available	Not Applicable	Yes
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Medium	Not Available	Not Applicable	Yes
	R-plot Derived		**MagTool**	**Population Model Results:**	

<table>
<tr><th>Life Stage: Juveniles</th><th>Risk</th><th>Confidence</th><th>Range in median percent mortalities of aquatic bins</th><th colspan="2">Coho Salmon</th><th>Risk Hypothesis Supported? Yes/No</th></tr>
<tr><td>Risk Hypothesis</td><td></td><td></td><td></td><td colspan="2"></td><td></td></tr>
<tr><td rowspan="5">Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.</td><td rowspan="5">High</td><td rowspan="5">Medium</td><td rowspan="5">4-day: 0-2</td><td>Portion of juveniles exposed to diazinon EECs; 100-2000 µg/l</td><td>Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles</td><td rowspan="5">Yes</td></tr>
<tr><td>25%</td><td>0-14% (7-23)</td></tr>
<tr><td>50%</td><td>1-27% (8-28)</td></tr>
<tr><td>75%</td><td>1-40% (7-26)</td></tr>
<tr><td>100%</td><td>1-92% (7-1)</td></tr>
<tr><td>Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)</td><td>High</td><td>Medium</td><td>Not Available</td><td colspan="2">Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)</td><td>Yes</td></tr>
<tr><td>Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability</td><td>High</td><td>Medium</td><td>4-day invert: 2-17</td><td colspan="2" rowspan="2">3-27% (7-8)</td><td>Yes</td></tr>
<tr><td>Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity</td><td>High</td><td>Medium</td><td>Not Available</td><td>Yes</td></tr>
<tr><td>Exposure to diazinon is sufficient to reduce juvenile abundance via impairments to ecologically</td><td>High</td><td>Medium</td><td>Not Available</td><td colspan="2">Not Applicable</td><td>Yes</td></tr>
</table>

significant behaviors.					

Effects analysis summary: Adult and juvenile Coho salmon, Central California Coast ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to diazinon. Population modelling results indicate that diazinon-induced mortality to juveniles may lead to severe reductions in lambda up to 92%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 0-2 percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, Coho will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed Coho. The overall risk to Coho salmon, Central California Coast ESU from the effects of the action is high and the confidence associated with that risk is medium.



13.15 Coho Salmon, Lower Columbia River ESU (Oncorhynchus kisutch)

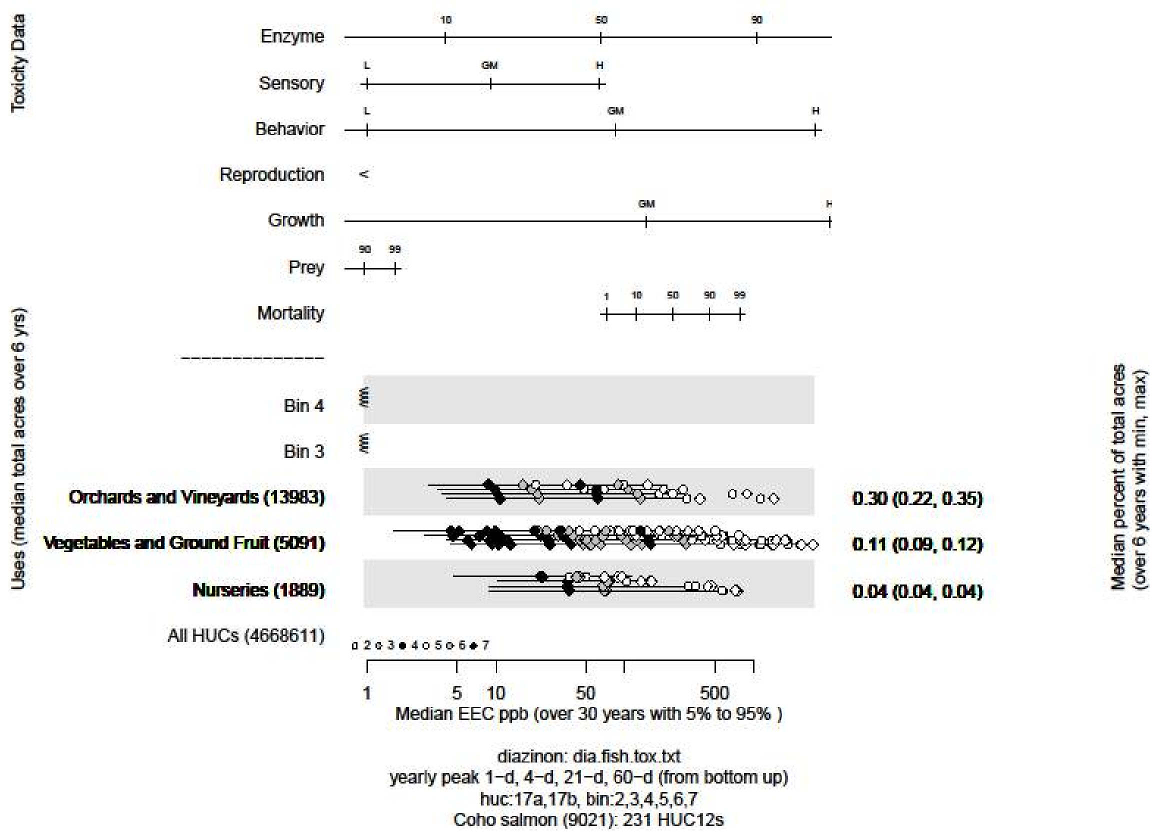


Figure 14. Effects analysis R-plot for Coho salmon, lower Columbia River ESU and diazinon

Table 132. Likelihood of exposure determination for Coho salmon, lower Columbia River ESU and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Orchards and Vineyards	1	yes	no	yes	NA	3	**Low**
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	**Low**
Nurseries	1	yes	no	yes	NA	3	**Low**
Bin 3	1	yes	no	yes	NA	3	**Low**
Bin 4	1	yes	no	yes	NA	3	**Low**
Juveniles							
Orchards and Vineyards	1	yes	no	yes	NA	3	**Low**
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	**Low**
Nurseries	1	yes	no	yes	NA	3	**Low**
Bin 3	1	yes	no	yes	NA	3	**Low**
Bin 4	1	yes	no	yes	NA	3	**Low**

Life Stage: Adults (full-range)

Table 133. Direct mortality risk hypothesis; Coho salmon, lower Columbia River ESU and diazinon; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.3	High	**Low**
Vegetables and Ground Fruit	0.1	High	**Low**
Nurseries	0.04	High	**Low**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**High**		

Table 134. Reproduction risk hypothesis; Coho salmon, lower Columbia River ESU and diazinon; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.3	High	**Low**
Vegetables and Ground Fruit	0.1	High	**Low**

Nurseries	0.04	High	**Low**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**High**		

Table 135. Behavior and sensory risk hypothesis; Coho salmon, lower Columbia River ESU and diazinon; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.3	High	**Low**
Vegetables and Ground Fruit	0.1	High	**Low**
Nurseries	0.04	High	**Low**
Bin 3		Medium	**Low**
Bin 4		Medium	**Low**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.3	High	**Low**
Vegetables and Ground Fruit	0.1	High	**Low**
Nurseries	0.04	High	**Low**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
Low	**High**		

Table 136. AChE risk hypothesis; Coho salmon, lower Columbia River ESU and diazinon; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.3	High	**Low**
Vegetables and Ground Fruit	0.1	High	**Low**
Nurseries	0.04	High	**Low**
Bin 3		Medium	**Low**

Bin 4		Medium	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**High**		

Life Stage: Juveniles (full-range)

Table 137. Direct mortality risk hypothesis; Coho salmon, lower Columbia River ESU and diazinon; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	0.3	High	Low
Vegetables and Ground Fruit	0.1	High	Low
Nurseries	0.04	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
Low	High		

Table 138. Growth risk hypothesis; Coho salmon, lower Columbia River ESU and diazinon; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	0.3	High	Low
Vegetables and Ground Fruit	0.1	High	Low
Nurseries	0.04	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
Low	High		

Table 139. Prey risk hypothesis; Coho salmon, lower Columbia River ESU and diazinon; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Orchards and Vineyards	0.3	High	**Low**
Vegetables and Ground Fruit	0.1	High	**Low**
Nurseries	0.04	High	**Low**
Bin 3		Medium	**Low**
Bin 4		Medium	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	**High**		

Table 140. AChE risk hypothesis; Coho salmon, lower Columbia River ESU and diazinon; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	0.3	High	Low
Vegetables and Ground Fruit	0.1	High	Low
Nurseries	0.04	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
Low	High		

Table 141. Behavior and sensory risk hypothesis; Coho salmon, lower Columbia River ESU and diazinon; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.3	High	**Low**
Vegetables and Ground Fruit	0.1	High	**Low**
Nurseries	0.04	High	**Low**
Bin 3		Medium	**Low**
Bin 4		Medium	**Low**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.3	High	**Low**

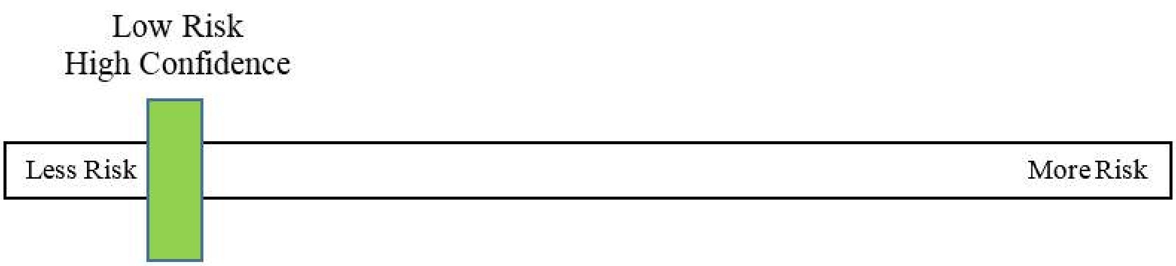
Vegetables and Ground Fruit	0.1	High	**Low**
Nurseries	0.04	High	**Low**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
Low	**High**		

Table 142. Effects analysis summary table: Coho salmon, lower Columbia River ESU and diazinon

	R-plot Derived		**MagTool**	**Population Model Results: Coho Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	Low	High	4-day: 0	Not Applicable	No
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Low	High	Not Available	Not Applicable	No
Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	Low	High	Not Available	Not Applicable	No
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	High	Not Available	Not Applicable	No
	R-plot Derived		**MagTool**	**Population Model Results: Coho Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities of aquatic bins**		

Risk Hypothesis						
Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.	Low	High	4-day: 0	Portion of juveniles exposed to diazinon EECs; 100-2000 µg/l	Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles	No
				25%	0-14% (7-23)	
				50%	1-27% (8-28)	
				75%	1-40% (7-26)	
				100%	1-92% (7-1)	
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	Low	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**		No
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	Low	High	4-day invert: 0-5	3-27% (7-8)		No
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	High	Not Available			No
Exposure to diazinon is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	Low	High	Not Available	Not Applicable		No

Effects analysis summary: Adult and juvenile Coho salmon, lower Columbia River ESU are not anticipated to experience significant reductions in abundance or productivity (spawning adults) from exposure to diazinon. Population modelling results indicate that diazinon-induced mortality to juveniles may lead to severe reductions in lambda up to 92%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that 0 percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, Coho may experience increased toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed Coho. The overall risk to Coho salmon, lower Columbia River ESU from the effects of the action is low and the confidence associated with that risk is high. Low risk is attributed primarily to the lack of diazinon use sites proximal to the species habitat.



13.16 Coho Salmon, Oregon Coast ESU (Oncorhynchus kisutch)

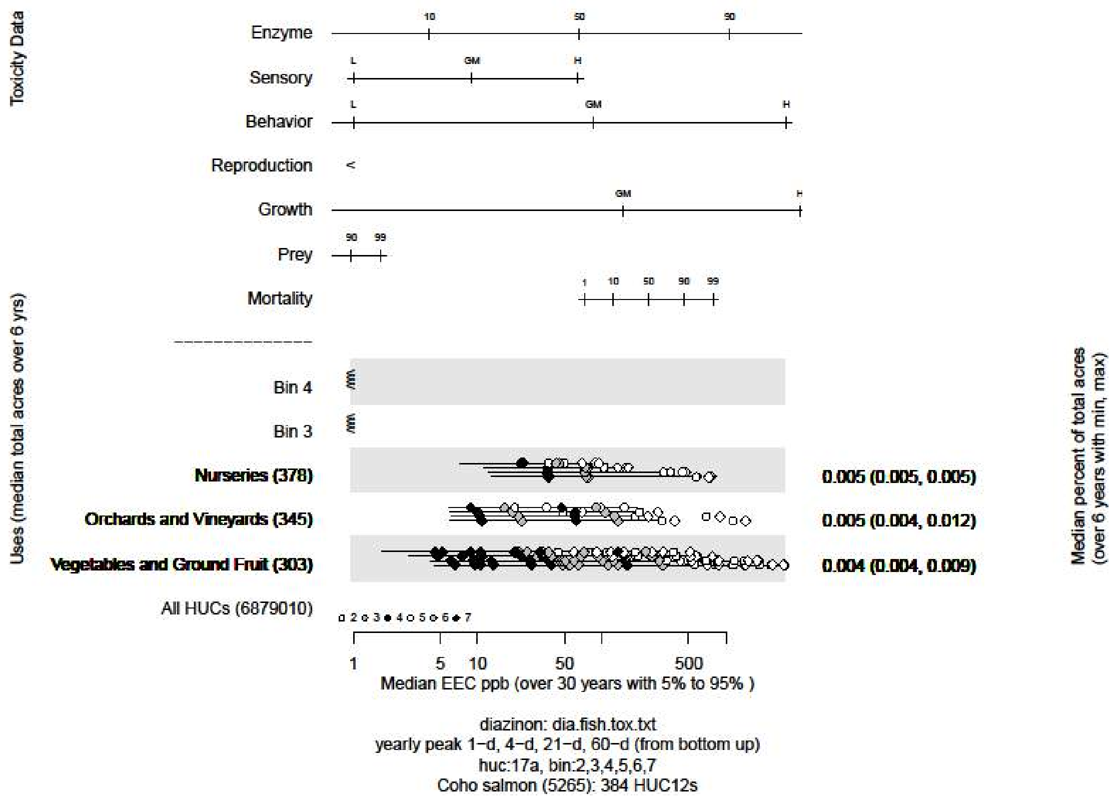


Figure 15. Effects analysis R-plot for Coho salmon, Oregon coast ESU and diazinon

Table 143. Likelihood of exposure determination for Coho salmon, Oregon coast ESU and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Nurseries	1	yes	no	yes	NA	3	**Low**
Orchards and Vineyards	1	yes	no	yes	NA	3	**Low**
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	**Low**
Bin 3	1	yes	no	yes	NA	3	**Low**
Bin 4	1	yes	no	yes	NA	3	**Low**
Juveniles							
Nurseries	1	yes	no	yes	NA	3	**Low**
Orchards and Vineyards	1	yes	no	yes	NA	3	**Low**
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	**Low**
Bin 3	1	yes	no	yes	NA	3	**Low**
Bin 4	1	yes	no	yes	NA	3	**Low**

Life Stage: Adults (full-range)

Table 144. Direct mortality risk hypothesis; Coho salmon, Oregon coast ESU and diazinon; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Nurseries	0.005	High	Low
Orchards and Vineyards	0.005	High	Low
Vegetables and Ground Fruit	0.005	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**High**		

Table 145. Reproduction risk hypothesis; Coho salmon, Oregon coast ESU and diazinon; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Nurseries	0.005	High	Low
Orchards and Vineyards	0.005	High	Low
Vegetables and Ground Fruit	0.005	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**High**		

Table 146. Behavior and sensory risk hypothesis; Coho salmon, Oregon coast ESU and diazinon; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Nurseries	0.005	High	Low
Orchards and Vineyards	0.005	High	Low
Vegetables and Ground Fruit	0.005	High	Low
Bin 3		Low	Low
Bin 4		Low	Low

Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Nurseries	0.005	High	Low
Orchards and Vineyards	0.005	High	Low
Vegetables and Ground Fruit	0.005	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
Low	**High**		

Table 147. AChE risk hypothesis; Coho salmon, Oregon coast ESU and diazinon; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Nurseries	0.005	High	Low
Orchards and Vineyards	0.005	High	Low
Vegetables and Ground Fruit	0.005	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**High**		

Life Stage: Juveniles (full-range)

Table 148. Direct mortality risk hypothesis; Coho salmon, Oregon coast ESU and diazinon; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Nurseries	0.005	High	Low
Orchards and Vineyards	0.005	High	Low
Vegetables and Ground Fruit	0.005	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			

Risk	Confidence	
Low	High	

Table 149. Growth risk hypothesis; Coho salmon, Oregon coast ESU and diazinon; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Nurseries	0.005	High	Low
Orchards and Vineyards	0.005	High	Low
Vegetables and Ground Fruit	0.005	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
Low	High		

Table 150. Prey risk hypothesis; Coho salmon, Oregon coast ESU and diazinon; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Nurseries	0.005	High	Low
Orchards and Vineyards	0.005	High	Low
Vegetables and Ground Fruit	0.005	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	**High**		

Table 151. AChE risk hypothesis; Coho salmon, Oregon coast ESU and diazinon; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Nurseries	0.005	High	Low
Orchards and Vineyards	0.005	High	Low
Vegetables and Ground Fruit	0.005	High	Low
Bin 3		Low	Low

Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
Low	High		

Table 152. Behavior and sensory risk hypothesis; Coho salmon, Oregon coast ESU and diazinon; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Nurseries	0.005	High	Low
Orchards and Vineyards	0.005	High	Low
Vegetables and Ground Fruit	0.005	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Nurseries	0.005	High	Low
Orchards and Vineyards	0.005	High	Low
Vegetables and Ground Fruit	0.005	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
Low	**High**		

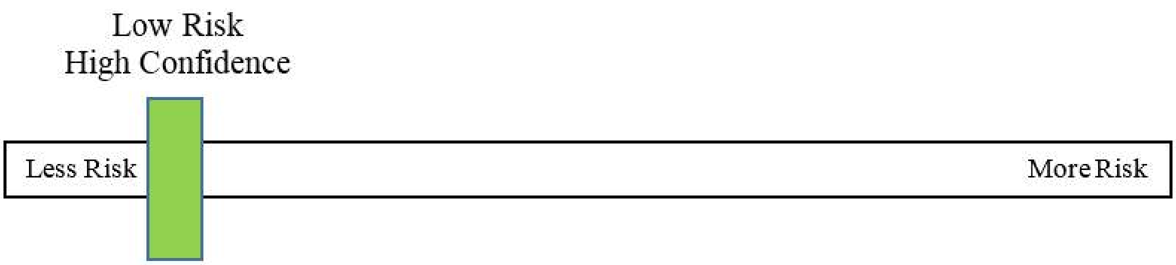
Table 153. Effects analysis summary table: Coho salmon, Oregon coast ESU and diazinon

	R-plot Derived		**MagTool**	**Population Model Results: Coho Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	Low	High	4-day: 0	Not Applicable	No

Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Low	High	Not Available	Not Applicable	No
Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	Low	High	Not Available	Not Applicable	No
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	High	Not Available	Not Applicable	No
	R-plot Derived		**MagTool**	**Population Model Results: Coho Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities of aquatic bins**		
Risk Hypothesis					
Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.	Low	High	4-day: 0	Portion of juveniles exposed to diazinon EECs; 100-2000 µg/l / Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles: 25% — 0-14% (7-23) 50% — 1-27% (8-28) 75% — 1-40% (7-26) 100% — 1-92% (7-1)	No

Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	Low	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**	No
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	Low	High	4-day invert: 0	3-27% (7-8)	No
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	High	Not Available		No
Exposure to diazinon is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	Low	High	Not Available	Not Applicable	No

Effects analysis summary: Adult and juvenile Coho salmon, Oregon Coast ESU are not anticipated to experience significant reductions in abundance or productivity (spawning adults) from exposure to diazinon. Population modelling results indicate that diazinon-induced mortality to juveniles may lead to severe reductions in lambda up to 92%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that 0 percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, Coho may experience increased toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed Coho. The overall risk to Coho salmon, Oregon Coast ESU from the effects of the action is low and the confidence associated with that risk is high. Low risk is attributed primarily to the lack of diazinon use sites proximal to the species habitat.


Low Risk
High Confidence
Less Risk
More Risk

13.17 Coho Salmon, Southern Oregon/Northern California Coast ESU (Oncorhynchus kisutch)

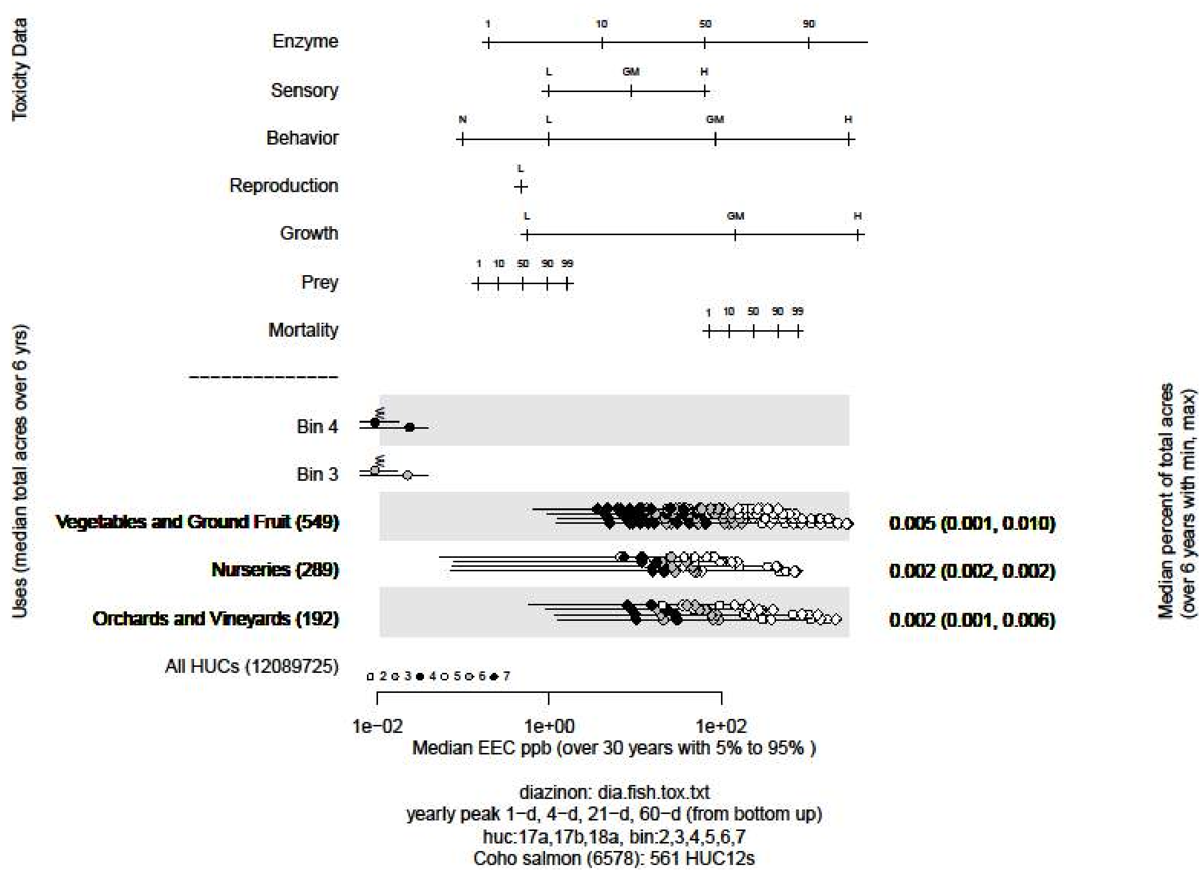


Figure 16. Effects analysis R-plot for Coho salmon, southern Oregon/northern California coast ESU and diazinon

Table 154. Likelihood of exposure determination for Coho salmon, southern Oregon/northern California coast ESU and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Vegetables and Ground Fruit	1	yes	no	yes	no	3	Low
Nurseries	1	yes	no	yes	no	3	Low
Orchards and Vineyards	1	yes	no	yes	no	3	Low
Bin 3	1	yes	no	yes	NA	3	Low
Bin 4	1	yes	no	yes	NA	3	Low
Juveniles							
Vegetables and Ground Fruit	1	yes	no	yes	no	3	Low
Nurseries	1	yes	no	yes	no	3	Low
Orchards and Vineyards	1	yes	no	yes	no	3	Low
Bin 3	1	yes	no	yes	NA	3	Low
Bin 4	1	yes	no	yes	NA	3	Low

Life Stage: Adults (full-range)

Table 155. Direct mortality risk hypothesis; Coho salmon, southern Oregon/northern California coast ESU and diazinon; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.005	High	Low
Nurseries	0.002	High	Low
Orchards and Vineyards	0.002	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**High**		

Table 156. Reproduction risk hypothesis; Coho salmon, southern Oregon/northern California coast ESU and diazinon; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Vegetables and Ground Fruit	0.005	High	Low
Nurseries	0.002	High	Low
Orchards and Vineyards	0.002	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**High**		

Table 157. Behavior and sensory risk hypothesis; Coho salmon, southern Oregon/northern California coast ESU and diazinon; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.005	High	Low
Nurseries	0.002	High	Low
Orchards and Vineyards	0.002	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.005	High	Low
Nurseries	0.002	High	Low
Orchards and Vineyards	0.002	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
Low	**High**		

Table 158. AChE risk hypothesis; Coho salmon, southern Oregon/northern California coast ESU and diazinon; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Vegetables and Ground Fruit	0.005	High	Low
Nurseries	0.002	High	Low
Orchards and Vineyards	0.002	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**High**		

Life Stage: Juveniles (full-range)

Table 159. Direct mortality risk hypothesis; Coho salmon, southern Oregon/northern California coast ESU and diazinon; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	0.005	High	Low
Nurseries	0.002	High	Low
Orchards and Vineyards	0.002	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
Low	High		

Table 160. Growth risk hypothesis; Coho salmon, southern Oregon/northern California coast ESU and diazinon; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	0.005	High	Low
Nurseries	0.002	High	Low
Orchards and Vineyards	0.002	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
Low	High		

Table 161. Prey risk hypothesis; Coho salmon, southern Oregon/northern California coast ESU and diazinon; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.005	High	Low
Nurseries	0.002	High	Low
Orchards and Vineyards	0.002	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	**High**		

Table 162. AChE risk hypothesis; Coho salmon, southern Oregon/northern California coast ESU and diazinon; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	0.005	High	Low
Nurseries	0.002	High	Low
Orchards and Vineyards	0.002	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
Low	High		

Table 163. Behavior and sensory risk hypothesis; Coho salmon, southern Oregon/northern California coast ESU and diazinon; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.005	High	Low
Nurseries	0.002	High	Low

Orchards and Vineyards	0.002	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.005	High	Low
Nurseries	0.002	High	Low
Orchards and Vineyards	0.002	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
Low	**High**		

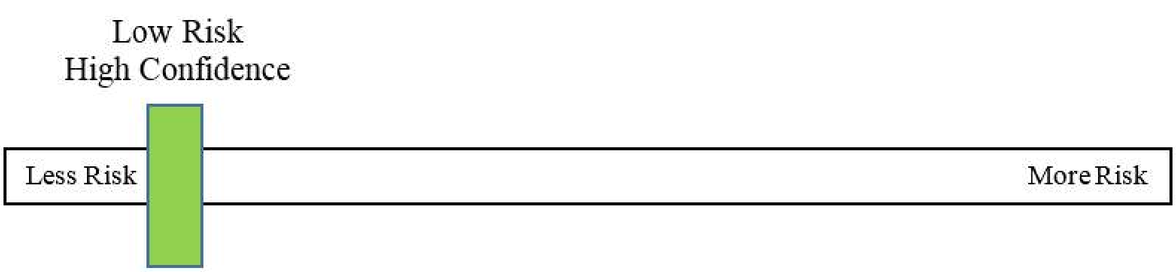
Table 164. Effects analysis summary table: Coho salmon, southern Oregon/northern California coast ESU and diazinon

	R-plot Derived		**MagTool**	**Population Model Results: Coho Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	Low	High	4-day: 0	Not Applicable	No
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Low	High	Not Available	Not Applicable	No
Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	Low	High	Not Available	Not Applicable	No

Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	High	Not Available	Not Applicable	No
	R-plot Derived		**MagTool**	**Population Model Results: Coho Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities of aquatic bins**		
Risk Hypothesis					
Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.	Low	High	4-day: 0	Portion of juveniles exposed to diazinon EECs; 100-2000 µg/l / Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles 25% / 0-14% (7-23) 50% / 1-27% (8-28) 75% / 1-40% (7-26) 100% / 1-92% (7-1)	No
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	Low	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**	No
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	Low	High	4-day invert: 0	3-27% (7-8)	No
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	High	Not Available		No

Exposure to diazinon is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	Low	High	Not Available	Not Applicable	No

Effects analysis summary: Adult and juvenile Coho salmon, southern Oregon/northern California Coast ESU are not anticipated to experience significant reductions in abundance or productivity (spawning adults) from exposure to diazinon. Population modelling results indicate that diazinon-induced mortality to juveniles may lead to severe reductions in lambda up to 92%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate 0 percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, Coho may experience increased toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed Coho. The overall risk to Coho salmon, southern Oregon/northern California Coast ESU from the effects of the action is low and the confidence associated with that risk is high. Low risk is attributed primarily to the lack of diazinon use sites proximal to the species habitat.



13.18 Sockeye Salmon, Ozette Lake ESU (Oncorhynchus nerka)

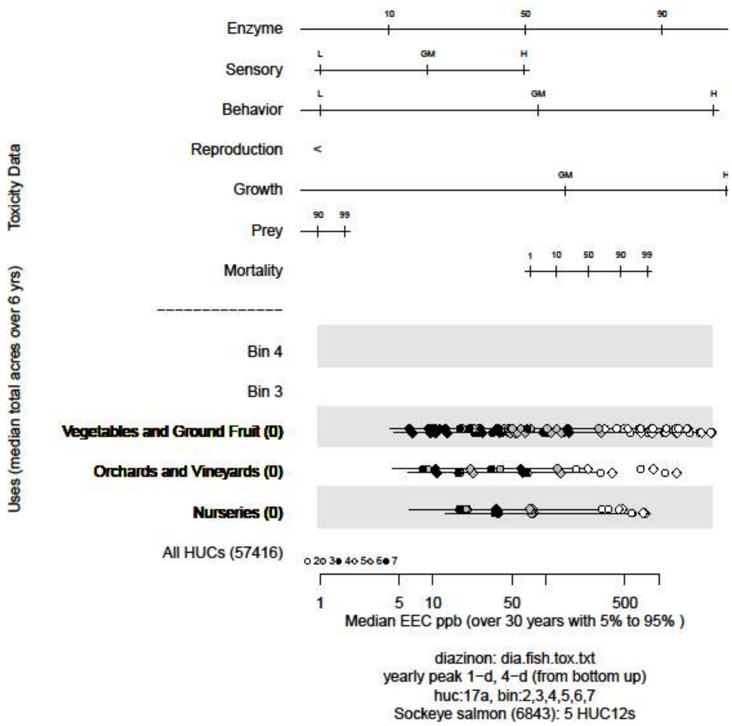


Figure 17. Effects analysis R-plot for Sockeye salmon, Ozette Lake ESU and diazinon

Table 165. Likelihood of exposure determination for Sockeye salmon, Ozette Lake ESU and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Vegetables & Ground	1	yes	no	yes	no	2	Low
Orchards and Vineyards	1	yes	no	yes	no	2	Low
Nurseries	1	yes	no	yes	no	2	Low
Bin 3	1	yes	no	yes	no	2	Low
Bin 4	1	yes	no	yes	no	2	Low
Juveniles							
Vegetables & Ground	1	yes	no	yes	no	3	Low
Orchards and Vineyards	1	yes	no	yes	no	3	Low
Nurseries	1	yes	no	yes	no	3	Low
Bin 3	1	yes	no	yes	no	3	Low
Bin 4	1	yes	no	yes	no	3	Low

Life Stage: Adults (full-range)

Table 166. Direct mortality risk hypothesis; Sockeye salmon, Ozette Lake ESU and diazinon; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables & Ground	<1	High	Low
Orchards and Vineyards	<1	High	Low
Nurseries	<1	High	Low
Bin 3		High	Low
Bin 4		High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**High**		

Table 167. Reproduction risk hypothesis; Sockeye salmon, Ozette Lake ESU and diazinon; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables & Ground	<1	High	Low
Orchards and Vineyards	<1	High	Low
Nurseries	<1	High	Low
Bin 3		High	Low
Bin 4		High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**High**		

Table 168. Behavior and sensory risk hypothesis; Sockeye salmon, Ozette Lake ESU and diazinon; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables & Ground	<1	High	Low
Orchards and Vineyards	<1	High	Low
Nurseries	<1	High	Low
Bin 3		High	Low
Bin 4		High	Low
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables & Ground	<1	High	Low

Orchards and Vineyards	<1	High	Low
Nurseries	<1	High	Low
Bin 3		High	Low
Bin 4		High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
Low	**High**		

Table 169. AChE risk hypothesis; Sockeye salmon, Ozette Lake ESU and diazinon; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables & Ground	<1	High	Low
Orchards and Vineyards	<1	High	Low
Nurseries	<1	High	Low
Bin 3		High	Low
Bin 4		High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**High**		

Life Stage: Juveniles (full-range)

Table 170. Direct mortality risk hypothesis; Sockeye salmon, Ozette Lake ESU and diazinon; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables & Ground	<1	High	Low
Orchards and Vineyards	<1	High	Low
Nurseries	<1	High	Low
Bin 3		High	Low
Bin 4		High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
Low	High		

Table 171. Growth risk hypothesis; Sockeye salmon, Ozette Lake ESU and diazinon; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure

Vegetables & Ground	<1	High	Low
Orchards and Vineyards	<1	High	Low
Nurseries	<1	High	Low
Bin 3		High	Low
Bin 4		High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
Low	High		

Table 172. Prey risk hypothesis; Sockeye salmon, Ozette Lake ESU and diazinon; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables & Ground	<1	High	Low
Orchards and Vineyards	<1	High	Low
Nurseries	<1	High	Low
Bin 3		High	Low
Bin 4		High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	**High**		

Table 173. AChE risk hypothesis; Sockeye salmon, Ozette Lake ESU and diazinon; Juveniles

Endpoint: Enzyme			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables & Ground	<1	High	Low
Orchards and Vineyards	<1	High	Low
Nurseries	<1	High	Low
Bin 3		High	Low
Bin 4		High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
Low	High		

Table 174. Behavior and sensory risk hypothesis; Sockeye salmon, Ozette Lake ESU and diazinon; Juveniles

Endpoint: Behavior

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables & Ground	<1	High	Low
Orchards and Vineyards	<1	High	Low
Nurseries	<1	High	Low
Bin 3		High	Low
Bin 4		High	Low
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables & Ground	<1	High	Low
Orchards and Vineyards	<1	High	Low
Nurseries	<1	High	Low
Bin 3		High	Low
Bin 4		High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
Low	**High**		

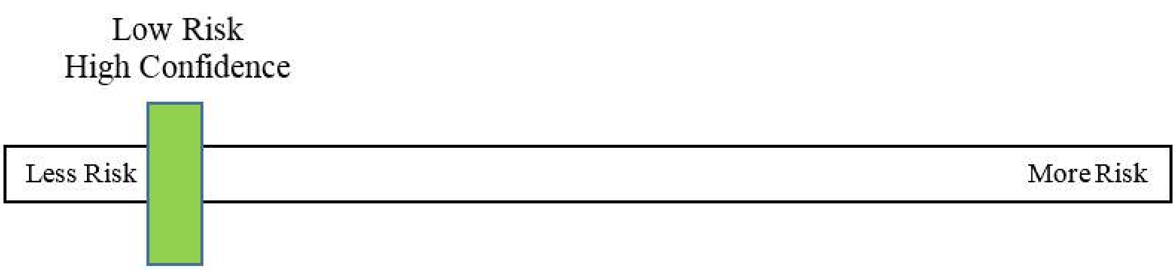
Table 175. Effects analysis summary table: Sockeye salmon, Ozette Lake ESU and diazinon

	R-plot Derived		MagTool	Population Model Results: Sockeye Salmon	Risk Hypothesis Supported? Yes/No
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	Low	High	4-day: 0	Not Applicable	No
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Low	High	Not Available	Not Applicable	No
Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically	Low	High	Not Available	Not Applicable	No

significant behaviors.						
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	High	Not Available	Not Applicable		No
	R-plot Derived		**MagTool Range in median percent mortalities of aquatic bins**	**Population Model Results: Sockeye Salmon**		**Risk Hypothesis Supported? Yes/No**
Life Stage: Juveniles	**Risk**	**Confidence**				
Risk Hypothesis						
Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.	Low	High	4-day: 0	Portion of juveniles exposed to diazinon EECs; 100-2000 µg/l	Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles	No
				25%	0-10% (8-19)	
				50%	1-19% (8-21)	
				75%	1-29% (8-21)	
				100%	1-83% (8-1)	
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	Low	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**		No
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	Low	High	4-day invert: 0	2-23% (4-6)		No
Exposure to diazinon is sufficient to reduce ChE activity; the identified	Low	High	Not Available			No

mechanism of toxicity					
Exposure to diazinon is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	Low	High	Not Available	Not Applicable	No

Effects analysis summary: Adult and juvenile Sockeye salmon, Ozette Lake ESU are not anticipated to experience significant reductions in abundance or productivity (spawning adults) from exposure to diazinon. Population modelling results indicate that diazinon-induced mortality to juveniles may lead to severe reductions in lambda up to 83%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that 0 percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, Sockeye may experience increased toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed Sockeye. The overall risk to Sockeye salmon, Ozette Lake ESU from the effects of the action is low and the confidence associated with that risk is high. Low risk is attributed primarily to the lack of diazinon use sites proximal to the species habitat.



13.19 Sockeye Salmon, Snake River ESU (Oncorhynchus nerka)

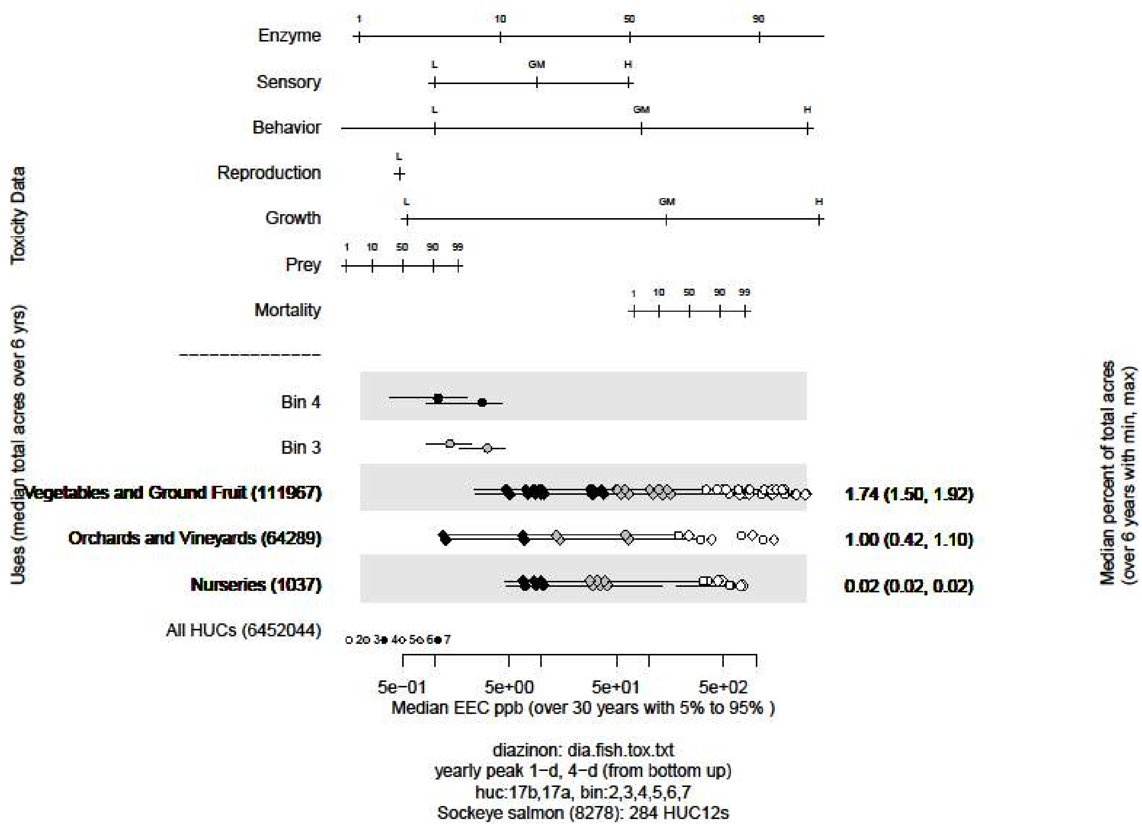


Figure 18. Effects analysis R-plot for Sockeye salmon, Snake River ESU and diazinon; full range

Table 176. Likelihood of exposure determination for Sockeye salmon, Snake River ESU and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Vegetables & Ground Fruit	2	yes	no	yes	NA	3	**Med**
Orchards and Vineyards	2	yes	no	yes	Na	3	**Med**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	3	yes	no	yes	NA	3	**High**
Bin 4	3	yes	no	yes	NA	3	**High**

Life Stage: Juvenile and adult migration (full-range)

Table 177. Direct mortality risk hypothesis; Sockeye salmon, Snake River ESU and diazinon; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables & Ground Fruit	2	High	Medium
Orchards and Vineyards	1	High	Medium
Nurseries	<1	High	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via acute lethality.			
Risk	**Confidence**		
High	**Medium**		

Table 178. Prey risk hypothesis; Sockeye salmon, Snake River ESU and diazinon; Adults

Endpoint: Prey (juveniles)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables & Ground Fruit	2	High	Medium
Orchards and Vineyards	1	High	Medium
Nurseries	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**Medium**		

Table 179. Behavior and sensory risk hypothesis; Sockeye salmon, Snake River ESU and diazinon; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables & Ground Fruit	2	High	Medium
Orchards and Vineyards	1	High	Medium
Nurseries	<1	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables & Ground Fruit	2	High	Medium
Orchards and Vineyards	1	High	Medium
Nurseries	<1	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**Medium**		

Table 180. AChE risk hypothesis; Sockeye salmon, Snake River ESU and diazinon; Adults

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables & Ground Fruit	2	High	Medium
Orchards and Vineyards	1	High	Medium
Nurseries	<1	High	Low

Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Medium**		

Table 181. Growth risk hypothesis; Sockeye salmon, Snake River ESU and diazinon; Adults

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables & Ground Fruit	2	High	Medium
Orchards and Vineyards	1	High	Medium
Nurseries	<1	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
High	**Medium**		

Life Stage: Juvenile rearing and adult spawning (Sawtooth Lakes)

There are no diazinon use sites within the portion of the species range associated with juvenile rearing and adult spawning (Redfish Lake; Sawtooth Lakes, Idaho).

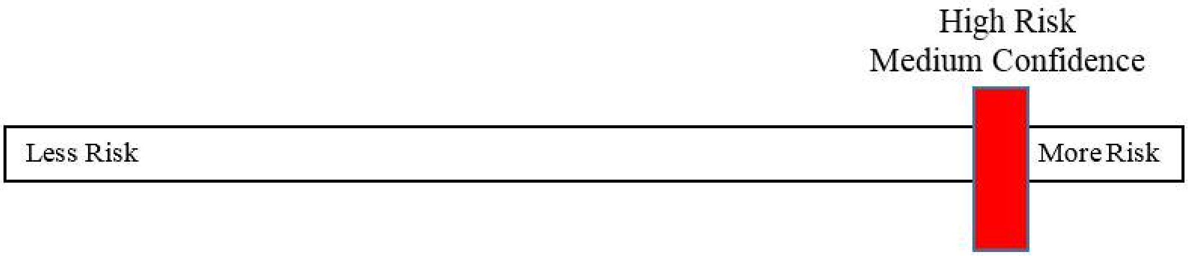
Table 182. Effects analysis summary table: Sockeye salmon, Snake River ESU and diazinon

	R-plot Derived	**MagTool**	**Population Model Results: Sockeye Salmon**	

Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**			**Risk Hypothesis Supported? Yes/No**
Risk Hypothesis						
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	High	Medium	4-day: 0-3	Not Applicable		Yes
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	High	Medium	Not Available	Not Applicable		Yes
Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	Medium	Not Available	Not Applicable		Yes
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Medium	Not Available	Not Applicable		Yes
	R-plot Derived		**MagTool**	**Population Model Results: Sockeye Salmon**		**Risk Hypothesis Supported? Yes/No**
Life Stage: Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities of aquatic bins**			
Risk Hypothesis						
Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.	Low	High	4-day: 0-3	Portion of juveniles exposed to diazinon EECs; 100-2000 µg/l	Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles	No
				25%	0-10% (8-19)	

				50% 1-19% (8-21) 75% 1-29% (8-21) 100% 1-83% (8-1)	
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	Low	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**	No
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	Low	High	4-day invert: 3-18	2-23% (4-6)	No
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	High	Not Available		No
Exposure to diazinon is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	Low	High	Not Available	Not Applicable	No

Effects analysis summary: Adult and juvenile Sockeye salmon, Snake River ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to diazinon. Population modelling results indicate that diazinon-induced mortality to juveniles may lead to severe reductions in lambda up to 93%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 0-3 percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, sockeye will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed sockeye. The overall risk to Sockeye salmon, Snake River ESU from the effects of the action is high and the confidence associated with that risk is medium.



13.20 Steelhead, California Central Valley DPS (Oncorhynchus mykiss)

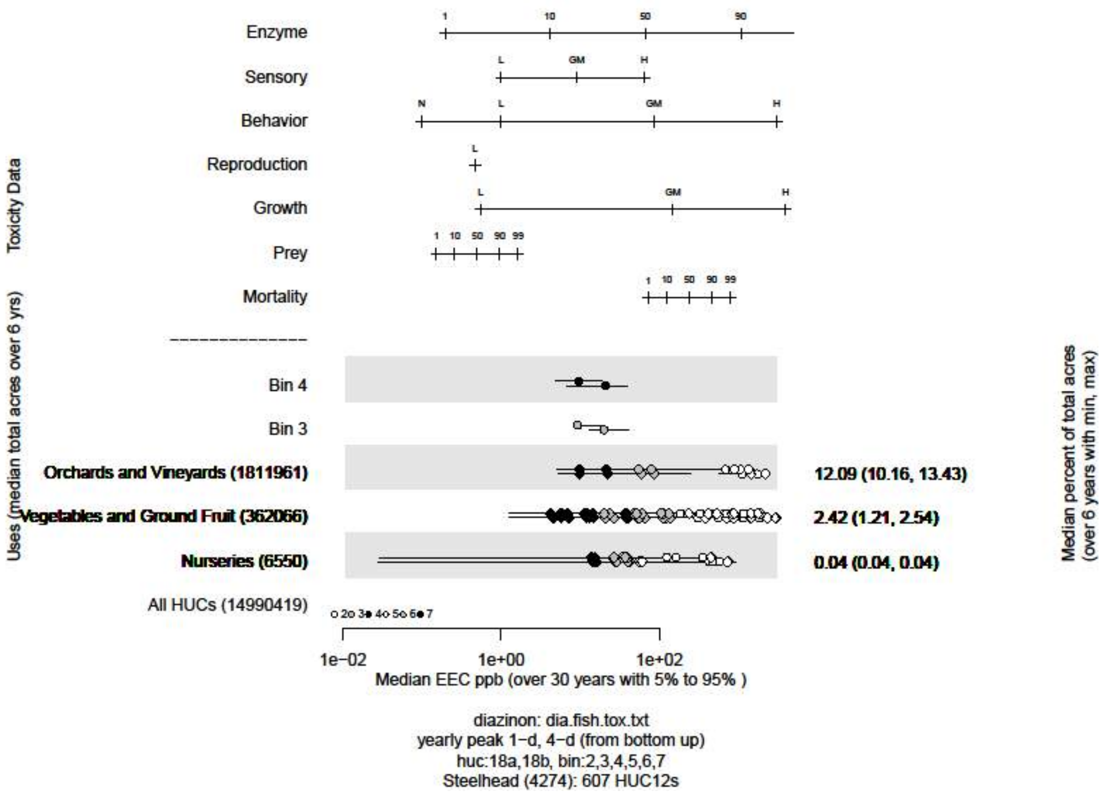


Figure 19. Effects analysis R-plot for Steelhead, California Central Valley DPS and diazinon

Table 183. Likelihood of exposure determination for Steelhead, California Central Valley DPS and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Orchards and Vineyards	3	yes	no	yes	NA	3	**High**
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	**Med**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	3	yes	no	yes	NA	3	**High**
Bin 4	3	yes	no	yes	NA	3	**High**
Juveniles							
Orchards and Vineyards	3	yes	no	yes	NA	3	**High**
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	**Med**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	3	yes	no	yes	NA	3	**High**
Bin 4	3	yes	no	yes	NA	3	**High**

Life Stage: Adults (full-range)

Table 184. Direct mortality risk hypothesis; Steelhead, California Central Valley DPS and diazinon; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	12.1	High	**High**
Vegetables and Ground Fruit	2.4	High	**Medium**
Nurseries	0.04	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 185. Reproduction risk hypothesis; Steelhead, California Central Valley DPS and diazinon; Adults

Endpoint: Reproduction

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	12.1	High	**High**
Vegetables and Ground Fruit	2.4	High	**Medium**
Nurseries	0.04	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 186. Behavior and sensory risk hypothesis; Steelhead, California Central Valley DPS and diazinon; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	12.1	High	**High**
Vegetables and Ground Fruit	2.4	High	**Medium**
Nurseries	0.04	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	12.1	High	**High**
Vegetables and Ground Fruit	2.4	High	**Medium**

Nurseries	0.04	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 187. AChE risk hypothesis; Steelhead, California Central Valley DPS and diazinon; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	12.1	High	**High**
Vegetables and Ground Fruit	2.4	High	**Medium**
Nurseries	0.04	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 188. Direct mortality risk hypothesis; Steelhead, California Central Valley DPS and diazinon; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure

Orchards and Vineyards	12.1	High	High
Vegetables and Ground Fruit	2.4	High	Medium
Nurseries	0.04	High	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 189. Growth risk hypothesis; Steelhead, California Central Valley DPS and diazinon; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	12.1	High	High
Vegetables and Ground Fruit	2.4	High	Medium
Nurseries	0.04	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 190. Prey risk hypothesis; Steelhead, California Central Valley DPS and diazinon; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Orchards and Vineyards	12.1	High	**High**
Vegetables and Ground Fruit	2.4	High	**Medium**
Nurseries	0.04	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 191. AChE risk hypothesis; Steelhead, California Central Valley DPS and diazinon; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	12.1	High	High
Vegetables and Ground Fruit	2.4	High	Medium
Nurseries	0.04	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 192. Behavior and sensory risk hypothesis; Steelhead, California Central Valley DPS and diazinon; Juveniles

Endpoint: Behavior

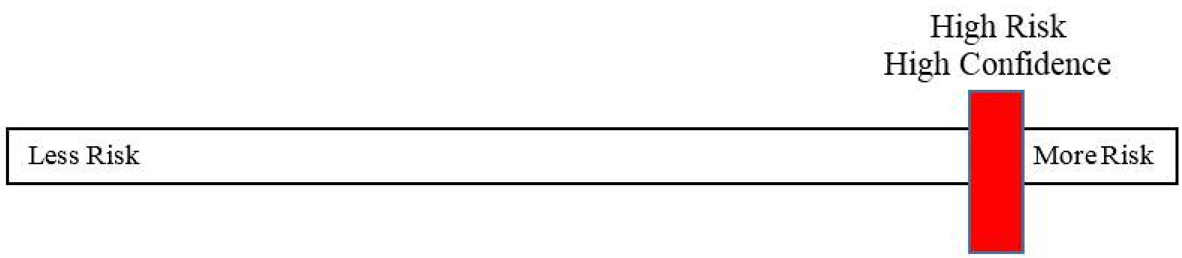
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	12.1	High	**High**
Vegetables and Ground Fruit	2.4	High	**Medium**
Nurseries	0.04	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	12.1	High	**High**
Vegetables and Ground Fruit	2.4	High	**Medium**
Nurseries	0.04	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 193. Effects analysis summary table: Steelhead, California Central Valley DPS and diazinon

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 0-15	**Yes**
Exposure to diazinon is sufficient to reduce adult	High	High	Not Available	**Yes**

productivity via impairments to reproduction				
Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 0-15	**Yes**
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day fish: 0-15 4-day invert: 15-64	**Yes**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, California Central Valley DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to diazinon. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where diazinon achieves predicted levels. The MagTool results indicate that between 0-15 percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed steelhead. The overall risk to Steelhead, California Central Valley DPS from the effects of the action is high and the confidence associated with that risk is high.



13.21 Steelhead, Central California Coast DPS (Oncorhynchus mykiss)

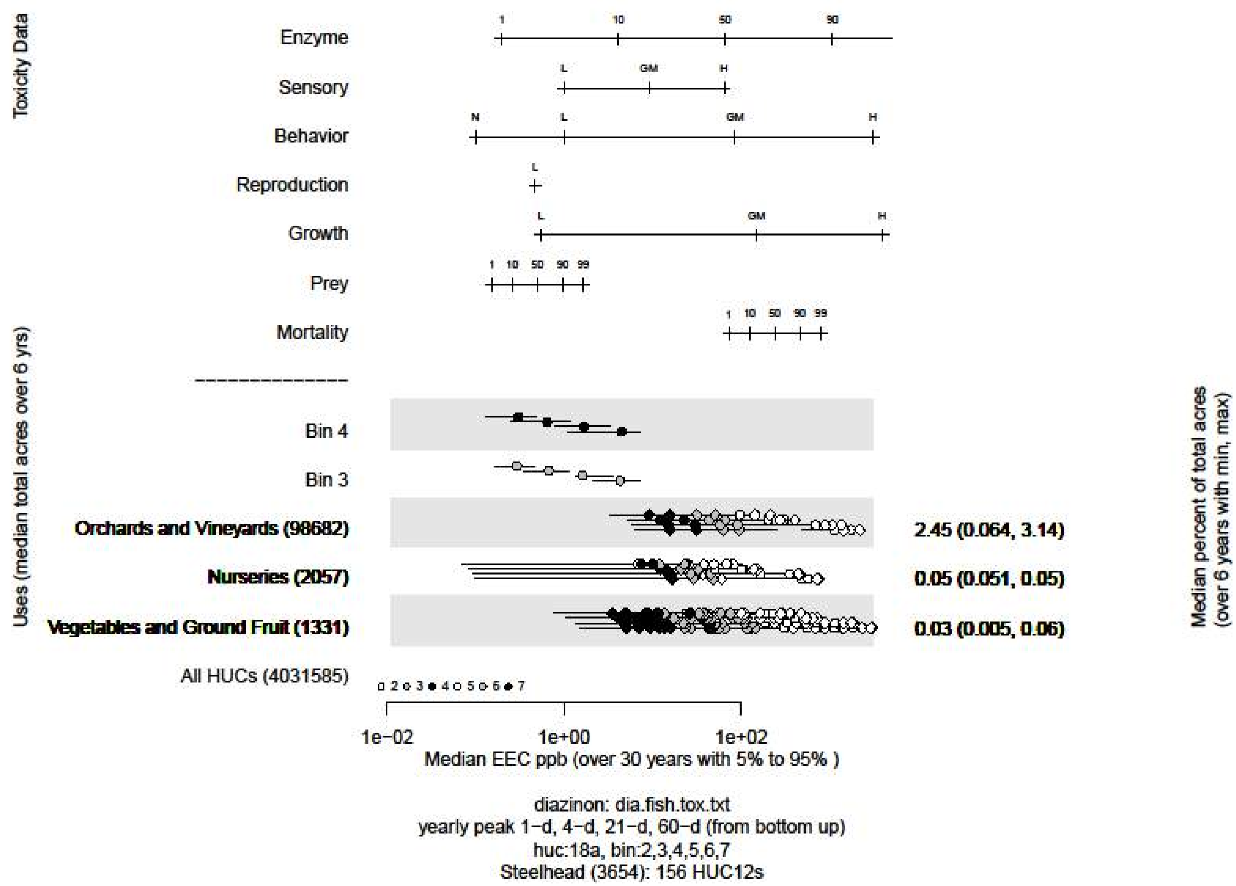


Figure 20. Effects analysis R-plot for Steelhead, Central California Coast DPS and diazinon

Table 194. Likelihood of exposure determination for Steelhead, Central California Coast DPS and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Orchards and Vineyards	2	yes	no	yes	NA	3	**Med**
Nurseries	1	yes	no	yes	no	3	**Low**
Vegetables and Ground Fruit	1	yes	no	yes	no	3	**Low**
Bin 3	2	yes	no	yes	NA	3	**Med**
Bin 4	2	yes	no	yes	NA	3	**Med**
Juveniles							
Orchards and Vineyards	2	yes	no	yes	NA	3	**Med**
Nurseries	1	yes	no	yes	no	3	**Low**
Vegetables and Ground Fruit	1	yes	no	yes	no	3	**Low**
Bin 3	2	yes	no	yes	NA	3	**Med**
Bin 4	2	yes	no	yes	NA	3	**Med**

Life Stage: Adults (full-range)

Table 195. Direct mortality risk hypothesis; Steelhead, Central California Coast DPS and diazinon; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.5	High	**Medium**
Nurseries	0.05	High	**Low**
Vegetables and Ground Fruit	0.03	High	**Low**
Bin 3		Low	**Medium**
Bin 4		Low	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**Medium**		

Table 196. Reproduction risk hypothesis; Steelhead, Central California Coast DPS and diazinon; Adults

Endpoint: Reproduction

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	2.5	High	**Medium**
Nurseries	0.05	High	**Low**
Vegetables and Ground Fruit	0.03	High	**Low**
Bin 3		High	**Medium**
Bin 4		High	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**Medium**		

Table 197. Behavior and sensory risk hypothesis; Steelhead, Central California Coast DPS and diazinon; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.5	High	**Medium**
Nurseries	0.05	High	**Low**
Vegetables and Ground Fruit	0.03	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.5	High	**Medium**
Nurseries	0.05	High	**Low**

Vegetables and Ground Fruit	0.03	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**Medium**		

Table 198. AChE risk hypothesis; Steelhead, Central California Coast DPS and diazinon; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.5	High	**Medium**
Nurseries	0.05	High	**Low**
Vegetables and Ground Fruit	0.03	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Medium**		

Life Stage: Juveniles (full-range)

Table 199. Direct mortality risk hypothesis; Steelhead, Central California Coast DPS and diazinon; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure

Orchards and Vineyards	2.5	High	Medium
Nurseries	0.05	High	Low
Vegetables and Ground Fruit	0.03	High	Low
Bin 3		Low	Medium
Bin 4		Low	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	Medium		

Table 200. Growth risk hypothesis; Steelhead, Central California Coast DPS and diazinon; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	2.5	High	Medium
Nurseries	0.05	High	Low
Vegetables and Ground Fruit	0.03	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	Medium		

Table 201. Prey risk hypothesis; Steelhead, Central California Coast DPS and diazinon; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Orchards and Vineyards	2.5	High	**Medium**
Nurseries	0.05	High	**Low**
Vegetables and Ground Fruit	0.03	High	**Low**
Bin 3		High	**Medium**
Bin 4		High	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**Medium**		

Table 202. AChE risk hypothesis; Steelhead, Central California Coast DPS and diazinon; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	2.5	High	Medium
Nurseries	0.05	High	Low
Vegetables and Ground Fruit	0.03	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	Medium		

Table 203. Behavior and sensory risk hypothesis; Steelhead, Central California Coast DPS and diazinon; Juveniles

Endpoint: Behavior

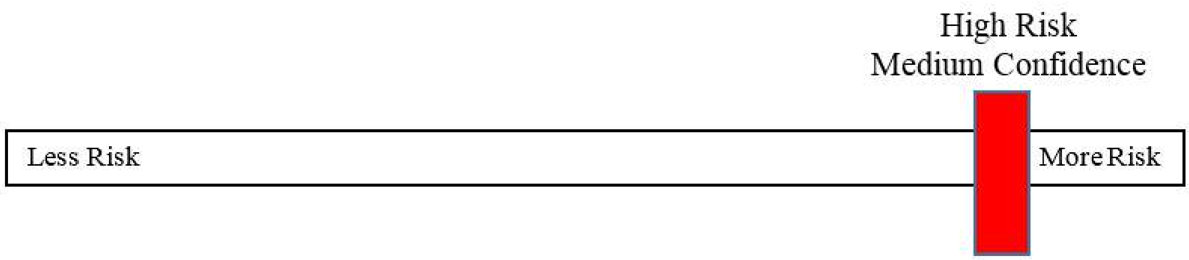
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	2.5	High	**Medium**
Nurseries	0.05	High	**Low**
Vegetables and Ground Fruit	0.03	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.5	High	**Medium**
Nurseries	0.05	High	**Low**
Vegetables and Ground Fruit	0.03	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**Medium**		

Table 204. Effects analysis summary table: Steelhead, Central California Coast DPS and diazinon

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	High	Medium	4-day: 0-3	**Yes**
Exposure to diazinon is sufficient to reduce adult	High	Medium	Not Available	**Yes**

productivity via impairments to reproduction				
Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	Medium	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Medium	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.	High	Medium	4-day: 0-3	**Yes**
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	Medium	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	High	Medium	4-day fish: 0-2 4-day invert: 3-23	**Yes**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Medium	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	Medium	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, Central California Coast DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to diazinon. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where diazinon achieves predicted levels. The MagTool results indicate that between 0-3 percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed steelhead. The overall risk to Steelhead, Central California Coast DPS from the effects of the action is high and the confidence associated with that risk is medium.



13.22 Steelhead, Lower Columbia River DPS (Oncorhynchus mykiss)

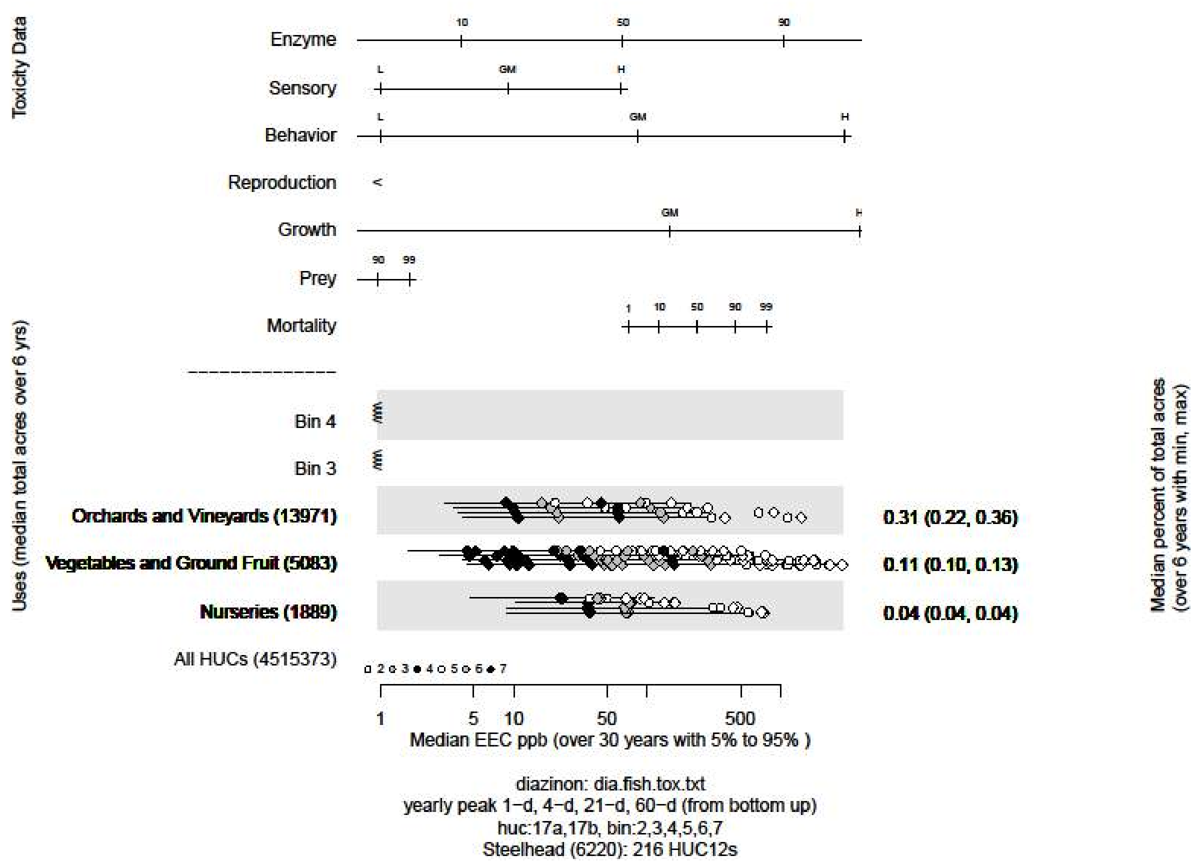


Figure 21. Effects analysis R-plot for Steelhead, Lower Columbia River DPS and diazinon

Table 205. Likelihood of exposure determination for Steelhead, Lower Columbia River DPS and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Orchards and Vineyards	1	yes	no	yes	yes	3	**High**
Vegetables and Ground Fruit	1	yes	no	yes	yes	3	**High**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	1	yes	no	yes	NA	3	**Low**
Bin 4	1	yes	no	yes	NA	3	**Low**
Juveniles							
Orchards and Vineyards	1	yes	no	yes	yes	3	**High**
Vegetables and Ground Fruit	1	yes	no	yes	yes	3	**High**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	1	yes	no	yes	NA	3	**Low**
Bin 4	1	yes	no	yes	NA	3	**Low**

Life Stage: Adults (full-range)

Table 206. Direct mortality risk hypothesis; Steelhead, Lower Columbia River DPS and diazinon; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.3	High	High
Vegetables and Ground Fruit	0.1	High	High
Nurseries	0.04	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to spawning streams of the Hood River winter-run population. High density of vegetable and ground fruit use sites proximal to the migratory corridor at Sauvie Island. The Hood River winter-run population has been determined essential to the recovery of the DPS per the 2013	
High	**High**		

		Lower Columbia River Recovery Plan for Salmon and Steelhead.

Table 207. Reproduction risk hypothesis; Steelhead, Lower Columbia River DPS and diazinon; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.3	High	High
Vegetables and Ground Fruit	0.1	High	High
Nurseries	0.04	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to spawning streams of the Hood River winter-run population. High density of vegetable and ground fruit use sites proximal to the migratory corridor at Sauvie Island. The Hood River winter-run population has been determined essential to the recovery of the DPS per the 2013 Lower Columbia River Recovery Plan for Salmon and Steelhead.	
High	**High**		

Table 208. Behavior and sensory risk hypothesis; Steelhead, Lower Columbia River DPS and diazinon; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.3	High	High
Vegetables and Ground Fruit	0.1	High	High

Nurseries	0.04	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.3	High	High
Vegetables and Ground Fruit	0.1	High	High
Nurseries	0.04	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to spawning streams of the Hood River winter-run population. High density of vegetable and ground fruit use sites proximal to the migratory corridor at Sauvie Island. The Hood River winter-run population has been determined essential to the recovery of the DPS per the 2013 Lower Columbia River Recovery Plan for Salmon and Steelhead.	
High	**High**		

Table 209. AChE risk hypothesis; Steelhead, Lower Columbia River DPS and diazinon; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.3	High	High
Vegetables and Ground Fruit	0.1	High	High
Nurseries	0.04	High	Low

Bin 3		Medium	Low
Bin 4		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to spawning streams of the Hood River winter-run population. High density of vegetable and ground fruit use sites proximal to the migratory corridor at Sauvie Island. The Hood River winter-run population has been determined essential to the recovery of the DPS per the 2013 Lower Columbia River Recovery Plan for Salmon and Steelhead.	
High	**High**		

Life Stage: Juveniles (full-range)

Table 210. Direct mortality risk hypothesis; Steelhead, Lower Columbia River DPS and diazinon; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	0.3	High	High
Vegetables and Ground Fruit	0.1	High	High
Nurseries	0.04	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence	High density of orchards and vineyards use sites proximal to spawning streams of the Hood River winter-run population. High density of vegetable and ground fruit use sites proximal to the migratory corridor at Sauvie Island. The Hood River winter-run population has been determined essential to the recovery of the DPS per the 2013	
High	High		

		Lower Columbia River Recovery Plan for Salmon and Steelhead.

Table 211. Growth risk hypothesis; Steelhead, Lower Columbia River DPS and diazinon; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	0.3	High	High
Vegetables and Ground Fruit	0.1	High	High
Nurseries	0.04	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence	High density of orchards and vineyards use sites proximal to spawning streams of the Hood River winter-run population. High density of vegetable and ground fruit use sites proximal to the migratory corridor at Sauvie Island. The Hood River winter-run population has been determined essential to the recovery of the DPS per the 2013 Lower Columbia River Recovery Plan for Salmon and Steelhead.	
High	High		

Table 212. Prey risk hypothesis; Steelhead, Lower Columbia River DPS and diazinon; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.3	High	High
Vegetables and Ground Fruit	0.1	High	High

Nurseries	0.04	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to spawning streams of the Hood River winter-run population. High density of vegetable and ground fruit use sites proximal to the migratory corridor at Sauvie Island. The Hood River winter-run population has been determined essential to the recovery of the DPS per the 2013 Lower Columbia River Recovery Plan for Salmon and Steelhead.	
High	**High**		

Table 213. AChE risk hypothesis; Steelhead, Lower Columbia River DPS and diazinon; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	0.3	High	High
Vegetables and Ground Fruit	0.1	High	High
Nurseries	0.04	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence	High density of orchards and vineyards use sites proximal to spawning streams of the Hood River winter-run population. High density of vegetable and ground fruit use sites proximal to the migratory corridor at Sauvie Island. The Hood River winter-run population has been determined essential to the recovery of the DPS per the 2013	
High	High		

		Lower Columbia River Recovery Plan for Salmon and Steelhead.

Table 214. Behavior and sensory risk hypothesis; Steelhead, Lower Columbia River DPS and diazinon; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.3	High	High
Vegetables and Ground Fruit	0.1	High	High
Nurseries	0.04	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.3	High	High
Vegetables and Ground Fruit	0.1	High	High
Nurseries	0.04	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Vegetables and Ground Fruit	0.03	High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to spawning streams of the Hood River winter-run population. High density of vegetable and ground fruit use sites proximal to the migratory corridor at Sauvie Island. The Hood	
High	**High**		

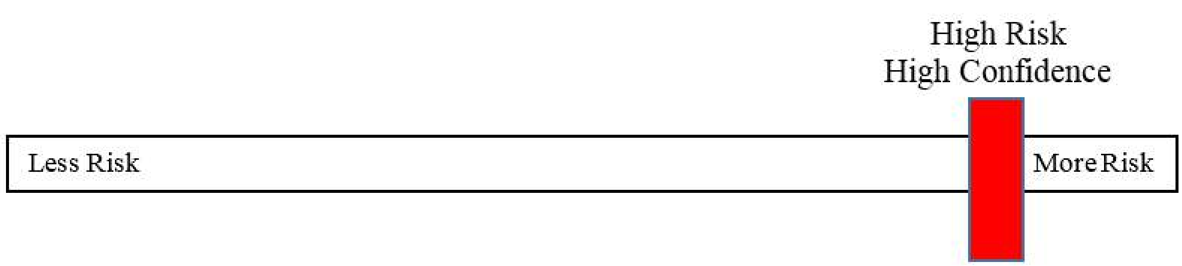
		River winter-run population has been determined essential to the recovery of the DPS per the 2013 Lower Columbia River Recovery Plan for Salmon and Steelhead.

Table 215. Effects analysis summary table: Steelhead, Lower Columbia River DPS and diazinon

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 0	**Yes**
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 0	**Yes**
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day fish: 0 4-day invert: 0-5	**Yes**

Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, Lower Columbia River DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to diazinon. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where diazinon achieves predicted levels. The MagTool results indicate that 0 percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed steelhead. The overall risk to Steelhead, Lower Columbia River DPS from the effects of the action is high and the confidence associated with that risk is high. High risk is due to the proximity of orchards and vineyards use sites to spawning streams of the Hood River winter-run population and vegetable and ground fruit use sites proximal to the migratory corridor at Sauvie Island. Uses associated with the orchards and vineyards GIS layer are approved for use at times when individuals of the Hood River winter-run population are present. This population has been determined essential to the recovery of the ESU per the 2011 Upper Willamette River Conservation and Recovery Plan for Chinook Salmon and Steelhead.



13.23 Steelhead, Middle Columbia River DPS

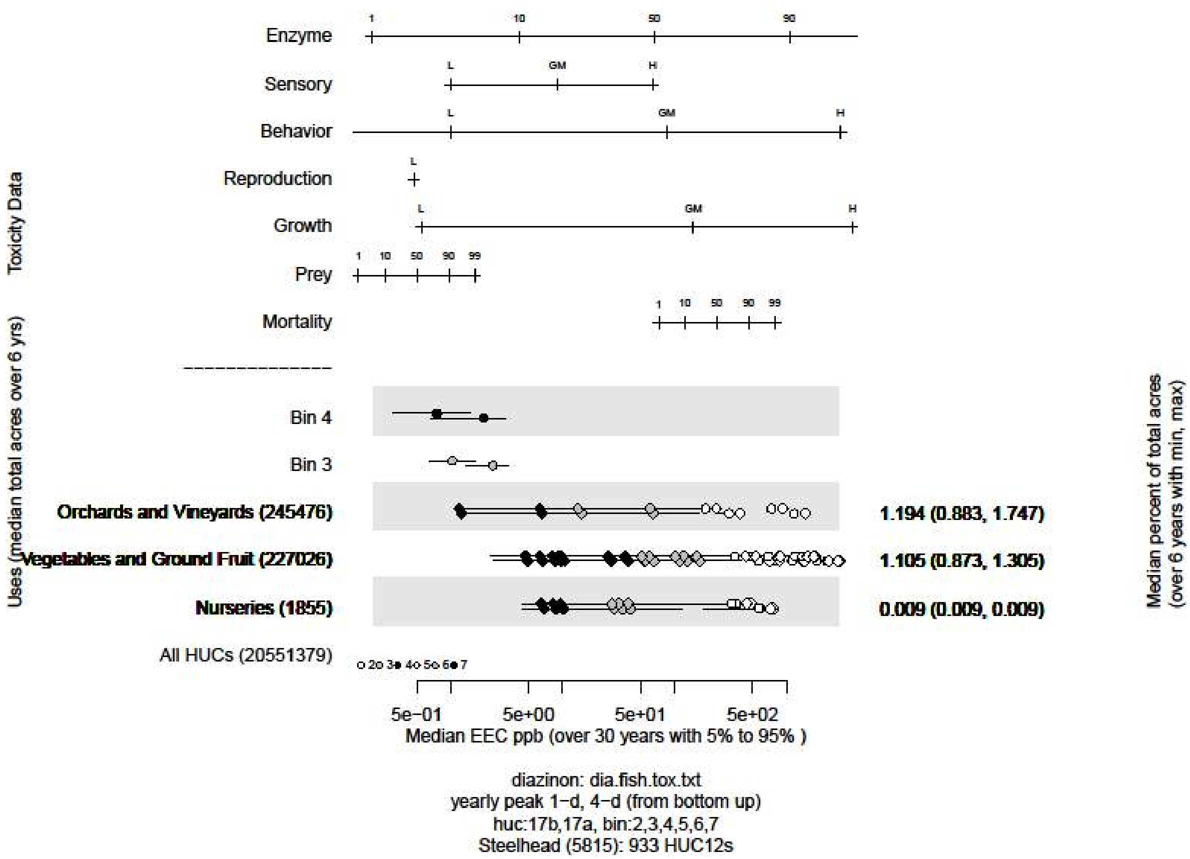


Figure 22. Effects analysis R-plot for Steelhead, Middle Columbia River DPS and diazinon

Table 216. Likelihood of exposure determination for Steelhead, Middle Columbia River DPS and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Orchards and Vineyards	2	yes	no	yes	NA	3	**Med**
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	**Med**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	2	yes	no	yes	NA	3	**Med**
Bin 4	2	yes	no	yes	NA	3	**Med**
Juveniles							
Orchards and Vineyards	2	yes	no	yes	NA	3	**Med**
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	**Med**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	2	yes	no	yes	NA	3	**Med**
Bin 4	2	yes	no	yes	NA	3	**Med**

Life Stage: Adults (full-range)

Table 217. Direct mortality risk hypothesis; Steelhead, Middle Columbia River DPS and diazinon; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	1.2	High	Medium
Vegetables and Ground Fruit	1.1	High	Medium
Nurseries	0.01	High	Low
Bin 3		Low	Medium
Bin 4		Low	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 218. Reproduction risk hypothesis; Steelhead, Middle Columbia River DPS and diazinon; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	1.2	High	Medium
Vegetables and Ground Fruit	1.1	High	Medium
Nurseries	0.01	High	Low
Bin 3		High	Medium
Bin 4		High	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 219. Behavior and sensory risk hypothesis; Steelhead, Middle Columbia River DPS and diazinon; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	1.2	High	Medium
Vegetables and Ground Fruit	1.1	High	Medium
Nurseries	0.01	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	1.2	High	Medium

Vegetables and Ground Fruit	1.1	High	Medium
Nurseries	0.01	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 220. AChE risk hypothesis; Steelhead, Middle Columbia River DPS and diazinon; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	1.2	High	Medium
Vegetables and Ground Fruit	1.1	High	Medium
Nurseries	0.01	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 221. Direct mortality risk hypothesis; Steelhead, Middle Columbia River DPS and diazinon; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure

Orchards and Vineyards	1.2	High	Medium
Vegetables and Ground Fruit	1.1	High	Medium
Nurseries	0.01	High	Low
Bin 3		Low	Medium
Bin 4		Low	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 222. Growth risk hypothesis; Steelhead, Middle Columbia River DPS and diazinon; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	1.2	High	Medium
Vegetables and Ground Fruit	1.1	High	Medium
Nurseries	0.01	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 223. Prey risk hypothesis; Steelhead, Middle Columbia River DPS and diazinon; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Orchards and Vineyards	1.2	High	Medium
Vegetables and Ground Fruit	1.1	High	Medium
Nurseries	0.01	High	Low
Bin 3		High	Medium
Bin 4		High	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 224. AChE risk hypothesis; Steelhead, Middle Columbia River DPS and diazinon; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	1.2	High	Medium
Vegetables and Ground Fruit	1.1	High	Medium
Nurseries	0.01	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 225. Behavior and sensory risk hypothesis; Steelhead, Middle Columbia River DPS and diazinon; Juveniles

Endpoint: Behavior

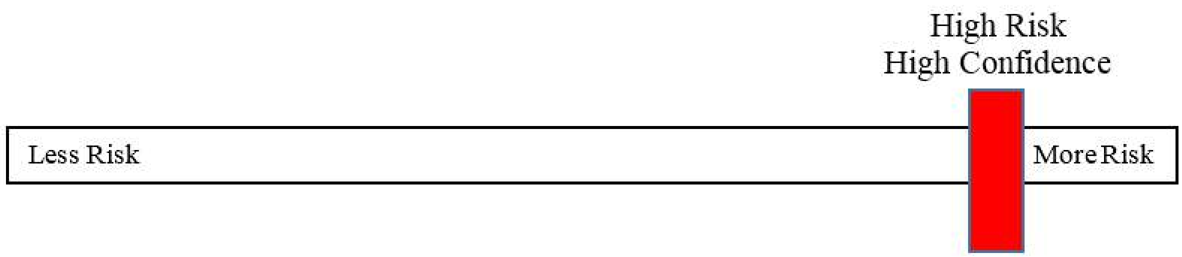
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	1.2	High	Medium
Vegetables and Ground Fruit	1.1	High	Medium
Nurseries	0.01	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	1.2	High	Medium
Vegetables and Ground Fruit	1.1	High	Medium
Nurseries	0.01	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 226. Effects analysis summary table: Steelhead, Middle Columbia River DPS and diazinon

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: pending	**Yes**
Exposure to diazinon is sufficient to reduce adult	High	High	Not Available	**Yes**

productivity via impairments to reproduction				
Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: pending	**Yes**
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day fish: pending 4-day invert: pending	**Yes**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, Middle Columbia River DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to diazinon. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where diazinon achieves predicted levels. The MagTool results indicate that between [pending] percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed steelhead. The overall risk to Steelhead, Middle Columbia River DPS from the effects of the action is high and the confidence associated with that risk is high.



13.24 Steelhead, Northern California DPS (Oncorhynchus mykiss)

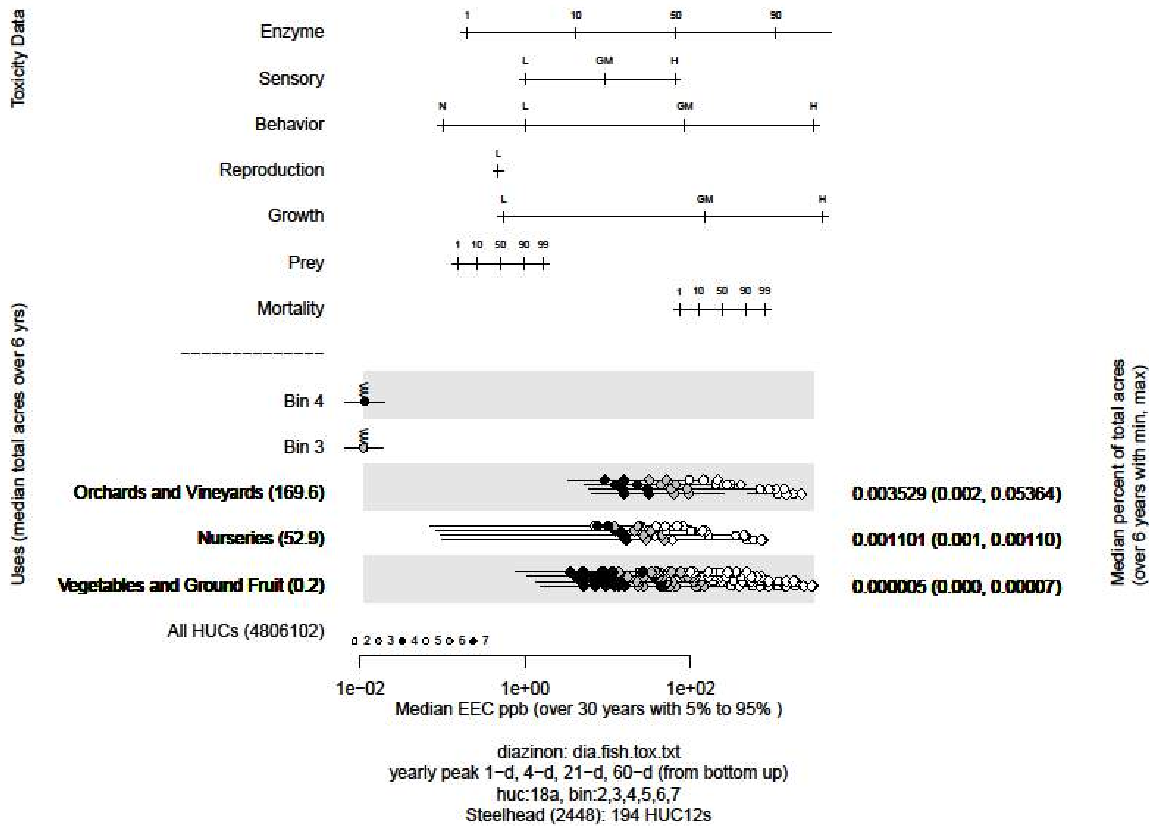


Figure 23. Effects analysis R-plot for Steelhead, Northern California DPS and diazinon

Table 227. Likelihood of exposure determination for Steelhead, Northern California DPS and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Orchards and Vineyards	1	yes	no	yes	yes	3	**Med**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	1	yes	no	yes	NA	3	**Low**
Bin 4	1	yes	no	yes	NA	3	**Low**
Juveniles							
Orchards and Vineyards	1	yes	no	yes	yes	3	**Med**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	1	yes	no	yes	NA	3	**Low**
Bin 4	1	yes	no	yes	NA	3	**Low**

Life Stage: Adults (full-range)

Table 228. Direct mortality risk hypothesis; Steelhead, Northern California DPS and diazinon; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.004	High	Medium
Nurseries	0.001	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to spawning streams of the Navarro River population. This population has been determined essential to the recovery of the DPS per the 2016 Coastal Multispecies Recovery Plan. The likelihood is characterized as medium as this is the only population within this DPS with significant use site overlap.	
Medium	**Medium**		

Table 229. Reproduction risk hypothesis; Steelhead, Northern California DPS and diazinon; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.004	High	Medium
Nurseries	0.001	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to spawning streams of the Navarro River population. This population has been determined essential to the recovery of the DPS per the 2016 Coastal Multispecies Recovery Plan. The likelihood is characterized as medium as this is the only population within this DPS with significant use site overlap.	
Medium	**Medium**		

Table 230. Behavior and sensory risk hypothesis; Steelhead, Northern California DPS and diazinon; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.004	High	Medium
Nurseries	0.001	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.004	High	Medium

Nurseries	0.001	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to spawning streams of the Navarro River population. This population has been determined essential to the recovery of the DPS per the 2016 Coastal Multispecies Recovery Plan. The likelihood is characterized as medium as this is the only population within this DPS with significant use site overlap.	
Medium	**Medium**		

Table 231. AChE risk hypothesis; Steelhead, Northern California DPS and diazinon; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.004	High	Medium
Nurseries	0.001	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to spawning streams of the Navarro River population. This population has been determined essential to the recovery of the DPS per the 2016 Coastal Multispecies Recovery Plan. The likelihood is characterized as medium as this is the only population within this DPS with significant use site overlap.	
Medium	**Medium**		

Life Stage: Juveniles (full-range)

Table 232. Direct mortality risk hypothesis; Steelhead, Northern California DPS and diazinon; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	0.004	High	Medium
Nurseries	0.001	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence	High density of orchards and vineyards use sites proximal to spawning streams of the Navarro River population. This population has been determined essential to the recovery of the DPS per the 2016 Coastal Multispecies Recovery Plan. The likelihood is characterized as medium as this is the only population within this DPS with significant use site overlap.	
Medium	Medium		

Table 233. Growth risk hypothesis; Steelhead, Northern California DPS and diazinon; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	0.004	High	Medium
Nurseries	0.001	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence	High density of orchards and vineyards use sites proximal to spawning streams of the Navarro River population. This population has been	
Medium	Medium		

		determined essential to the recovery of the DPS per the 2016 Coastal Multispecies Recovery Plan. The likelihood is characterized as medium as this is the only population within this DPS with significant use site overlap.

Table 234. Prey risk hypothesis; Steelhead, Northern California DPS and diazinon; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.004	High	Medium
Nurseries	0.001	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to spawning streams of the Navarro River population. This population has been determined essential to the recovery of the DPS per the 2016 Coastal Multispecies Recovery Plan. The likelihood is characterized as medium as this is the only population within this DPS with significant use site overlap.	
Medium	**Medium**		

Table 235. AChE risk hypothesis; Steelhead, Northern California DPS and diazinon; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	0.004	High	Medium
Nurseries	0.001	High	Low
Bin 3		Low	Low

Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence	High density of orchards and vineyards use sites proximal to spawning streams of the Navarro River population. This population has been determined essential to the recovery of the DPS per the 2016 Coastal Multispecies Recovery Plan. The likelihood is characterized as medium as this is the only population within this DPS with significant use site overlap.	
Medium	Medium		

Table 236. Behavior and sensory risk hypothesis; Steelhead, Northern California DPS and diazinon; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.004	High	Medium
Nurseries	0.001	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.004	High	Medium
Nurseries	0.001	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to spawning streams of the Navarro River population. This population has been	
Medium	**Medium**		

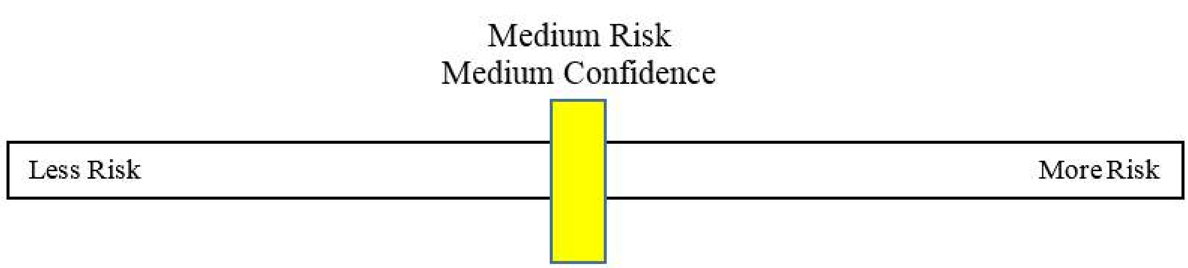
		determined essential to the recovery of the DPS per the 2016 Coastal Multispecies Recovery Plan. The likelihood is characterized as medium as this is the only population within this DPS with significant use site overlap.

Table 237. Effects analysis summary table: Steelhead, Northern California DPS and diazinon

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	Medium	Medium	4-day: 0	**Yes**
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Medium	Medium	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	Medium	Medium	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Medium	Medium	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.	Medium	Medium	4-day: 0	**Yes**
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	Medium	Medium	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce Juvenile	Medium	Medium	4-day fish: 0 4-day invert:	**Yes**

abundance via reduction in prey availability			0	
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Medium	Medium	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	Medium	Medium	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, Northern California DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to diazinon. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where diazinon achieves predicted levels. The MagTool results indicate that 0 percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed steelhead. The overall risk to Steelhead, Northern California DPS from the effects of the action is medium and the confidence associated with that risk is medium. Medium risk is due to the proximity of use sites to spawning streams of the Navarro River population. Uses associated with the orchards and vineyards GIS layer are approved for use at times when individuals of this population are present. The Navarro River population has been determined essential to the recovery of the ESU per the 2016 Coastal Multispecies Recovery Plan. The risk was determined to be medium (as opposed to high) because the Navarro population is the only population within this DPS with significant use site overlap.



13.25 Steelhead, Puget Sound DPS (Oncorhynchus mykiss)

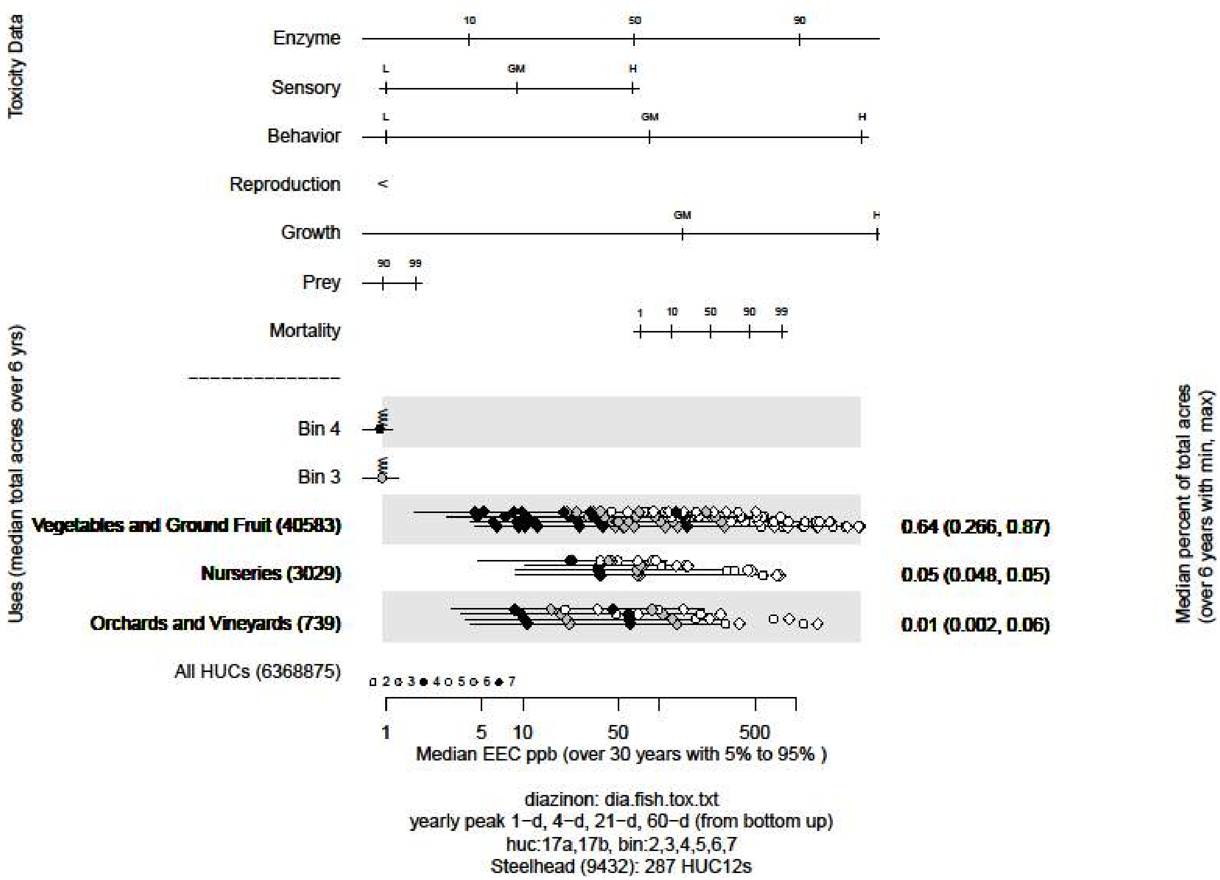


Figure 24. Effects analysis R-plot for Steelhead, Puget Sound DPS and diazinon

Table 238. Likelihood of exposure determination for Steelhead, Puget Sound DPS and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	**Low**
Nurseries	1	yes	no	yes	NA	3	**Low**
Orchards and Vineyards	1	yes	no	yes	NA	3	**Low**
Bin 3	1	yes	no	yes	NA	3	**Low**
Bin 4	1	yes	no	yes	NA	3	**Low**
Juveniles							
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	**Low**
Nurseries	1	yes	no	yes	NA	3	**Low**
Orchards and Vineyards	1	yes	no	yes	NA	3	**Low**
Bin 3	1	yes	no	yes	NA	3	**Low**
Bin 4	1	yes	no	yes	NA	3	**Low**

Life Stage: Adults (full-range)

Table 239. Direct mortality risk hypothesis; Steelhead, Puget Sound DPS and diazinon; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.6	High	Low
Nurseries	0.05	High	Low
Orchards and Vineyards	0.01	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**High**		

Table 240. Reproduction risk hypothesis; Steelhead, Puget Sound DPS and diazinon; Adults

Endpoint: Reproduction

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	0.6	High	Low
Nurseries	0.05	High	Low
Orchards and Vineyards	0.01	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**High**		

Table 241. Behavior and sensory risk hypothesis; Steelhead, Puget Sound DPS and diazinon; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.6	High	Low
Nurseries	0.05	High	Low
Orchards and Vineyards	0.01	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.6	High	Low
Nurseries	0.05	High	Low
Orchards and Vineyards	0.01	High	Low

Bin 3		Medium	Low
Bin 4		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
Low	**High**		

Table 242. AChE risk hypothesis; Steelhead, Puget Sound DPS and diazinon; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.6	High	Low
Nurseries	0.05	High	Low
Orchards and Vineyards	0.01	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**High**		

Life Stage: Juveniles (full-range)

Table 243. Direct mortality risk hypothesis; Steelhead, Puget Sound DPS and diazinon; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	0.6	High	Low
Nurseries	0.05	High	Low

Orchards and Vineyards	0.01	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
Low	High		

Table 244. Growth risk hypothesis; Steelhead, Puget Sound DPS and diazinon; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	0.6	High	Low
Nurseries	0.05	High	Low
Orchards and Vineyards	0.01	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
Low	High		

Table 245. Prey risk hypothesis; Steelhead, Puget Sound DPS and diazinon; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.6	High	Low
Nurseries	0.05	High	Low

Orchards and Vineyards	0.01	High	Low
Bin 3		High	Low
Bin 4		High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	**High**		

Table 246. AChE risk hypothesis; Steelhead, Puget Sound DPS and diazinon; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	0.6	High	Low
Nurseries	0.05	High	Low
Orchards and Vineyards	0.01	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
Low	High		

Table 247. Behavior and sensory risk hypothesis; Steelhead, Puget Sound DPS and diazinon; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.6	High	Low

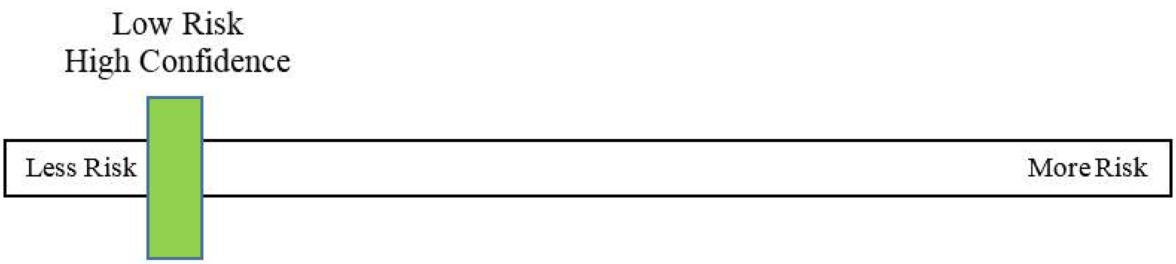
Nurseries	0.05	High	Low
Orchards and Vineyards	0.01	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.6	High	Low
Nurseries	0.05	High	Low
Orchards and Vineyards	0.01	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
Low	**High**		

Table 248. Effects analysis summary table: Steelhead, Puget Sound DPS and diazinon

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	Low	High	4-day: 0-1	No
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce adult abundance and productivity	Low	High	Not Available	No

via impairments to ecologically significant behaviors.				
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	High	Not Available	No
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.	Low	High	4-day: 0-1	No
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	Low	High	4-day fish: 0-1 4-day invert: 1-9	No
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	Low	High	Not Available	No

Effects analysis summary: Adult and juvenile Steelhead, Puget Sound DPS are not anticipated to experience significant reductions in abundance or productivity (spawning adults) from exposure to diazinon. The MagTool results indicate that between 0-1 percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, steelhead may experience increased toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed steelhead. The National Marine Fisheries Service (NMFS) was unable to assess whether or not use sites were proximal to sensitive areas because a recovery plan has not yet been generated and thus it is unclear which, if any, of the populations are considered essential to recovery. The overall risk to Steelhead, Puget Sound DPS from the effects of the action is low and the confidence associated with that risk is high. Low risk is attributed primarily to the lack of diazinon use sites proximal to the species habitat.



13.26 Steelhead, Snake River Basin DPS

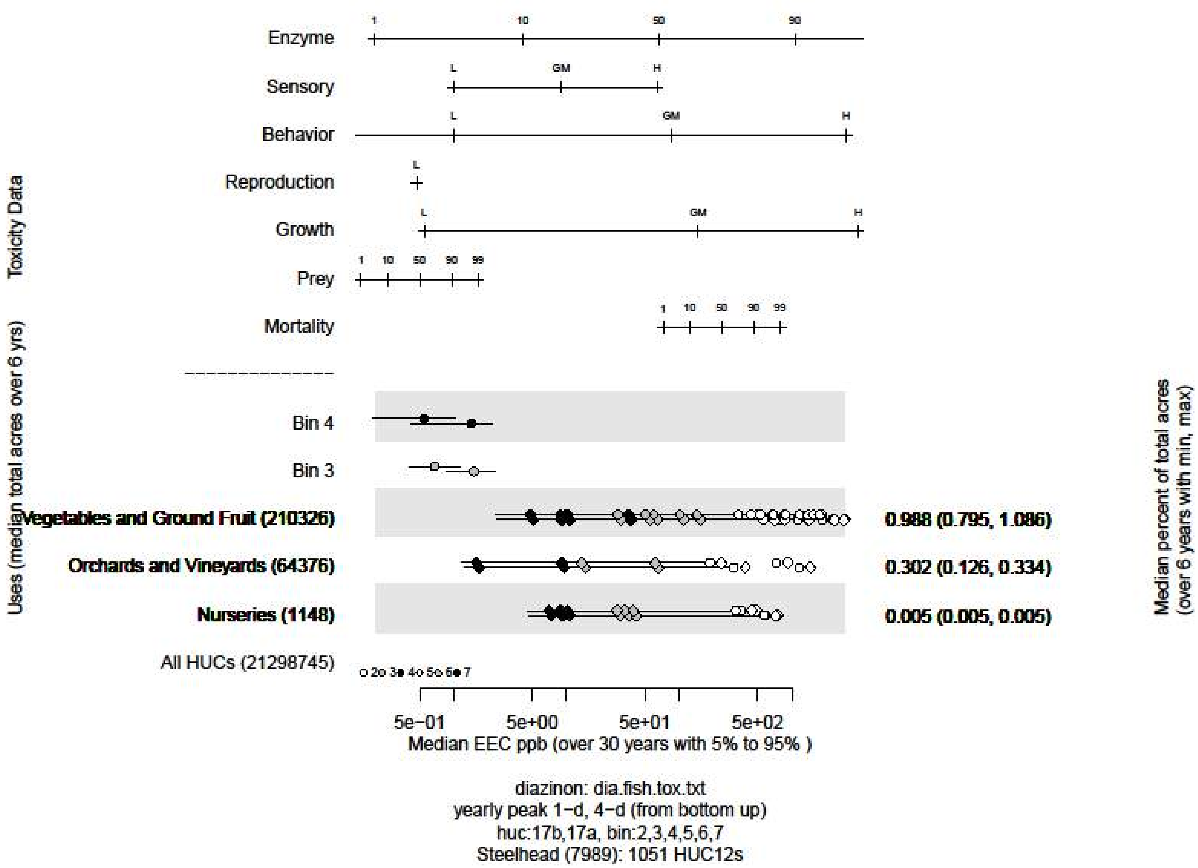


Figure 25. Effects analysis R-plot for Steelhead, Snake River Basin DPS and diazinon

Table 249. Likelihood of exposure determination for Steelhead, Snake River Basin DPS and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	**Med**
Orchards and Vineyards	1	yes	no	yes	yes	3	**High**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	2	yes	no	yes	NA	3	**Med**
Bin 4	2	yes	no	yes	NA	3	**Med**
Juveniles							
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	**Med**
Orchards and Vineyards	1	yes	no	yes	yes	3	**High**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	2	yes	no	yes	NA	3	**Med**
Bin 4	2	yes	no	yes	NA	3	**Med**

Life Stage: Adults (full-range)

Table 250. Direct mortality risk hypothesis; Steelhead, Snake River Basin DPS and diazinon; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.0	High	**Medium**
Orchards and Vineyards	0.3	High	**High**
Nurseries	0.005	High	**Low**
Bin 3		Low	**Medium**
Bin 4		Low	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to the migratory corridor at the confluence of the Snake and Columbia rivers. All populations of this DPS utilize this migratory corridor.	
High	**High**		

Table 251. Reproduction risk hypothesis; Steelhead, Snake River Basin DPS and diazinon; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.0	High	**Medium**
Orchards and Vineyards	0.3	High	**High**
Nurseries	0.005	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Low	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to the migratory corridor at the confluence of the Snake and Columbia rivers. All populations of this DPS utilize this migratory corridor.	
High	**High**		

Table 252. Behavior and sensory risk hypothesis; Steelhead, Snake River Basin DPS and diazinon; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.0	High	**Medium**
Orchards and Vineyards	0.3	High	**High**
Nurseries	0.005	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Vegetables and Ground Fruit	1.0	High	**Medium**
Orchards and Vineyards	0.3	High	**High**
Nurseries	0.005	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to the migratory corridor at the confluence of the Snake and Columbia rivers. All populations of this DPS utilize this migratory corridor.	
High	**High**		

Table 253. AChE risk hypothesis; Steelhead, Snake River Basin DPS and diazinon; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.0	High	**Medium**
Orchards and Vineyards	0.3	High	**High**
Nurseries	0.005	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to the migratory corridor at the confluence of the Snake and Columbia rivers. All populations of this DPS utilize this migratory corridor.	
High	**High**		

Life Stage: Juveniles (full-range)

Table 254. Direct mortality risk hypothesis; Steelhead, Snake River Basin DPS and diazinon; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	1.0	High	Medium
Orchards and Vineyards	0.3	High	High
Nurseries	0.005	High	Low
Bin 3		Low	Medium
Bin 4		Low	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence	High density of orchards and vineyards use sites proximal to the migratory corridor at the confluence of the Snake and Columbia rivers. All populations of this DPS utilize this migratory corridor.	
High	High		

Table 255. Growth risk hypothesis; Steelhead, Snake River Basin DPS and diazinon; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	1.0	High	Medium
Orchards and Vineyards	0.3	High	High
Nurseries	0.005	High	Low
Bin 3		Low	Medium
Bin 4		Low	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			

Risk	Confidence	
High	High	High density of orchards and vineyards use sites proximal to the migratory corridor at the confluence of the Snake and Columbia rivers. All populations of this DPS utilize this migratory corridor.

Table 256. Prey risk hypothesis; Steelhead, Snake River Basin DPS and diazinon; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.0	High	**Medium**
Orchards and Vineyards	0.3	High	**High**
Nurseries	0.005	High	**Low**
Bin 3		High	**Medium**
Bin 4		High	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**	High density of orchards and vineyards use sites proximal to the migratory corridor at the confluence of the Snake and Columbia rivers. All populations of this DPS utilize this migratory corridor.	
High	**High**		

Table 257. AChE risk hypothesis; Steelhead, Snake River Basin DPS and diazinon; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	1.0	High	Medium
Orchards and Vineyards	0.3	High	High
Nurseries	0.005	High	Low

Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence	High density of orchards and vineyards use sites proximal to the migratory corridor at the confluence of the Snake and Columbia rivers. All populations of this DPS utilize this migratory corridor.	
High	High		

Table 258. Behavior and sensory risk hypothesis; Steelhead, Snake River Basin DPS and diazinon; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.0	High	**Medium**
Orchards and Vineyards	0.3	High	**High**
Nurseries	0.005	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.0	High	**Medium**
Orchards and Vineyards	0.3	High	**High**
Nurseries	0.005	High	**Low**
Bin 3		Medium	**Medium**
Bin 4		Medium	**Medium**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			

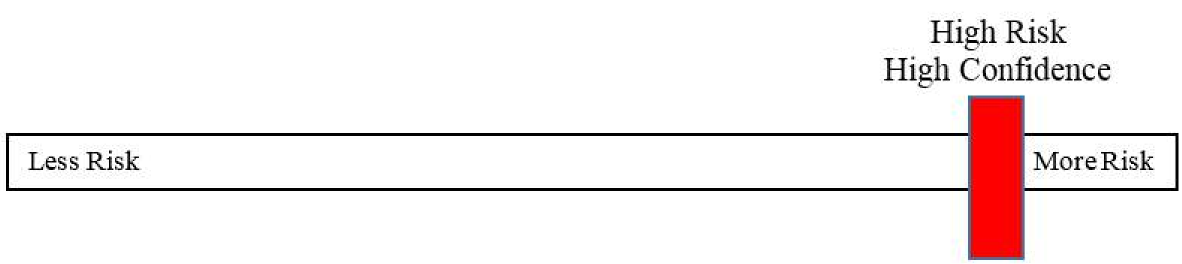
Risk	Confidence	High density of orchards and vineyards use sites proximal to the migratory corridor at the confluence of the Snake and Columbia rivers. All populations of this DPS utilize this migratory corridor.
High	**High**	

Table 259. Effects analysis summary table: Steelhead, Snake River Basin DPS and diazinon

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 0-1	**Yes**
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 0-1	**Yes**
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce Juvenile	High	High	4-day fish: 0-1 4-day invert:	**Yes**

abundance via reduction in prey availability			1-11	
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, Snake River Basin DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to diazinon. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where diazinon achieves predicted levels. The MagTool results indicate that between 0-1 percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed steelhead. The overall risk to Steelhead, Snake River Basin DPS from the effects of the action is high and the confidence associated with that risk is high. High risk is due to the proximity of orchards and vineyards use sites to the migratory corridor at the confluence of the Snake and Columbia rivers. All populations of this DPS utilize this migratory corridor.



13.27 Steelhead, South-Central California Coast DPS (Oncorhynchus mykiss)

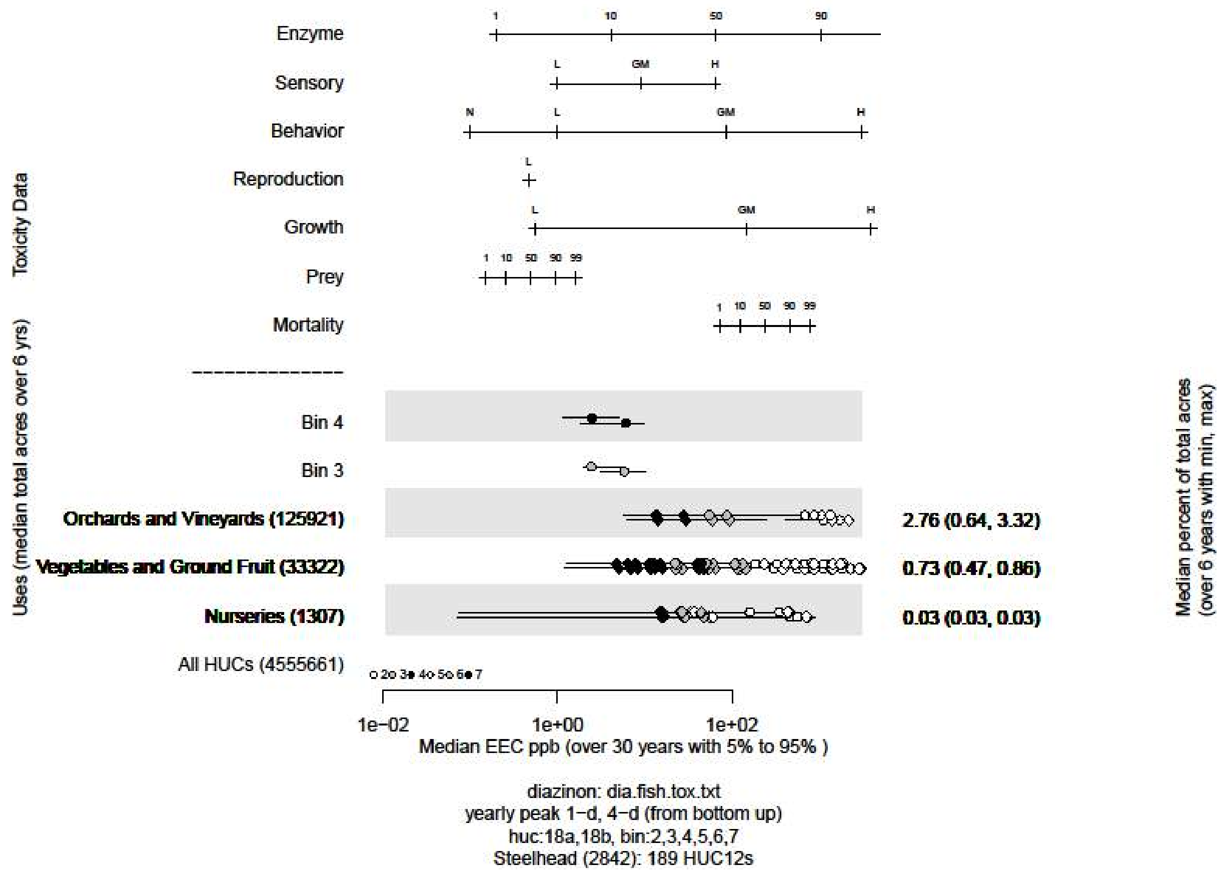


Figure 26. Effects analysis R-plot for Steelhead, South-Central California Coast DPS and diazinon

Table 260. Likelihood of exposure determination for Steelhead, South-Central California Coast DPS and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Orchards and Vineyards	2	yes	no	yes	NA	3	**Med**
Vegetables and Ground Fruit	1	yes	no	yes	yes	3	**High**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	2	yes	no	yes	NA	3	**Med**
Bin 4	2	yes	no	yes	NA	3	**Med**
Juveniles							
Orchards and Vineyards	2	yes	no	yes	NA	3	**Med**
Vegetables and Ground Fruit	1	yes	no	yes	yes	3	**High**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	2	yes	no	yes	NA	3	**Med**
Bin 4	2	yes	no	yes	NA	3	**Med**

Life Stage: Adults (full-range)

Table 261. Direct mortality risk hypothesis; Steelhead, South-Central California Coast DPS and diazinon; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.8	High	Medium
Vegetables and Ground Fruit	0.7	High	High
Nurseries	0.03	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**	High density of vegetables and ground fruit use sites proximal to the spawning streams of populations within the Salinas River watershed. All populations within the Salinas River watershed have been determined essential to the	
High	**High**		

		recovery of the DPS per the 2013 South-Central California Steelhead Recovery Plan.

Table 262. Reproduction risk hypothesis; Steelhead, South-Central California Coast DPS and diazinon; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.8	High	Medium
Vegetables and Ground Fruit	0.7	High	High
Nurseries	0.03	High	Low
Bin 3		High	Medium
Bin 4		High	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**	High density of vegetables and ground fruit use sites proximal to the spawning streams of populations within the Salinas River watershed. All populations within the Salinas River watershed have been determined essential to the recovery of the DPS per the 2013 South-Central California Steelhead Recovery Plan.	
High	**High**		

Table 263. Behavior and sensory risk hypothesis; Steelhead, South-Central California Coast DPS and diazinon; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.8	High	Medium
Vegetables and Ground Fruit	0.7	High	High

Nurseries	0.03	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.8	High	Medium
Vegetables and Ground Fruit	0.7	High	High
Nurseries	0.03	High	Low
Bin 3		High	Medium
Bin 4		High	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**	High density of vegetables and ground fruit use sites proximal to the spawning streams of populations within the Salinas River watershed. All populations within the Salinas River watershed have been determined essential to the recovery of the DPS per the 2013 South-Central California Steelhead Recovery Plan.	
High	**High**		

Table 264. AChE risk hypothesis; Steelhead, South-Central California Coast DPS and diazinon; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.8	High	Medium
Vegetables and Ground Fruit	0.7	High	High
Nurseries	0.03	High	Low
Bin 3		Medium	Medium

Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**	High density of vegetables and ground fruit use sites proximal to the spawning streams of populations within the Salinas River watershed. All populations within the Salinas River watershed have been determined essential to the recovery of the DPS per the 2013 South-Central California Steelhead Recovery Plan.	
High	**High**		

Life Stage: Juveniles (full-range)

Table 265. Direct mortality risk hypothesis; Steelhead, South-Central California Coast DPS and diazinon; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	2.8	High	Medium
Vegetables and Ground Fruit	0.7	High	High
Nurseries	0.03	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence	High density of vegetables and ground fruit use sites proximal to the spawning streams of populations within the Salinas River watershed. All populations within the Salinas River watershed have been determined essential to the recovery of the DPS per the 2013 South-Central California Steelhead Recovery Plan.	
High	High		

Table 266. Growth risk hypothesis; Steelhead, South-Central California Coast DPS and diazinon; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	2.8	High	Medium
Vegetables and Ground Fruit	0.7	High	High
Nurseries	0.03	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence	High density of vegetables and ground fruit use sites proximal to the spawning streams of populations within the Salinas River watershed. All populations within the Salinas River watershed have been determined essential to the recovery of the DPS per the 2013 South-Central California Steelhead Recovery Plan.	
High	High		

Table 267. Prey risk hypothesis; Steelhead, South-Central California Coast DPS and diazinon; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.8	High	Medium
Vegetables and Ground Fruit	0.7	High	High
Nurseries	0.03	High	Low
Bin 3		High	Medium
Bin 4		High	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			

Risk	**Confidence**	High density of vegetables and ground fruit use sites proximal to the spawning streams of populations within the Salinas River watershed. All populations within the Salinas River watershed have been determined essential to the recovery of the DPS per the 2013 South-Central California Steelhead Recovery Plan.
High	**High**	

Table 268. AChE risk hypothesis; Steelhead, South-Central California Coast DPS and diazinon; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	2.8	High	Medium
Vegetables and Ground Fruit	0.7	High	High
Nurseries	0.03	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence	High density of vegetables and ground fruit use sites proximal to the spawning streams of populations within the Salinas River watershed. All populations within the Salinas River watershed have been determined essential to the recovery of the DPS per the 2013 South-Central California Steelhead Recovery Plan.	
High	High		

Table 269. Behavior and sensory risk hypothesis; Steelhead, South-Central California Coast DPS and diazinon; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

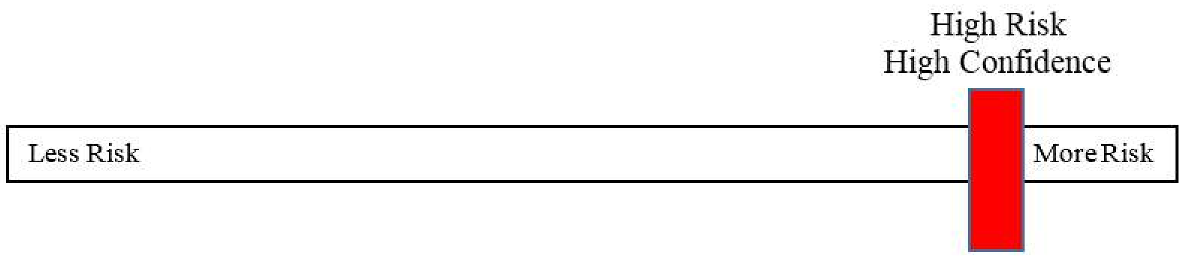
Orchards and Vineyards	2.8	High	Medium
Vegetables and Ground Fruit	0.7	High	High
Nurseries	0.03	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.8	High	Medium
Vegetables and Ground Fruit	0.7	High	High
Nurseries	0.03	High	Low
Bin 3		High	Medium
Bin 4		High	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**	High density of vegetables and ground fruit use sites proximal to the spawning streams of populations within the Salinas River watershed. All populations within the Salinas River watershed have been determined essential to the recovery of the DPS per the 2013 South-Central California Steelhead Recovery Plan.	
High	**High**		

Table 270. Effects analysis summary table: Steelhead, South-Central California Coast DPS and diazinon

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 0-3	**Yes**

Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 0-3	**Yes**
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day fish: 0-3 4-day invert: 3-37	**Yes**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, South-Central California Coast DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to diazinon. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where diazinon achieves predicted levels. The MagTool results indicate that between 0-3 percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed steelhead. The overall risk to Steelhead, South-Central California Coast DPS from the effects of the action is high and the confidence associated with that risk is high. High risk is due, in part, to the proximity of vegetables and ground fruit use sites to spawning streams of the Salinas River watershed populations. Uses associated with the vegetables and ground fruit GIS layer are approved for use at times when individuals of these populations are present. All populations within the Salinas River watershed have been determined essential to the recovery of the ESU per the 2013 South-Central California Steelhead Recovery Plan.



13.28 Steelhead, Southern California DPS (Oncorhynchus mykiss)

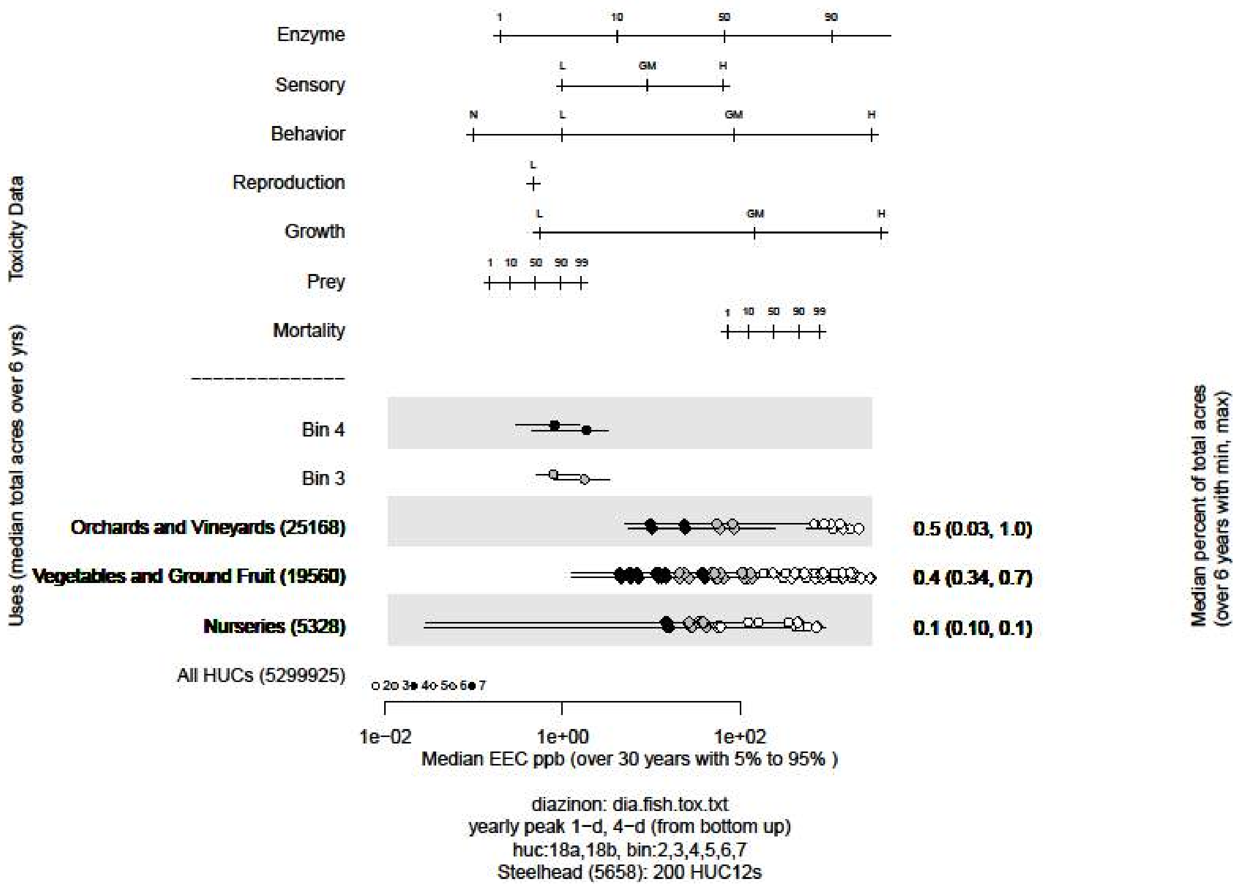


Figure 27. Effects analysis R-plot for Steelhead, Southern California DPS and diazinon

Table 271. Likelihood of exposure determination for Steelhead, Southern California DPS and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Orchards and Vineyards	1	yes	no	yes	yes	3	**High**
Vegetables and Ground Fruit	1	yes	no	yes	yes	3	**High**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	1	yes	no	yes	NA	3	**Low**
Bin 4	1	yes	no	yes	NA	3	**Low**
Juveniles							
Orchards and Vineyards	1	yes	no	yes	yes	3	**High**
Vegetables and Ground Fruit	1	yes	no	yes	yes	3	**High**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	1	yes	no	yes	NA	3	**Low**
Bin 4	1	yes	no	yes	NA	3	**Low**

Life Stage: Adults (full-range)

Table 272. Direct mortality risk hypothesis; Steelhead, Southern California DPS and diazinon; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High
Nurseries	0.1	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**	High density of vegetables and ground fruit, and orchards and vineyards use sites proximal to the spawning streams of the Monte Arido Highlands major population group. All populations within this population group have been determined	
High	**High**		

		essential to the recovery of the DPS per the 2012 Southern California Steelhead Recovery Plan.

Table 273. Reproduction risk hypothesis; Steelhead, Southern California DPS and diazinon; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High
Nurseries	0.1	High	Low
Bin 3		High	Low
Bin 4		High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**	High density of vegetables and ground fruit, and orchards and vineyards use sites proximal to the spawning streams of the Monte Arido Highlands major population group. All populations within this population group have been determined essential to the recovery of the DPS per the 2012 Southern California Steelhead Recovery Plan.	
High	**High**		

Table 274. Behavior and sensory risk hypothesis; Steelhead, Southern California DPS and diazinon; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High
Nurseries	0.1	High	Low
Bin 3		Medium	Low

Bin 4		Medium	Low
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High
Nurseries	0.1	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**	High density of vegetables and ground fruit, and orchards and vineyards use sites proximal to the spawning streams of the Monte Arido Highlands major population group. All populations within this population group have been determined essential to the recovery of the DPS per the 2012 Southern California Steelhead Recovery Plan.	
High	**High**		

Table 275. AChE risk hypothesis; Steelhead, Southern California DPS and diazinon; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High
Nurseries	0.1	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			

Risk	Confidence	
High	**High**	High density of vegetables and ground fruit, and orchards and vineyards use sites proximal to the spawning streams of the Monte Arido Highlands major population group. All populations within this population group have been determined essential to the recovery of the DPS per the 2012 Southern California Steelhead Recovery Plan.

Life Stage: Juveniles (full-range)

Table 276. Direct mortality risk hypothesis; Steelhead, Southern California DPS and diazinon; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High
Nurseries	0.1	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence	High density of vegetables and ground fruit, and orchards and vineyards use sites proximal to the spawning streams of the Monte Arido Highlands major population group. All populations within this population group have been determined essential to the recovery of the DPS per the 2012 Southern California Steelhead Recovery Plan.	
High	High		

Table 277. Growth risk hypothesis; Steelhead, Southern California DPS and diazinon; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure

Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High
Nurseries	0.1	High	Low
Bin 3		Low	Low
Bin 4		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence	High density of vegetables and ground fruit, and orchards and vineyards use sites proximal to the spawning streams of the Monte Arido Highlands major population group. All populations within this population group have been determined essential to the recovery of the DPS per the 2012 Southern California Steelhead Recovery Plan.	
High	High		

Table 278. Prey risk hypothesis; Steelhead, Southern California DPS and diazinon; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High
Nurseries	0.1	High	Low
Bin 3		High	Low
Bin 4		High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**	High density of vegetables and ground fruit, and orchards and vineyards use sites proximal to the spawning streams of the Monte Arido Highlands major population group. All populations within	
High	**High**		

		this population group have been determined essential to the recovery of the DPS per the 2012 Southern California Steelhead Recovery Plan.

Table 279. AChE risk hypothesis; Steelhead, Southern California DPS and diazinon; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High
Nurseries	0.1	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence	High density of vegetables and ground fruit, and orchards and vineyards use sites proximal to the spawning streams of the Monte Arido Highlands major population group. All populations within this population group have been determined essential to the recovery of the DPS per the 2012 Southern California Steelhead Recovery Plan.	
High	High		

Table 280. Behavior and sensory risk hypothesis; Steelhead, Southern California DPS and diazinon; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High

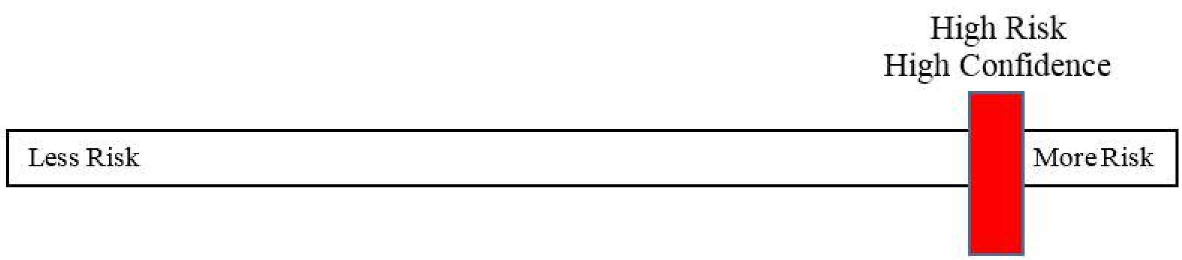
Nurseries	0.1	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High
Nurseries	0.1	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**	High density of vegetables and ground fruit, and orchards and vineyards use sites proximal to the spawning streams of the Monte Arido Highlands major population group. All populations within this population group have been determined essential to the recovery of the DPS per the 2012 Southern California Steelhead Recovery Plan.	
High	**High**		

Table 281. Effects analysis summary table: Steelhead, Southern California DPS and diazinon

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 0-1	**Yes**
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**

Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 0-1	**Yes**
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day fish: 0-1 4-day invert: 1-18	**Yes**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, Southern California DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to diazinon. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where diazinon achieves predicted levels. The MagTool results indicate that between 0-1 percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed steelhead. The overall risk to Steelhead, Southern California DPS from the effects of the action is high and the confidence associated with that risk is high. High risk is due to the proximity of vegetables and ground fruit, and orchards and vineyards use sites to the spawning streams of the Monte Arido Highlands major population group. Uses associated with the vegetables and ground fruit, and orchards and vineyards GIS layers are approved for use at times when individuals of these populations are present. All populations within the Monte Arido Highlands major population group have been determined essential to the recovery of the ESU per the 2012 Southern California Steelhead Recovery Plan.



13.29 Steelhead, Upper Columbia River DPS (Oncorhynchus mykiss)

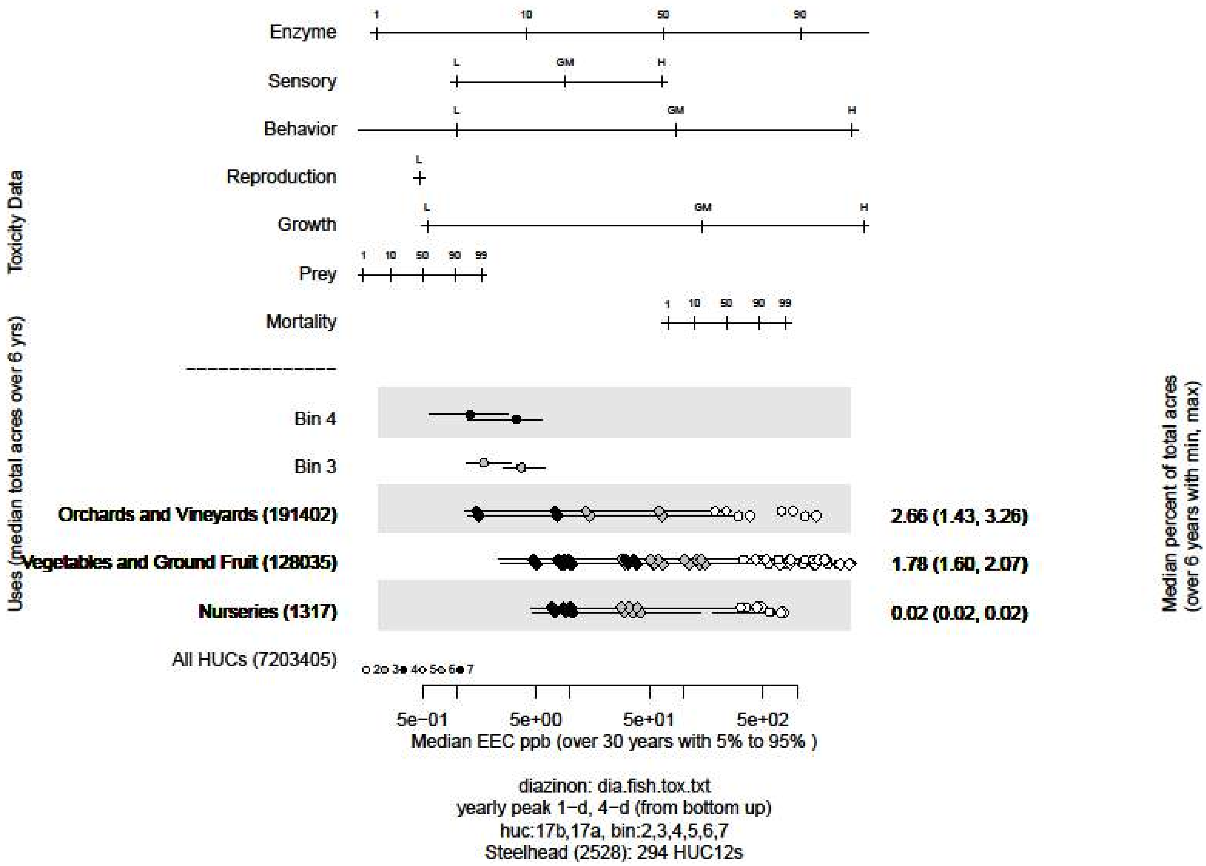


Figure 28. Effects analysis R-plot for Steelhead, Upper Columbia River DPS and diazinon

Table 282. Likelihood of exposure determination for Steelhead, Upper Columbia River DPS and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Orchards and Vineyards	2	yes	no	yes	NA	3	**Med**
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	**Med**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	2	yes	no	yes	NA	3	**Med**
Bin 4	2	yes	no	yes	NA	3	**Med**
Juveniles							
Orchards and Vineyards	2	yes	no	yes	NA	3	**Med**
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	**Med**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	2	yes	no	yes	NA	3	**Med**
Bin 4	2	yes	no	yes	NA	3	**Med**

Life Stage: Adults (full-range)

Table 283. Direct mortality risk hypothesis; Steelhead, Upper Columbia River DPS and diazinon; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.7	High	Medium
Vegetables and Ground Fruit	1.8	High	Medium
Nurseries	0.02	High	Low
Bin 3		Low	Medium
Bin 4		Low	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 284. Reproduction risk hypothesis; Steelhead, Upper Columbia River DPS and diazinon; Adults

Endpoint: Reproduction

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	2.7	High	Medium
Vegetables and Ground Fruit	1.8	High	Medium
Nurseries	0.02	High	Low
Bin 3		High	Medium
Bin 4		High	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 285. Behavior and sensory risk hypothesis; Steelhead, Upper Columbia River DPS and diazinon; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.7	High	Medium
Vegetables and Ground Fruit	1.8	High	Medium
Nurseries	0.02	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.7	High	Medium
Vegetables and Ground Fruit	1.8	High	Medium

Nurseries	0.02	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 286. AChE risk hypothesis; Steelhead, Upper Columbia River DPS and diazinon; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.7	High	Medium
Vegetables and Ground Fruit	1.8	High	Medium
Nurseries	0.02	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 287. Direct mortality risk hypothesis; Steelhead, Upper Columbia River DPS and diazinon; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	2.7	High	Medium

Vegetables and Ground Fruit	1.8	High	Medium
Nurseries	0.02	High	Low
Bin 3		Low	Medium
Bin 4		Low	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 288. Growth risk hypothesis; Steelhead, Upper Columbia River DPS and diazinon; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	2.7	High	Medium
Vegetables and Ground Fruit	1.8	High	Medium
Nurseries	0.02	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 289. Prey risk hypothesis; Steelhead, Upper Columbia River DPS and diazinon; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.7	High	Medium

Vegetables and Ground Fruit	1.8	High	Medium
Nurseries	0.02	High	Low
Bin 3		High	Medium
Bin 4		High	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 290. AChE risk hypothesis; Steelhead, Upper Columbia River DPS and diazinon; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	2.7	High	Medium
Vegetables and Ground Fruit	1.8	High	Medium
Nurseries	0.02	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 291. Behavior and sensory risk hypothesis; Steelhead, Upper Columbia River DPS and diazinon; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

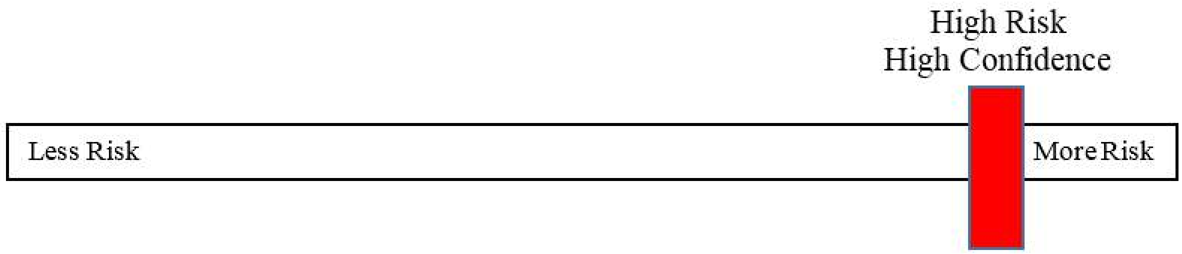
Orchards and Vineyards	2.7	High	Medium
Vegetables and Ground Fruit	1.8	High	Medium
Nurseries	0.02	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.7	High	Medium
Vegetables and Ground Fruit	1.8	High	Medium
Nurseries	0.02	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 292. Effects analysis summary table: Steelhead, Upper Columbia River DPS and diazinon

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 0-5	**Yes**
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**

Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 0-5	**Yes**
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day fish: 0-4 4-day invert: 5-30	**Yes**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, Upper Columbia River DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to diazinon. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where diazinon achieves predicted levels. The MagTool results indicate that between 0-5 percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed steelhead. The overall risk to Steelhead, Upper Columbia River DPS from the effects of the action is high and the confidence associated with that risk is high.



13.30 Steelhead, Upper Willamette River DPS (Oncorhynchus mykiss)

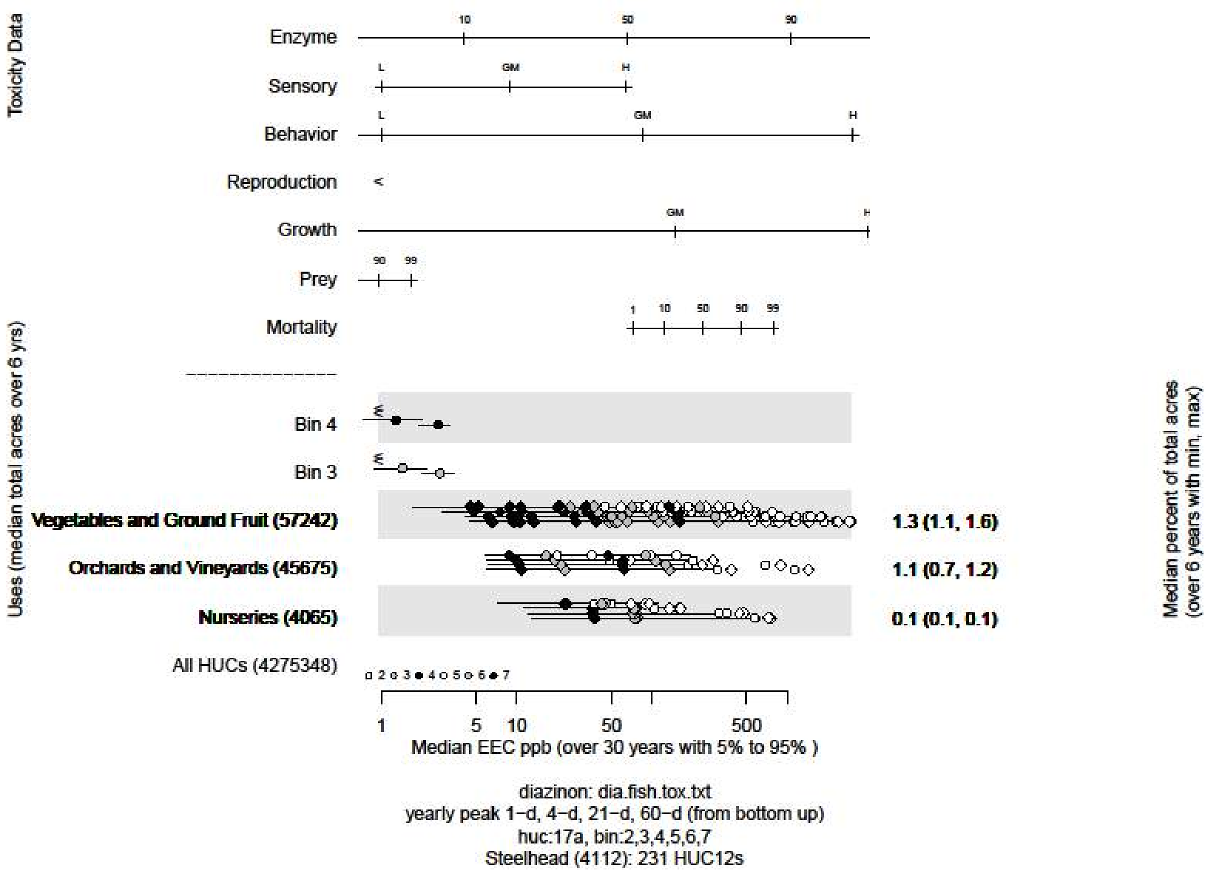


Figure 29. Effects analysis R-plot for Steelhead, Upper Willamette River DPS and diazinon

Table 293. Likelihood of exposure determination for Steelhead, Upper Willamette River DPS and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	**Med**
Orchards and Vineyards	2	yes	no	yes	NA	3	**Med**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	2	yes	no	yes	NA	3	**Med**
Bin 4	2	yes	no	yes	NA	3	**Med**
Juveniles							
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	**Med**
Orchards and Vineyards	2	yes	no	yes	NA	3	**Med**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	2	yes	no	yes	NA	3	**Med**
Bin 4	2	yes	no	yes	NA	3	**Med**

Life Stage: Adults (full-range)

Table 294. Direct mortality risk hypothesis; Steelhead, Upper Willamette River DPS and diazinon; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.3	High	Medium
Orchards and Vineyards	1.1	High	Medium
Nurseries	0.1	High	Low
Bin 3		High	Medium
Bin 4		High	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 295. Reproduction risk hypothesis; Steelhead, Upper Willamette River DPS and diazinon; Adults

Endpoint: Reproduction

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	1.3	High	Medium
Orchards and Vineyards	1.1	High	Medium
Nurseries	0.1	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 296. Behavior and sensory risk hypothesis; Steelhead, Upper Willamette River DPS and diazinon; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.3	High	Medium
Orchards and Vineyards	1.1	High	Medium
Nurseries	0.1	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.3	High	Medium
Orchards and Vineyards	1.1	High	Medium

Nurseries	0.1	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 297. AChE risk hypothesis; Steelhead, Upper Willamette River DPS and diazinon; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.3	High	Medium
Orchards and Vineyards	1.1	High	Medium
Nurseries	0.1	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 298. Direct mortality risk hypothesis; Steelhead, Upper Willamette River DPS and diazinon; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	1.3	High	Medium

Orchards and Vineyards	1.1	High	Medium
Nurseries	0.1	High	Low
Bin 3		High	Medium
Bin 4		High	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 299. Growth risk hypothesis; Steelhead, Upper Willamette River DPS and diazinon; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	1.3	High	Medium
Orchards and Vineyards	1.1	High	Medium
Nurseries	0.1	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 300. Prey risk hypothesis; Steelhead, Upper Willamette River DPS and diazinon; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.3	High	Medium

Orchards and Vineyards	1.1	High	Medium
Nurseries	0.1	High	Low
Bin 3		High	Medium
Bin 4		High	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 301. AChE risk hypothesis; Steelhead, Upper Willamette River DPS and diazinon; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	1.3	High	Medium
Orchards and Vineyards	1.1	High	Medium
Nurseries	0.1	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 302. Behavior and sensory risk hypothesis; Steelhead, Upper Willamette River DPS and diazinon; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

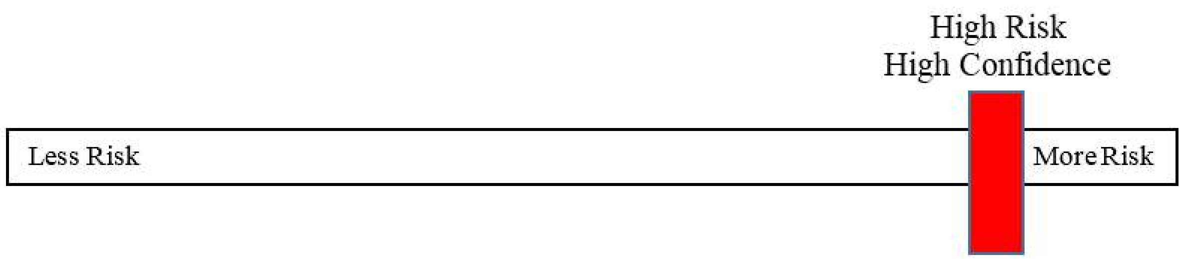
Vegetables and Ground Fruit	1.3	High	Medium
Orchards and Vineyards	1.1	High	Medium
Nurseries	0.1	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1.3	High	Medium
Orchards and Vineyards	1.1	High	Medium
Nurseries	0.1	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 303. Effects analysis summary table: Steelhead, Upper Willamette River DPS and diazinon

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 0-2	**Yes**
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**

Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 0-2	**Yes**
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day fish: 0-2 4-day invert: 3-32	**Yes**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, Upper Willamette River DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to diazinon. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where diazinon achieves predicted levels. The MagTool results indicate that between 0-2 percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed steelhead. The overall risk to Steelhead, Upper Willamette River DPS from the effects of the action is high and the confidence associated with that risk is high.



13.31 Eulachon, Southern DPS (Thaleichthys pacificus)

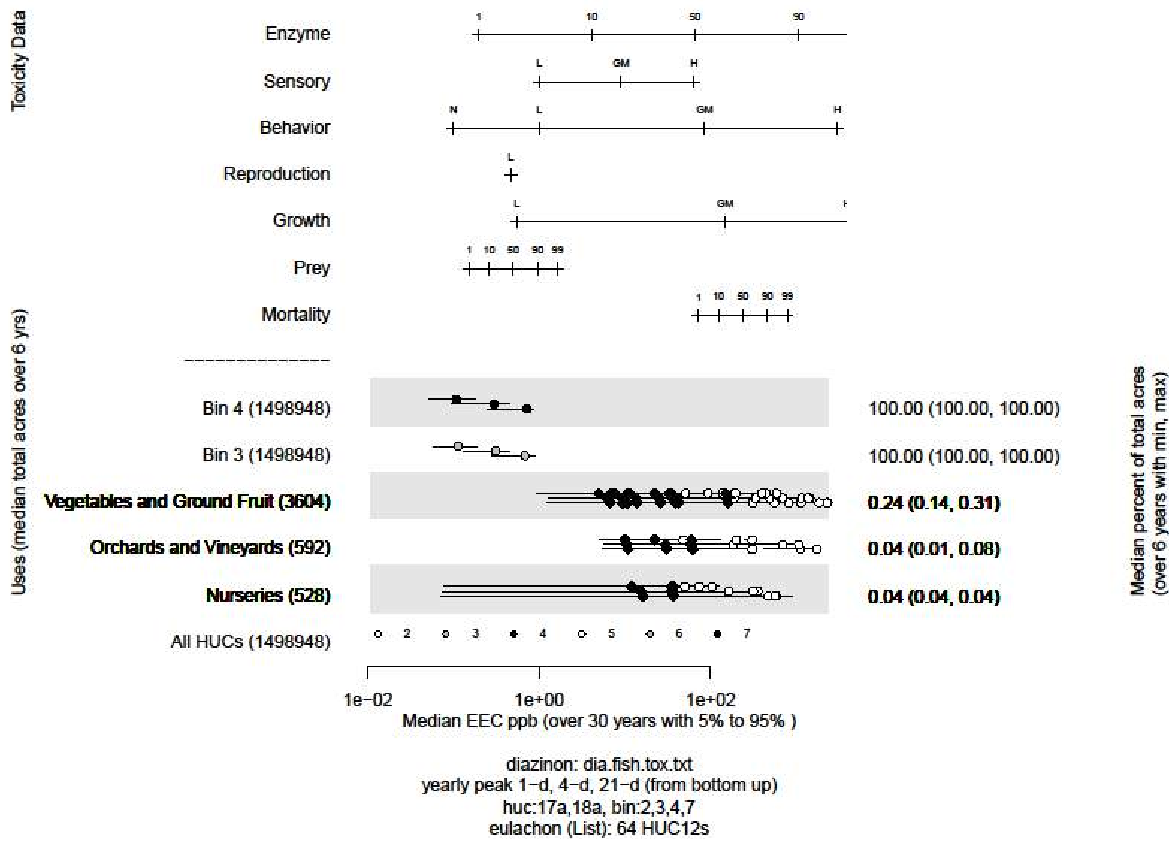


Figure 30. Effects analysis R-plot for Eulachon, Southern DPS and diazinon

Table 304. Likelihood of exposure determination for Eulachon, Southern DPS and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Vegetables and Ground Fruit	1	yes	no	yes	no	2	**Low**
Orchards and Vineyards	1	yes	no	yes	no	2	**Low**
Nurseries	1	yes	no	yes	no	2	**Low**
Bin 3	1	yes	no	yes	no	2	**Low**
Bin 4	1	yes	no	yes	no	2	**Low**

Life Stage: Juvenile and Adult (full-range)

Table 305. Direct mortality risk hypothesis; Eulachon, Southern DPS and diazinon; Adults and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.24	High	Low
Orchards and Vineyards	0.04	High	Low
Nurseries	0.04	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile and adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**High**		

Table 306. Prey risk hypothesis; Eulachon, Southern DPS and diazinon; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.24	High	Low
Orchards and Vineyards	0.04	High	Low
Nurseries	0.04	High	Low
Bin 3		High	Low
Bin 4		High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	**High**		

Table 307. Behavior and sensory risk hypothesis; Eulachon, Southern DPS and diazinon; Adults and Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.24	High	Low
Orchards and Vineyards	0.04	High	Low
Nurseries	0.04	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.24	High	Low
Orchards and Vineyards	0.04	High	Low
Nurseries	0.04	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile and adult abundance and adult productivity via impairments to ecologically significant behaviors			
Risk	**Confidence**		
Low	**High**		

Table 308. AChE risk hypothesis; Eulachon, Southern DPS and diazinon; Adults and Juveniles

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.24	High	Low

Orchards and Vineyards	0.04	High	Low
Nurseries	0.04	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**High**		

Table 309. Growth risk hypothesis; Eulachon, Southern DPS and diazinon; Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.24	High	Low
Orchards and Vineyards	0.04	High	Low
Nurseries	0.04	Medium	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
Low	**High**		

Table 310. Reproduction risk hypothesis; Eulachon, Southern DPS and diazinon; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

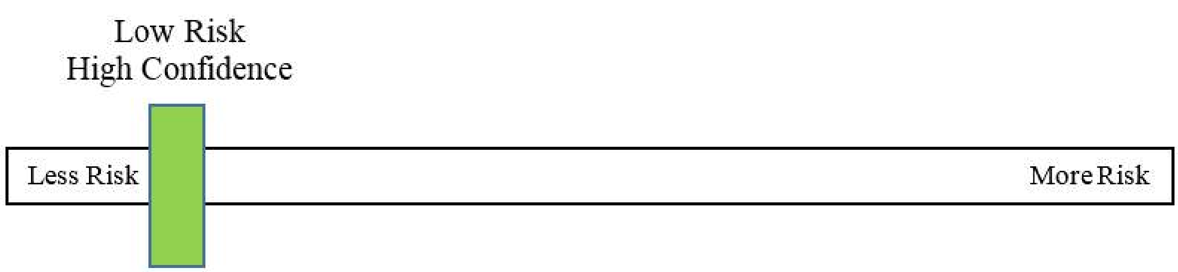
Vegetables and Ground Fruit	0.24	High	Low
Orchards and Vineyards	0.04	High	Low
Nurseries	0.04	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**High**		

Table 311. Effects analysis summary table: Eulachon, Southern DPS and diazinon

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles and Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce juvenile and adult abundance via acute lethality.	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce juvenile abundance via reduction in prey availability	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce juvenile and adult abundance and adult productivity via impairments to ecologically significant behaviors	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce ChE	Low	High	Not Available	No

activity; the identified mechanism of toxicity				
Exposure to diazinon is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Low	High	Not Available	No

Effects analysis summary: Adult and juvenile Eulachon, Southern DPS are not anticipated to experience significant reductions in abundance or productivity (spawning adults) from exposure to diazinon. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, eulachon may experience increased toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed eulachon. The overall risk to Eulachon, Southern DPS from the effects of the action is low and the confidence associated with that risk is high.



13.32 Green Sturgeon, Southern DPS (Acipenser medirostris)

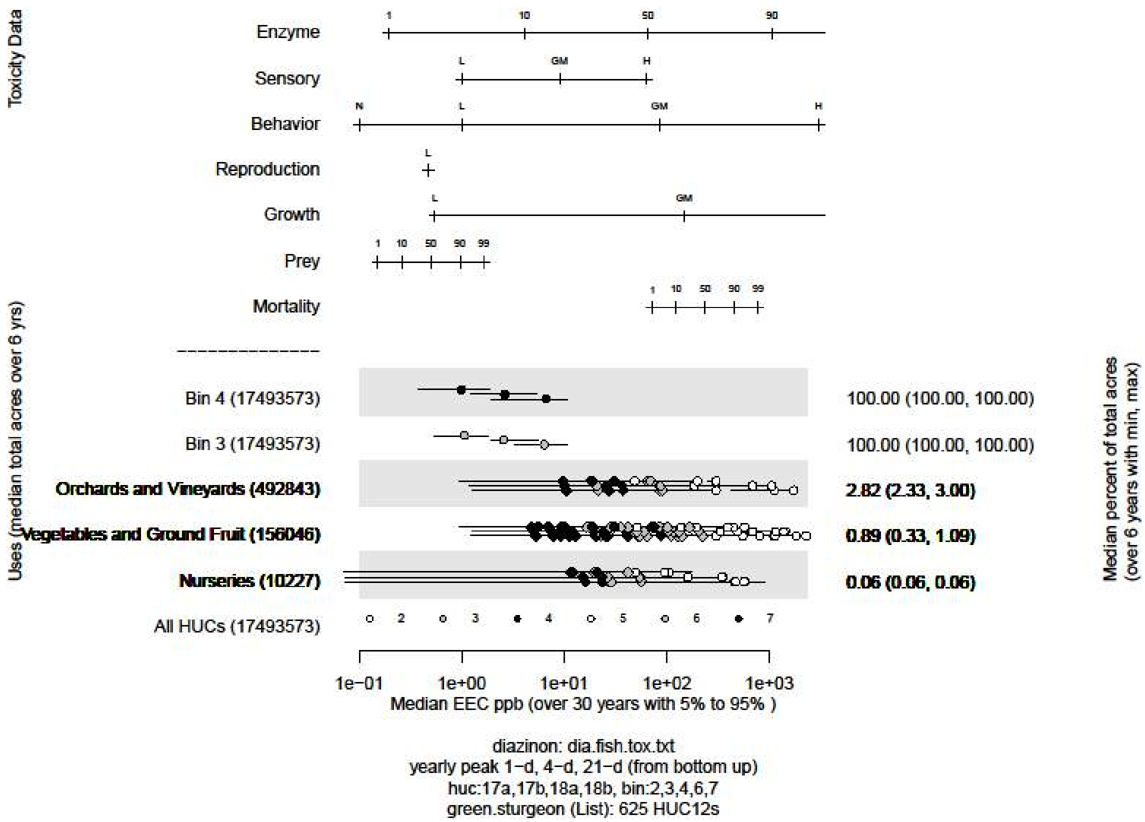


Figure 31. Effects analysis R-plot for Adult and Sub-Adult Green Sturgeon, Southern DPS and diazinon

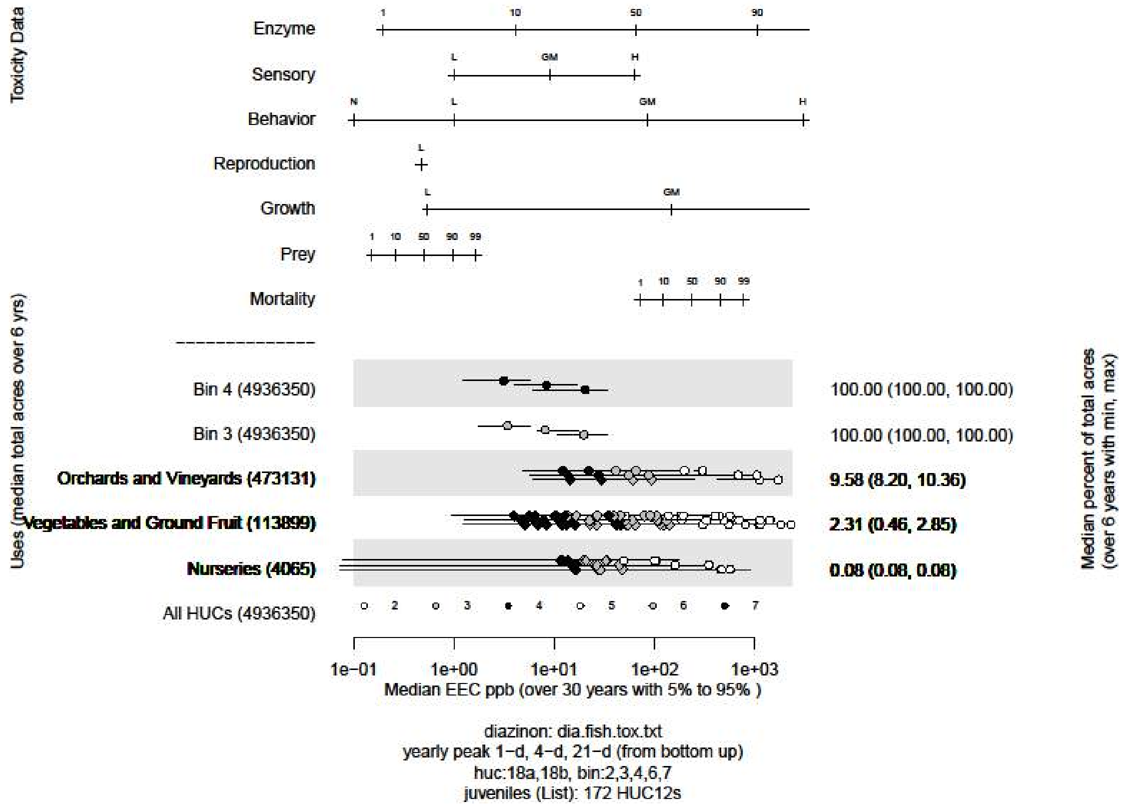


Figure 32. Effects analysis R-plot for Juvenile Green Sturgeon, Southern DPS and diazinon

Table 312. Likelihood of exposure determination for Green Sturgeon, Southern DPS and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adult and Sub-Adult							
Orchards and Vineyards	2	yes	no	yes	NA	3	**Med**
Vegetables and Ground Fruit	1	yes	no	yes	yes	3	**High**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	2	yes	no	yes	NA	3	**Med**
Bin 4	2	yes	no	yes	NA	3	**Med**
Juveniles							
Orchards and Vineyards	3	yes	no	yes	NA	3	**High**
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	**Med**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	3	yes	no	yes	NA	3	**High**
Bin 4	3	yes	no	yes	NA	3	**High**

Life Stage: Adults and Sub-Adults (full-range)

Table 313. Direct mortality risk hypothesis; Green Sturgeon, Southern DPS and diazinon; Adults and Sub-Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.8	High	Medium
Vegetables and Ground Fruit	0.9	High	High
Nurseries	0.06	High	Low
Bin 3		Low	Medium
Bin 4		Low	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult and sub-adult abundance via acute lethality.			
Risk	**Confidence**	High density of vegetables and ground fruit use sites proximal to the mainstem of the Sacramento River.	
High	**High**		

Table 314. Reproduction risk hypothesis; Green Sturgeon, Southern DPS and diazinon; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.8	High	Medium
Vegetables and Ground Fruit	0.9	High	High
Nurseries	0.06	High	Low
Bin 3		High	Medium
Bin 4		High	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			

Risk	Confidence	High density of vegetables and ground fruit use sites proximal to the mainstem of the Sacramento River.
High	**High**	

Table 315. Behavior and sensory risk hypothesis; Green Sturgeon, Southern DPS and diazinon; Adults and Sub-Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.8	High	Medium
Vegetables and Ground Fruit	0.9	High	High
Nurseries	0.06	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.8	High	Medium
Vegetables and Ground Fruit	0.9	High	High
Nurseries	0.06	High	Low
Bin 3		High	Medium
Bin 4		High	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult and sub-adult abundance and adult productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**	High density of vegetables and ground fruit use sites proximal to the mainstem of the Sacramento River.	
High	**High**		

Table 316. Prey risk hypothesis; Green Sturgeon, Southern DPS and diazinon; Adults and Sub-Adults

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.8	High	Medium
Vegetables and Ground Fruit	0.9	High	High
Nurseries	0.06	High	Low
Bin 3		High	Medium
Bin 4		High	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult and sub-adult abundance via reduction in prey availability			
Risk	**Confidence**	High density of vegetables and ground fruit use sites proximal to the mainstem of the Sacramento River.	
High	**High**		

Table 317. AChE risk hypothesis; Green Sturgeon, Southern DPS and diazinon; Adults and Sub-Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	2.8	High	Medium
Vegetables and Ground Fruit	0.9	High	High
Nurseries	0.06	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**	High density of vegetables and ground fruit use sites proximal to the mainstem of the Sacramento River.	
High	**High**		

Life Stage: Juveniles

Table 318. Direct mortality risk hypothesis; Green Sturgeon, Southern DPS and diazinon; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	9.6	High	High
Vegetables and Ground Fruit	2.3	High	Medium
Nurseries	0.08	High	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence	High density of vegetables and ground fruit use sites proximal to the mainstem of the Sacramento River.	
High	High		

Table 319. Growth risk hypothesis; Green Sturgeon, Southern DPS and diazinon; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	9.6	High	High
Vegetables and Ground Fruit	2.3	High	Medium
Nurseries	0.08	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)			
Risk	Confidence		

High	High	High density of vegetables and ground fruit use sites proximal to the mainstem of the Sacramento River.

Table 320. Prey risk hypothesis; Green Sturgeon, Southern DPS and diazinon; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	9.6	High	High
Vegetables and Ground Fruit	2.3	High	Medium
Nurseries	0.08	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**	High density of vegetables and ground fruit use sites proximal to the mainstem of the Sacramento River.	
High	**High**		

Table 321. AChE risk hypothesis; Green Sturgeon, Southern DPS and diazinon; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Orchards and Vineyards	9.6	High	High
Vegetables and Ground Fruit	2.3	High	Medium
Nurseries	0.08	High	Low
Bin 3		Medium	High
Bin 4		Medium	High

Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity		
Risk	Confidence	High density of vegetables and ground fruit use sites proximal to the mainstem of the Sacramento River.
High	High	

Table 322. Behavior and sensory risk hypothesis; Green Sturgeon, Southern DPS and diazinon; Juveniles

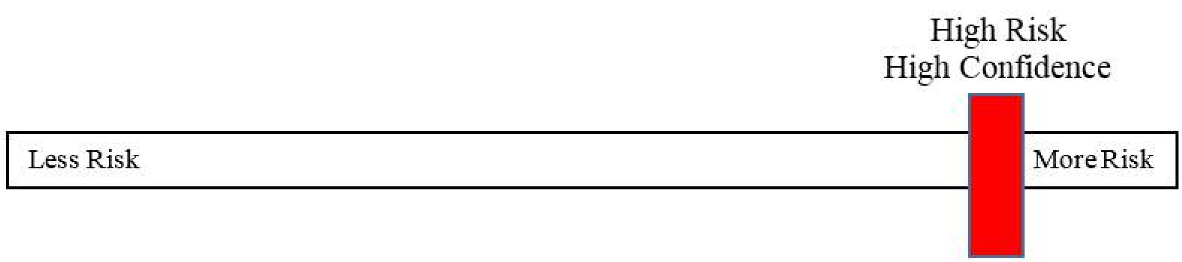
Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	9.6	High	High
Vegetables and Ground Fruit	2.3	High	Medium
Nurseries	0.08	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	9.6	High	High
Vegetables and Ground Fruit	2.3	High	Medium
Nurseries	0.08	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**	High density of vegetables and ground fruit use sites proximal to the mainstem of the Sacramento River.	
High	**High**		

Table 323. Effects analysis summary table: Green Sturgeon, Southern DPS and diazinon

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Adults and Sub-Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult and sub-adult abundance via acute lethality.	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce adult and sub-adult abundance and adult productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce adult and sub-adult abundance via reduction in prey availability	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce ChE	High	High	Not Available	**Yes**

activity; the identified mechanism of toxicity				
Exposure to diazinon is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Green Sturgeon, Southern DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to diazinon. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where diazinon achieves predicted levels. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, sturgeon will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed sturgeon. The overall risk to Green Sturgeon, Southern DPS from the effects of the action is high and the confidence associated with that risk is high. High risk is due primarily to the proximity of vegetables and ground fruit use sites to the mainstem of the Sacramento River.



13.33 Shortnose Sturgeon (Acipenser brevirostrum)

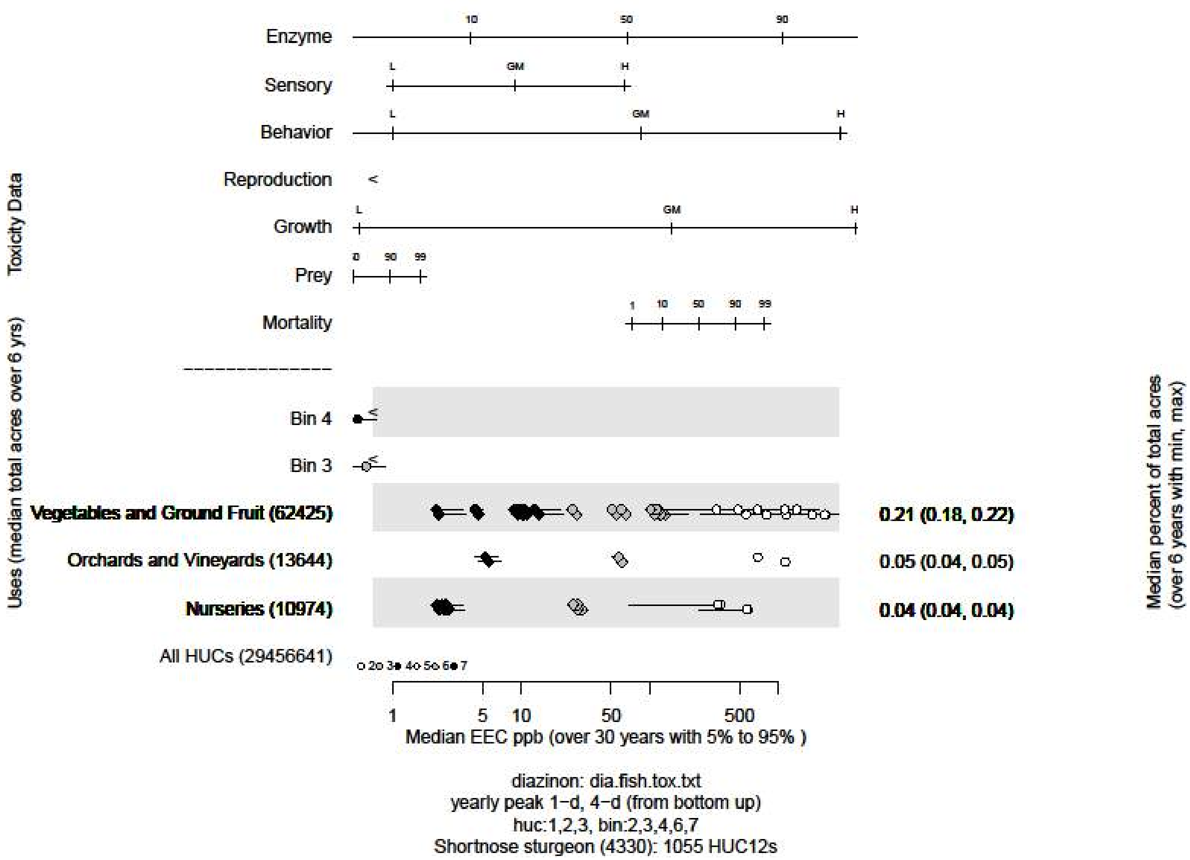


Figure 33. Effects analysis R-plot for Shortnose Sturgeon and diazinon

Table 324. Likelihood of exposure determination for Shortnose Sturgeon and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	**Low**
Orchards and Vineyards	1	yes	no	yes	NA	3	**Low**
Nurseries	1	yes	no	yes	NA	3	**Low**
Bin 3	1	yes	no	yes	NA	3	**Low**
Bin 4	1	yes	no	yes	NA	3	**Low**

Life Stage: Juvenile and Adult (Full Range)

Table 325. Direct mortality risk hypothesis; Shortnose Sturgeon and diazinon; Adults and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.21	High	Low
Orchards and Vineyards	0.05	High	Low
Nurseries	0.04	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult and juvenile abundance via acute lethality.			
Risk	**Confidence**		
Low	**High**		

Table 326. Prey risk hypothesis; Shortnose Sturgeon and diazinon; Adults and Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.21	High	Low
Orchards and Vineyards	0.05	High	Low
Nurseries	0.04	High	Low
Bin 3		High	Low
Bin 4		High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult and juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	**High**		

Table 327. Behavior and sensory risk hypothesis; Shortnose Sturgeon and diazinon; Adults and Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.21	High	Low
Orchards and Vineyards	0.05	High	Low
Nurseries	0.04	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.21	High	Low
Orchards and Vineyards	0.05	High	Low
Nurseries	0.04	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
Low	**High**		

Table 328. AChE risk hypothesis; Shortnose Sturgeon and diazinon; Adults and Juveniles

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.21	High	Low

Orchards and Vineyards	0.05	High	Low
Nurseries	0.04	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**High**		

Table 329. Growth risk hypothesis; Shortnose Sturgeon and diazinon; Adults and Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.21	High	Low
Orchards and Vineyards	0.05	High	Low
Nurseries	0.04	Medium	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
Low	**High**		

Table 330. Reproduction risk hypothesis; Shortnose Sturgeon and diazinon; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

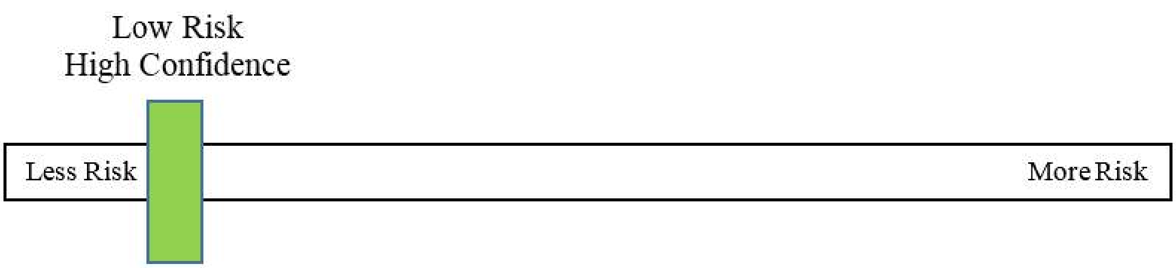
Vegetables and Ground Fruit	0.21	High	Low
Orchards and Vineyards	0.05	High	Low
Nurseries	0.04	High	Low
Bin 3		-	Low
Bin 4		-	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**High**		

Table 331. Effects analysis summary table: Shortnose Sturgeon and diazinon

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles and Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult and juvenile abundance via acute lethality.	Low	High	4-day: 0	No
Exposure to diazinon is sufficient to reduce adult and juvenile abundance via reduction in prey availability	Low	High	4-day fish: 0 4-day invert: 0-5	No
Exposure to diazinon is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	Low	High	Not Available	No

Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Low	High	Not Available	No

Effects analysis summary: Adult and juvenile Shortnose Sturgeon are not anticipated to experience significant reductions in abundance or productivity (spawning adults) from exposure to diazinon. The MagTool results indicate that 0 percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, sturgeon may experience increased toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed sturgeon in northern regions. The overall risk to Shortnose Sturgeon from the effects of the action is low and the confidence associated with that risk is high.



13.34 Atlantic Sturgeon, Carolina DPS (Acipenser oxyrinchus oxyrinchus)

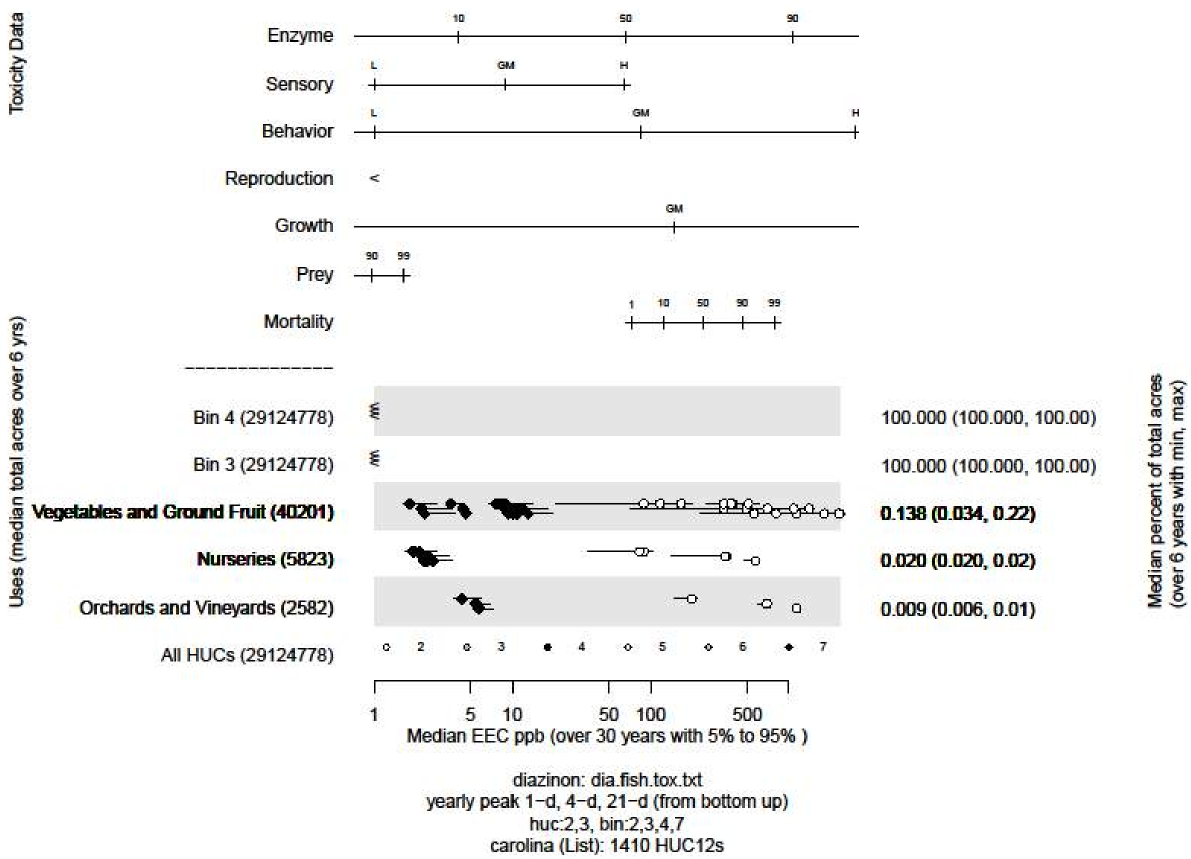


Figure 34. Effects analysis R-plot for Atlantic sturgeon, Carolina DPS and diazinon

Table 332. Likelihood of exposure determination for Atlantic sturgeon, Carolina DPS and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Vegetables and Ground Fruit	1	yes	no	yes	no	3	Low
Nurseries	1	yes	no	yes	no	3	Low
Orchards and Vineyards	1	yes	no	yes	no	3	Low
Bin 3	1	yes	no	yes	no	3	Low
Bin 4	1	yes	no	yes	no	3	Low

Life Stage: Juvenile and Adult

Table 333. Direct mortality risk hypothesis; Atlantic sturgeon, Carolina DPS and diazinon; Adults and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.1	High	**Low**
Nurseries	0.02	High	**Low**
Orchards and Vineyards	0.009	High	**Low**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult and juvenile abundance via acute lethality.			
Risk	**Confidence**		
Low	**High**		

Table 334. Prey risk hypothesis; Atlantic sturgeon, Carolina DPS and diazinon; Adults and Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.1	High	**Low**
Nurseries	0.02	High	**Low**
Orchards and Vineyards	0.009	High	**Low**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult and juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	**High**		

Table 335. Behavior and sensory risk hypothesis; Atlantic sturgeon, Carolina DPS and diazinon; Adults and Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.1	High	**Low**
Nurseries	0.02	High	**Low**
Orchards and Vineyards	0.009	High	**Low**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.1	High	**Low**
Nurseries	0.02	High	**Low**
Orchards and Vineyards	0.009	High	**Low**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
Low	**High**		

Table 336. AChE risk hypothesis; Atlantic sturgeon, Carolina DPS and diazinon; Adults and Juveniles

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.1	High	**Low**

Nurseries	0.02	High	**Low**
Orchards and Vineyards	0.009	High	**Low**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**High**		

Table 337. Growth risk hypothesis; Atlantic sturgeon, Carolina DPS and diazinon; Adults and Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.1	High	**Low**
Nurseries	0.02	Medium	**Low**
Orchards and Vineyards	0.009	High	**Low**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
Low	**High**		

Table 338. Reproduction risk hypothesis; Atlantic sturgeon, Carolina DPS and diazinon; Adults

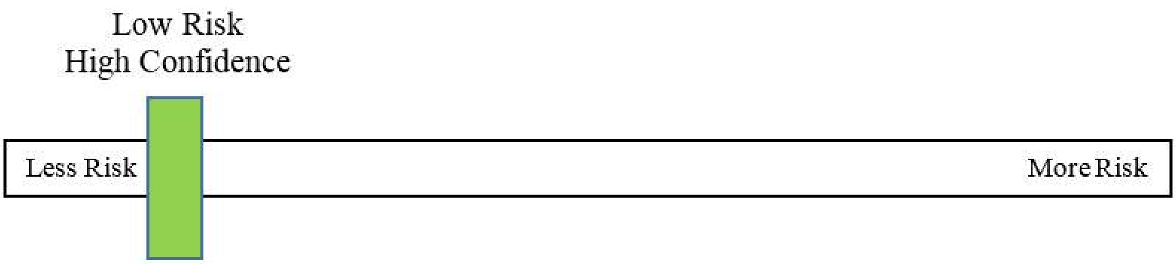
Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.1	High	**Low**

Nurseries	0.02	High	**Low**
Orchards and Vineyards	0.009	High	**Low**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**High**		

Table 339. Effects analysis summary table: Atlantic sturgeon, Carolina DPS and diazinon

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles and Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult and juvenile abundance via acute lethality.	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce adult and juvenile abundance via reduction in prey availability	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Low	High	Not Available	No

Effects analysis summary: Adult and juvenile Atlantic sturgeon, Carolina are not anticipated to experience significant reductions in abundance or productivity (spawning adults) from exposure to diazinon. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, sturgeon may experience increased toxicity. The overall risk to Atlantic sturgeon, Carolina DPS from the effects of the action is low and the confidence associated with that risk is high.



13.35 Atlantic Sturgeon, Chesapeake Bay DPS (Acipenser oxyrinchus oxyrinchus)

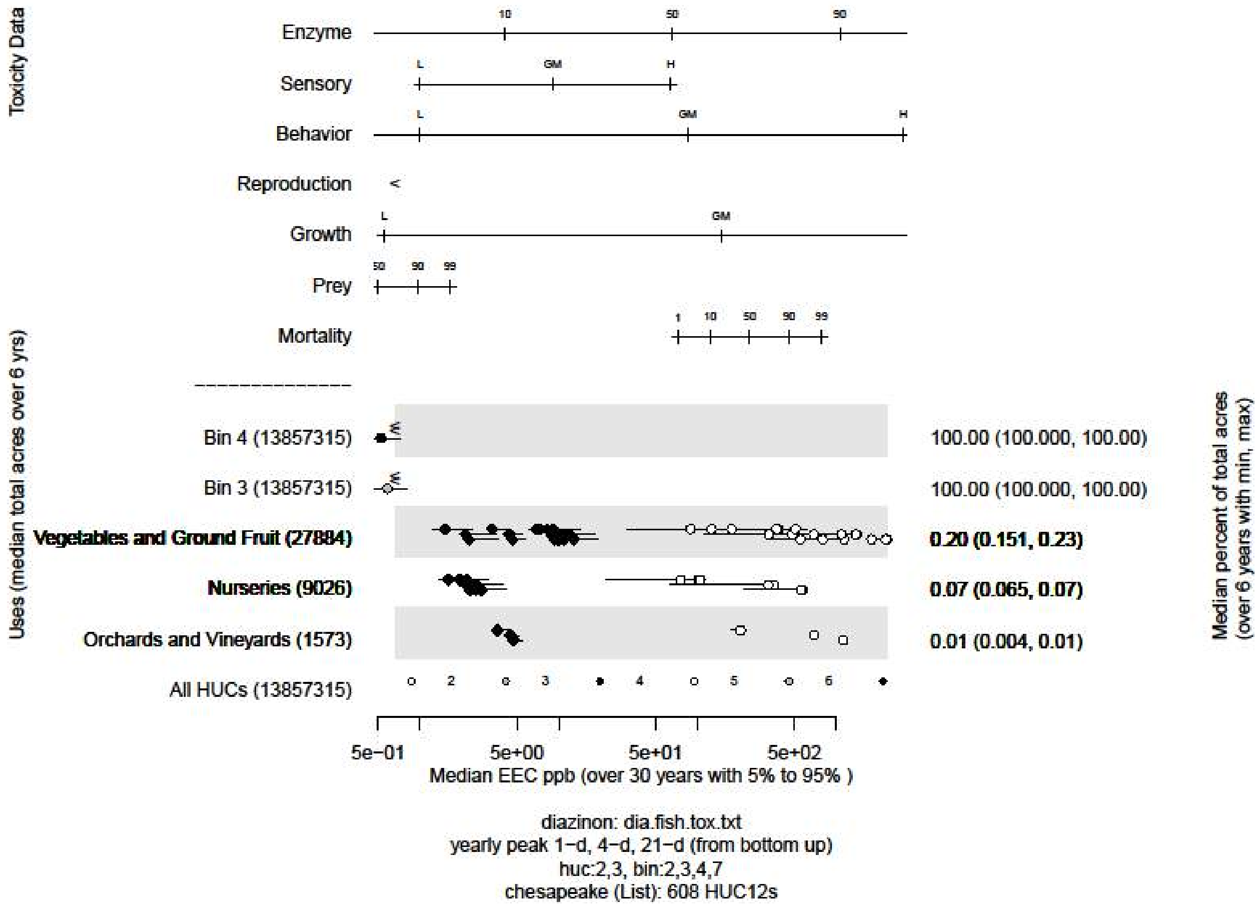


Figure 35. Effects analysis R-plot for Atlantic sturgeon, Chesapeake Bay DPS and diazinon

Table 340. Likelihood of exposure determination for Atlantic sturgeon, Chesapeake Bay DPS and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Vegetables and Ground fruit	1	yes	no	yes	no	3	**Low**
Nurseries	1	yes	no	yes	no	3	**Low**
Orchards and Vineyards	1	yes	no	yes	no	3	**Low**
Bin 3	1	yes	no	yes	NA	3	**Low**
Bin 4	1	yes	no	yes	NA	3	**Low**

Life Stage: Juvenile and Adult

Table 341. Direct mortality risk hypothesis; Atlantic sturgeon, Chesapeake Bay DPS and diazinon; Adults and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground fruit	0.2	High	**Low**
Nurseries	0.07	High	**Low**
Orchards and Vineyards	0.01	High	**Low**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult and juvenile abundance via acute lethality.			
Risk	**Confidence**		
Low	**High**		

Table 342. Prey risk hypothesis; Atlantic sturgeon, Chesapeake Bay DPS and diazinon; Adults and Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground fruit	0.2	High	**Low**
Nurseries	0.07	High	**Low**
Orchards and Vineyards	0.01	High	**Low**
Bin 3		High	**Low**
Bin 4		High	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult and juvenile abundance via reduction in prey availability			
Risk	**Confidence**		

Low	**High**	

Table 343. Behavior and sensory risk hypothesis; Atlantic sturgeon, Chesapeake Bay DPS and diazinon; Adults and Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground fruit	0.2	High	**Low**
Nurseries	0.07	High	**Low**
Orchards and Vineyards	0.01	High	**Low**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground fruit	0.2	High	**Low**
Nurseries	0.07	High	**Low**
Orchards and Vineyards	0.01	High	**Low**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
Low	**High**		

Table 344. AChE risk hypothesis; Atlantic sturgeon, Chesapeake Bay DPS and diazinon; Adults and Juveniles

Endpoint: enzyme

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground fruit	0.2	High	**Low**
Nurseries	0.07	High	**Low**
Orchards and Vineyards	0.01	High	**Low**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**High**		

Table 345. Growth risk hypothesis; Atlantic sturgeon, Chesapeake Bay DPS and diazinon; Adults and Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground fruit	0.2	High	**Low**
Nurseries	0.07	Medium	**Low**
Orchards and Vineyards	0.01	High	**Low**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
Low	**High**		

Table 346. Reproduction risk hypothesis; Atlantic sturgeon, Chesapeake Bay DPS and diazinon; Adults and Juveniles

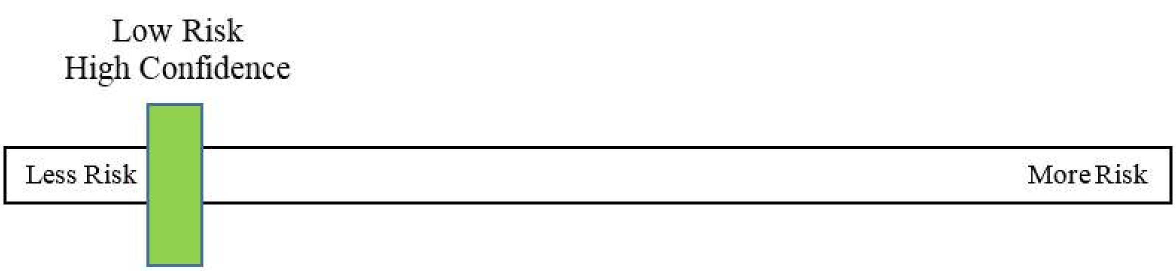
Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground fruit	0.2	High	**Low**
Nurseries	0.07	High	**Low**
Orchards and Vineyards	0.01	High	**Low**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**High**		

Table 347. Effects analysis summary table: Atlantic sturgeon, Chesapeake Bay DPS and diazinon

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles and Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult and juvenile abundance via acute lethality.	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce adult and juvenile abundance via reduction in prey availability	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce ChE	Low	High	Not Available	No

activity; the identified mechanism of toxicity				
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Low	High	Not Available	No

Effects analysis summary: Adult and juvenile Atlantic sturgeon, Chesapeake Bay DPS are not anticipated to experience significant reductions in abundance or productivity (spawning adults) from exposure to diazinon. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, sturgeon may experience increased toxicity. The overall risk to Atlantic sturgeon, Chesapeake Bay DPS from the effects of the action is low and the confidence associated with that risk is high.



13.36 Atlantic Sturgeon, Gulf of Maine DPS (Acipenser oxyrinchus oxyrinchus)

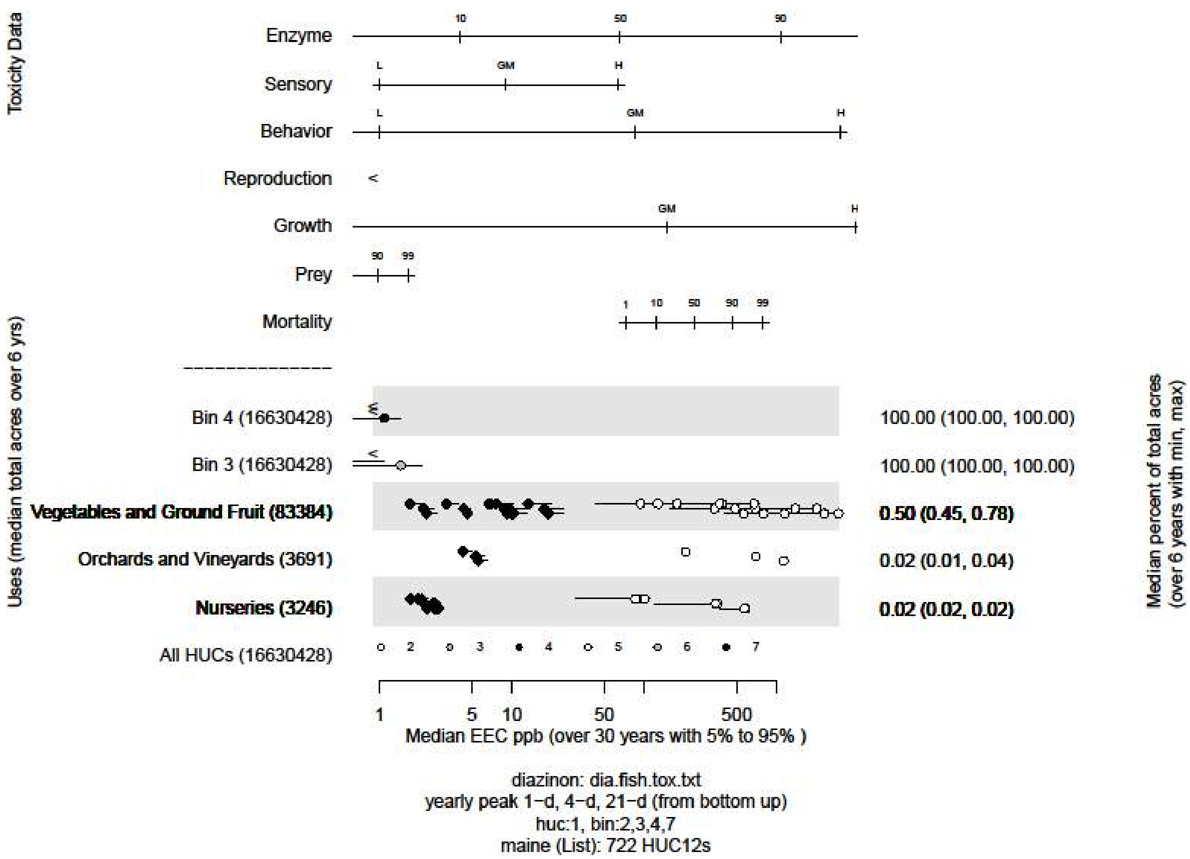


Figure 36. Effects analysis R-plot for Atlantic sturgeon, Gulf of Maine DPS and diazinon

Table 348. Likelihood of exposure determination for Atlantic sturgeon, Gulf of Maine DPS and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Vegetables and Ground Fruit	1	yes	no	yes	no	3	**Low**
Orchards and Vineyards	1	yes	no	yes	no	3	**Low**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	1	yes	no	yes	no	3	**Low**
Bin 4	1	yes	no	yes	no	3	**Low**

Life Stage: Juvenile and Adult

Table 349. Direct mortality risk hypothesis; Atlantic sturgeon, Gulf of Maine DPS and diazinon; Adults and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.05	High	Low
Orchards and Vineyards	0.02	High	Low
Nurseries	0.02	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult and juvenile abundance via acute lethality.			
Risk	**Confidence**		
Low	**High**		

Table 350. Prey risk hypothesis; Atlantic sturgeon, Gulf of Maine DPS and diazinon; Adults and Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.05	High	Low
Orchards and Vineyards	0.02	High	Low
Nurseries	0.02	High	Low
Bin 3		High	Low
Bin 4		High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult and juvenile abundance via reduction in prey availability			
Risk	**Confidence**		

Low	**High**	

Table 351. Behavior and sensory risk hypothesis; Atlantic sturgeon, Gulf of Maine DPS and diazinon; Adults and Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.05	High	Low
Orchards and Vineyards	0.02	High	Low
Nurseries	0.02	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.05	High	Low
Orchards and Vineyards	0.02	High	Low
Nurseries	0.02	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
Low	**High**		

Table 352. AChE risk hypothesis; Atlantic sturgeon, Gulf of Maine DPS and diazinon; Adults and Juveniles

Endpoint: enzyme

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	0.05	High	Low
Orchards and Vineyards	0.02	High	Low
Nurseries	0.02	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**High**		

Table 353. Growth risk hypothesis; Atlantic sturgeon, Gulf of Maine DPS and diazinon; Adults and Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.05	High	Low
Orchards and Vineyards	0.02	High	Low
Nurseries	0.02	Medium	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
Low	**High**		

Table 354. Reproduction risk hypothesis; Atlantic sturgeon, Gulf of Maine DPS and diazinon; Adults

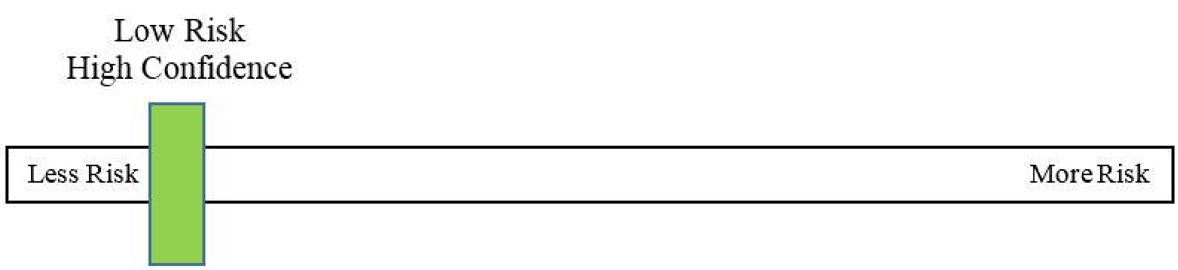
Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	0.05	High	Low
Orchards and Vineyards	0.02	High	Low
Nurseries	0.02	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**High**		

Table 355. Effects analysis summary table: Atlantic sturgeon, Gulf of Maine DPS and diazinon

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles and Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult and juvenile abundance via acute lethality.	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce adult and juvenile abundance via reduction in prey availability	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	High	Not Available	No

Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Low	High	Not Available	No

Effects analysis summary: Adult and juvenile Atlantic sturgeon, Gulf of Maine DPS are not anticipated to experience significant reductions in abundance or productivity (spawning adults) from exposure to diazinon. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, sturgeon may experience increased toxicity. The overall risk to Atlantic sturgeon, Gulf of Maine DPS from the effects of the action is low and the confidence associated with that risk is high.



13.37 Atlantic Sturgeon, New York Bight DPS (Acipenser oxyrinchus oxyrinchus)

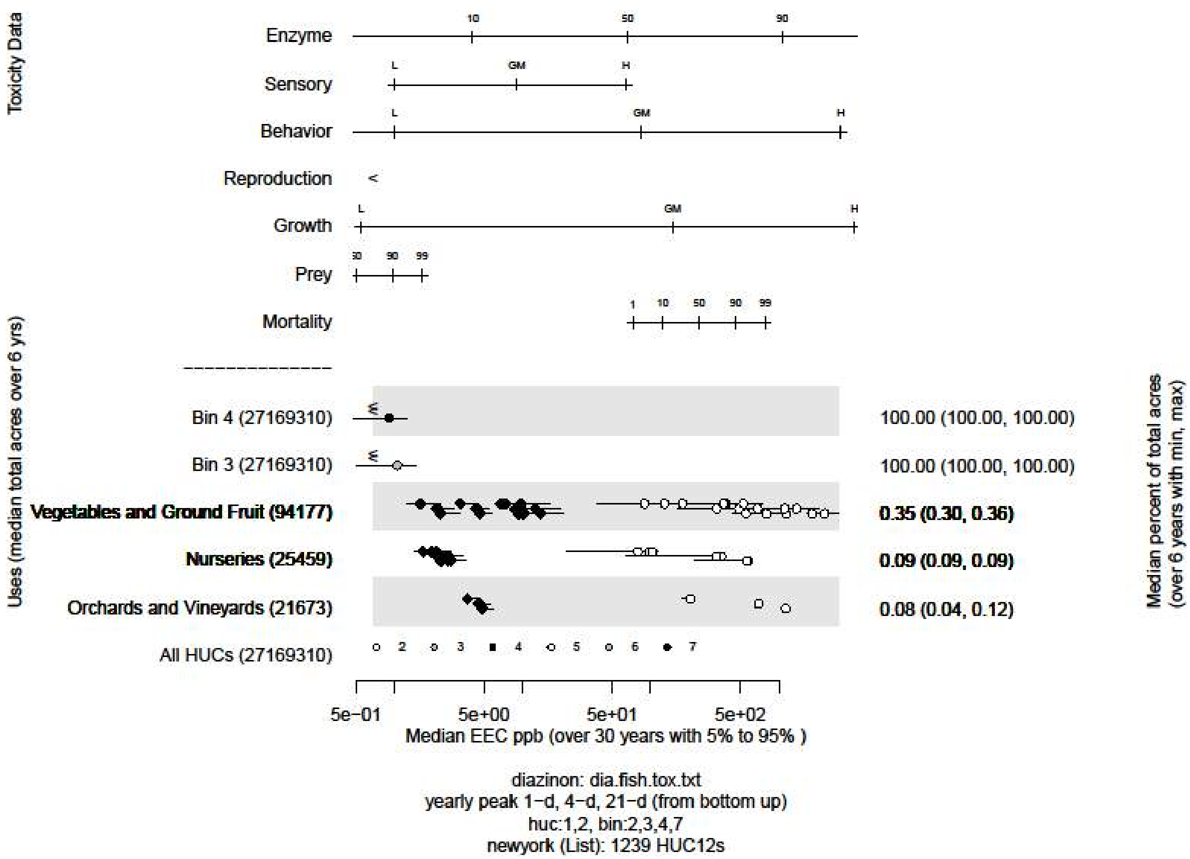


Figure 37. Effects analysis R-plot for Atlantic sturgeon, New York Bight DPS and diazinon

Table 356. Likelihood of exposure determination for Atlantic sturgeon, New York Bight DPS and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Vegetables and Ground Fruit	1	yes	no	yes	yes	3	**High**
Nurseries	1	yes	no	yes	no	3	**Low**
Orchards and Vineyards	1	yes	no	yes	yes	3	**High**
Bin 3	1	yes	no	yes	NA	3	**Low**
Bin 4	1	yes	no	yes	NA	3	**Low**

Life Stage: Juvenile and Adult

Table 357. Direct mortality risk hypothesis; Atlantic sturgeon, New York Bight DPS and diazinon; Adults and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	.4	High	**High**
Nurseries	.1	High	**Low**
Orchards and Vineyards	.1	High	**High**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult and juvenile abundance via acute lethality.			
Risk	**Confidence**	High density of vegetables and ground fruit use sites proximal to designated critical habitat along the mainstem of the Connecticut River. High Density of orchards and vineyards use sites proximal to designated critical habitat along the mainstem of the Hudson River.	
High	**High**		

Table 358. Prey risk hypothesis; Atlantic sturgeon, New York Bight DPS and diazinon; Adults and Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	.4	High	**High**
Nurseries	.1	High	**Low**
Orchards and Vineyards	.1	High	**High**
Bin 3		High	**Low**
Bin 4		High	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult and juvenile abundance via reduction in prey availability			

Risk	Confidence	
High	**High**	High density of vegetables and ground fruit use sites proximal to designated critical habitat along the mainstem of the Connecticut River. High Density of orchards and vineyards use sites proximal to designated critical habitat along the mainstem of the Hudson River.

Table 359. Behavior and sensory risk hypothesis; Atlantic sturgeon, New York Bight DPS and diazinon; Adults and Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	.4	High	**High**
Nurseries	.1	High	**Low**
Orchards and Vineyards	.1	High	**High**
Bin 3		Medium	**Low**
Bin 4		Medium	**Low**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	.4	High	**High**
Nurseries	.1	High	**Low**
Orchards and Vineyards	.1	High	**High**
Bin 3		Medium	**Low**
Bin 4		Medium	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**	High density of vegetables and ground fruit use sites proximal to designated critical habitat along the mainstem of the Connecticut River. High Density of orchards and vineyards use sites	
High	**High**		

		proximal to designated critical habitat along the mainstem of the Hudson River.

Table 360. AChE risk hypothesis; Atlantic sturgeon, New York Bight DPS and diazinon; Adults and Juveniles

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	.4	High	**High**
Nurseries	.1	High	**Low**
Orchards and Vineyards	.1	High	**High**
Bin 3		Medium	**Low**
Bin 4		Medium	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**	High density of vegetables and ground fruit use sites proximal to designated critical habitat along the mainstem of the Connecticut River. High Density of orchards and vineyards use sites proximal to designated critical habitat along the mainstem of the Hudson River.	
High	**High**		

Table 361. Growth risk hypothesis; Atlantic sturgeon, New York Bight DPS and diazinon; Adults and Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	.4	High	**High**
Nurseries	.1	Medium	**Low**
Orchards and Vineyards	.1	High	**High**

Bin 3		Low	**Low**
Bin 4		Low	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**	High density of vegetables and ground fruit use sites proximal to designated critical habitat along the mainstem of the Connecticut River. High Density of orchards and vineyards use sites proximal to designated critical habitat along the mainstem of the Hudson River.	
High	**High**		

Table 362. Reproduction risk hypothesis; Atlantic sturgeon, New York Bight DPS and diazinon; Adults

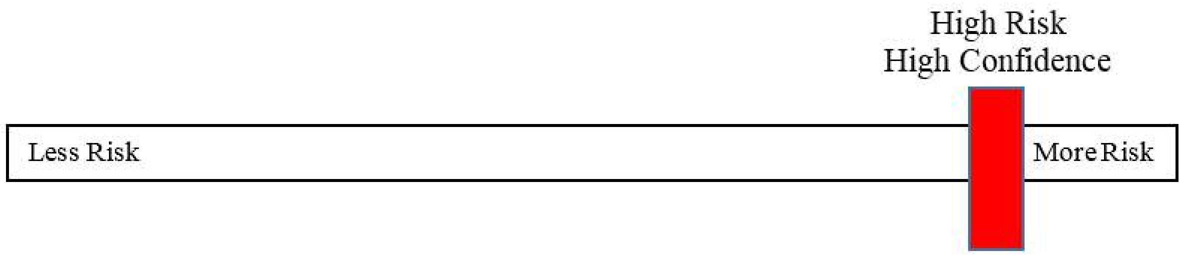
Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	.4	High	**High**
Nurseries	.1	High	**Low**
Orchards and Vineyards	.1	High	**High**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**	High density of vegetables and ground fruit use sites proximal to designated critical habitat along the mainstem of the Connecticut River. High Density of orchards and vineyards use sites proximal to designated critical habitat along the mainstem of the Hudson River.	
High	**High**		

Table 363. Effects analysis summary table: Atlantic sturgeon, New York Bight DPS and diazinon

	R-plot Derived	MagTool	

Juveniles and Adults	Risk	Confidence	Range in median percent mortalities for aquatic bins	Risk Hypothesis Supported? Yes/No
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult and juvenile abundance via acute lethality.	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce adult and juvenile abundance via reduction in prey availability	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Atlantic sturgeon, New York Bight DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to diazinon. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where diazinon achieves predicted levels. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, sturgeon will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of diazinon and mixtures containing Diazinon to exposed sturgeon. The overall risk to Atlantic sturgeon, New York Bight DPS from the effects of the action is high and the confidence associated with that risk is high. High risk is due primarily to vegetables and ground fruit use sites proximal to designated critical habitat along the mainstem of the Connecticut River, and orchards and vineyards use sites proximal to designated critical habitat along the mainstem of the Hudson River.



13.38 Atlantic Sturgeon, South Atlantic DPS (Acipenser oxyrinchus oxyrinchus)

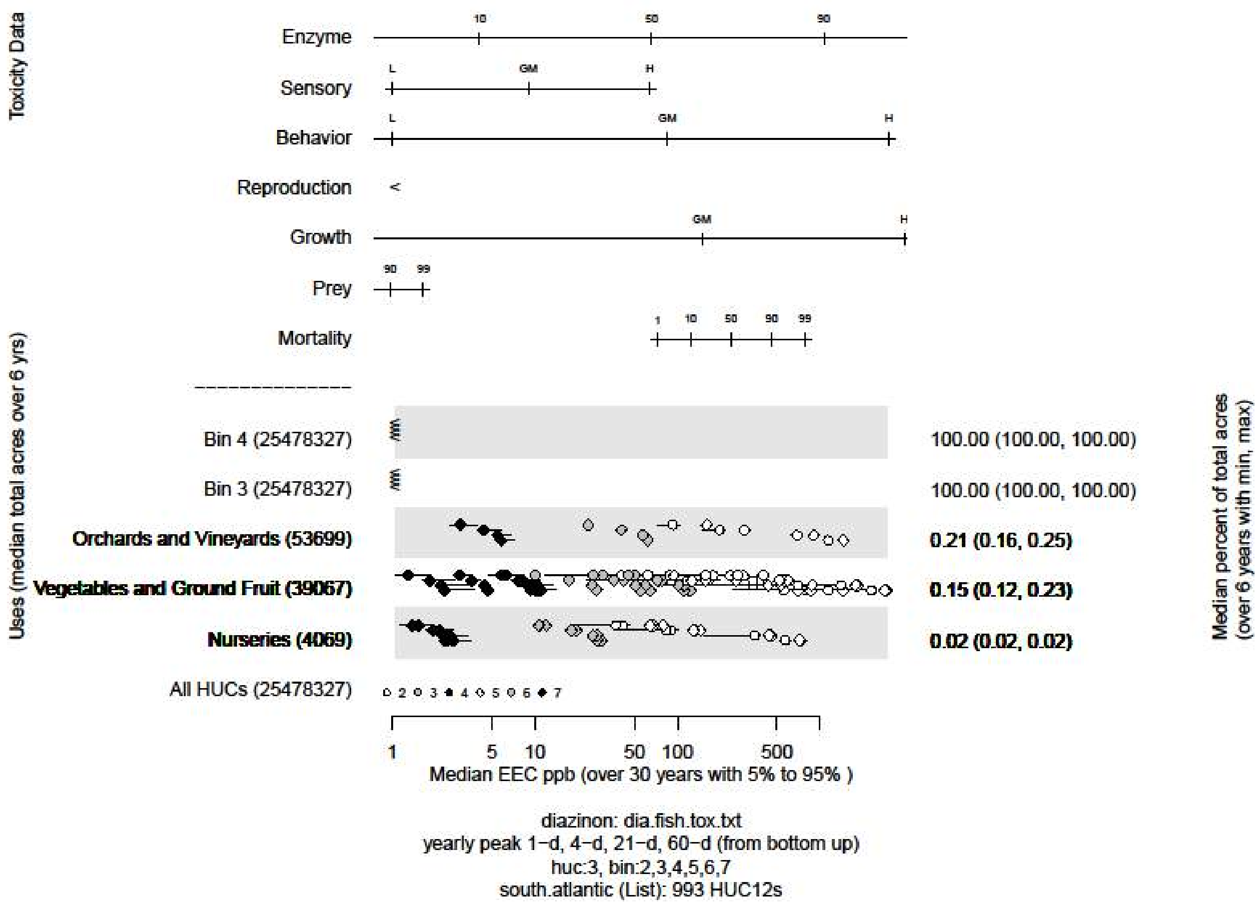


Figure 38. Effects analysis R-plot for Atlantic Sturgeon, South Atlantic DPS and diazinon

Table 364. Likelihood of exposure determination for Atlantic Sturgeon, South Atlantic DPS and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Orchards and Vineyards	1	yes	no	yes	yes	3	**High**
Vegetables and Ground Fruit	1	yes	no	yes	no	3	**Low**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	1	yes	no	NA	NA	3	**Low**
Bin 4	1	yes	no	NA	NA	3	**Low**

Life Stage: Juvenile and Adult

Table 365. Direct mortality risk hypothesis; Atlantic Sturgeon, South Atlantic DPS and diazinon; Adults and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.21	High	**High**
Vegetables and Ground Fruit	0.15	High	**Low**
Nurseries	0.02	High	**Low**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult and juvenile abundance via acute lethality.			
Risk	**Confidence**	High Density of orchards and vineyards use sites proximal to designated critical habitat along the South Fork Edisto River.	
High	**Medium**		

Table 366. Prey risk hypothesis; Atlantic Sturgeon, South Atlantic DPS and diazinon; Adults and Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Orchards and Vineyards	0.21	High	**High**
Vegetables and Ground Fruit	0.15	High	**Low**
Nurseries	0.02	High	**Low**
Bin 3		Medium	**Low**
Bin 4		Medium	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult and juvenile abundance via reduction in prey availability			
Risk	**Confidence**	High Density of orchards and vineyards use sites proximal to designated critical habitat along the South Fork Edisto River.	
High	**Medium**		

Table 367. Behavior and sensory risk hypothesis; Atlantic Sturgeon, South Atlantic DPS and diazinon; Adults and Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.21	High	**High**
Vegetables and Ground Fruit	0.15	High	**Low**
Nurseries	0.02	High	**Low**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.21	High	**High**
Vegetables and Ground Fruit	0.15	High	**Low**
Nurseries	0.02	High	**Low**
Bin 3		Low	**Low**

Bin 4		Low	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**	High Density of orchards and vineyards use sites proximal to designated critical habitat along the South Fork Edisto River.	
High	**Medium**		

Table 368. AChE risk hypothesis; Atlantic Sturgeon, South Atlantic DPS and diazinon; Adults and Juveniles

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.21	High	**High**
Vegetables and Ground Fruit	0.15	High	**Low**
Nurseries	0.02	High	**Low**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**	High Density of orchards and vineyards use sites proximal to designated critical habitat along the South Fork Edisto River.	
High	**Medium**		

Table 369. Growth risk hypothesis; Atlantic Sturgeon, South Atlantic DPS and diazinon; Adults and Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.21	High	**High**
Vegetables and Ground Fruit	0.15	High	**Low**

Nurseries	0.02	Medium	**Low**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**	High Density of orchards and vineyards use sites proximal to designated critical habitat along the South Fork Edisto River.	
High	**Medium**		

Table 370. Reproduction risk hypothesis; Atlantic Sturgeon, South Atlantic DPS and diazinon; Adults

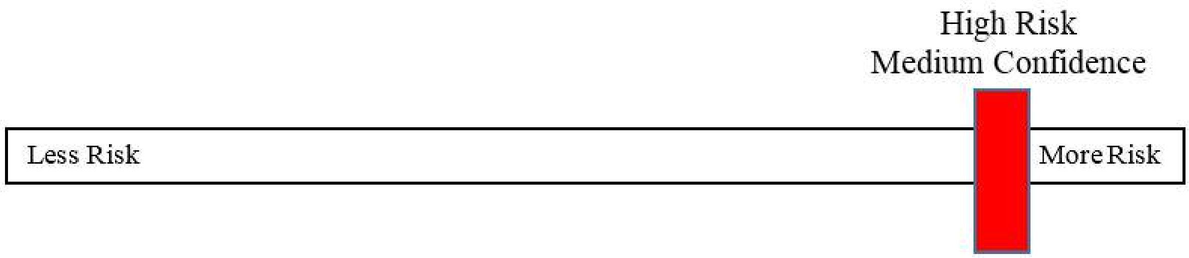
Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.21	High	**High**
Vegetables and Ground Fruit	0.15	High	**Low**
Nurseries	0.02	High	**Low**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**	High Density of orchards and vineyards use sites proximal to designated critical habitat along the South Fork Edisto River.	
High	**Medium**		

Table 371. Effects analysis summary table: Atlantic Sturgeon, South Atlantic DPS and diazinon

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles and Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult and	High	Medium	Not Available	**Yes**

juvenile abundance via acute lethality.				
Exposure to diazinon is sufficient to reduce adult and juvenile abundance via reduction in prey availability	High	Medium	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.	High	Medium	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Medium	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	Medium	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	High	Medium	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Atlantic Sturgeon, South Atlantic DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to diazinon. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where diazinon achieves predicted levels. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, sturgeon will likely experience more toxicity. The overall risk to Atlantic Sturgeon, South Atlantic DPS from the effects of the action is high and the confidence associated with that risk is medium. The high risk to the South Atlantic DPS is attributed primarily to high density areas of diazinon use (orchards and vineyards) proximal to sensitive areas within the species habitat. High risk is due primarily to the proximity of orchards and vineyards use sites to designated critical habitat along the South Fork Edisto River.


High Risk
Medium Confidence
Less Risk
More Risk

13.39 Gulf Sturgeon (Acipenser oxyrinchus desotoi)

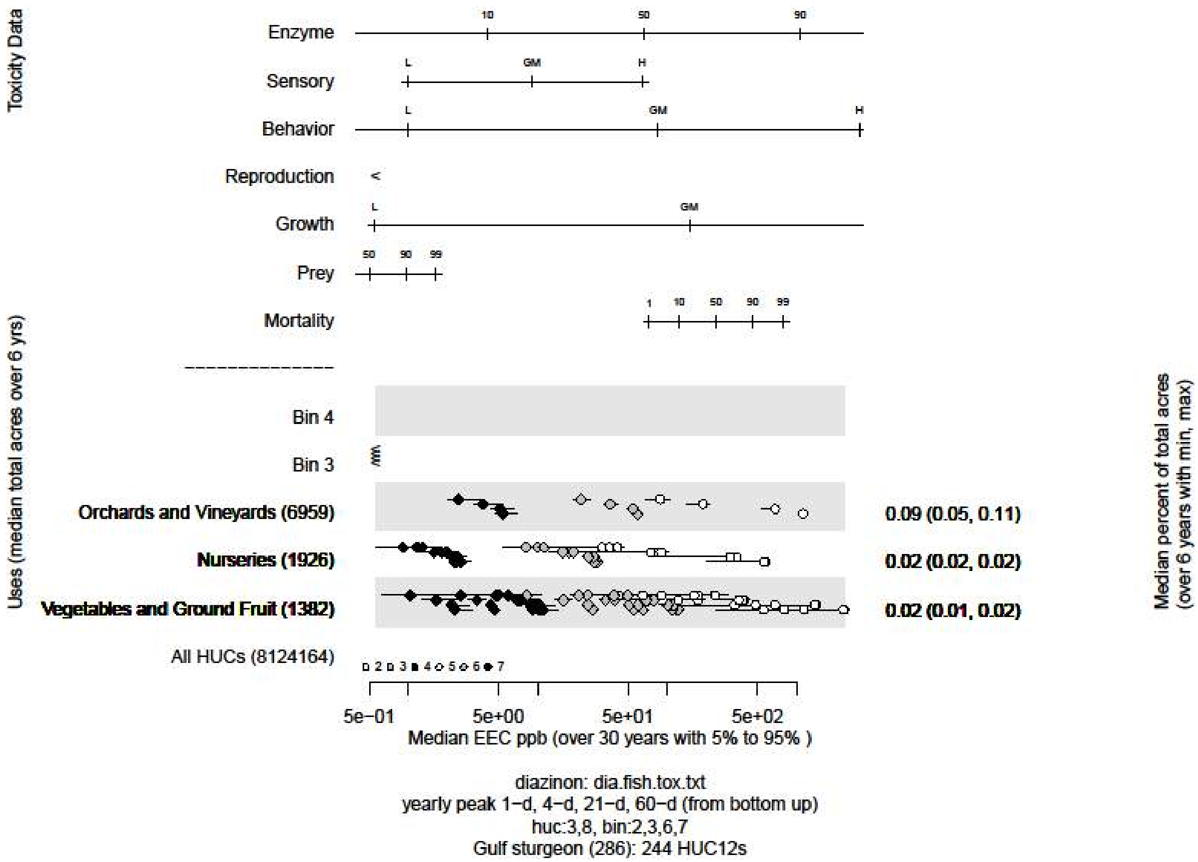


Figure 39. Effects analysis R-plot for Gulf Sturgeon and diazinon

Table 372. Likelihood of exposure determination for Gulf Sturgeon and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Orchards and Vineyards	1	yes	no	yes	NA	3	**Low**
Nurseries	1	yes	no	yes	NA	3	**Low**
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	**Low**
Bin 3	1	yes	no	yes	NA	3	**Low**

Life Stage: Juvenile and Adult (Marine Environment Only)

Table 373. Direct mortality risk hypothesis; Gulf Sturgeon and diazinon; Adults and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.09	High	Low
Nurseries	0.02	High	Low
Vegetables and Ground Fruit	0.02	High	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult and juvenile abundance via acute lethality.			
Risk	**Confidence**		
Low	**High**		

Table 374. Prey risk hypothesis; Gulf Sturgeon and diazinon; Adults and Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.09	High	Low
Nurseries	0.02	High	Low
Vegetables and Ground Fruit	0.02	High	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult and juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	**High**		

Table 375. Behavior and sensory risk hypothesis; Gulf Sturgeon and diazinon; Adults and Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.09	High	Low
Nurseries	0.02	High	Low
Vegetables and Ground Fruit	0.02	High	Low
Bin 3		Low	Low
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.09	High	Low
Nurseries	0.02	High	Low
Vegetables and Ground Fruit	0.02	High	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
Low	**High**		

Table 376. AChE risk hypothesis; Gulf Sturgeon and diazinon; Adults and Juveniles

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.09	High	Low
Nurseries	0.02	High	Low
Vegetables and Ground Fruit	0.02	High	Low

Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**High**		

Table 377. Growth risk hypothesis; Gulf Sturgeon and diazinon; Adults and Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.09	High	Low
Nurseries	0.02	Medium	Low
Vegetables and Ground Fruit	0.02	High	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
Low	**High**		

Table 378. Reproduction risk hypothesis; Gulf Sturgeon and diazinon; Adults

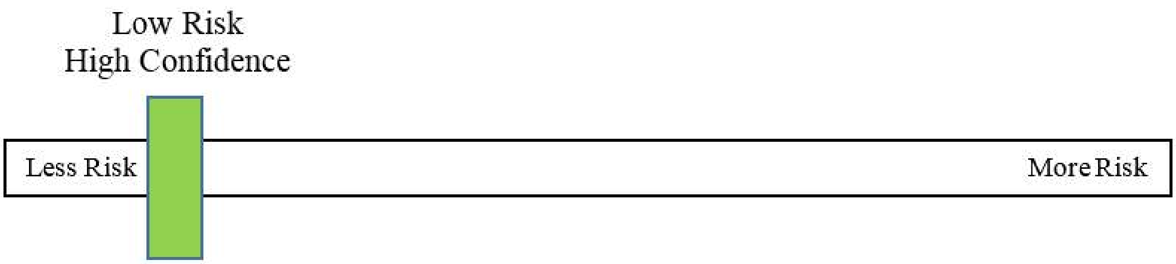
Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	0.09	High	Low
Nurseries	0.02	High	Low
Vegetables and Ground Fruit	0.02	High	Low
Bin 3		Low	Low

Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction		
Risk	**Confidence**	
Low	**High**	

Table 379. Effects analysis summary table: Gulf Sturgeon and diazinon

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Juveniles and Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult and juvenile abundance via acute lethality.	Low	High	4-day: pending	No
Exposure to diazinon is sufficient to reduce adult and juvenile abundance via reduction in prey availability	Low	High	4-day fish: pending 4-day invert: pending	No
Exposure to diazinon is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Low	High	Not Available	No

Effects analysis summary: Adult and juvenile Gulf Sturgeon are not anticipated to experience significant reductions in abundance or productivity (spawning adults) from exposure to diazinon in the marine environment. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, sturgeon may experience increased toxicity. If exposed to formulated products and tank mixtures containing diazinon, Gulf sturgeon may experience increased toxicity. The MagTool results indicate that between [pending] percent of individuals within a population will die. The overall risk to Gulf Sturgeon from the effects of the action is low and the confidence associated with that risk is high.



13.40 Yelloweye Rockfish (Sebastes ruberrimus)

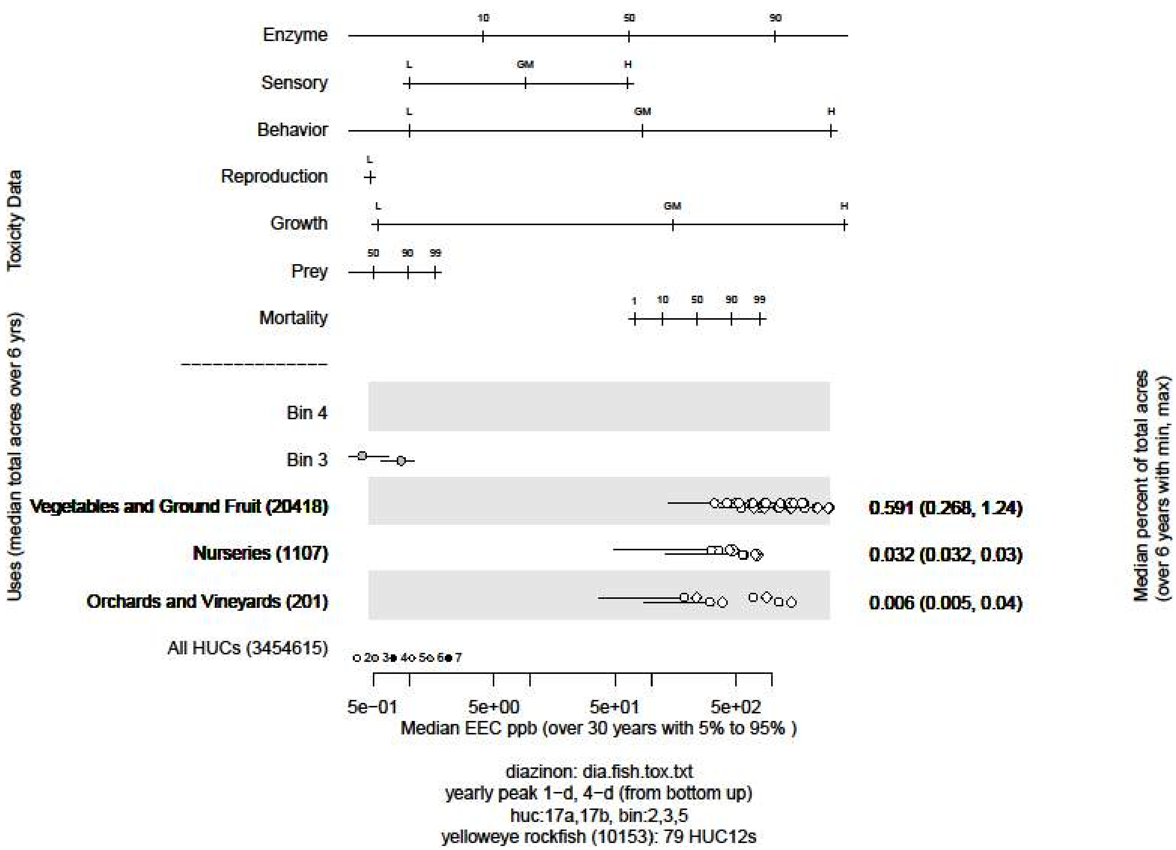


Figure 40. Effects analysis R-plot for Yelloweye Rockfish and diazinon

Table 380. Likelihood of exposure determination for Yelloweye Rockfish and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	**Low**
Nurseries	1	yes	no	yes	NA	3	**Low**
Orchards and Vineyards	1	yes	no	yes	NA	3	**Low**
Bin 3	1	yes	no	yes	NA	3	**Low**
Bin 4	1	yes	no	yes	NA	3	**Low**

Life Stage: Larvae and Juveniles

Table 381. Direct mortality risk hypothesis; Yelloweye Rockfish and diazinon; Larvae and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	<1	High	Low
Nurseries	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce larval and juvenile abundance via acute lethality.			
Risk	**Confidence**		
Low	**High**		

Table 382. Growth risk hypothesis; Yelloweye Rockfish and diazinon; Larvae and Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	<1	High	Low
Nurseries	<1	Medium	Low

Orchards and Vineyards	<1	High	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce larval and juvenile abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
Low	**High**		

Table 383. Prey risk hypothesis; Yelloweye Rockfish and diazinon; Larvae and Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	<1	High	Low
Nurseries	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce larval and juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	**High**		

Table 384. AChE risk hypothesis; Yelloweye Rockfish and diazinon; Larvae and Juveniles

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	<1	High	Low
Nurseries	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		Medium	Low

Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity		
Risk	**Confidence**	
Low	**High**	

Table 385. Behavior and sensory risk hypothesis; Yelloweye Rockfish and diazinon; Larvae and Juveniles

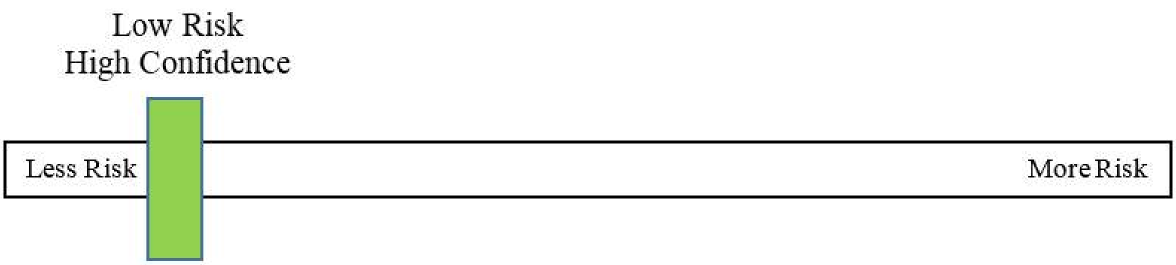
Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	<1	High	Low
Nurseries	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		Medium	Low
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	<1	High	Low
Nurseries	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce larval and juvenile abundance via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
Low	**High**		

Table 386. Effects analysis summary table: Yelloweye Rockfish and diazinon

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Larvae and Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	

Risk Hypothesis				
Exposure to diazinon is sufficient to reduce larval and juvenile abundance via acute lethality.	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce larval and juvenile abundance via impacts to growth (direct toxicity)	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce larval and juvenile abundance via reduction in prey availability	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce larval and juvenile abundance via impairments to ecologically significant behaviors.	Low	High	Not Available	No

Effects analysis summary: Adult, juvenile and larval Yelloweye Rockfish are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to diazinon in the marine environment. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, rockfish may experience increased toxicity. If exposed to formulated products and tank mixtures containing diazinon, rockfish may experience increased toxicity. The overall risk to yelloweye rockfish from the effects of the action is low and the confidence associated with that risk is high. Low risk is attributed to uncertainty in the route of exposure to adult rockfish which are typically found in deep marine habitats. Low risk is also due to the minimal amount of diazinon use sites within the species range.



13.41 Boccacio, Puget Sound/Georgia Basin DPS (Sebastes paucispinis)

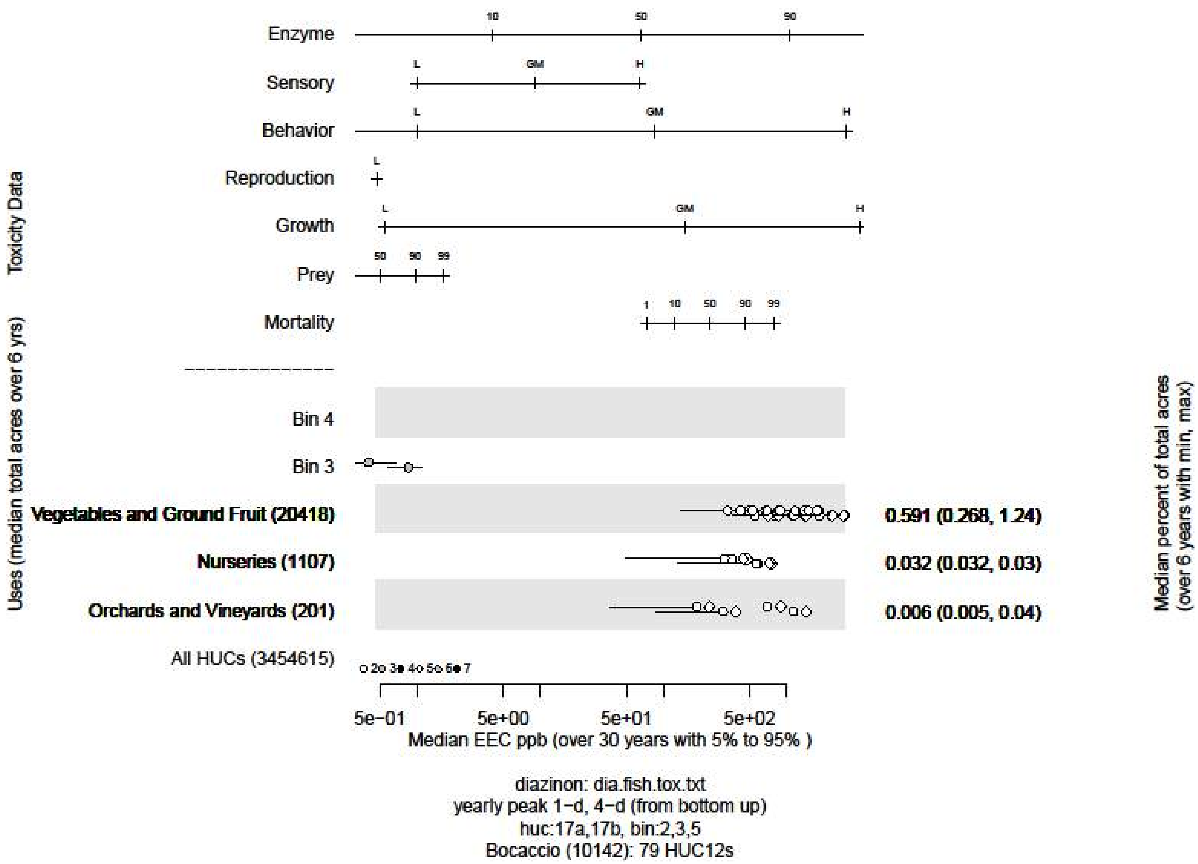


Figure 41. Effects analysis R-plot for Boccacio, Puget Sound/Georgia Basin DPS and diazinon

Table 387. Likelihood of exposure determination for Boccacio, Puget Sound/Georgia Basin DPS and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	Low
Nurseries	1	yes	no	yes	NA	3	Low
Orchards and Vineyards	1	yes	no	yes	NA	3	Low
Bin 3	1	yes	no	yes	NA	3	Low
Bin 4	1	yes	no	yes	NA	3	Low

Life Stage: Larvae and Juveniles

Table 388. Direct mortality risk hypothesis; Boccacio, Puget Sound/Georgia Basin DPS and diazinon; Larvae and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1	High	Low
Nurseries	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce larval and juvenile abundance via acute lethality.			
Risk	**Confidence**		
Low	**High**		

Table 389. Growth risk hypothesis; Boccacio, Puget Sound/Georgia Basin DPS and diazinon; Larvae and Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Vegetables and Ground Fruit	1	High	Low
Nurseries	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		Low	Low
Bin 4		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce larval and juvenile abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
Low	**High**		

Table 390. Prey risk hypothesis; Boccacio, Puget Sound/Georgia Basin DPS and diazinon; Larvae and Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1	High	Low
Nurseries	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		High	Low
Bin 4		High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce larval and juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	**High**		

Table 391. AChE risk hypothesis; Boccacio, Puget Sound/Georgia Basin DPS and diazinon; Larvae and Juveniles

Endpoint: enzyme

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	1	High	Low
Nurseries	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**High**		

Table 392. Behavior and sensory risk hypothesis; Boccacio, Puget Sound/Georgia Basin DPS and diazinon; Larvae and Juveniles

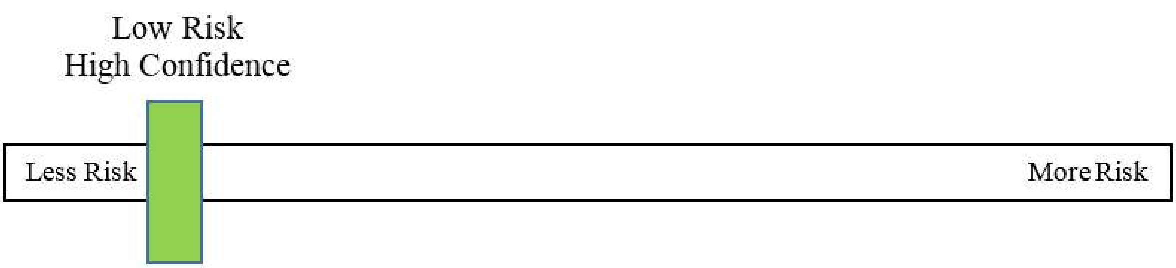
Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1	High	Low
Nurseries	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		Medium	Low
Bin 4		Medium	Low
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	1	High	Low
Nurseries	<1	High	Low
Orchards and Vineyards	<1	High	Low

Bin 3		Medium	Low
Bin 4		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce larval and juvenile abundance via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
Low	**High**		

Table 393. Effects analysis summary table: Boccacio, Puget Sound/Georgia Basin DPS and diazinon

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Larvae and Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce larval and juvenile abundance via acute lethality.	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce larval and juvenile abundance via impacts to growth (direct toxicity)	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce larval and juvenile abundance via reduction in prey availability	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	High	Not Available	No
Exposure to diazinon is sufficient to reduce larval and juvenile abundance via impairments to ecologically significant behaviors.	Low	High	Not Available	No

Effects analysis summary: Adult, juvenile and larval boccacio are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to diazinon in the marine environment. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, boccacio may experience increased toxicity. If exposed to formulated products and tank mixtures containing diazinon, boccacio may experience increased toxicity. The overall risk to boccacio from the effects of the action is low and the confidence associated with that risk is high. Low risk is attributed to uncertainty in the route of exposure to adult boccacio which are typically found in deep marine habitats. Low risk is also due to the minimal amount of diazinon use sites within the species range.



13.42 Gulf Grouper (Mycteroperca jordani)

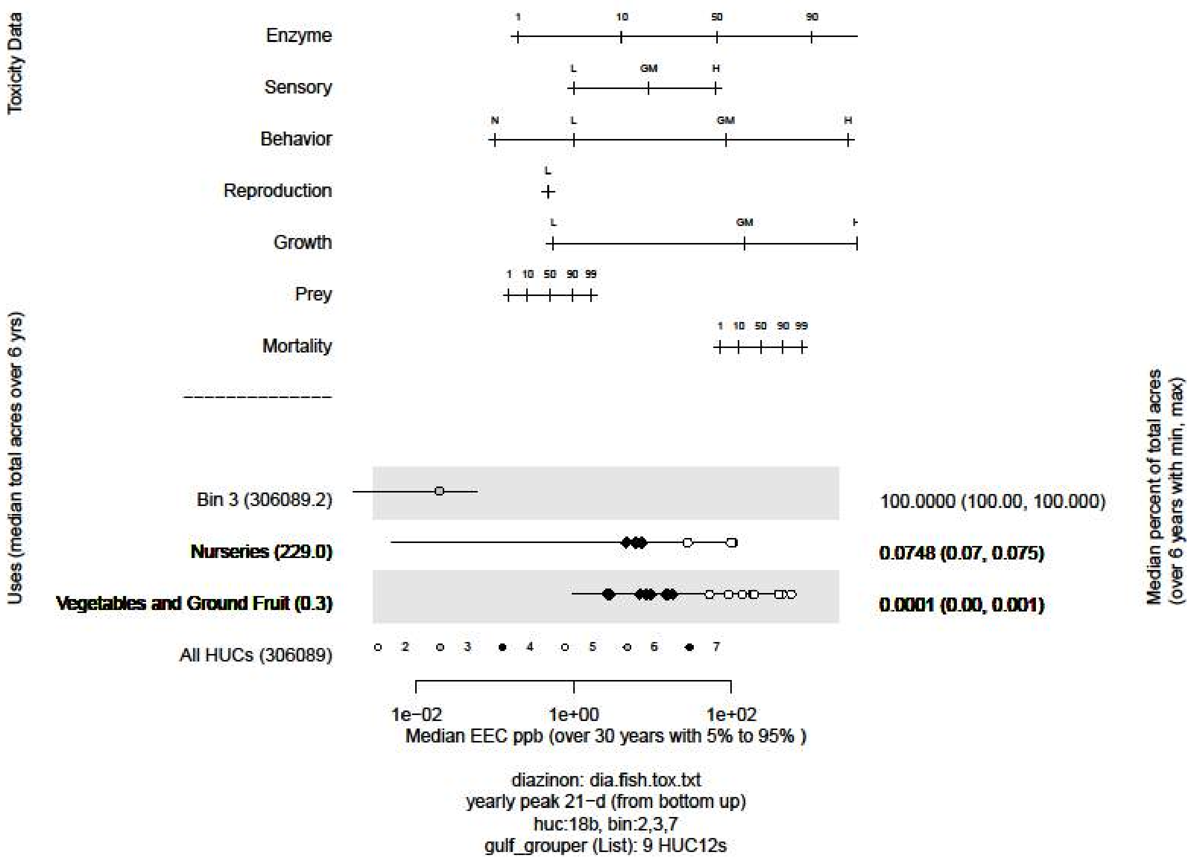


Figure 42. Effects analysis R-plot for Gulf grouper and diazinon

Table 394. Likelihood of exposure determination for Gulf grouper and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range in US Territories	Likelihood of Exposure
Juveniles								
Nurseries	1	yes	yes	yes	NA	3	small	Low
Vegetables and Ground Fruit	1	yes	yes	yes	NA	3	small	Low
Bin 3	1	yes	yes	yes	NA	3	small	Low

Life Stage: Adult

Exposure pathway not anticipated for adult life history of this species, therefore risk hypotheses for adult life stages not evaluated.

Life Stage: Juvenile

Table 395. Direct mortality risk hypothesis; Gulf grouper and diazinon; Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Nurseries	<1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			
Risk	**Confidence**		
Low	**High**		

Table 396. Prey risk hypothesis; Gulf grouper and diazinon; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Nurseries	<1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Bin 3		High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	**High**		

Table 397. Growth risk hypothesis; Gulf grouper and diazinon; Juveniles

Endpoint: Growth

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Nurseries	<1	Medium	Low
Vegetables and Ground Fruit	<1	High	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
Low	**High**		

Table 398. AChE risk hypothesis; Gulf grouper and diazinon; Juveniles

Endpoint: Enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Nurseries	<1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Bin 3		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**High**		

Table 399. Behavior and sensory risk hypothesis; Gulf grouper and diazinon; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Nurseries	<1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Bin 3		Medium	Low

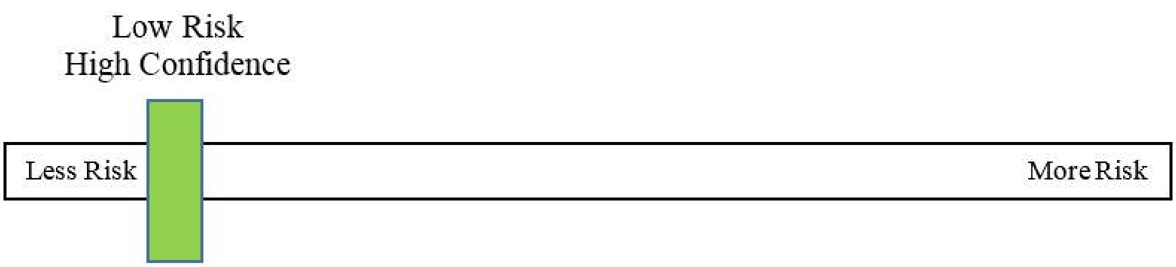
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Nurseries	<1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors			
Risk	**Confidence**		
Low	**High**		

Table 400. Effects analysis summary table: Gulf grouper and diazinon

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.	Low	**High**	Not Available	**No**
Exposure to diazinon is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)	Low	**High**	Not Available	**No**
Exposure to diazinon is sufficient to reduce juvenile abundance via reduction in prey availability	Low	**High**	Not Available	**No**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	**High**	Not Available	**No**
Exposure to diazinon is sufficient to reduce juvenile abundance via	Low	**High**	Not Available	**No**

impairments to ecologically significant behaviors.				

Effects analysis summary: Adult and juvenile Gulf grouper are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to diazinon in the marine environment. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, groupers may experience increased toxicity. The overall risk to Gulf grouper from the effects of the action is low and the confidence associated with that risk is high. The low risk to groupers is due primarily to the small portion of the species' range within US territories. Low risk is also attributed to uncertainty in the route of exposure to adult groupers which are typically found in deep marine habitats



13.43 Nassau Grouper (Epinephelus striatus)

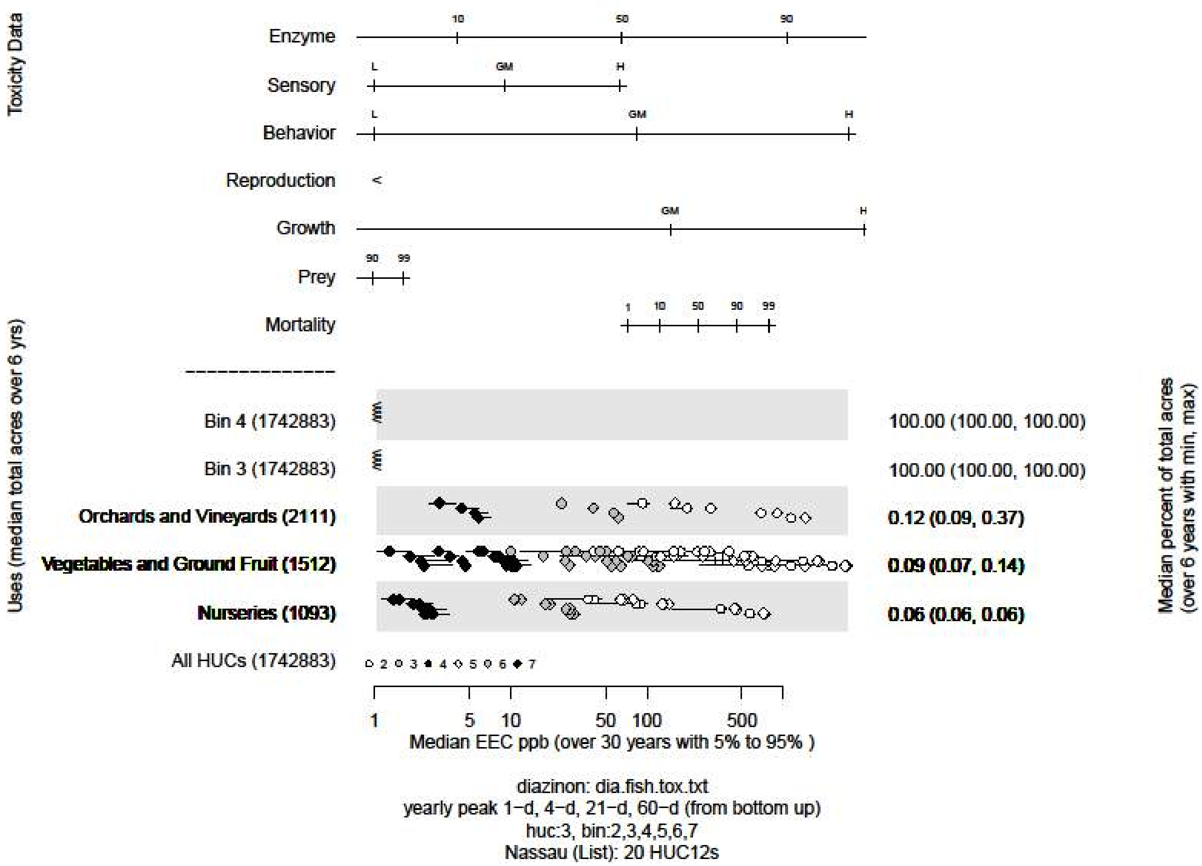


Figure 43. Effects analysis R-plot for Nassau Grouper and diazinon

Table 401. Likelihood of exposure determination for Nassau Grouper and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range within US Territories	Likelihood of Exposure
Adults and Juveniles (Florida)								
Orchards and Vineyards	1	yes	no	yes	NA	3	small	Low
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	small	Low
Nurseries	1	yes	no	yes	NA	3	small	Low
Bin 3	1	yes	no	yes	NA	3	small	Low
Adults and Juveniles (US Territories in Caribbean)								
All uses	Na	yes	no	yes	NA	3	small	Low

Life Stage: Adult

Table 402. Direct mortality risk hypothesis; Nassau Grouper and diazinon; Adults (Florida Coast)

Endpoint: Mortality (Florida Coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	>1	High	Low
Vegetables and Ground Fruit	>1	High	Low
Nurseries	>1	High	Low
Bin 3		Low-Med	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**High**		

Table 403. Direct mortality risk hypothesis; Nassau Grouper and diazinon; Adults (US Territories in the Caribbean)

Endpoint: Mortality (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All uses	Not Available	High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**High**		

Table 404. Reproduction risk hypothesis; Nassau Grouper and diazinon; Adults (Florida Coast)

Endpoint: Reproduction (Florida coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	>1	High	Low

Vegetables and Ground Fruit	>1	High	Low
Nurseries	>1	High	Low
Bin 3		Low-Med	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**High**		

Table 405. Reproduction risk hypothesis; Nassau Grouper and diazinon; Adults (US Territories in the Caribbean)

Endpoint: Reproduction (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All uses	Not Available	High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**High**		

Table 406. AChE risk hypothesis; Nassau Grouper and diazinon; Adults (Florida Coast)

Endpoint: enzyme (Florida coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	>1	High	Low
Vegetables and Ground Fruit	>1	High	Low
Nurseries	>1	High	Low
Bin 3		Low-Med	Low

Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity		
Risk	**Confidence**	
Low	**High**	

Table 407. AChE risk hypothesis; Nassau Grouper and diazinon; Adults (US Territories in the Caribbean)

Endpoint: Enzyme (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All uses	Not Available	High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**High**		

Table 408. Behavior and sensory risk hypothesis; Nassau Grouper and diazinon; Adults (Florida Coast)

Endpoint: Behavior (Florida coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	>1	High	Low
Vegetables and Ground Fruit	>1	High	Low
Nurseries	>1	High	Low
Bin 3		Low-Med	Low
Endpoint: Sensory (Florida coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	>1	High	Low
Vegetables and Ground Fruit	>1	High	Low

Nurseries	>1	High	Low
Bin 3		Low-Med	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors			
Risk	**Confidence**		
Low	**High**		

Table 409. Behavior and sensory risk hypothesis; Nassau Grouper and diazinon; Adults (US Territories in the Caribbean)

Endpoint: Behavior (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All uses	Not Available	High	Low
Endpoint: Sensory (HUC03 – Puerto Rico)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All uses	Not Available	High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors			
Risk	**Confidence**		
Low	**High**		

Life Stage: Juvenile

Table 410. Direct mortality risk hypothesis; Nassau Grouper and diazinon; Juveniles (Florida Coast)

Endpoint: Mortality (Florida coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	>1	High	Low
Vegetables and Ground Fruit	>1	High	Low
Nurseries	>1	High	Low

Bin 3		Low-Med	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			
Risk	**Confidence**		
Low	**High**		

Table 411. Direct mortality risk hypothesis; Nassau Grouper and diazinon; Juveniles (US Territories in the Caribbean)

Endpoint: Mortality (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All uses	Not Available	High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.			
Risk	**Confidence**		
Low	**High**		

Table 412. Prey risk hypothesis; Nassau Grouper and diazinon; Juveniles (Florida Coast)

Endpoint: Prey (Florida coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	>1	High	Low
Vegetables and Ground Fruit	>1	High	Low
Nurseries	>1	High	Low
Bin 3		Low-Med	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	**High**		

Table 413. Prey risk hypothesis; Nassau Grouper and diazinon; Juveniles (US Territories in the Caribbean)

Endpoint: Prey (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All uses	Not Available	High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	**High**		

Table 414. Growth risk hypothesis; Nassau Grouper and diazinon; Juveniles (Florida Coast)

Endpoint: Growth (Florida coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	>1	High	Low
Vegetables and Ground Fruit	>1	High	Low
Nurseries	>1	Med	Low
Bin 3		Low-Med	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
Low	**High**		

Table 415. Growth risk hypothesis; Nassau Grouper and diazinon; Juveniles (US Territories in the Caribbean)

Endpoint: Growth (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All uses	Not Available	Med-High	Low

Risk Hypothesis: Exposure to diazinon is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)		
Risk	**Confidence**	
Low	**High**	

Table 416. AChE risk hypothesis; Nassau Grouper and diazinon; Juveniles (Florida Coast)

Endpoint: Enzyme (Florida coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	>1	High	Low
Vegetables and Ground Fruit	>1	High	Low
Nurseries	>1	High	Low
Bin 3		Low-Med	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**High**		

Table 417. AChE risk hypothesis; Nassau Grouper and diazinon; Juveniles (US Territories in the Caribbean)

Endpoint: Enzyme (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All uses	Not Available	High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**High**		

Table 418. Behavior and sensory risk hypothesis; Nassau Grouper and diazinon; Juveniles (Florida Coast)

Endpoint: Behavior (Florida coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	>1	High	Low
Vegetables and Ground Fruit	>1	High	Low
Nurseries	>1	High	Low
Bin 3		Low-Med	Low
Endpoint: Sensory (Florida coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	>1	High	Low
Vegetables and Ground Fruit	>1	High	Low
Nurseries	>1	High	Low
Bin 3		Low-Med	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors			
Risk	**Confidence**		
Low	**High**		

Table 419. Behavior and sensory risk hypothesis; Nassau Grouper and diazinon; Juveniles (US Territories in the Caribbean)

Endpoint: behavior (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All uses	Not Available	High	Low
Endpoint: sensory (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All uses	Not Available	High	Low

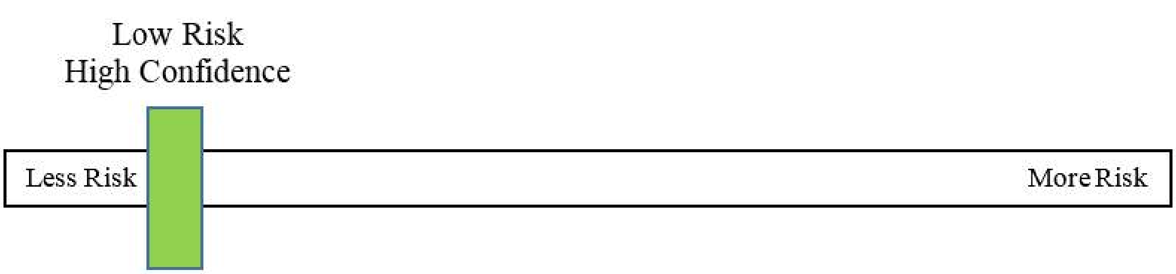
Risk Hypothesis: Exposure to diazinon is sufficient to reduce productivity of populations via effects on larvae (settling, metamorphosis, mortality, etc.)		
Risk	Confidence	
Low	High	

Table 420. Effects analysis summary table: Nassau Grouper and diazinon

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Juveniles and Adults (Florida Coast)	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	**Low**	**High**	Not Available	**No**
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction (Adult)	**Low**	**High**	Not Available	**No**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	**Low**	**High**	Not Available	**No**
Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	**Low**	**High**	Not Available	**No**
Exposure to diazinon is sufficient to reduce juvenile abundance via reduction in prey availability	**Low**	**High**	Not Available	**No**
Juveniles and Adults (HUC03 – Puerto Rico, Virgin Islands)				
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	**Low**	**High**	Not Available	**No**

Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction (Adults)	**Low**	**High**	Not Available	**No**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	**Low**	**High**	Not Available	**No**
Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	**Low**	**High**	Not Available	**No**
Exposure to diazinon is sufficient to reduce juvenile abundance via reduction in prey availability	**Low**	**High**	Not Available	**No**

Effects analysis summary: Adult and juvenile Nassau Grouper are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to diazinon in the marine environment. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, groupers may experience increased toxicity. The overall risk to Nassau Grouper from the effects of the action is low and the confidence associated with that risk is high. The low risk to Nassau Grouper is due primarily to the small portion of the species' range within US territories. Low risk is also attributed to uncertainty in the route of exposure to adult groupers which are typically found in deep marine habitats.



13.44 Smalltooth Sawfish (Pristis pectinate)

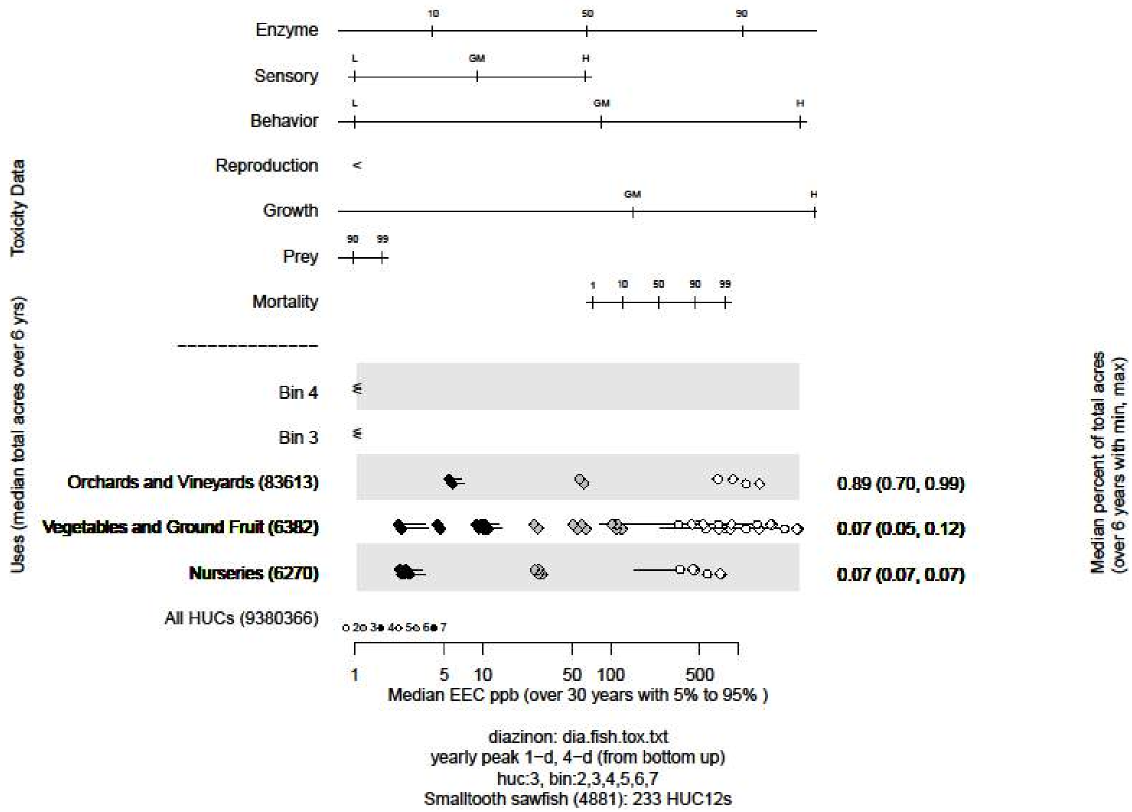


Figure 44. Effects analysis R-plot for Smalltooth sawfish and diazinon; Full Range

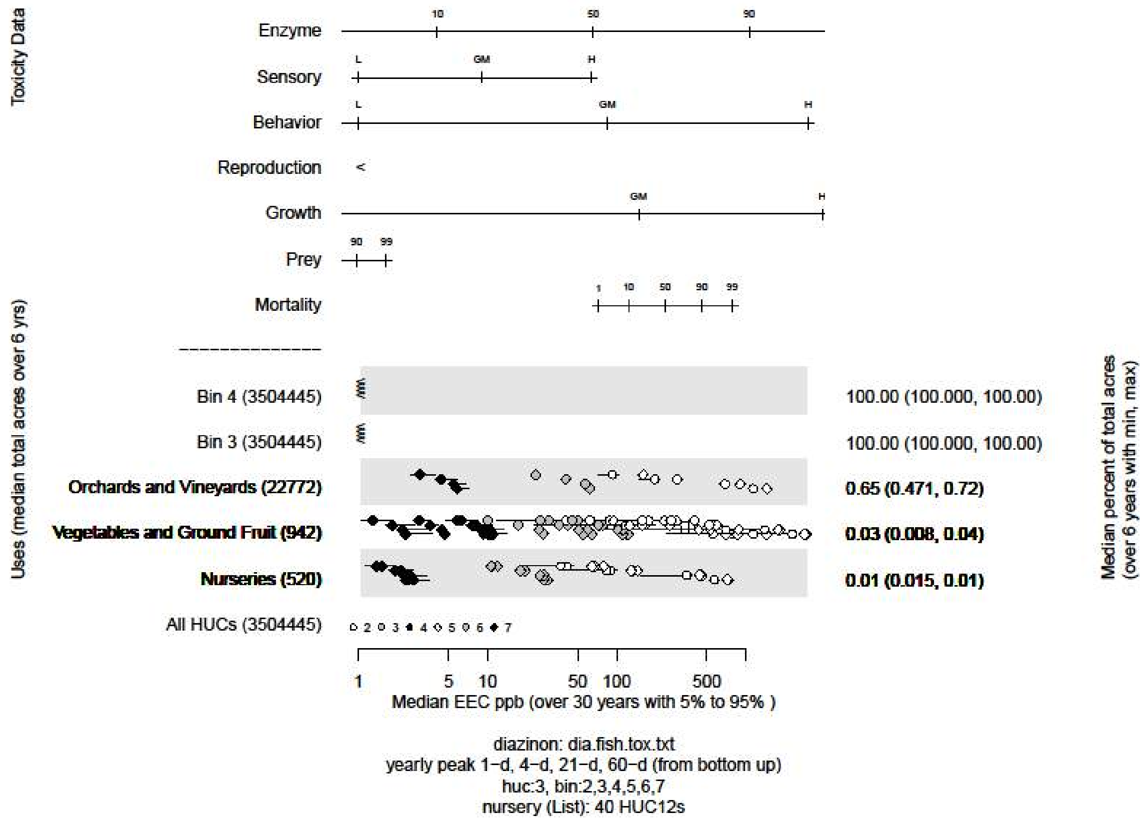


Figure 45. Effects analysis R-plot for Smalltooth sawfish and diazinon; Charlotte Harbor, Ten Thousand Islands, Everglades Nursery Areas

Table 421. Likelihood of exposure determination for Smalltooth sawfish and diazinon

	Percent Overlap*	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Full Range							
Orchards and Vineyards	1	yes	no	yes	no	3	**Low**
Vegetables and ground fruit	1	yes	no	yes	no	3	**Low**
Nursery	1	yes	no	yes	no	3	**Low**
bin 3	2	yes	no	yes	NA	3	**Low**
Nursery Only							
Orchards and Vineyards	1	yes	no	yes	no	3	**Low**
Vegetables and ground fruit	1	yes	no	yes	no	3	**Low**
Nursery	1	yes	no	yes	no	3	**Low**
bin 3	2	yes	no	yes	NA	3	**Low**
bin 4	2	yes	no	yes	NA	3	**Low**

Adult Life Stage (Coastal Habitats - Full Species Range)

Table 422. Direct mortality risk hypothesis; Smalltooth sawfish and diazinon; Adults

Mortality (% overlap)	**Effect of Exposure**	**Likelihood of Exposure**
Orchards & Vineyards (<1%)	High	Low
Veggie & Ground Fruit (<1%)	High	Low
Nurseries (<1%)	High	Low
Nearshore (~Bin 3)	Low	Low
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.		
	Risk	**Confidence**
	Low	**High**

Table 423. Prey risk hypothesis; Smalltooth sawfish and diazinon; Adults

Prey (% overlap)	**Effect of Exposure**	**Likelihood of Exposure**
Orchards & Vineyards (<1%)	High	Low
Veggie & Ground Fruit (<1%)	High	Low
Nurseries (<1%)	High	Low
Bin 3	Low	Low
Exposure to diazinon is sufficient to reduce adult abundance via reduction in prey availability		
	Risk	**Confidence**
	Low	**High**

Table 424. AChE risk hypothesis; Smalltooth sawfish and diazinon; Adults

Enzyme - AChE (% overlap)	**Effect of Exposure**	**Likelihood of Exposure**
Orchards & Vineyards (<1%)	High	Low
Veggie & Ground Fruit (<1%)	High	Low
Nurseries (<1%)	High	Low
Bin 3	Low	Low
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity		
	Risk	**Confidence**

	Low	High

Table 425. Behavior and sensory risk hypothesis; Smalltooth sawfish and diazinon; Adults

Sensory (% overlap)	**Effect of Exposure**	**Likelihood of Exposure**
Orchards & Vineyards (<1%)	High	Low
Veggie & Ground Fruit (<1%)	High	Low
Nurseries (<1%)	High	Low
Bin 3	Med	Low
Behavior (% overlap)	**Effect of Exposure**	**Likelihood of Exposure**
Orchards & Vineyards (<1%)	High	Low
Veggie & Ground Fruit (<1%)	High	Low
Nurseries (<1%)	High	Low
Bin 3	Med	Low
Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.		
	Risk	**Confidence**
	Low	**High**

Table 426. Reproduction risk hypothesis; Smalltooth sawfish and diazinon; Adults

Reproduction (% overlap)	**Effect of Exposure**	**Likelihood of Exposure**
Orchards & Vineyards (<1%)	High	Low
Veggie & Ground Fruit (<1%)	High	Low
Nurseries (<1%)	High	Low
Bin 3	High	Low
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction		
	Risk	**Confidence**
	Low	**High**

Juvenile and Adult Female Life Stages (Nursery Habitats)

Table 427. Direct mortality risk hypothesis; Smalltooth sawfish and diazinon; Adults and Juveniles

Mortality (% overlap)	**Effect of Exposure**	**Likelihood of Exposure**

Orchards & Vineyards (<1%)	High	Low
Veggie & Ground Fruit (<1%)	High	Low
Nurseries (<1%)	High	Low
Bin 3	Low	Low
Bin 4	Low	Low
Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.		
	Risk	**Confidence**
	Low	**High**

Table 428. Prey risk hypothesis; Smalltooth sawfish and diazinon; Adults and Juveniles

Prey (% overlap)	**Effect of Exposure**	**Likelihood of Exposure**
Orchards & Vineyards (<1%)	High	Low
Veggie & Ground Fruit (<1%)	High	Low
Nurseries (<1%)	High	Low
Bin 3	Med	Low
Bin 4	Med	Low
Exposure to diazinon is sufficient to reduce juvenile abundance via reduction in prey availability		
	Risk	**Confidence**
	Low	**High**

Table 429. AChE risk hypothesis; Smalltooth sawfish and diazinon; Adults and Juveniles

AChE (% overlap)	**Effect of Exposure**	**Likelihood of Exposure**
Orchards & Vineyards (<1%)	High	Low
Veggie & Ground Fruit (<1%)	High	Low
Nurseries (<1%)	High	Low
Bin 3	Low	Low
Bin 4	Low	Low

Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity		
	Risk	**Confidence**
	Low	**High**

Table 430. Behavior and sensory risk hypothesis; Smalltooth sawfish and diazinon; Adults and Juveniles

Juvenile Sensory (% overlap)	**Effect of Exposure**	**Likelihood of Exposure**
Orchards & Vineyards (<1%)	High	Low
Veggie & Ground Fruit (<1%)	High	Low
Nurseries (<1%)	High	Low
Bin 3	Med	Low
Bin 4	Med	Low
Juvenile Behavior (% overlap)	**Effect of Exposure**	**Likelihood of Exposure**
Orchards & Vineyards (<1%)	High	Low
Veggie & Ground Fruit (<1%)	High	Low
Nurseries (<1%)	High	Low
Bin 3	Low	Low
Bin 4	Low	Low
Exposure to diazinon is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.		
	Risk	**Confidence**
	Low	**High**

Table 431. Reproduction risk hypothesis; Smalltooth sawfish and diazinon; Adults

Adult Female Reproduction	**Effect of Exposure**	**Likelihood of Exposure**
Orchards & Vineyards (<1%)	High	Low
Veggie & Ground Fruit (<1%)	High	Low
Nurseries (<1%)	High	Low

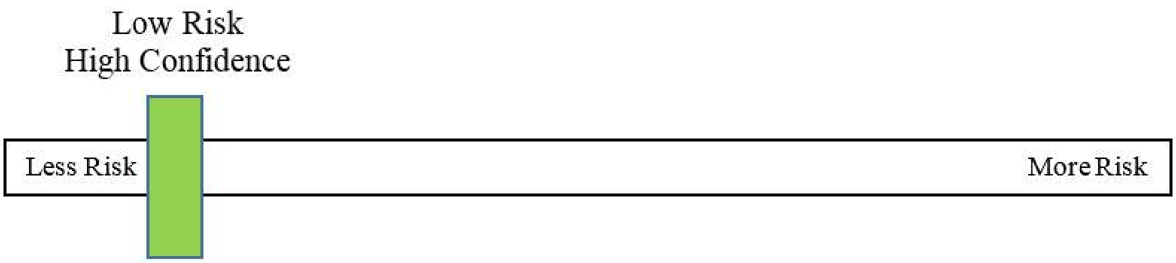
Bin 3	Low	Low
Bin 4	Low	Low
Exposure to diazinon is sufficient to reduce female productivity via impairments to reproduction		
	Risk	**Confidence**
	Low	**High**

Table 432. Effects analysis summary table: Smalltooth sawfish and diazinon

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults (Full Range)	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	**Low**	**High**	4-day: 0-1	No
Exposure to diazinon is sufficient to reduce adult abundance via reduction in prey availability	**Low**	**High**	4-day fish: 0-1 4-day invert: 1-7	No
Exposure to diazinon is sufficient to reduce ChE activity; mechanism of toxicity	**Low**	**High**	Not Available	No
Exposure to diazinon is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	**Low**	**High**	Not Available	No
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	**Low**	**High**	Not Available	No
Adult Females in Nursery Areas				
Exposure to diazinon is sufficient to reduce	**Low**	**High**	Not Available	**No**

female productivity via impairments to reproduction				
Juveniles in Nursery Areas				
Exposure to diazinon is sufficient to reduce juvenile abundance via acute lethality.	**Low**	**High**	4-day: 0-1	No
Exposure to diazinon is sufficient to reduce juvenile abundance via reduction in prey availability	**Low**	**High**	4-day fish: 0-1 4-day invert: 1-6	No
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	**Low**	**High**	Not Available	No
Exposure to diazinon is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	**Low**	**High**	Not Available	No
Exposure to diazinon is sufficient to reduce abundance via impacts to growth (direct toxicity)	**Low**	**High**	Not Available	No

Effects analysis summary: Adult and juvenile Smalltooth sawfish are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to diazinon. The MagTool results indicate that between 0-1 percent of individuals within a population will die. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, sawfish may experience increased toxicity. The overall risk to Smalltooth sawfish from the effects of the action is low and the confidence associated with that risk is high.



13.45 Black Abalone (Haliotis cracherodii)

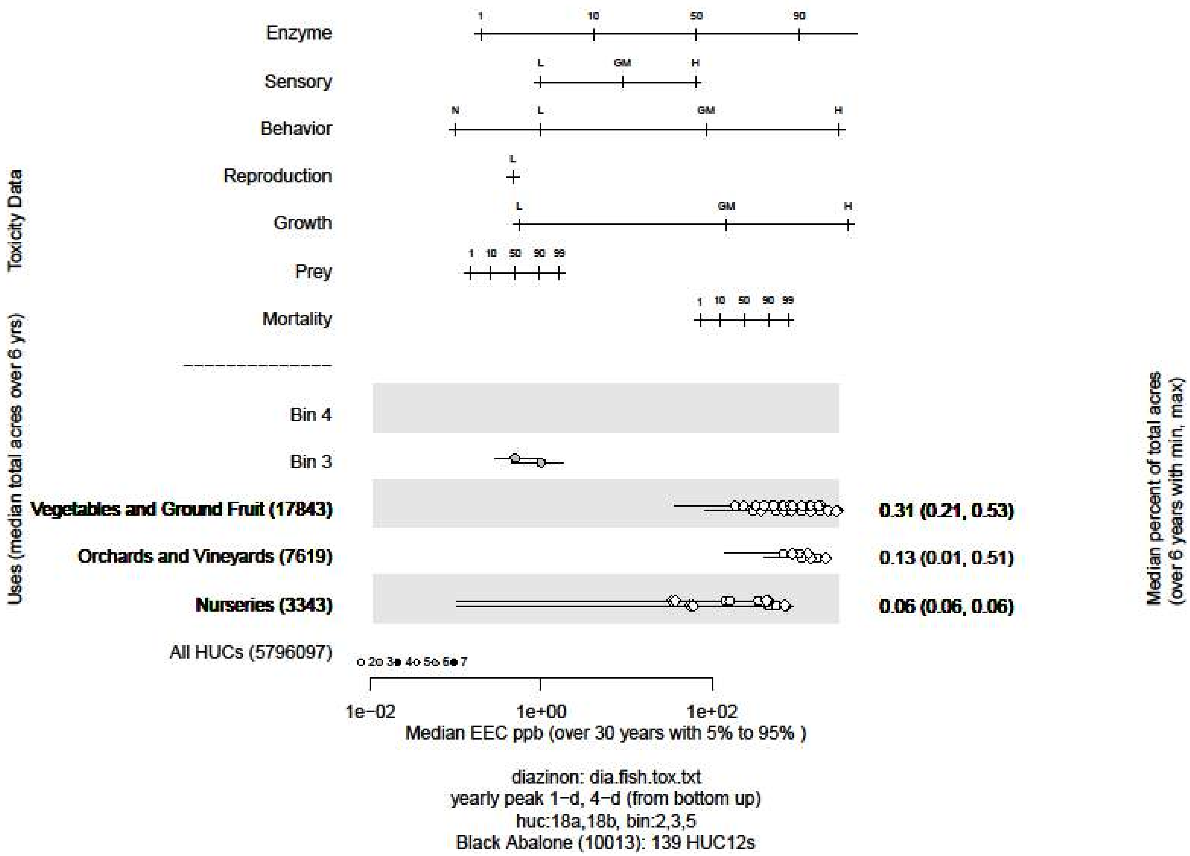


Figure 46. Effects analysis R-plot for Black abalone and diazinon

Table 433. Likelihood of exposure determination for Black abalone and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	**Low**
Orchards and Vineyard	1	yes	no	yes	NA	3	**Low**
Nurseries	1	yes	no	yes	NA	3	**Low**
Bin 3	1	yes	no	yes	NA	3	**Low**

Life Stage: Larvae/Juvenile and Adult (full-range)

Table 434. Direct mortality risk hypothesis; Black abalone and diazinon; Larvae/Juvenile and Adult

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	<1	High	Low
Orchards and Vineyard	<1	High	Low
Nurseries	<1	High	Low
Bin 3		High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce the abundance of larval/juvenile and adults via direct toxicity			
Risk	**Confidence**		
Low	**Medium**		

Table 435. Prey risk hypothesis; Black abalone and diazinon; Juvenile and Adult

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	<1	Medium	Low
Orchards and Vineyard	<1	Medium	Low

Nurseries	<1	Low	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce the abundance of juvenile and adults via reduction in prey availability			
Risk	**Confidence**		
Low	**Medium**		

Table 436. Behavior and sensory risk hypothesis; Black abalone and diazinon; Larvae/Juvenile and Adult

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	<1	Medium	Low
Orchards and Vineyard	<1	Medium	Low
Nurseries	<1	Medium	Low
Bin 3		Medium	Low
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	<1	Not Available	Low
Orchards and Vineyard	<1	Not Available	Low
Nurseries	<1	Not Available	Low
Bin 3		Not Available	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce the abundance and productivity of larval/juvenile and adults via impairments to ecologically significant behaviors (e.g. prey capture, settling, metamorphosis).			
Risk	**Confidence**		
Low	**Medium**		

Table 437. AChE risk hypothesis; Black abalone and diazinon; Larvae/Juvenile and Adult

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	<1	High	Low
Orchards and Vineyard	<1	High	Low
Nurseries	<1	High	Low
Bin 3		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**Medium**		

Table 438. Growth risk hypothesis; Black abalone and diazinon; Larvae/Juvenile and Adult

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	<1	High	Low
Orchards and Vineyard	<1	High	Low
Nurseries	<1	High	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce the abundance and productivity of larval/juvenile and adults via reductions in growth (direct toxicity)			
Risk	**Confidence**		
Low	**Medium**		

Table 439. Reproduction risk hypothesis; Black abalone and diazinon; Adult

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

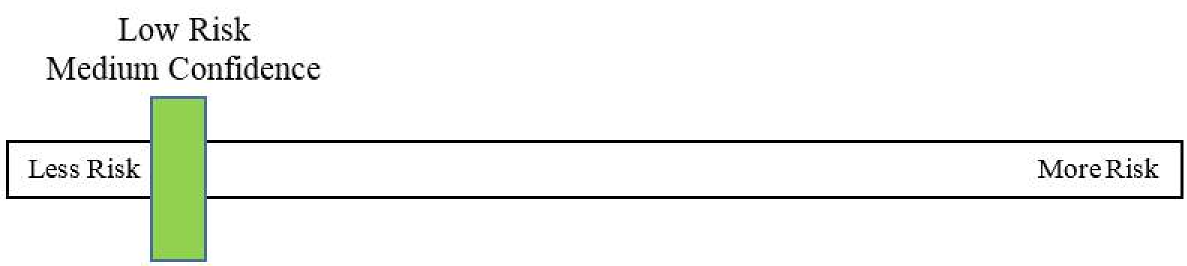
Vegetables and Ground Fruit	<1	High	Low
Orchards and Vineyard	<1	High	Low
Nurseries	<1	High	Low
Bin 3		Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce the productivity of adults via impairments to reproduction.			
Risk	**Confidence**		
Low	**Medium**		

Table 440. Effects analysis summary table: Black abalone and diazinon

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Larvae/Juveniles and Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce the abundance of larval/juvenile and adults via direct toxicity	Low	Medium	Not Available	No
Exposure to diazinon is sufficient to reduce the abundance of juvenile and adults via reduction in prey availability	Low	Medium	Not Available	No
Exposure to diazinon is sufficient to reduce the abundance and productivity of larval/juvenile and adults via impairments to ecologically significant behaviors (e.g. prey capture, settling, metamorphosis).	Low	Medium	Not Available	No
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	Medium	Not Available	No
Exposure to diazinon is sufficient to reduce the abundance and productivity of larval/juvenile and adults	Low	Medium	Not Available	No

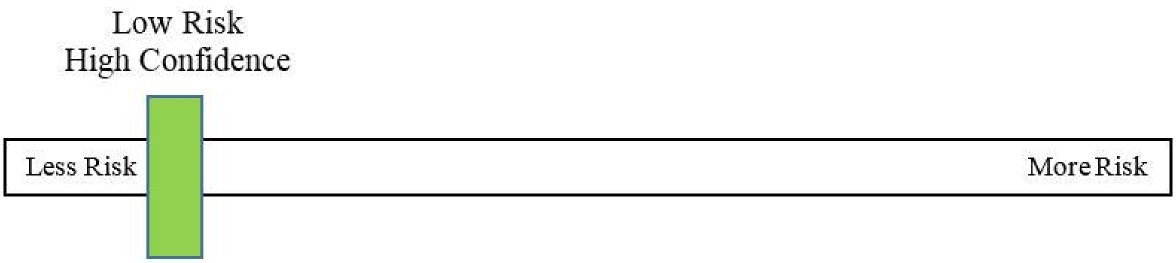
via reductions in growth (direct toxicity)				
Exposure to diazinon is sufficient to reduce the productivity of adults via impairments to reproduction.	Low	Medium	Not Available	No

Effects analysis summary: Adult, juvenile and larval black abalone are not anticipated to experience significant reductions in abundance and productivity (adults) from exposure to diazinon. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, abalone may experience increased toxicity. The overall risk to black abalone from the effects of the action is low and the confidence associated with that risk is medium. The lack in confidence is due primarily to the uncertainty in predicted diazinon concentrations in coastal habitats. Medium confidence of risk is also attributed to uncertainty regarding the portion of the population which occupy tide-pools.



13.46 White Abalone (Haliotis sorenseni)

Effects analysis summary: Adult and juvenile white abalone are not anticipated to experience significant reductions in abundance and productivity (adults) from exposure to diazinon. The overall risk to white abalone from the effects of the action is low and the confidence associated with that risk is high. The low risk is due primarily to the proximity of white abalone habitat (marine off-shore; depths of 80-100 feet) relative to diazinon use sites.



13.47 Caribbean Corals (7 species): Orbicella franksi; Orbicella annularis; Orbicella faveolata; Mycetophyllia ferox; Acropora cervicornis; Acropora palmate; Dendrogyra cylindrus

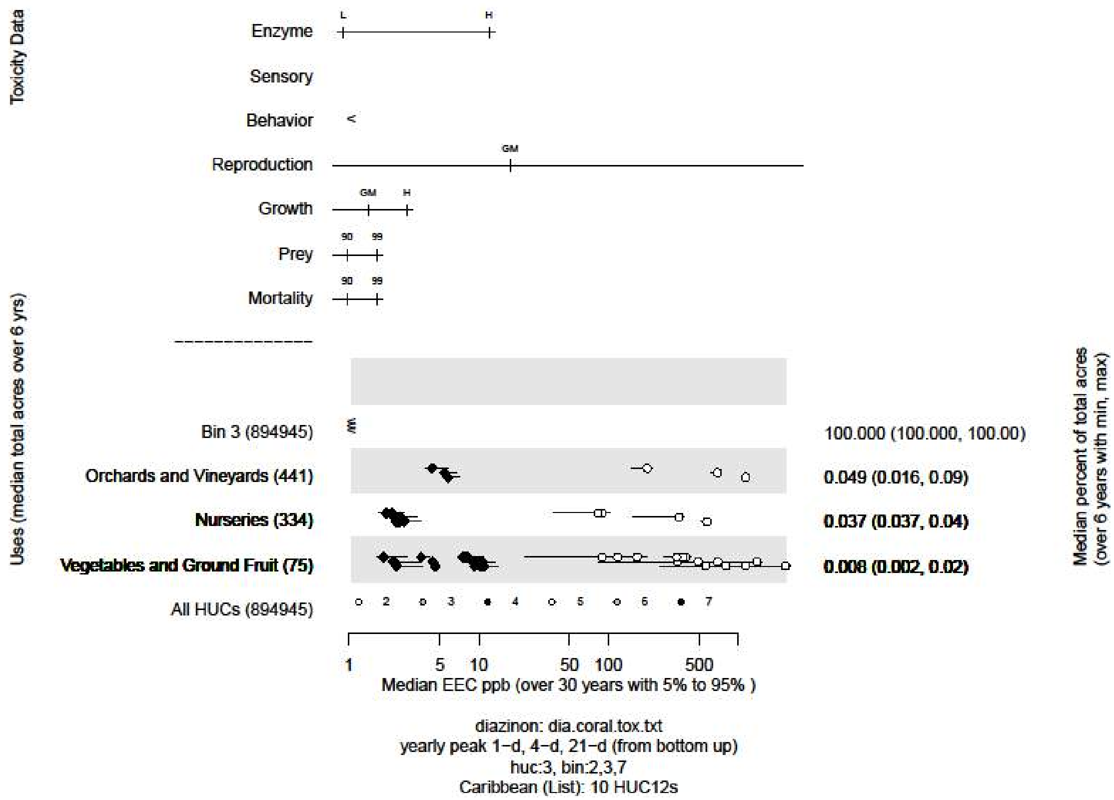


Figure 47. Effects Analysis R-plot for Caribbean Corals (7 Species) and Diazinon; Florida Coast

Table 441. Likelihood of exposure determination for Caribbean corals (7 species) and diazinon

	Percent Overlap	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range within US Territories	Likelihood of Exposure
Florida Coast								
Orchards and Vineyards	1	yes	no	yes	NA	3	8%	Low
Nurseries	1	yes	no	yes	NA	3	8%	Low
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	8%	Low
Bin 3	1	yes	no	yes	NA	3	8%	Low
US Territories in Caribbean								
Crops	NA	yes	yes	yes	NA	3	8%	Med

Table 442. Direct mortality risk hypothesis; Caribbean corals (7 species) and diazinon; Florida Coast

Endpoint: Mortality (Southeast Florida Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low
Vegetables and Ground Fruit	.008	High	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce the abundance of populations via direct toxicity			
Risk	**Confidence**		
Low	**Medium**		

Table 443. Direct mortality risk hypothesis; Caribbean corals (7 species) and diazinon; US Territories in the Caribbean

Endpoint: Mortality (HUC03; US territories in the Caribbean)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

All Ag Uses	Not Available	High	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce the abundance of populations via direct toxicity			
Risk	**Confidence**		
High	**Low**		

Table 444. Prey risk hypothesis; Caribbean corals (7 species) and diazinon; Florida Coast

Endpoint: Prey (Southeast Florida Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low
Vegetables and Ground Fruit	.008	High	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**Medium**		

Table 445. Prey risk hypothesis; Caribbean corals (7 species) and diazinon; US Territories in the Caribbean

Endpoint: Prey (HUC03; US territories in the Caribbean)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All Uses	Not Available	High	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce the abundance of populations via reduction in prey availability			
Risk	**Confidence**		
High	**Low**		

Table 446. AChE risk hypothesis; Caribbean corals (7 species) and diazinon; Florida Coast

Endpoint: Enzyme (Southeast Florida Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low
Vegetables and Ground Fruit	.008	High	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**Medium**		

Table 447. AChE risk hypothesis; Caribbean corals (7 species) and diazinon; US Territories in the Caribbean

Endpoint: Enzyme (HUC03; US territories in the Caribbean)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All Uses	Not Available	High	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Low**		

Table 448. Behavior and sensory risk hypothesis; Caribbean corals (7 species) and diazinon; Florida Coast

Endpoint: Behavior (Southeast Florida Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low
Vegetables and Ground Fruit	.008	High	Low

Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**Medium**		

Table 449. Behavior and sensory risk hypothesis; Caribbean corals (7 species) and diazinon; US Territories in the Caribbean

Endpoint: Behavior (HUC03; US territories in the Caribbean)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All Uses	Not Available	High	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce the abundance and productivity of populations via impairments to ecologically significant behaviors (e.g. prey capture).			
Risk	**Confidence**		
High	**Low**		

Table 450. Reproduction risk hypothesis; Caribbean corals (7 species) and diazinon; Florida Coast

Endpoint: Reproduction (Southeast Florida Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low
Vegetables and Ground Fruit	.008	High	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**Medium**		

Table 451. Reproduction risk hypothesis; Caribbean corals (7 species) and diazinon; US Territories in the Caribbean

Endpoint: Reproduction (HUC03; US territories in the Caribbean)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All Uses	Not Available	High	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce the productivity of populations via impairments to reproduction (e.g. spawning cues).			
Risk	**Confidence**		
High	**Low**		

Table 452. Direct mortality, behavior, reproduction risk hypothesis; Caribbean corals (7 species) and diazinon; Florida Coast; Larvae

Endpoint: mortality (Southeast Florida Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low
Vegetables and Ground Fruit	.008	High	Low
Bin 3		Low	Low
Endpoint: behavior (Southeast Florida Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low
Vegetables and Ground Fruit	.008	High	Low
Bin 3		Low	Low
Endpoint: reproduction (Southeast Florida Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low
Vegetables and Ground Fruit	.008	High	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce productivity of populations via effects on larvae (settling, metamorphosis, mortality, etc.)			
Risk	**Confidence**		
Low	**Mediumium**		

Table 453. Direct mortality, behavior, reproduction risk hypothesis; Caribbean corals (7 species) and diazinon; US Territories in the Caribbean; Larvae

Endpoint: mortality (HUC03; US territories in the Caribbean)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All Ag Uses	Not Available	High	Medium
Endpoint: behavior (HUC03; US territories in the Caribbean)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All Uses	Not Available	High	Medium
Endpoint: reproduction (HUC03; US territories in the Caribbean)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All Uses	Not Available	High	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce productivity of populations via effects on larvae (settling, metamorphosis, mortality, etc.)			
Risk	**Confidence**		
High	**Low**		

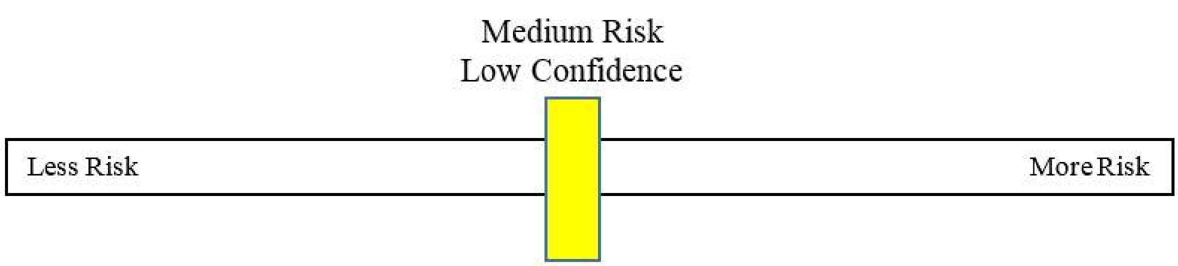
Table 454. Effects analysis summary table: Caribbean corals (7 species) and diazinon

	R-plot Derived	MagTool	

(Southeast Florida Coastal HUC-12s)	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	**Risk Hypothesis Supported? Yes/No**
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce the abundance of populations via direct toxicity	Low	Medium	Not Available	No
Exposure to diazinon is sufficient to reduce the abundance of populations via reduction in prey availability	Low	Medium	Not Available	No
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	Medium	Not Available	No
Exposure to diazinon is sufficient to reduce the abundance and productivity of populations via impairments to ecologically significant behaviors (e.g. prey capture).	Low	Medium	Not Available	No
Exposure to diazinon is sufficient to reduce the productivity of populations via impairments to reproduction (e.g. spawning cues).	Low	Medium	Not Available	No
Exposure to diazinon is sufficient to reduce productivity of populations via effects on larvae (settling, metamorphosis, mortality, etc.)	Low	Medium	Not Available	No
(HUC03; US territories in the Caribbean)				
Exposure to diazinon is sufficient to reduce the abundance of populations via direct toxicity	**High**	**Low**	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce the abundance of populations via reduction in prey availability	**High**	**Low**	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	**High**	**Low**	Not Available	**Yes**

Exposure to diazinon is sufficient to reduce the abundance and productivity of populations via impairments to ecologically significant behaviors (e.g. prey capture).	**High**	**Low**	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce the productivity of populations via impairments to reproduction (e.g. spawning cues).	**High**	**Low**	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce productivity of populations via effects on larvae (settling, metamorphosis, mortality, etc.)	**High**	**Low**	Not Available	**Yes**

Effects analysis summary: Caribbean coral populations (7 species: Orbicella franksi; Orbicella annularis; Orbicella faveolata; Mycetophyllia ferox; Acropora cervicornis; Acropora palmate; Dendrogyra cylindrus) are not anticipated to experience significant reductions in abundance or productivity from exposure to diazinon. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, coral may experience increased toxicity. The overall risk to Caribbean corals (7 species) from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted diazinon concentrations in coastal habitats. Low confidence of risk is also attributed to the low portion of the species range within US territories.



13.48 Indo-Pacific Corals (7 species): Acropora retusa; Acropora globiceps; Seriatopora aculeate; Euphyllia paradivisa; Isopora crateriformis; Acropora jacquelineae; Acropora speciose

Table 455. Effects analysis R-plot for Indo-Pacific corals (7 species) and diazinon

	Percent Overlap	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range within US Territories	Likelihood of Exposure
All Uses	NA	yes	no	yes	NA	3	0.2 - 1.4%	Low

Table 456. Direct mortality risk hypothesis; Indo-Pacific corals (7 species) and diazinon; Hawaii/US Territories in the Pacific

Endpoint: Mortality (HUC2: 20a/20b Hawaii and US territories in the Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All Uses (Agricultural)	Not Available	High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce the abundance of populations via direct toxicity			
Risk	**Confidence**		
Low	**Medium**		

Table 457. Prey risk hypothesis; Indo-Pacific corals (7 species) and diazinon; Hawaii/US Territories in the Pacific

Endpoint: Prey (HUC2: 20a/20b Hawaii and US territories in the Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All Uses (Agricultural)	Not Available	High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce the abundance of populations via reduction in prey availability			

Risk	Confidence	
Low	**Medium**	

Table 458. AChE risk hypothesis; Indo-Pacific corals (7 species) and diazinon; Hawaii/US Territories in the Pacific

Endpoint: Enzyme (HUC2: 20a/20b Hawaii and US territories in the Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All Uses (Agricultural)	Not Available	High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**Medium**		

Table 459. Behavior and sensory risk hypothesis; Indo-Pacific corals (7 species) and diazinon; Hawaii/US Territories in the Pacific

Endpoint: Behavior (HUC2: 20a/20b Hawaii and US territories in the Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All Uses (Agricultural)	Not Available	High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce the abundance and productivity of populations via impairments to ecologically significant behaviors (e.g. prey capture).			
Risk	**Confidence**		
Low	**Medium**		

Table 460. Reproduction risk hypothesis; Indo-Pacific corals (7 species) and diazinon; Hawaii/US Territories in the Pacific

Endpoint: Reproduction (HUC2: 20a/20b Hawaii and US territories in the Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All Uses (Agricultural)	Not Available	High	Low

Risk Hypothesis: Exposure to diazinon is sufficient to reduce the productivity of populations via impairments to reproduction (e.g. spawning cues).		
Risk	**Confidence**	
Low	**Medium**	

Table 461. Direct mortality, behavior, reproduction risk hypothesis; Indo-Pacific corals (7 species) and diazinon; Hawaii/US Territories in the Pacific; larvae

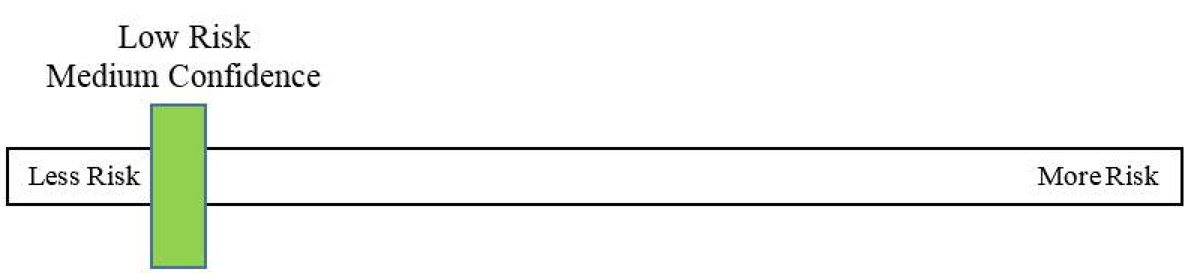
Endpoint: mortality (HUC2: 20a/20b Hawaii and US territories in the Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All Uses (Agricultural)	Not Available	High	Low
Endpoint: behavior (HUC2: 20a/20b Hawaii and US territories in the Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All Uses (Agricultural)	Not Available	High	Low
Endpoint: reproduction (HUC2: 20a/20b Hawaii and US territories in the Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All Uses (Agricultural)	Not Available	High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce productivity of populations via effects on larvae (settling, metamorphosis, mortality, etc.)			
Risk	**Confidence**		
Low	**Medium**		

Table 462. Effects analysis summary table: Indo-Pacific corals (7 species) and diazinon

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Hawaii and US territories in the Pacific	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce the abundance of populations via direct toxicity	**Low**	**Medium**	Not Available	**No**
Exposure to diazinon is sufficient to reduce the abundance of populations	**Low**	**Medium**	Not Available	**No**

via reduction in prey availability				
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	**Low**	**Medium**	Not Available	**No**
Exposure to diazinon is sufficient to reduce the abundance and productivity of populations via impairments to ecologically significant behaviors (e.g. prey capture).	**Low**	**Medium**	Not Available	**No**
Exposure to diazinon is sufficient to reduce the productivity of populations via impairments to reproduction (e.g. spawning cues).	**Low**	**Medium**	Not Available	**No**
Exposure to diazinon is sufficient to reduce productivity of populations via effects on larvae (settling, metamorphosis, mortality, etc.)	**Low**	**Medium**	Not Available	**No**

Effects analysis summary: Indo-Pacific coral populations (7 species: Acropora retusa; Acropora globiceps; Seriatopora aculeate; Euphyllia paradivisa; Isopora crateriformis; Acropora jacquelineae; Acropora speciose) are not anticipated to experience significant reductions in abundance or productivity from exposure to diazinon. Where formulated products and tank mixtures containing diazinon occur in aquatic habitats, coral may experience increased toxicity. The overall risk to Indo-Pacific corals (7 species) from the effects of the action is low and the confidence associated with that risk is med. The lack in confidence is due primarily to the uncertainty in predicted diazinon concentrations in coastal habitats. Low risk is attributed primarily to the low portion of the species range within US territories.



13.49 Green Sea Turtle, Central North Pacific DPS (Chelonia mydas)

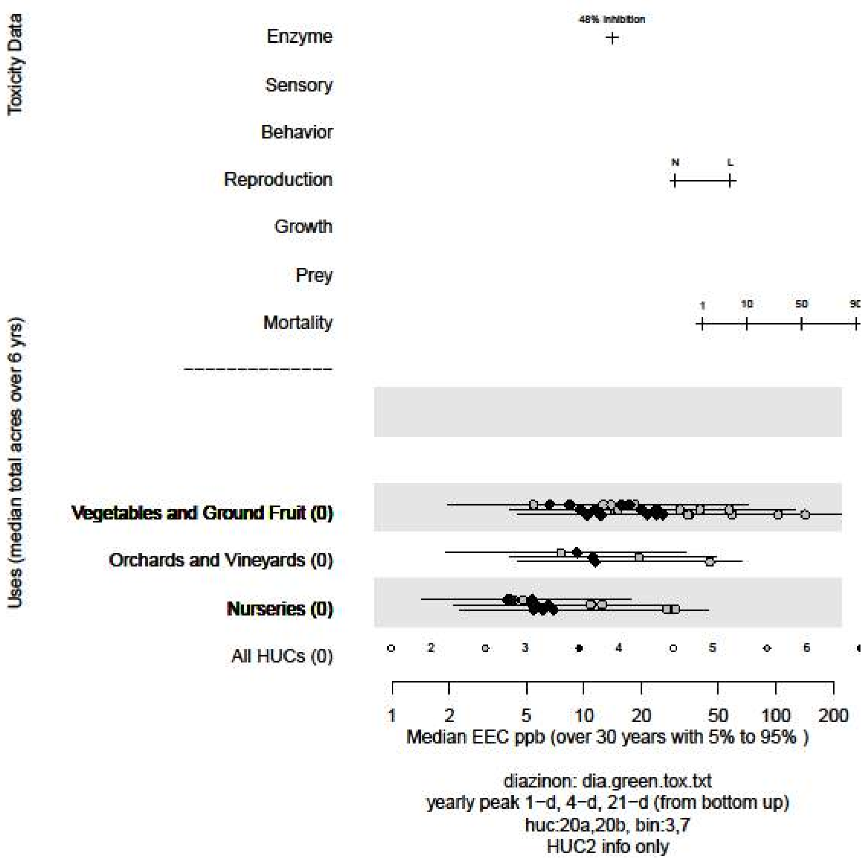


Figure 48. Effects analysis R-plot for Green sea turtle, central north pacific DPS and diazinon

Table 463. Likelihood of exposure determination for Green sea turtle, central north pacific DPS and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Vegetables and Ground Fruit	NA	yes	no	yes	NA	3	**Med**
Orchards and Vineyards	NA	yes	no	yes	NA	3	**Med**
Nurseries	NA	yes	no	yes	NA	3	**Med**
Bin 3	NA	yes	no	yes	NA	3	**NA**

Life Stage: Juveniles

Based on the life history of green turtles, hatchlings crawl to the water and swim to offshore areas where they reside for several years. Therefore juveniles are not expected to experience substantial exposure to diazinon.

Life Stage: Adults

Table 464. Direct mortality risk hypothesis; Green sea turtle, central north pacific DPS and diazinon; Adults

Endpoint: Mortality (HUC2: 20 Hawaii)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	NA	High	**Medium**
Orchards and Vineyards	NA	Medium	**Medium**
Nurseries	NA	Medium	**Medium**
Bin 3	NA	NA	**NA**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Medium	**Low**		

Table 465. Reproduction risk hypothesis; Green sea turtle, central north pacific DPS and diazinon; Adults

Endpoint: Reproduction (HUC2: 20 Hawaii)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	NA	High	**Medium**
Orchards and Vineyards	NA	Medium	**Medium**
Nurseries	NA	Low	**Medium**
Bin 3	NA	NA	**NA**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Medium	**Low**		

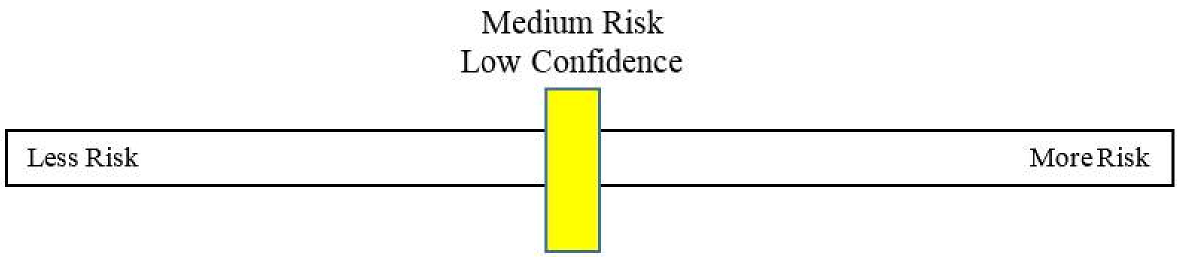
Table 466. AChE risk hypothesis; Green sea turtle, central north pacific DPS and diazinon; Adults

Endpoint: enzyme (HUC2: 20 Hawaii)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	NA	High	**Medium**
Orchards and Vineyards	NA	High	**Medium**
Nurseries	NA	High	**Medium**
Bin 3	NA	NA	**NA**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Low**		

Table 467. Effects analysis summary table: Green sea turtle, central north pacific DPS and diazinon

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	Medium	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Medium	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Low	Not Available	**No**

Effects analysis summary: Adult and juvenile Green sea turtle, central north pacific DPS are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to diazinon in the marine environment. If exposed to formulated products and tank mixtures containing diazinon, sea turtles may experience increased toxicity. The overall risk to Green sea turtle, central north pacific DPS from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted diazinon concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites within the species range.



13.50 Green Sea Turtle, Central South Pacific DPS (Chelonia mydas)

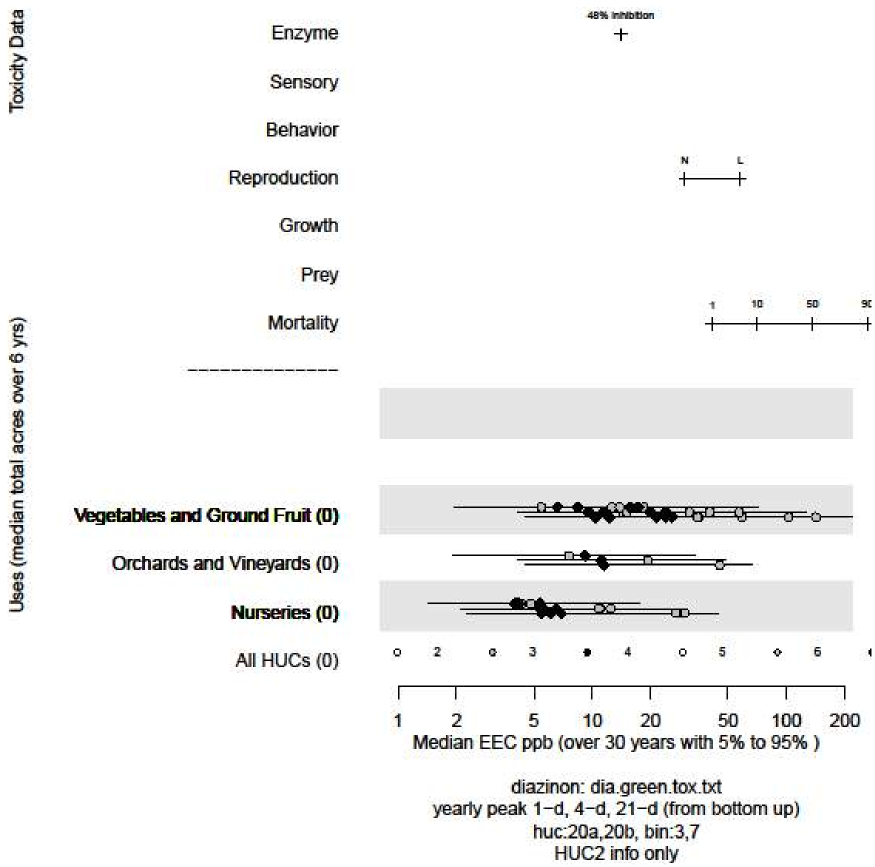


Figure 49. Effects analysis R-plot for Green sea turtle, central south pacific DPS and diazinon

Table 468. Likelihood of exposure determination for Green sea turtle, central south pacific DPS and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Vegetables and Ground Fruit	NA	yes	no	yes	NA	3	**Med**
Orchards and Vineyards	NA	yes	no	yes	NA	3	**Med**
Nurseries	NA	yes	no	yes	NA	3	**Med**
Bin 3	NA	yes	no	yes	NA	3	**NA**

Life Stage: Juveniles

Based on the life history of green turtles, hatchlings crawl to the water and swim to offshore areas where they reside for several years. Therefore juveniles are not expected to experience substantial exposure to diazinon.

Life Stage: Adults

Table 469. Direct mortality risk hypothesis; Green sea turtle, central south pacific DPS and diazinon; Adults

Endpoint: Mortality (HUC2: 20 Hawaii)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	NA	High	**Medium**
Orchards and Vineyards	NA	Medium	**Medium**
Nurseries	NA	Medium	**Medium**
Bin 3	NA	NA	**NA**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Medium	**Low**		

Table 470. Reproduction risk hypothesis; Green sea turtle, central south pacific DPS and diazinon; Adults

Endpoint: Reproduction (HUC2: 20 Hawaii)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	NA	High	**Medium**
Orchards and Vineyards	NA	Medium	**Medium**
Nurseries	NA	Low	**Medium**
Bin 3	NA	NA	**NA**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		

Medium	**Low**	

Table 471. AChE risk hypothesis; Green sea turtle, central south pacific DPS and diazinon; Adults

Endpoint: enzyme (HUC2: 20 Hawaii)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	NA	High	**Medium**
Orchards and Vineyards	NA	High	**Medium**
Nurseries	NA	High	**Medium**
Bin 3	NA	NA	**NA**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Low**		

Table 472. Effects analysis summary table: Green sea turtle, central south pacific DPS and diazinon

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	Medium	Low	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Medium	Low	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Low	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Green sea turtle, central south pacific DPS are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to diazinon in the marine environment. If exposed to formulated products and tank mixtures containing diazinon, sea turtles may experience increased toxicity. The overall risk to Green sea turtle, central south pacific DPS from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted diazinon concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites with the species range.

13.51 Green Sea Turtle, Central West Pacific DPS (Chelonia mydas)

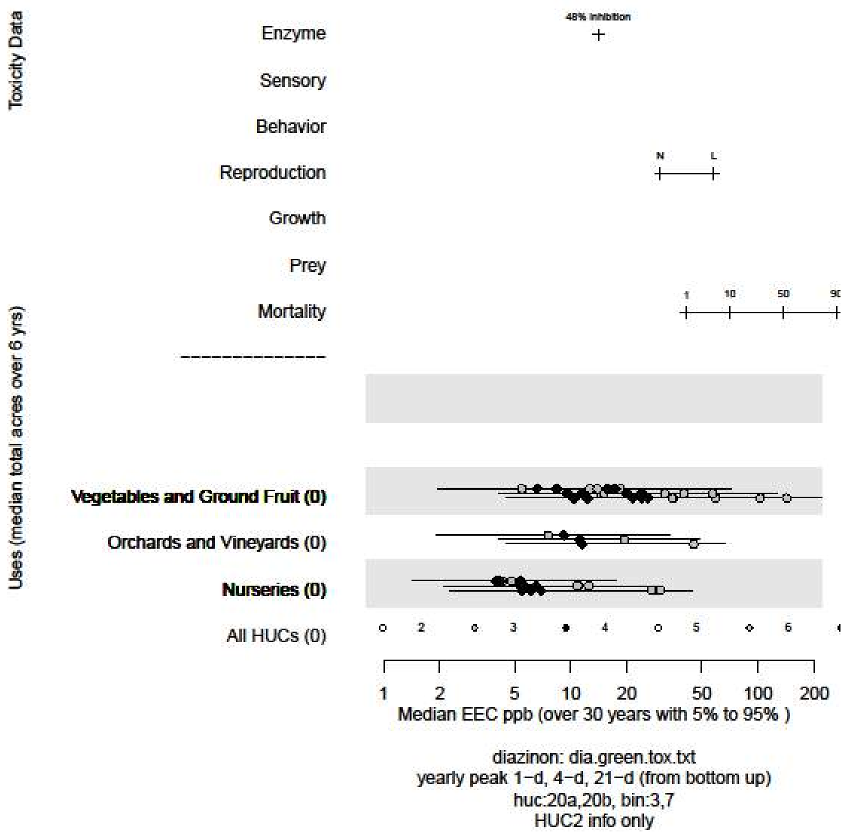


Figure 50. Effects analysis R-plot for Green sea turtle, central west pacific DPS and diazinon

Table 473. Likelihood of exposure determination for Green sea turtle, central west pacific DPS and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range within US Territories	Likelihood of Exposure
Vegetables and Ground Fruit	NA	yes	no	yes	NA	3	small	Low
Orchards and Vineyards	NA	yes	no	yes	NA	3	small	Low
Nurseries	NA	yes	no	yes	NA	3	small	Low
Bin 3	NA	yes	no	yes	NA	3	small	Low

Life Stage: Juveniles

Based on the life history of green turtles, hatchlings crawl to the water and swim to offshore areas where they reside for several years. Therefore juveniles are not expected to experience substantial exposure to diazinon.

Life Stage: Adults

Table 474. Direct mortality risk hypothesis; Green sea turtle, central west pacific DPS and diazinon; Adults

Endpoint: Mortality (HUC20; Guam and Mariana)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	NA	High	**Low**
Orchards and Vineyards	NA	Medium	**Low**
Nurseries	NA	Medium	**Low**
Bin 3	NA	NA	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Medium	**Low**		

Table 475. Reproduction risk hypothesis; Green sea turtle, central west pacific DPS and diazinon; Adults

Endpoint: Reproduction (HUC20; Guam and Mariana)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	NA	High	**Low**
Orchards and Vineyards	NA	Medium	**Low**
Nurseries	NA	Low	**Low**
Bin 3	NA	NA	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		

Medium	**Low**	

Table 476. AChE risk hypothesis; Green sea turtle, central west pacific DPS and diazinon; Adults

Endpoint: enzyme (HUC20; Guam and Mariana)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	NA	High	**Low**
Orchards and Vineyards	NA	High	**Low**
Nurseries	NA	High	**Low**
Bin 3	NA	NA	**Low**
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Low**		

Table 477. Effects analysis summary table: Green sea turtle, central west pacific DPS and diazinon

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	Medium	Low	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Medium	Low	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Low	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Green sea turtle, central west pacific DPS are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to diazinon in the marine environment. If exposed to formulated products and tank mixtures containing diazinon, sea turtles may experience increased toxicity. The overall risk to Green sea turtle, central south pacific DPS from the effects of the action is medium and the confidence associated with that risk is low. The low risk is due primarily to the small portion of the species range within US territories. The lack in confidence is due primarily to the uncertainty in predicted diazinon concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites with the species range.

13.52 Green Sea Turtle, East Pacific DPS (Chelonia mydas)

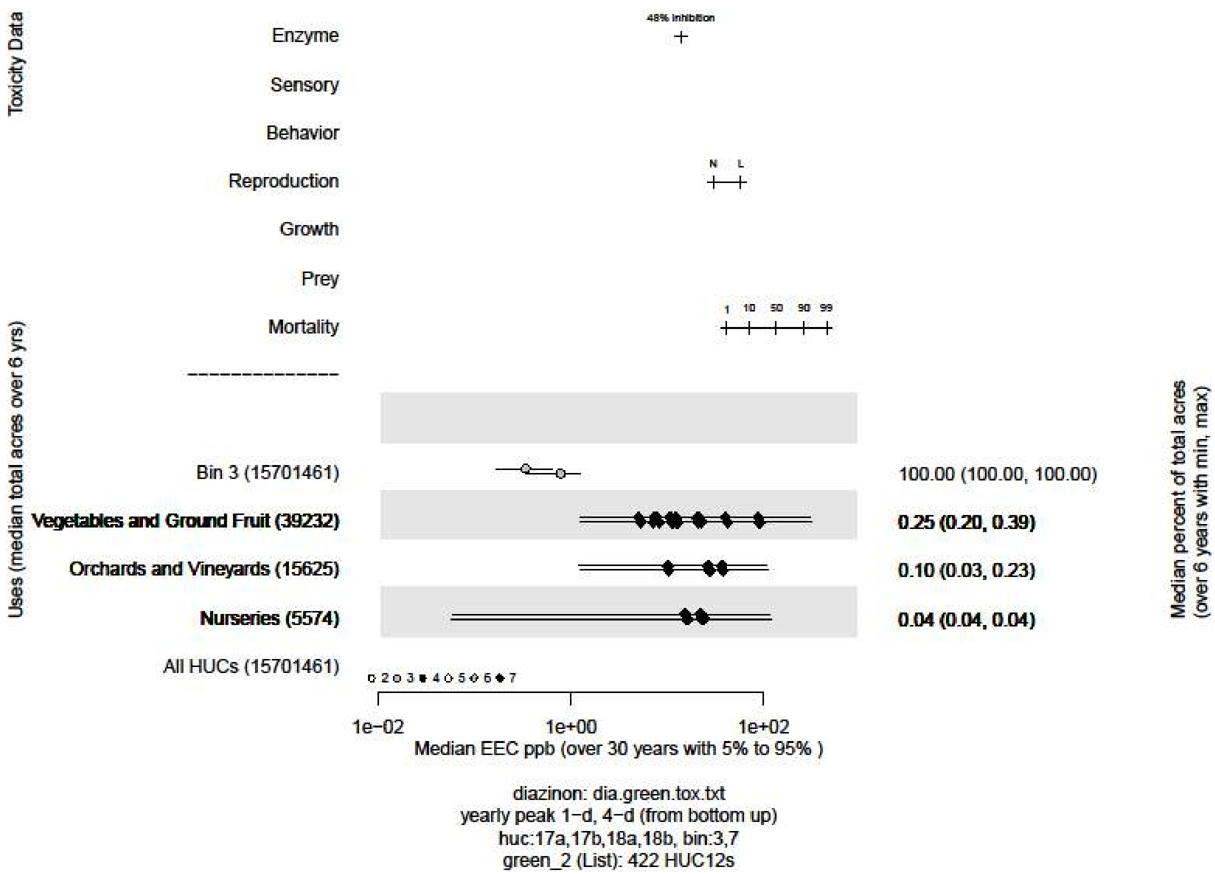


Figure 51. Effects analysis R-plot for Green sea turtle, east pacific DPS and diazinon

Table 478. Likelihood of exposure determination for Green sea turtle, east pacific DPS and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range within US Territories	Likelihood of Exposure
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	8%	Low
Orchards and Vineyards	1	yes	no	yes	NA	3	8%	Low
Nurseries	1	yes	no	yes	NA	3	8%	Low
Bin 3	1	yes	no	yes	NA	3	8%	Low

Life Stage: Juveniles

Based on the life history of green turtles, hatchlings crawl to the water and swim to offshore areas where they reside for several years. Therefore juveniles are not expected to experience substantial exposure to diazinon.

Life Stage: Adults

Table 479. Direct mortality risk hypothesis; Green sea turtle, east pacific DPS and diazinon; Adults

Endpoint: Mortality (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	.3	High	Low
Orchards and Vineyards	.2	Medium	Low
Nurseries	.05	Medium	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**Low**		

Table 480. Reproduction risk hypothesis; Green sea turtle, east pacific DPS and diazinon; Adults

Endpoint: Reproduction (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	.3	High	Low
Orchards and Vineyards	.2	High	Low
Nurseries	.05	High	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**Low**		

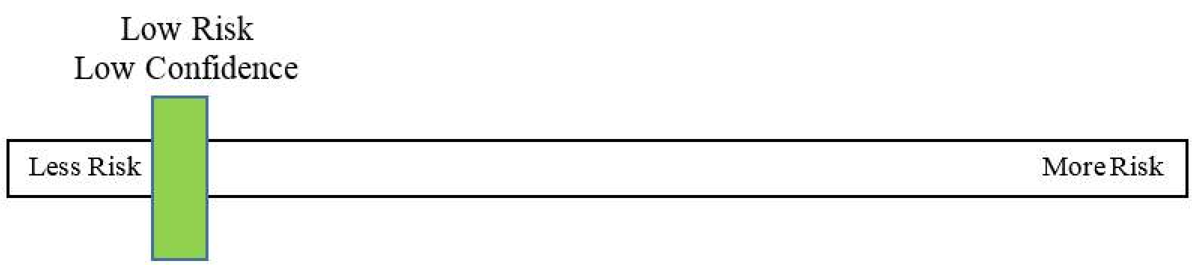
Table 481. AChE risk hypothesis; Green sea turtle, east pacific DPS and diazinon; Adults

Endpoint: enzyme (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	.3	High	Low
Orchards and Vineyards	.2	High	Low
Nurseries	.05	High	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**Low**		

Table 482. Effects analysis summary table: Green sea turtle, east pacific DPS and diazinon

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	Low	Not Available	**No**

Effects analysis summary: Adult and juvenile Green sea turtle, east pacific DPS are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to diazinon in the marine environment. If exposed to formulated products and tank mixtures containing diazinon, sea turtles may experience increased toxicity. The overall risk to Green sea turtle, east pacific DPS from the effects of the action is low and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted diazinon concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites with the species range.



13.53 Green Sea Turtle, North Atlantic DPS (Chelonia mydas)

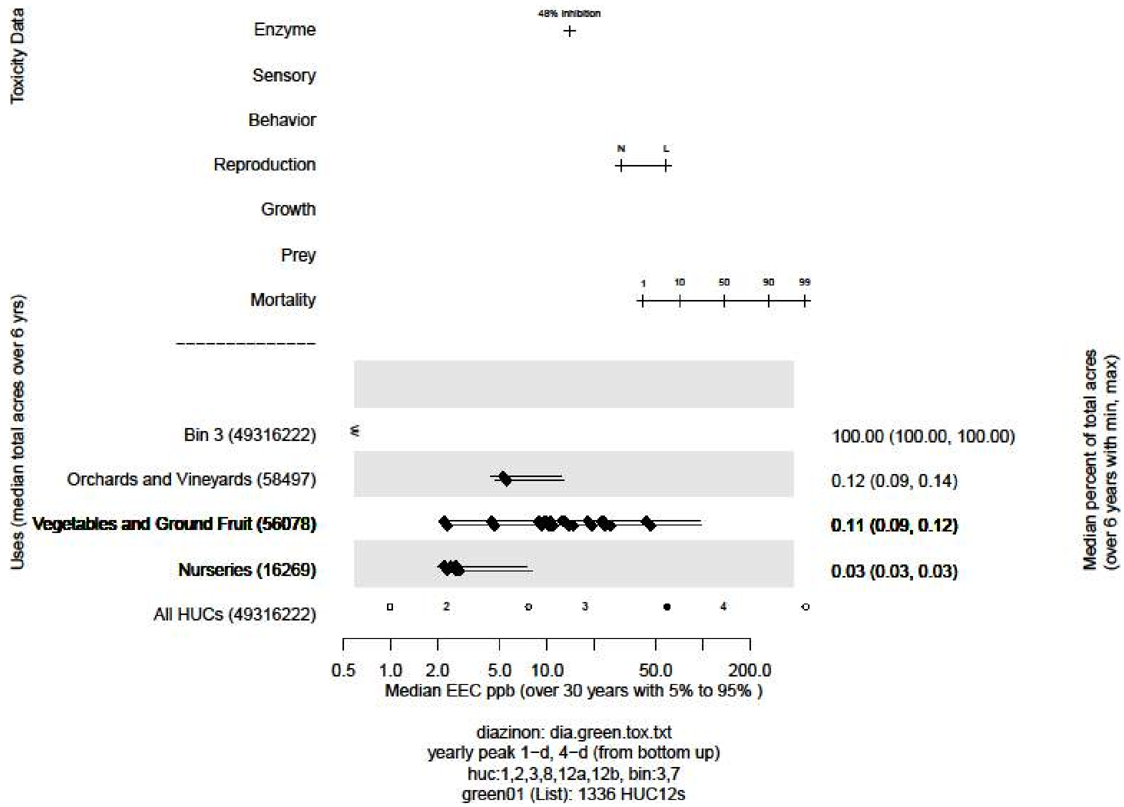


Figure 52. Effects analysis R-plot for Green sea turtle, north Atlantic DPS and diazinon

Table 483. Likelihood of exposure determination for Green sea turtle, north Atlantic DPS and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of the Species Range in US Territories	Likelihood of Exposure
Atlantic Coast								
Orchards and Vineyards	1	yes	no	yes	NA	3	Med	Low
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	Med	Low
Nurseries	1	yes	no	yes	NA	3	Med	Low
Bin 3	1	yes	no	yes	NA	3	Med	Low
US Territories in Caribbean								
All Uses	1	yes	no	yes	NA	3	Med	Low

Life Stage: Juveniles

Based on the life history of green turtles, hatchlings crawl to the water and swim to offshore areas where they reside for several years. Therefore juveniles are not expected to experience substantial exposure to diazinon.

Life Stage: Adults

Table 484. Direct mortality risk hypothesis; Green sea turtle, north Atlantic DPS and diazinon; Adults; Atlantic Coast

Endpoint: Mortality (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	.1	Low	Low
Vegetables and Ground Fruit	.1	Medium	Low
Nurseries	.03	Low	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**Low**		

Table 485. Direct mortality risk hypothesis; Green sea turtle, north Atlantic DPS and diazinon; Adults; US Territories in Atlantic

Endpoint: Mortality (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All uses	Not Available	Low-Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**Low**		

Table 486. Reproduction risk hypothesis; Green sea turtle, north Atlantic DPS and diazinon; Adults; Atlantic Coast

Endpoint: Reproduction (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	.1	Low	Low
Vegetables and Ground Fruit	.1	High	Low
Nurseries	.03	Low	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**Low**		

Table 487. Reproduction risk hypothesis; Green sea turtle, north Atlantic DPS and diazinon; Adults; US Territories in Atlantic

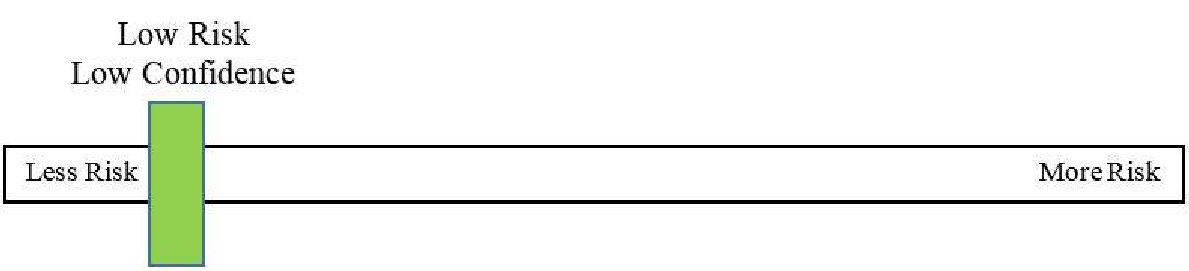
Endpoint: Reproduction (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All uses	Not Available	Medium-High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**Low**		

Table 488. Effects analysis summary table: Green sea turtle, north Atlantic DPS and diazinon

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults (Lower 48 – Coastal HUC-12s)	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult	Low	Low	Not Available	**No**

abundance via acute lethality.				
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	Low	Not Available	**No**
Adults (HUC03 – Territories in Atlantic)				
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	Low	Not Available	**No**

Effects analysis summary: Adult and juvenile Green sea turtle, north Atlantic DPS are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to diazinon in the marine environment. If exposed to formulated products and tank mixtures containing diazinon, sea turtles may experience increased toxicity. The overall risk to Green sea turtle, north Atlantic DPS from the effects of the action is low and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted diazinon concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites with the species range.



13.54 Green Sea Turtle, South Atlantic DPS (Chelonia mydas)

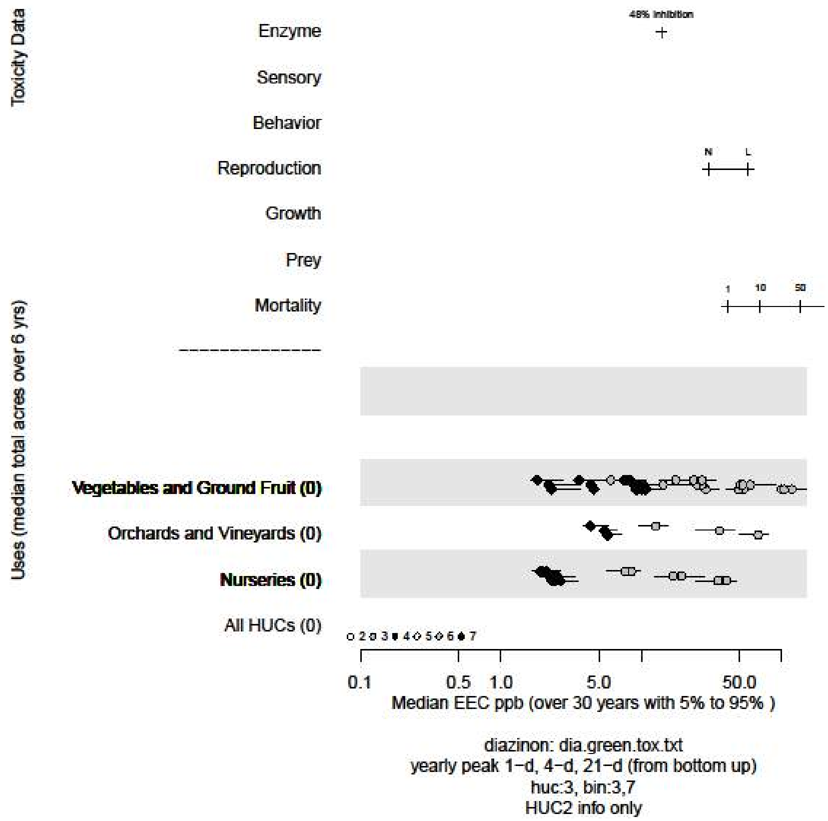


Figure 53. Effects analysis R-plot for Green sea turtle, south Atlantic DPS and diazinon

Table 489. Likelihood of exposure determination for Green sea turtle, south Atlantic DPS and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range within US Territories	Likelihood of Exposure
Vegetables and Ground Fruit	NA	yes	no	yes	NA	3	small	Low
Orchards and Vineyards	NA	yes	no	yes	NA	3	small	Low
Nurseries	NA	yes	no	yes	NA	3	small	Low

Life Stage: Juveniles

Based on the life history of green turtles, hatchlings crawl to the water and swim to offshore areas where they reside for several years. Therefore juveniles are not expected to experience substantial exposure to diazinon.

Life Stage: Adults

Table 490. Direct mortality risk hypothesis; Green sea turtle, south Atlantic DPS and diazinon; Adults

Endpoint: Mortality (HUC2: 03)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	NA	High	Low
Orchards and Vineyards	NA	Medium	Low
Nurseries	NA	Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**Low**		

Table 491. Reproduction risk hypothesis; Green sea turtle, south Atlantic DPS and diazinon; Adults

Endpoint: Reproduction (HUC2: 03)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	NA	Medium	Low
Orchards and Vineyards	NA	Low	Low
Nurseries	NA	Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**Low**		

Table 492. AChE risk hypothesis; Green sea turtle, south Atlantic DPS and diazinon; Adults

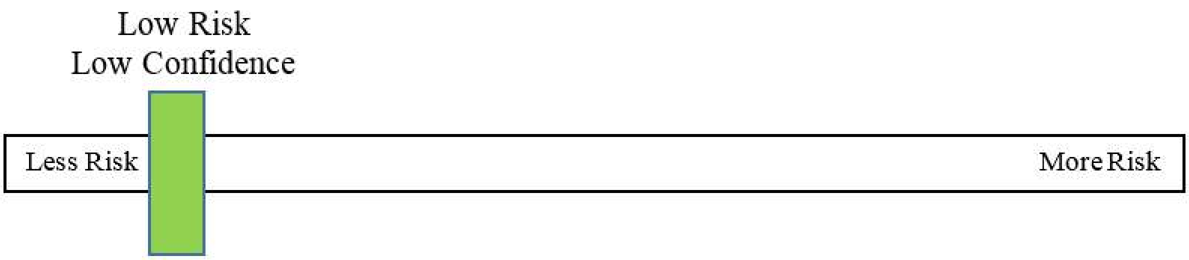
Endpoint: enzyme (HUC2: 03)

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	NA	High	Low
Orchards and Vineyards	NA	High	Low
Nurseries	NA	High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**Low**		

Table 493. Effects analysis summary table: Green sea turtle, south Atlantic DPS and diazinon

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	Low	Not Available	**No**

Effects analysis summary: Adult and juvenile Green sea turtle, south Atlantic DPS are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to diazinon in the marine environment. If exposed to formulated products and tank mixtures containing diazinon, sea turtles may experience increased toxicity. The overall risk to Green sea turtle, south Atlantic DPS from the effects of the action is low and the confidence associated with that risk is low. The low risk is due primarily to the small portion of the species range within US territories. The lack in confidence is due primarily to the uncertainty in predicted diazinon concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites with the species range.



13.55 Hawksbill Sea Turtle (Eretmochelys imbricate)

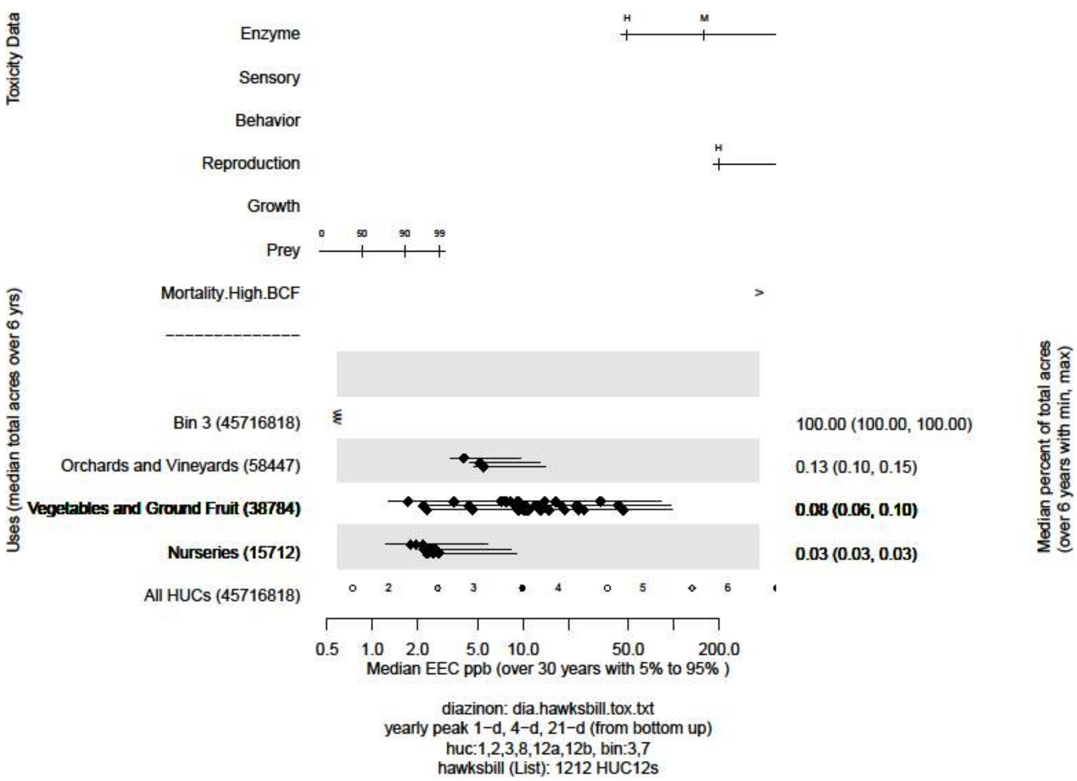


Figure 54. Effects analysis R-plot for Hawskbill sea turtle and diazinon

Table 494. Likelihood of exposure determination for Hawskbill sea turtle and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range within US Territories	Likelihood of Exposure
Lower-48 Coastal Habitats								
Orchards and Vineyards	1	yes	no	yes	NA	3	small	Low
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	small	Low
Nurseries	1	yes	no	yes	NA	3	small	Low
Bin 3	1	yes	no	yes	NA	4	small	Low
US Territories in Pacific								
Crops	NA	yes	yes	yes	NA	low	small	Low
US Territories in Atlantic								
Crops	NA	yes	yes	yes	NA	low	small	Low

Life Stage: Adults and Juveniles

Table 495. Direct mortality risk hypothesis; Hawskbill sea turtle and diazinon; Adults and Juveniles; Lower-48

Endpoint: Mortality (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	.13	Low	Low
Vegetables and Ground Fruit	.1	Low	Low
Nurseries	.03	Low	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juveniles abundance via acute lethality.			
Risk	**Confidence**		
Low	**Low**		

Table 496. Direct mortality risk hypothesis; Hawskbill sea turtle and diazinon; Adults and Juveniles; US Territories in Pacific

Endpoint: Mortality (HUC20 – Hawaii; US territories in Pacific)

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
All Uses	Not Available	Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juveniles abundance via acute lethality.			
Risk	**Confidence**		
Low	**Low**		

Table 497. Direct mortality risk hypothesis; Hawskbill sea turtle and diazinon; Adults and Juveniles; US Territories in Atlantic

Endpoint: Mortality (HUC03 – US territories in Caribbean/Atlantic)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All Uses	Not Available	Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juveniles abundance via acute lethality.			
Risk	**Confidence**		
Low	Low		

Table 498. Prey risk hypothesis; Hawskbill sea turtle and diazinon; Adults and Juveniles; Lower-48

Endpoint: Prey (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	.13	High	Low
Vegetables and Ground Fruit	.1	High	Low
Nurseries	.03	High	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	**Low**		

Table 499. Prey risk hypothesis; Hawskbill sea turtle and diazinon; Adults and Juveniles; US Territories in Atlantic

Endpoint: Prey (HUC03 – US territories in Caribbean/Atlantic)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All Uses	Not Available	High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	**Low**		

Table 500. Prey risk hypothesis; Hawskbill sea turtle and diazinon; Adults and Juveniles; US Territories in Pacific

Endpoint: Prey (HUC20 – Hawaii; US territories in Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All Uses	Not Available	High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	Low		

Table 501. AChE risk hypothesis; Hawskbill sea turtle and diazinon; Adults and Juveniles; Lower-48

Endpoint: enzyme (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	.13	Low	Low
Vegetables and Ground Fruit	.1	Med	Low
Nurseries	.03	Low	Low
Bin 3		Low	Low

Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity		
Risk	**Confidence**	
Low	**Low**	

Table 502. AChE risk hypothesis; Hawskbill sea turtle and diazinon; Adults and Juveniles; US Territories in Atlantic

Endpoint: Enzyme (HUC03 – US territories in Caribbean/Atlantic)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All Uses	Not Available	Low to Medium	NA
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**Low**		

Table 503. AChE risk hypothesis; Hawskbill sea turtle and diazinon; Adults and Juveniles; US Territories in Pacific

Endpoint: Enzyme (HUC20 – Hawaii; US territories in Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All Uses	Not Available	Medium to High	NA
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	Low		

Table 504. Reproduction risk hypothesis; Hawskbill sea turtle and diazinon; Adults and Juveniles; Lower-48

Endpoint: Reproduction (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Orchards and Vineyards	.13	Low	Low
Vegetables and Ground Fruit	.1	Low	Low
Nurseries	.03	Low	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**Low**		

Table 505. Reproduction risk hypothesis; Hawskbill sea turtle and diazinon; Adults and Juveniles; US Territories in Pacific

Endpoint: Reproduction (HUC20 – Hawaii; US territories in Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All Uses	Not Available	Low to Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**Low**		

Table 506. Reproduction risk hypothesis; Hawskbill sea turtle and diazinon; Adults and Juveniles; US Territories in Atlantic

Endpoint: Reproduction (HUC03 – US territories in Caribbean/Atlantic)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All Uses	Not Available	Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		

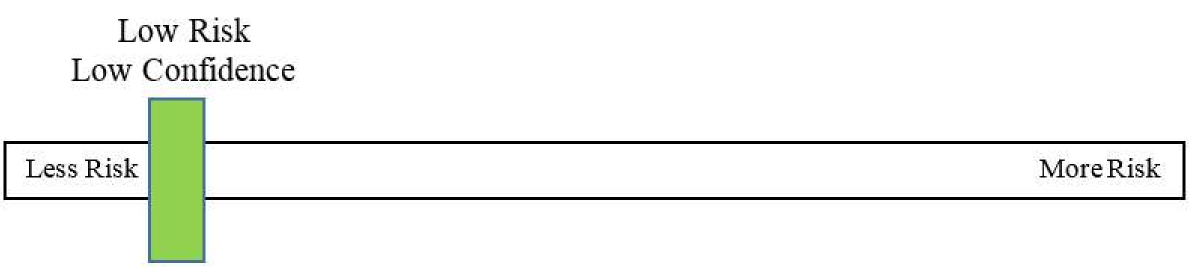
Low	Low	

Table 507. Effects analysis summary table: Hawskbill sea turtle and diazinon

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
(Lower 48 – Coastal HUC-12s)	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	Low	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	Low	Not Available	**No**
(HUC20 – Hawaii; US territories in Pacific)				
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	Low	Low	Not Available	**No**

Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	Low	Not Available	**No**
(HUC03 – US territories in Caribbean/Atlantic)				
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	Low	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	Low	Not Available	**No**

Effects analysis summary: Adult and juvenile hawksbill sea turtles are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to diazinon in the marine environment. If exposed to formulated products and tank mixtures containing diazinon, sea turtles may experience increased toxicity. The overall risk to hawksbill sea turtles from the effects of the action is low and the confidence associated with that risk is low. The low risk is due primarily to the small portion of the species range within US territories. The lack in confidence is due primarily to the uncertainty in predicted diazinon concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites with the species range.



13.56 Kemp's Ridley Sea Turtle (Lepidochelys kempii)

Table 508. Likelihood of exposure determination for Kemp's ridley sea turtle and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
US Lower-48							
Orchards and Vineyards	1	yes	no	yes	NA	3	**Low**
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	**Low**
Nurseries	1	yes	no	yes	NA	3	**Low**
Bin 3	1	yes	no	yes	NA	3	**Low**
US Territories in Atlantic							
all uses	NA	yes	no	yes	NA	3	**Med**

Life Stage: Adults and Juveniles

Table 509. Direct mortality risk hypothesis; Kemp's ridley sea turtle and diazinon; Adults and Juveniles; US Lower-48

Endpoint: Mortality (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	.21	Low	Low
Vegetables and Ground Fruit	.11	Low	Low
Nurseries	.03	Low	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**Low**		

Table 510. Direct mortality risk hypothesis; Kemp's ridley sea turtle and diazinon; Adults; US Territories in Atlantic

Endpoint: Mortality (HUC03 – US territories in Caribbean/Atlantic)

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
All uses	Not Available	Low	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce juveniles abundance via acute lethality.			
Risk	**Confidence**		
Low	Low		

Table 511. Prey risk hypothesis; Kemp's ridley sea turtle and diazinon; Adults and Juveniles; US Lower-48

Endpoint: Prey (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	.21	High	Low
Vegetables and Ground Fruit	.11	High	Low
Nurseries	.03	High	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	**Low**		

Table 512. Prey risk hypothesis; Kemp's ridley sea turtle and diazinon; Adults; US Territories in Atlantic

Endpoint: Prey (HUC03 – US territories in Caribbean/Atlantic)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All uses	Not Available	High	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**Low**		

Table 513. Reproduction risk hypothesis; Kemp's ridley sea turtle and diazinon; Adults; US Territories in Atlantic

Endpoint: Reproduction (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	.21	Low	Low
Vegetables and Ground Fruit	.11	Low	Low
Nurseries	.03	Low	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**Low**		

Table 514. Reproduction risk hypothesis; Kemp's ridley sea turtle and diazinon; Adults; US Territories in Atlantic

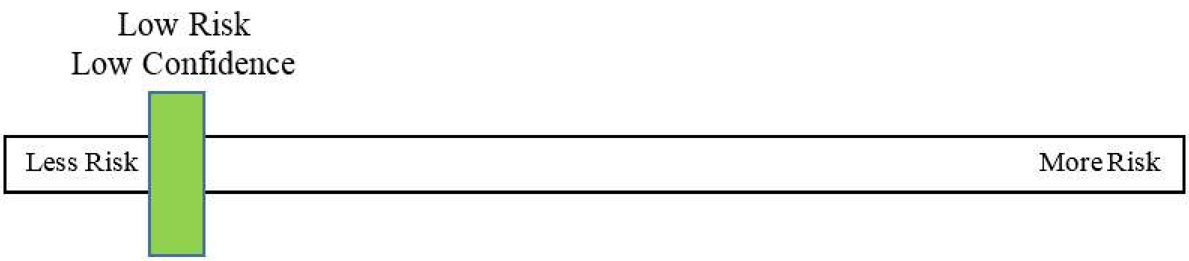
Endpoint: Reproduction (HUC03 – US territories in Caribbean/Atlantic)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All uses	Not Available	Low	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	Low		

Table 515. Effects analysis summary table: Kemp's ridley sea turtle and diazinon

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
(Lower 48 – Coastal HUC-12s)	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult	Low	Low	Not Available	**No**

abundance via acute lethality.				
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	High	Low	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	Low	Not Available	**NA**
(HUC03 – US territories in Caribbean/Atlantic)				
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	High	Low	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	Low	Not Available	**NA**

Effects analysis summary: Adult and juvenile Kemp's ridley sea turtles are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to diazinon in the marine environment. If exposed to formulated products and tank mixtures containing diazinon, sea turtles may experience increased toxicity. The overall risk to Kemp's ridley sea turtles from the effects of the action is low and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted diazinon concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites with the species range.



13.57 Leatherback Sea Turtle (Dermochelys coriacea)

Table 516. Likelihood of exposure determination for Leatherback sea turtle and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Range within US Territories	Likelihood of Exposure
US Lower-48								
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	Med	**Low**
Orchards and Vineyards	1	yes	no	yes	NA	3	Med	**Low**
Nurseries	1	yes	no	yes	NA	3	Med	**Low**
Bin 3	1	yes	no	yes	NA	3	Med	**Low**
US Territories								
All Uses	NA	yes	no	yes	NA	3	Med	**Low**

Life Stage: Juveniles

Based on the life history of leatherback turtles, hatchlings crawl to the water and swim to offshore areas where they reside for several years. Therefore juveniles are not expected to experience substantial exposure to diazinon.

Life Stage: Adults

Table 517. Direct mortality risk hypothesis; Leatherback sea turtle and diazinon; Adults; US Lower-48

Endpoint: Mortality (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	.2	Low	Low
Orchards and Vineyards	.1	Low	Low
Nurseries	.03	Low	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**Low**		

Table 518. Direct mortality risk hypothesis; Leatherback sea turtle and diazinon; Adults; US Territories in Pacific

Endpoint: Mortality (HUC20 – Hawaii; US territories in Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All Uses	Not Available	Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**Low**		

Table 519. Direct mortality risk hypothesis; Leatherback sea turtle and diazinon; Adults; US Territories in Atlantic

Endpoint: Mortality (HUC03 – US territories in Caribbean/Atlantic)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All Uses	Not Available	Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	Low		

Table 520. Reproduction risk hypothesis; Leatherback sea turtle and diazinon; Adults; US Lower-48

Endpoint: Reproduction (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	.2	Low	Low
Orchards and Vineyards	.1	Low	Low
Nurseries	.03	Low	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			

Risk	Confidence	
Low	**Low**	

Table 521. Reproduction risk hypothesis; Leatherback sea turtle and diazinon; Adults; US Territories in Pacific

Endpoint: Reproduction (HUC20 – Hawaii; US territories in Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All Uses	Not Available	Low to Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	Low		

Table 522. Reproduction risk hypothesis; Leatherback sea turtle and diazinon; Adults; US Territories in Atlantic

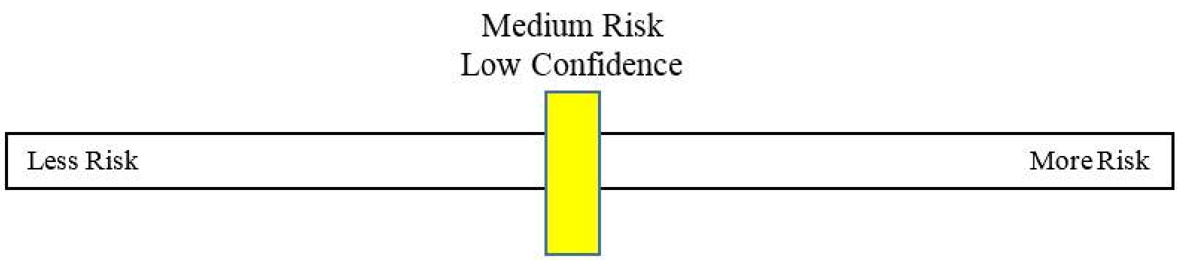
Endpoint: Reproduction (HUC03 – US territories in Caribbean/Atlantic)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All Uses	Not Available	Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	Low		

Table 523. Effects analysis summary table: Leatherback sea turtle and diazinon

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
(Lower 48 – Coastal HUC-12s)	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult	Low	Low	Not Available	**No**

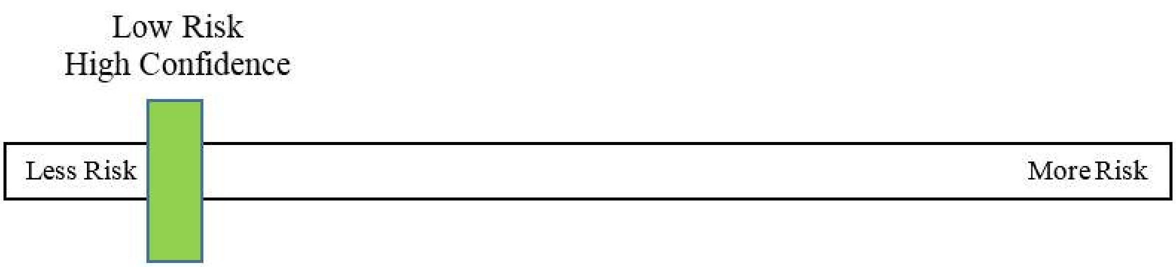
abundance via acute lethality.				
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	Low	Not Available	**No**
(HUC03 – US territories in Caribbean/Atlantic)				
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	Low	Not Available	**No**
(HUC20 – Hawaii; US territories in Pacific)				
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	Low	Not Available	**No**

Effects analysis summary: Adult and juvenile leatherback sea turtles are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to diazinon in the marine environment. If exposed to formulated products and tank mixtures containing diazinon, sea turtles may experience increased toxicity. The overall risk to leatherback sea turtles from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted diazinon concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites with the species range.



13.58 Loggerhead Sea Turtle, North Pacific Ocean DPS (Caretta caretta)

Effects analysis summary: Adult and juvenile loggerhead sea turtle, North Pacific Ocean DPS are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to diazinon in the marine environment. If exposed to formulated products and tank mixtures containing diazinon, sea turtles may experience increased toxicity. The overall risk to loggerhead sea turtle, North Pacific DPS from the effects of the action is low and the confidence associated with that risk is high. Low risk is due primarily to the small portion of the species range within US territories and the species utilization of off-shore habitats.



13.58.1.1 Loggerhead Sea Turtle, Northwest Atlantic Ocean DPS (Caretta caretta)

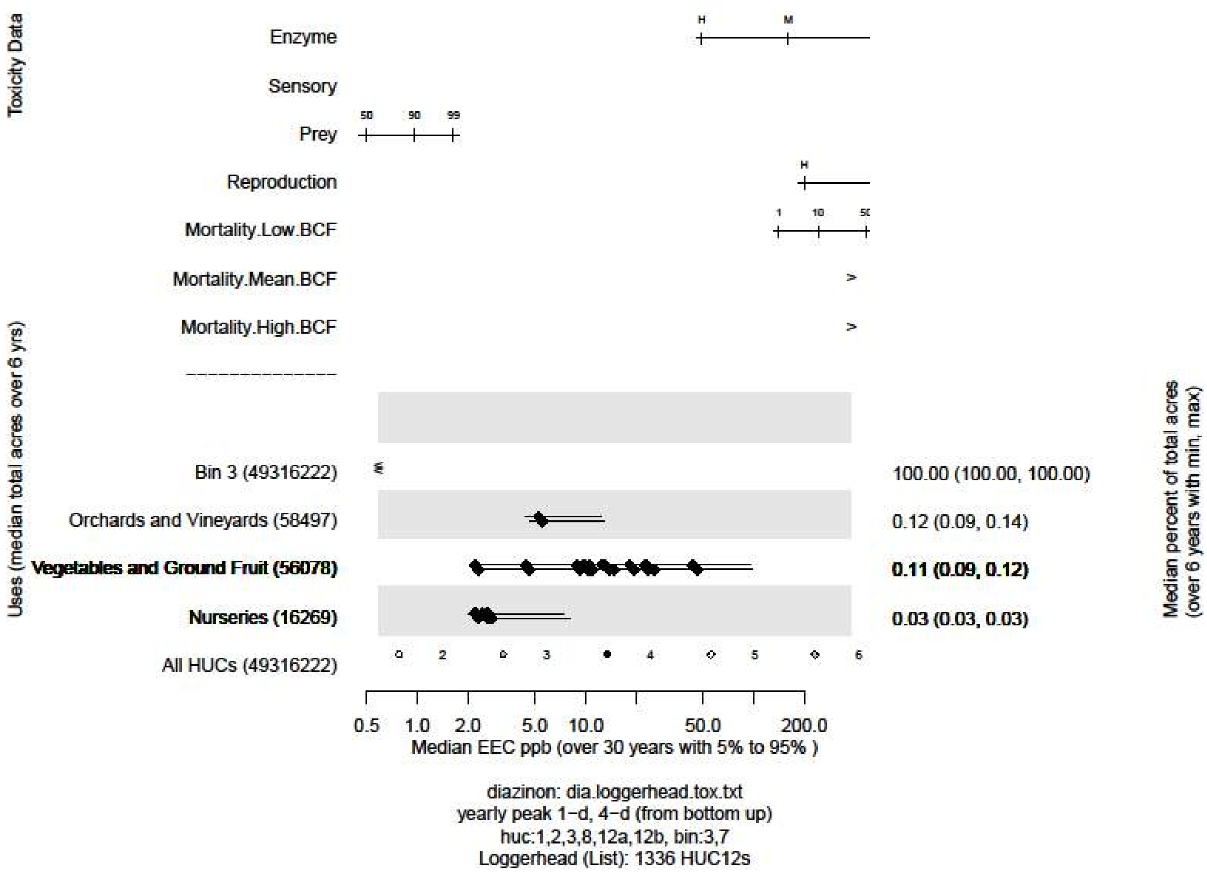


Figure 55. Effects analysis R-plot for Loggerhead sea turtle, northwest Atlantic Ocean DPS and diazinon

Table 524. Likelihood of exposure determination for Loggerhead sea turtle, northwest Atlantic Ocean DPS and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
US Lower-48							
Orchards and Vineyards	1	yes	no	yes	NA	3	**Low**
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	**Low**
Nurseries	1	yes	no	yes	NA	3	**Low**
Bin 3	1	yes	no	yes	NA	3	**Low**
US Territories in Atlantic							
all uses	NA	yes	no	yes	NA	3	**Med**

Life Stage: Adults and Juveniles

Table 525. Direct mortality risk hypothesis; Loggerhead sea turtle, northwest Atlantic Ocean DPS and diazinon; Adults and Juveniles; US Lower-48

Endpoint: Mortality (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	.21	Low	Low
Vegetables and Ground Fruit	.11	Low	Low
Nurseries	.03	Low	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**Low**		

Table 526. Direct mortality risk hypothesis; Loggerhead sea turtle, northwest Atlantic Ocean DPS and diazinon; Adults and Juveniles; US Territories in Atlantic

Endpoint: Mortality (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All uses	Not Available	Low	Medium

Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.		
Risk	**Confidence**	
Low	**Low**	

Table 527. Prey risk hypothesis; Loggerhead sea turtle, northwest Atlantic Ocean DPS and diazinon; Adults and Juveniles; US Lower-48

Endpoint: Prey (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	.21	High	Low
Vegetables and Ground Fruit	.11	High	Low
Nurseries	.03	High	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	**Low**		

Table 528. Prey risk hypothesis; Loggerhead sea turtle, northwest Atlantic Ocean DPS and diazinon; Adults and Juveniles; US Territories in Atlantic

Endpoint: Prey (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All uses	Not Available	High	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**Low**		

Table 529. Reproduction risk hypothesis; Loggerhead sea turtle, northwest Atlantic Ocean DPS and diazinon; Adults; US Lower-48

Endpoint: Reproduction (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	.21	Low	Low
Vegetables and Ground Fruit	.11	Low	Low
Nurseries	.03	Low	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**Low**		

Table 530. Reproduction risk hypothesis; Loggerhead sea turtle, northwest Atlantic Ocean DPS and diazinon; Adults; US Territories in Atlantic

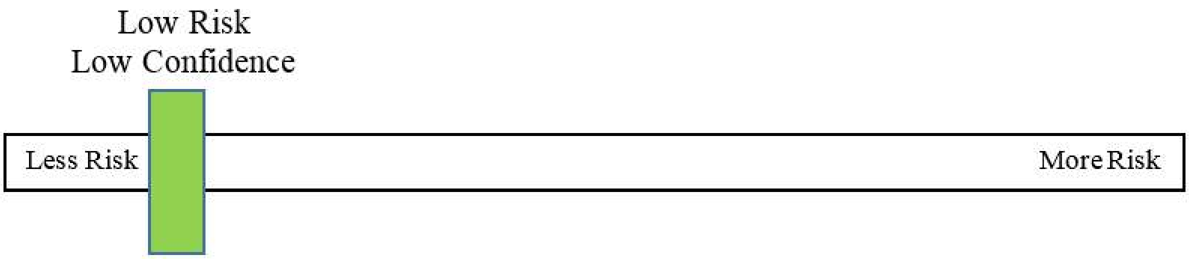
Endpoint: Reproduction (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All uses	Not Available	Low	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**Low**		

Table 531. Effects analysis summary table: Loggerhead sea turtle, northwest Atlantic Ocean DPS and diazinon

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
(Lower 48 – Coastal HUC-12s)	Risk	Confidence	Range in median percent mortalities for aquatic bins	

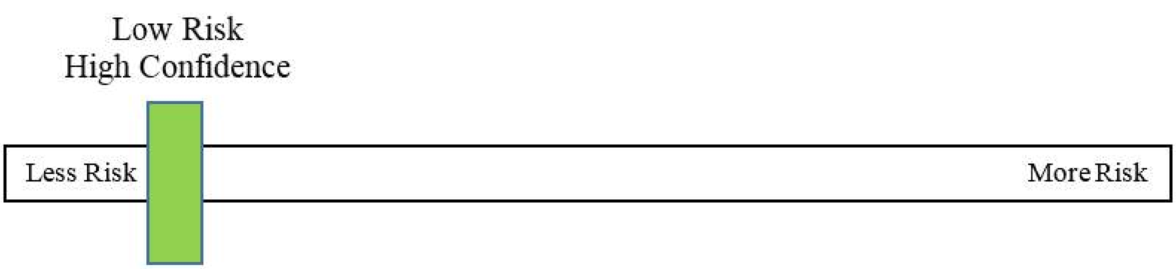
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	Low	Low	Not Available	**No**
(HUC03 – US territories in Caribbean/Atlantic)				
Exposure to diazinon is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce Juvenile abundance via reduction in prey availability	High	Low	Not Available	**Yes**

Effects analysis summary: Adult and juvenile loggerhead sea turtles, northwest Atlantic Ocean DPS are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to diazinon in the marine environment. If exposed to formulated products and tank mixtures containing diazinon, sea turtles may experience increased toxicity. The overall risk to loggerhead sea turtles from the effects of the action is low and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted diazinon concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites with the species range.


Low Risk
Low Confidence
Less Risk
More Risk

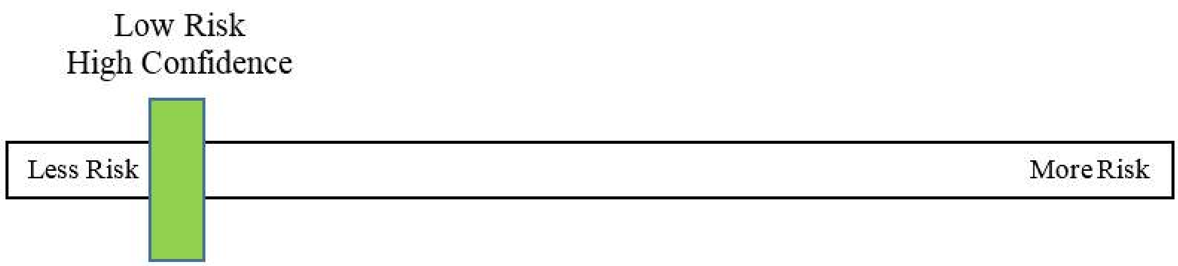
13.59 Olive Ridley Sea Turtle, Mexico's Pacific Coast Breeding Colonies (Lepidochelys olivacea)

Effects analysis summary: Adult and juvenile Olive ridley sea turtles within Mexico's Pacific breeding colonies are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to diazinon in the marine environment. If exposed to formulated products and tank mixtures containing diazinon, sea turtles may experience increased toxicity. The overall risk to Mexico's Pacific coast breeding colonies of Olive ridley sea turtles is low and the confidence associated with that risk is high. Low risk is due primarily to the small portion of the species range within US territories and the species' utilization of off-shore habitats.



13.60 Olive Ridley Sea Turtle, All Other Areas (Lepidochelys olivacea)

Effects analysis summary: Adult and juvenile Olive ridley sea turtles (all areas outside of Mexico's Pacific breeding colonies) are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to diazinon in the marine environment. If exposed to formulated products and tank mixtures containing diazinon, sea turtles may experience increased toxicity. The overall risk to Olive ridley sea turtles (all areas outside of Mexico's Pacific coast breeding colonies) is low and the confidence associated with that risk is high. Low risk is due primarily to the small portion of the species range within US territories and the species' utilization of off-shore habitats.



13.61 Killer Whale, Southern Resident DPS (Orcinus orca)

Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via reduction in prey availability (primarily salmonids and other fish)

Table 532. Prey Risk Hypothesis; Killer Whale, Southern Resident DPS; Adults and Juveniles

Endpoint: Prey			
Prey Species	**DPS**	**Biological Opinion Conclusion (Jeopardy/No jeopardy)**	
Chum Salmon (Oncorhynchus keta)			
Chum	Hood Canal summer-run	No Jeopardy	
Chum	Lower Columbia R.	No Jeopardy	
Chinook Salmon (Oncorhynchus tshawytscha)			
Chinook	California coastal	Jeopardy	
Chinook	Central Valley spring-run	Jeopardy	
Chinook	Lower Columbia River	Jeopardy	
Chinook	Puget Sound	Jeopardy	
Chinook	Sacramento R winter-run	Jeopardy	
Chinook	Snake River fall-run	Jeopardy	
Chinook	Snake River spring/summer	Jeopardy	
Chinook	Upper Col. R. spring-run	Jeopardy	
Chinook	Upper Willamette River	Jeopardy	
Population Model: Chinook, ocean-type		***Population Model: Chinook, stream-type***	
Portion of juveniles exposed to diazinon EECs; 0.75-100 µg/l	*Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles*	*Portion of juveniles exposed to diazinon EECs; 0.75-100 µg/l*	*Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles*
25%	0-12% (13-23)	*25%*	0-11% (4-18)
50%	1-23% (13-26)	*50%*	0-20% (4-21)

75%	1-35% (13-24)	*75%*	1-31% (4-21)
100%	1-86% (13-2)	*100%*	1-84 (4-1)
Coho Salmon (Oncorhynchus kisutch)			
Coho	Central California coast	Jeopardy	
Coho	Lower Columbia River	No Jeopardy	
Coho	Oregon coast	No Jeopardy	
Coho	SONC	No Jeopardy	
Population Model: Coho Salmon			
Portion of juveniles exposed to diazinon EECs; 0.75-100 µg/l		*Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles*	
25%		0-14% (7-23)	
50%		1-27% (8-28)	
75%		1-40% (7-26)	
100%		1-92% (7-1)	
Sockeye Salmon (Oncorhynchus nerka)			
Sockeye	Ozette Lake	No Jeopardy	
Sockeye	Snake R	Jeopardy	
Population Model: Sockeye Salmon			
Portion of juveniles exposed to diazinon EECs; 0.75-100 µg/l		*Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles*	
25%		0-10% (8-19)	
50%		1-19% (8-21)	
75%		1-29% (8-21)	
100%		1-83% (8-1)	
Steelhead	California C. Valley	Jeopardy	
Steelhead	CCC	Jeopardy	
Steelhead	LC River	Jeopardy	

Steelhead	MC River	Jeopardy
Steelhead	Northern California	No Jeopardy
Steelhead	Puget Sound	No Jeopardy
Steelhead	Snake River Basin	Jeopardy
Steelhead	South-Central California coast	Jeopardy
Steelhead	Southern California	Jeopardy
Steelhead	Upper Columbia River	Jeopardy
Steelhead	Upper Willamette River	Jeopardy
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via reduction in prey availability (primarily salmonids and other fish)		
Risk	**Confidence**	
High	**Medium**	

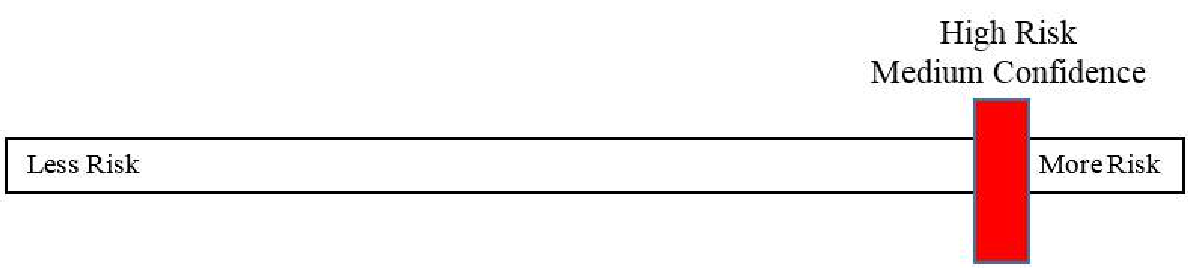
Effects analysis summary: Adult and juvenile Killer whales (southern resident DPS) are anticipated to experience reduced abundance via reductions in prey from exposure to diazinon. The primary dietary item of the southern resident killer whale is salmon (predominantly Chinook). Chinook salmon populations have declined due to degradation of habitat, hydrology issues, harvest, and hatchery introgression; such reductions may require an increase in foraging effort. In addition, these prey contain environmental pollutants. These contaminants become concentrated at higher trophic levels and may lead to immune suppression or reproductive impairment. The overall risk to Killer whale, southern resident DPS from the effects of the action is high and the confidence associated with that risk is medium.

NMFS qualitatively evaluated long-term effects on the Southern Residents from the anticipated appreciable reduction in the likelihood of survival and recovery of 20 Pacific salmon Evolutionarily Significant Units (ESUs)/District Population Segments (DPSs), and in particular, the nine Chinook salmon ESUs. We assessed the likelihood for localized depletions, and long-term implications for Southern Residents' survival and recovery, resulting from the increased risk of extinction of all listed Chinook salmon ESUs. In this way, NMFS can determine whether the increased likelihood of extinction of prey species is also likely to appreciably reduce the likelihood of survival and recovery of Southern Residents.

A reduction in prey would occur over time as abundance declined for the nine ESUs of Chinook salmon, along with the decline of lesser preferred prey ESUs/DPSs of other listed salmon. The continued depletion of these ESUs would also preclude the potential for their future recovery to healthy, more substantial numbers. Fewer populations contributing to Southern Residents' prey base will reduce the representation of diversity in life histories, resiliency in withstanding stochastic events, and redundancy to ensure there is a margin of safety for the salmon and Southern Residents to withstand catastrophic events.

The long-term reduction of the nine ESUs of Chinook salmon and other listed salmon and steelhead can lead to nutritional stress in the whales. Nutritional stress can lead to reduced body size and condition of individuals and can also lower reproductive and survival rates. Prey sharing would distribute more evenly the effects of prey limitation across individuals of the population that would otherwise be the case. Therefore, poor nutrition from the reduction of prey could contribute to additional mortality in this population. Food scarcity could also cause whales to draw on fat stores, mobilizing contaminants stored in their fat and affecting reproduction and immune function.

Differences in adult salmon life histories and locations of their natal streams likely affect the distribution of salmon across the Southern Residents' coastal range. The continued decline and potential extinction of the nine ESUs of Chinook salmon and other listed salmonids, and consequent interruption in the geographic continuity of salmon-bearing watersheds in the Southern Residents' coastal range, is likely to alter the distribution of migrating salmon and increase the likelihood of localized depletions in prey. This would have adverse effects on the Southern Residents' ability to meet their energy needs. A fundamental change in the prey base originating from the whales' geographic range is likely to result in Southern Residents abandoning areas in search of more abundant prey or expending substantial effort to find depleted prey resources. This potential increase in energy demands should have the same effect on an animal's energy budget as reductions in available energy, such as one would expect from reductions in prey.



13.62 Steller Sea Lion, Western DPS (Eumetopias jubatus)

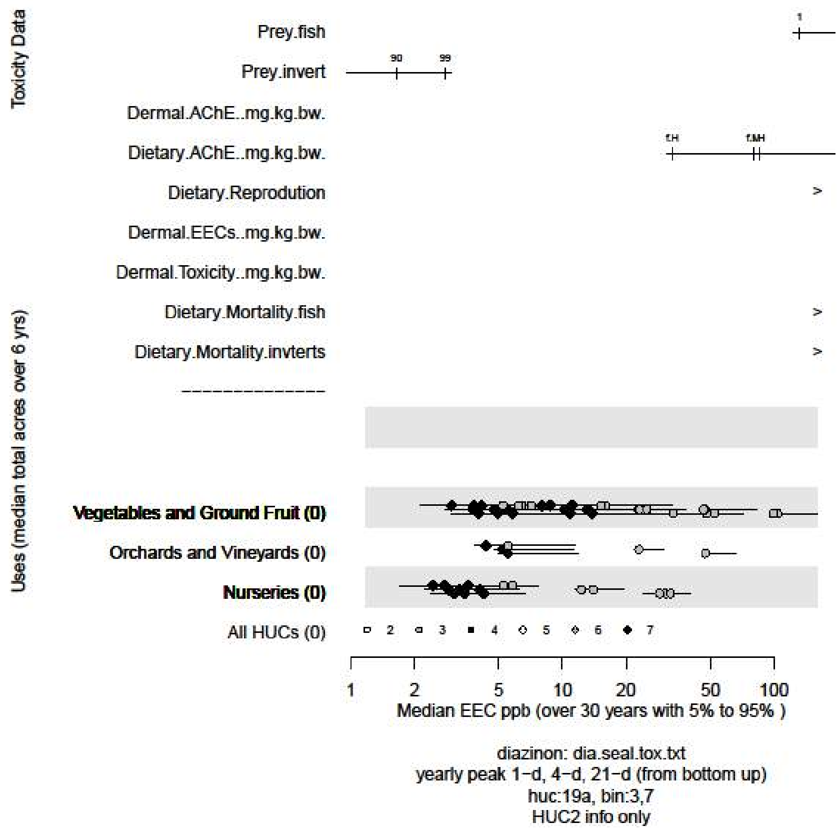


Figure 56. Effects analysis R-plot for Steller sea lion (western DPS) and diazinon

Table 533. Likelihood of exposure determination for Steller sea lion (western DPS) and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Vegetables and Ground Fruit	NA	yes	no	yes	NA	3	**Low**
Orchards and Vineyards	NA	yes	no	yes	NA	3	**Low**
Nurseries	NA	yes	no	yes	NA	3	**Low**

Life Stage: Juvenile and Adult (full-range)

Table 534. Direct mortality (dietary: fish) risk hypothesis; Steller sea lion (western DPS) and diazinon; Adults and Juveniles

Endpoint: Mortality (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	Unknown	Low	Low
Orchards and Vineyards	Unknown	Low	Low
Nurseries	Unknown	Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via dietary aquatic exposure (fish)			
Risk	**Confidence**		
Low	**Medium**		

Table 535. Prey (inverts) risk hypothesis; Steller sea lion (western DPS) and diazinon; Adults and Juveniles

Endpoint: Prey (inverts)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	Unknown	High	Low
Orchards and Vineyards	Unknown	High	Low
Nurseries	Unknown	High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via reduction in prey availability (aquatic inverts)			
Risk	**Confidence**		
Low	**Medium**		

Table 536. Prey (fish) risk hypothesis; Steller sea lion (western DPS) and diazinon; Adults and Juveniles

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	Unknown	Medium	Low

Orchards and Vineyards	Unknown	Low	Low
Nurseries	Unknown	Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via reduction in prey availability (fish)			
Risk	**Confidence**		
Low	**Medium**		

Table 537. AChE (dietary) risk hypothesis; Steller sea lion (western DPS) and diazinon; Adults and Juveniles

Endpoint: AChE (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	Unknown	High	Low
Orchards and Vineyards	Unknown	Medium	Low
Nurseries	Unknown	Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity via dietary exposure (inverts and fish); the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**Medium**		

Table 538. Reproduction (dietary) risk hypothesis; Steller sea lion (western DPS) and diazinon; Adults

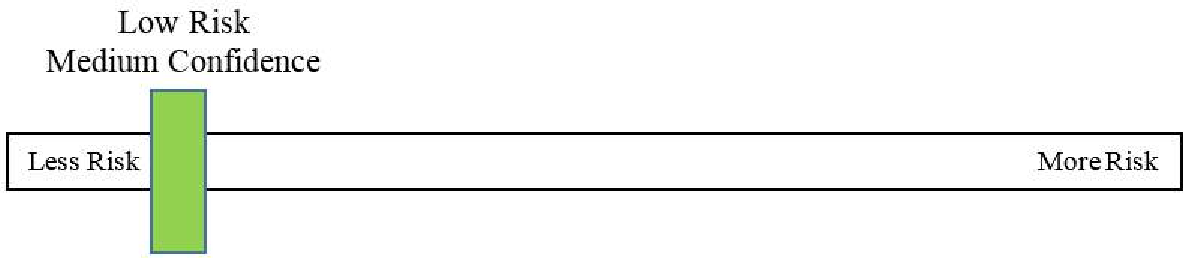
Endpoint: Reproduction (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	Unknown	Low	Low
Orchards and Vineyards	Unknown	Low	Low
Nurseries	Unknown	Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction via dietary exposure (fish)			

Risk	Confidence	
Low	**Medium**	

Table 539. Effects analysis summary table: Steller sea lion (western DPS) and diazinon

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Adults and Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce abundance via dietary aquatic exposure (fish)	**Low**	**Medium**	Not Available	No
Exposure to diazinon is sufficient to reduce abundance via reduction in prey availability (aquatic inverts)	**Low**	**Medium**	Not Available	No
Exposure to diazinon is sufficient to reduce abundance via reduction in prey availability (fish)	**Low**	**Medium**	Not Available	No
Exposure to diazinon is sufficient to reduce ChE activity via dietary exposure (inverts and fish); the identified mechanism of toxicity	Low	Medium	Not Available	No
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction via dietary exposure (fish)	Low	Medium	Not Available	No

Effects analysis summary: Adult and juvenile Steller sea lion (western DPS) are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to diazinon in the marine environment. If exposed to formulated products and tank mixtures containing diazinon, sea lions may experience increased toxicity. The overall risk to Steller sea lion (western DPS) from the effects of the action is low and the confidence associated with that risk is medium. The lack in confidence is due primarily to the uncertainty in predicted diazinon concentrations in coastal habitats.



13.63 Guadalupe Fur Seal (Arctocephalus townsendi)

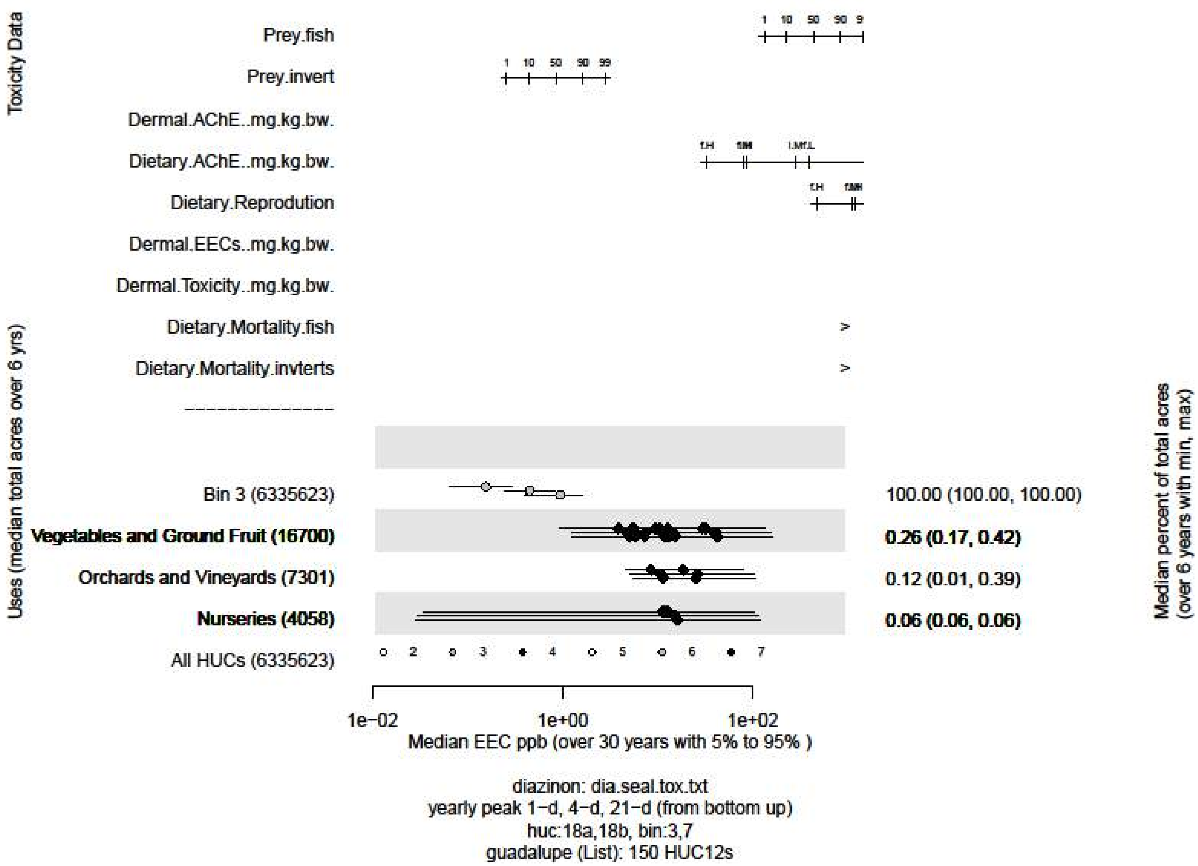


Figure 57. Effects analysis R-plot for Guadalupe fur seal and diazinon

Table 540. Likelihood of exposure determination for Guadalupe fur seal and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range within US Territories	Likelihood of Exposure
Vegetables and Ground Fruit	1	yes	no	yes	NA	unknown	small	Low
Orchards and Vineyards	1	yes	no	yes	NA	unknown	small	Low
Nurseries	1	yes	no	yes	NA	unknown	small	Low

Life Stage: Juvenile and Adult (full-range)

Table 541. Direct mortality (dietary – inverts) risk hypothesis; Guadalupe fur seal and diazinon; Adults and Juveniles

Endpoint: Mortality (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	.26	Low	Low
Orchards and Vineyards	.12	Low	Low
Nurseries	.06	Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via dietary aquatic exposure (inverts)			
Risk	**Confidence**		
Low	**Medium**		

Table 542. Direct mortality (dietary – fish) risk hypothesis; Guadalupe fur seal and diazinon; Adults and Juveniles

Endpoint: Mortality (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	.26	Low	Low
Orchards and Vineyards	.12	Low	Low

Nurseries	.06	Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via dietary aquatic exposure (fish)			
Risk	**Confidence**		
Low	**Medium**		

Table 543. Prey (inverts) risk hypothesis; Guadalupe fur seal and diazinon; Adults and Juveniles

Endpoint: Prey (inverts)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	.26	High	Low
Orchards and Vineyards	.12	High	Low
Nurseries	.06	High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via reduction in prey availability (aquatic inverts)			
Risk	**Confidence**		
Low	**Medium**		

Table 544. Prey (fish) risk hypothesis; Guadalupe fur seal and diazinon; Adults and Juveniles

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	.26	Medium	Low
Orchards and Vineyards	.12	Medium	Low
Nurseries	.06	Medium	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via reduction in prey availability (fish)			
Risk	**Confidence**		
Low	**Medium**		

Table 545. AChE (dietary) risk hypothesis; Guadalupe fur seal and diazinon; Adults and Juveniles

Endpoint: AChE (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	.26	High	Low
Orchards and Vineyards	.12	High	Low
Nurseries	.06	High	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity via dietary exposure (inverts and fish); the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**Medium**		

Table 546. Reproduction (dietary) risk hypothesis; Guadalupe fur seal and diazinon; Adults

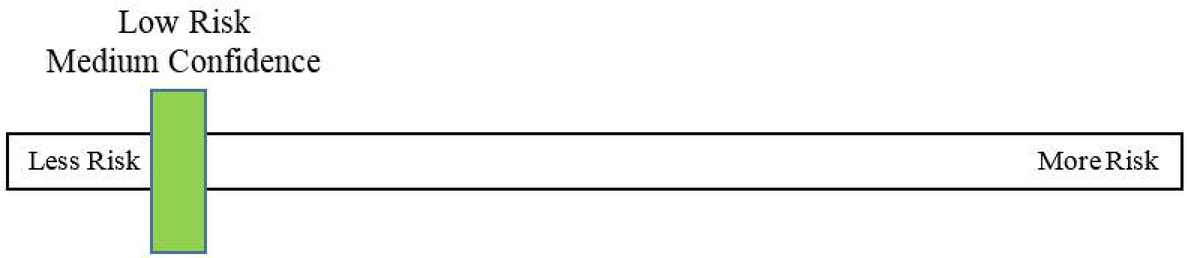
Endpoint: Reproduction (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	.26	Low	Low
Orchards and Vineyards	.12	Low	Low
Nurseries	.06	Low	Low
Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction via dietary exposure (fish)			
Risk	**Confidence**		
Low	**Medium**		

Table 547. Effects analysis summary table: Guadalupe fur seal and diazinon

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Adults and Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				

Exposure to diazinon is sufficient to reduce abundance via dietary aquatic exposure (inverts)	**Low**	**Medium**	Not Available	**No**
Exposure to diazinon is sufficient to reduce abundance via dietary aquatic exposure (fish)	**Low**	**Medium**	Not Available	**No**
Exposure to diazinon is sufficient to reduce abundance via reduction in prey availability (aquatic inverts)	**Low**	**Medium**	Not Available	**No**
Exposure to diazinon is sufficient to reduce abundance via reduction in prey availability (fish)	**Low**	**Medium**	Not Available	**No**
Exposure to diazinon is sufficient to reduce ChE activity via dietary exposure (inverts and fish); the identified mechanism of toxicity	**Low**	**Medium**	Not Available	**No**
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction via dietary exposure (fish)	**Low**	**Medium**	Not Available	**No**

Effects analysis summary: Adult and juvenile Guadalupe fur seals are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to diazinon in the marine environment. If exposed to formulated products and tank mixtures containing diazinon, fur seals may experience increased toxicity. The overall risk to Guadalupe fur seals from the effects of the action is low and the confidence associated with that risk is medium. The Low risk is due primarily to the small portion of the species' range within US territories. The lack in confidence is due primarily to the uncertainty in predicted diazinon concentrations in coastal habitats.


Low Risk
Medium Confidence
Less Risk
More Risk

13.64 Hawaiian Monk Seal (Monachus schauinslandi)

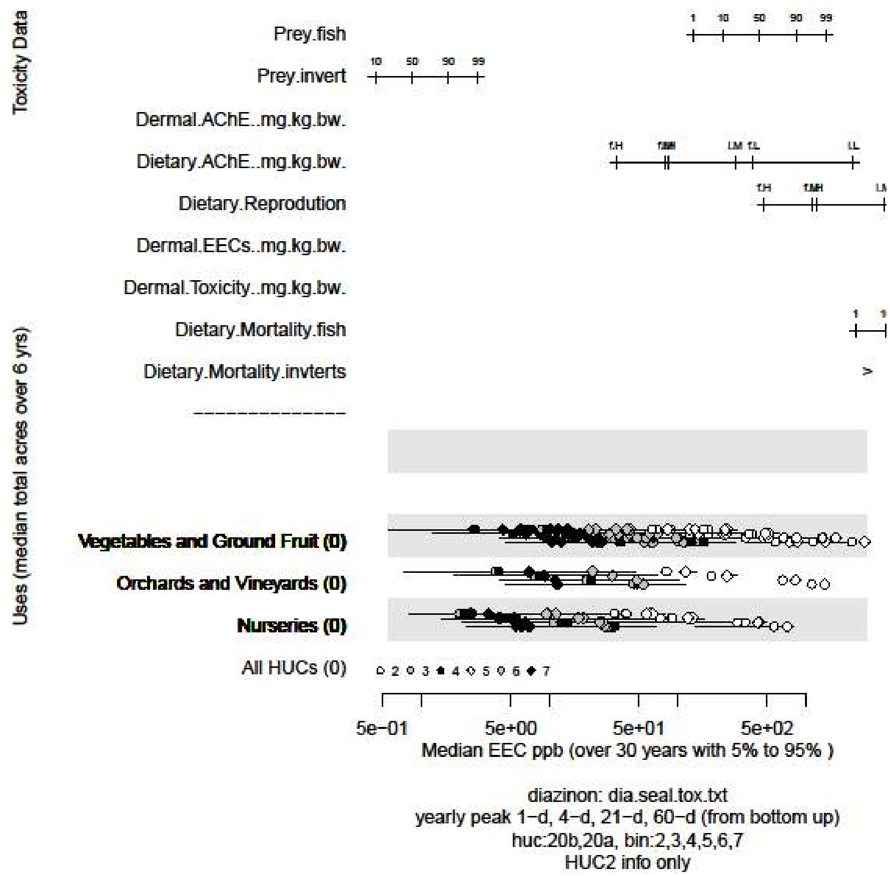


Figure 58. Effects analysis R-plot for Hawaiian monk seal and diazinon

Table 548. Likelihood of exposure determination for Hawaiian monk seal and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Vegetables and Ground Fruit	NA	yes	no	yes	NA	3	**Med**
Orchards and Vineyards	NA	yes	no	yes	NA	3	**Med**
Nurseries	NA	yes	no	yes	NA	3	**Med**

Life Stage: Juvenile and Adult (full-range)

Table 549. Direct mortality (dietary – fish) risk hypothesis; Hawaiian monk seal and diazinon; Adults and Juveniles

Endpoint: Mortality (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	Unknown	Low	Medium
Orchards and Vineyards	Unknown	Low	Medium
Nurseries	Unknown	Low	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via dietary aquatic exposure (fish)			
Risk	**Confidence**		
Low	**Medium**		

Table 550. Prey (inverts) risk hypothesis; Hawaiian monk seal and diazinon; Adults and Juveniles

Endpoint: Prey (inverts)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	Unknown	High	Medium
Orchards and Vineyards	Unknown	High	Medium
Nurseries	Unknown	High	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via reduction in prey availability (aquatic inverts)			
Risk	**Confidence**		
High	**Low**		

Table 551. Prey (fish) risk hypothesis; Hawaiian monk seal and diazinon; Adults and Juveniles

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Vegetables and Ground Fruit	Unknown	Medium	Medium
Orchards and Vineyards	Unknown	Low	Medium
Nurseries	Unknown	Low	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce abundance via reduction in prey availability (fish)			
Risk	**Confidence**		
Medium	**Low**		

Table 552. AChE (dietary) risk hypothesis; Hawaiian monk seal and diazinon; Adults and Juveniles

Endpoint: AChE (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	Unknown	High	Medium
Orchards and Vineyards	Unknown	Medium	Medium
Nurseries	Unknown	Medium	Medium
Risk Hypothesis: Exposure to diazinon is sufficient to reduce ChE activity via dietary exposure (fish); the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Low**		

Table 553. Reproduction (dietary) risk hypothesis; Hawaiian monk seal and diazinon; Adults

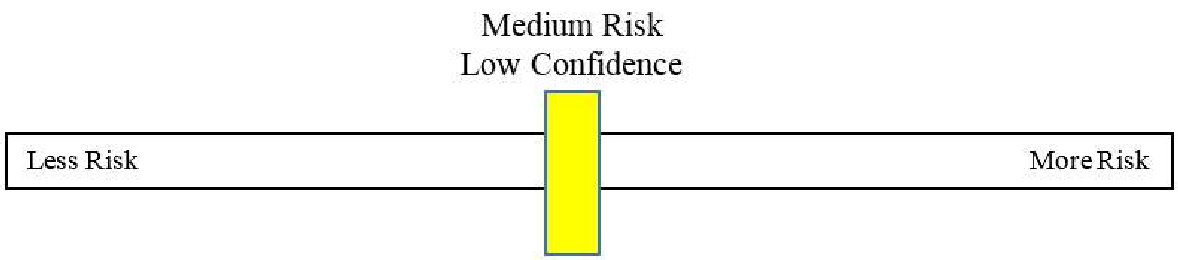
Endpoint: Reproduction (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	Unknown	Low	Medium
Orchards and Vineyards	Unknown	Low	Medium
Nurseries	Unknown	Low	Medium

Risk Hypothesis: Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction via dietary exposure (fish)		
Risk	**Confidence**	
Low	**Medium**	

Table 554. Effects analysis summary table: Hawaiian monk seal and diazinon

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Adults and Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to diazinon is sufficient to reduce abundance via dietary aquatic exposure (fish)	Low	Medium	Not Available	**No**
Exposure to diazinon is sufficient to reduce abundance via reduction in prey availability (aquatic inverts)	High	Low	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce abundance via reduction in prey availability (fish)	Medium	Low	Not Available	**Yes**
Exposure to diazinon is sufficient to reduce ChE activity via dietary exposure (inverts and fish); the identified mechanism of toxicity	High	Low	Not Available	**No**
Exposure to diazinon is sufficient to reduce adult productivity via impairments to reproduction via dietary exposure (fish)	Low	Medium	Not Available	**No**

Effects analysis summary: Adult and juvenile Hawaiian monk seals are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to diazinon in the marine environment. If exposed to formulated products and tank mixtures containing diazinon, fur seals may experience increased toxicity. The overall risk to Hawaiian monk seals from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted diazinon concentrations in coastal habitats.



13.65 Johnson's Seagrass (Halophila johnsonii)

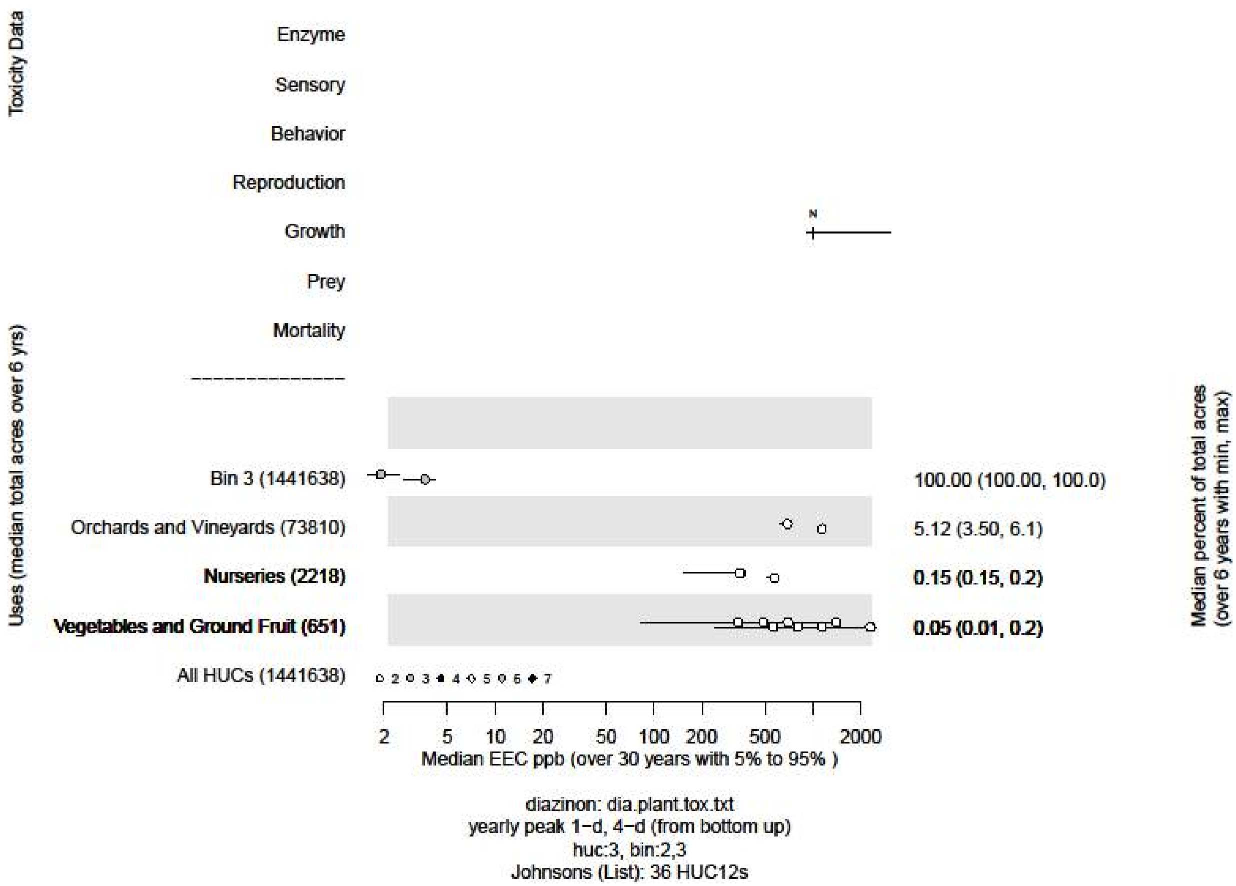


Figure 59. Effects analysis R-plot for Johnson's seagrass and diazinon

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Orchards and Vineyards	3	yes	yes	yes	NA	3	**High**
Nurseries	1	yes	yes	yes	no	3	**Low**
Vegetables and Ground Fruit	1	yes	yes	yes	no	3	**Low**
Bin 3	3	yes	yes	yes	NA	3	**High**
Bin 4	3	yes	yes	yes	NA	3	**High**

Figure 60. Likelihood of exposure determination for Johnson's seagrass and diazinon

Table 555. Direct mortality risk hypothesis; Johnson's seagrass and diazinon

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	5	NA	High
Nurseries	<1	NA	Low
Vegetables and Ground Fruit	<1	NA	Low
Bin 3		NA	High
Bin 4		NA	High
Risk Hypothesis: Exposure to the pesticide is sufficient to reduce abundance via direct mortality.			
Risk	**Confidence**		
NA	**NA**		

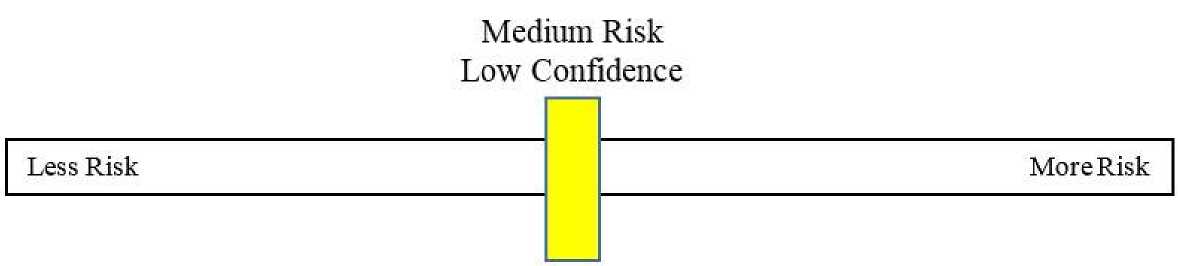
Table 556. Growth risk hypothesis; Johnson's seagrass and diazinon

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Orchards and Vineyards	5	Medium	High
Nurseries	<1	Low	Low
Vegetables and Ground Fruit	<1	Medium	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to the pesticides is sufficient to reduce abundance via impacts to growth.			
Risk	**Confidence**		
High	**Low**		

Table 557. Effects analysis summary table: Johnson's seagrass and diazinon

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Adults (Lower 48 – Coastal HUC-12s)	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to the pesticide is sufficient to reduce abundance via direct mortality.	NA	NA	Not Available	No
Exposure to the pesticides is sufficient to reduce abundance via impacts to growth.	High	Low	Not Available	Yes

Effects analysis summary: Johnson's seagrass is not anticipated to experience significant reductions in abundance or productivity from exposure to diazinon in the marine environment. The overall risk to Johnson's seagrass from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted diazinon concentrations in coastal habitats.



CHAPTER 14

MALATHION SPECIES EFFECTS ANALYSIS

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14 MALATHION EFFECTS ANALYSIS

14.1 Introduction

See Chapters 3 (Approach to the Assessment) and 11 (Effects Analysis Introduction) for descriptions of the methods and information used in this section. In this section we integrate the exposure and response information to evaluate the likelihood of adverse effects from stressors of the action at the population and species level. The information is organized by species. Within each species section the information is presented in the following order:

1. R- Plots figures: Demonstrate the relationship between geographically-specific exposure distributions and assessment measures (response distributions). These figures also convey the prevalence of registered use sites within the species range (example **Figure 1**).
2. Likelihood of exposure tables: Tables summarizing assessment of likelihood of exposure to each pesticide use that occurs within the species range (example **Table 1**).
3. Risk Hypotheses Tables: tables for each risk hypothesis summarizing risk and confidence associated with each registered use that occurs within the species range (example **Table 2**).
4. Final effects analysis table and narrative summary: Each species sections concludes with a Table indicating which risk hypotheses were supported and associated narrative summary of overall risk of the action to the species (example **Table 5**). Where applicable, the effects analysis table includes MagTool and/or Pacific salmon population model output. MagTool and population model output is also provided in appendix A: MagTool Results, and appendix B: Pacific Salmon Population Modeling.

14.2 Atlantic Salmon (Salmo salar)

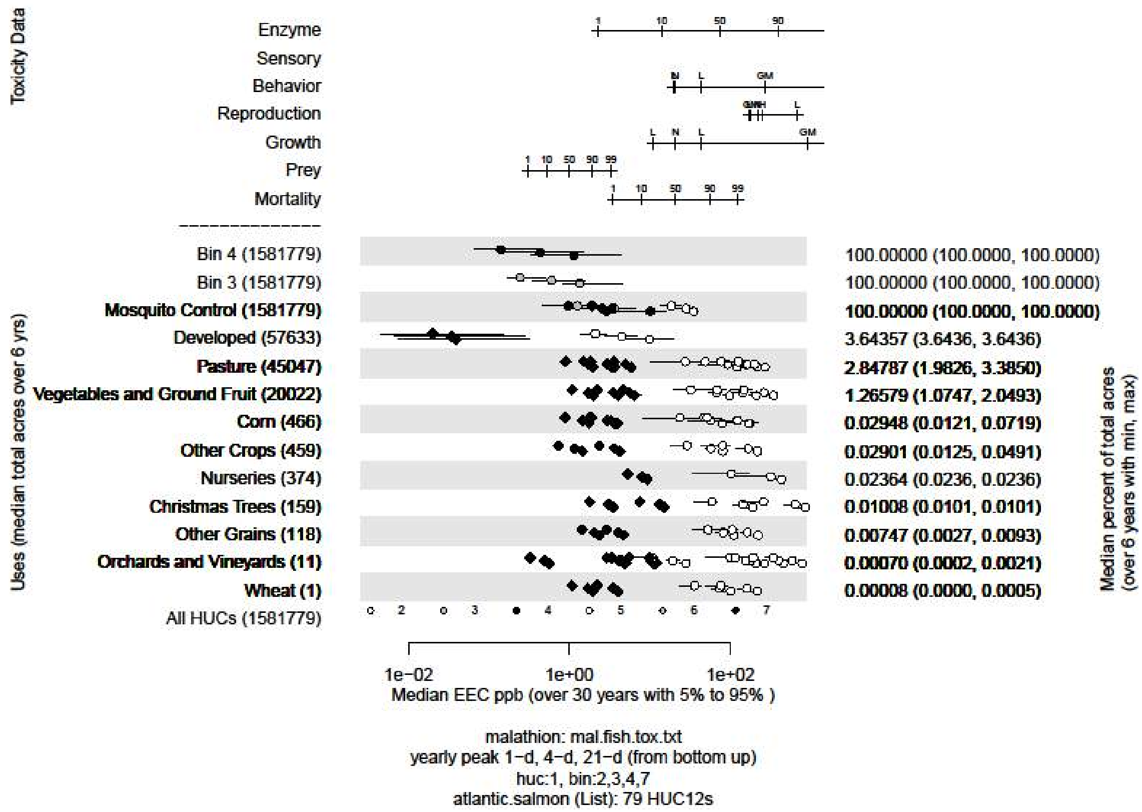


Figure 1. Effects analysis R-plot for Atlantic salmon (coastal marine habitat) and malathion

Table 1. Likelihood of exposure determination for Atlantic salmon (coastal marine habitat) and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Mosquito Control	3	yes	no	yes	NA	2	**High**
Developed	2	yes	no	yes	NA	2	**Med**
Pasture	2	yes	no	yes	NA	2	**Med**
Vegetables and Ground Fruit	2	yes	no	yes	NA	2	**Med**
Corn	1	yes	no	yes	NA	2	**Low**
Other Crops	1	yes	no	yes	NA	2	**Low**
Nurseries	1	yes	no	yes	NA	2	**Low**
Christmas Trees	1	yes	no	yes	NA	2	**Low**
Other Grains	1	yes	no	yes	NA	2	**Low**
Bin 3	3	yes	no	yes	NA	2	**High**
Bin 4	3	yes	no	yes	NA	2	**High**

Life Stage: Juvenile and Adult (Marine Environment Only)

Table 2.Direct mortality risk hypothesis; Atlantic salmon and malathion

Endpoint: Mortality (Marine Environment Only)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Developed	3.6	Medium	**Medium**
Pasture	2.8	High	**Medium**
Vegetables and Ground Fruit	1.3	High	**Medium**
Corn	.03	High	**Low**
Other Crops	.03	High	**Low**
Nurseries	.02	High	**Low**
Christmas Trees	.01	High	**Low**
Other Grains	.007	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult and juvenile abundance via acute lethality.			
Risk	**Confidence**		
High	**Low**		

Table 3. Behavior and sensory risk hypothesis; Atlantic salmon and Malathion

Endpoint: Behavior (Marine Environment Only)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**

Developed	3.6	Low	**Medium**
Pasture	2.8	High	**Medium**
Vegetables and Ground Fruit	1.3	High	**Medium**
Corn	.03	Medium	**Low**
Other Crops	.03	Medium	**Low**
Nurseries	.02	High	**Low**
Christmas Trees	.01	High	**Low**
Other Grains	.007	Medium	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Endpoint: Sensory (Marine Environment Only)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Developed	3.6	Not Available	**Medium**
Pasture	2.8	Not Available	**Medium**
Vegetables and Ground Fruit	1.3	Not Available	**Medium**
Corn	.03	Not Available	**Low**
Other Crops	.03	Not Available	**Low**
Nurseries	.02	Not Available	**Low**
Christmas Trees	.01	Not Available	**Low**
Other Grains	.007	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**Low**		

Table 4. AChE risk hypothesis; Atlantic salmon and malathion

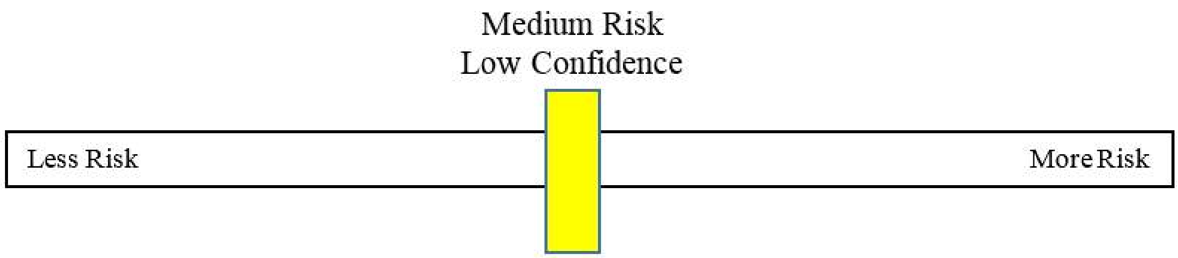
Endpoint: enzyme (Marine Environment Only)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Developed	3.6	Medium	**Medium**
Pasture	2.8	High	**Medium**
Vegetables and Ground Fruit	1.3	High	**Medium**
Corn	.03	High	**Low**
Other Crops	.03	High	**Low**
Nurseries	.02	High	**Low**
Christmas Trees	.01	High	**Low**
Other Grains	.007	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**

Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity		
Risk	**Confidence**	
High	**Low**	

Table 5. Effects analysis summary table: Atlantic salmon and malathion

	R-plot Derived		MagTool Range in median percent mortalities for aquatic bins	Risk Hypothesis Supported? Yes/No
Juveniles and Adults (Marine Environment Only)	**Risk**	**Confidence**		
Exposure to malathion is sufficient to reduce adult and juvenile abundance via acute lethality.	**High**	**Low**	**Not Available**	**Yes**
Exposure to malathion is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.	**High**	**Low**	**Not Available**	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	**High**	**Low**	**Not Available**	**Yes**

Effects analysis summary: Atlantic salmon are not anticipated to experience significant reductions in abundance or productivity (spawning adults) from exposure to malathion in the marine environment. If exposed to formulated products and tank mixtures containing malathion, Atlantic salmon may experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed Atlantic salmon. The overall risk to Atlantic salmon from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted malathion concentrations in coastal habitats. Low confidence of risk is also attributed to lack of information regarding duration of residency of Atlantic salmon in the coastal marine environment within US waters.


Medium Risk
Low Confidence
Less Risk
More Risk

14.3 Chum salmon, Columbia River ESU (Oncorhynchus keta)

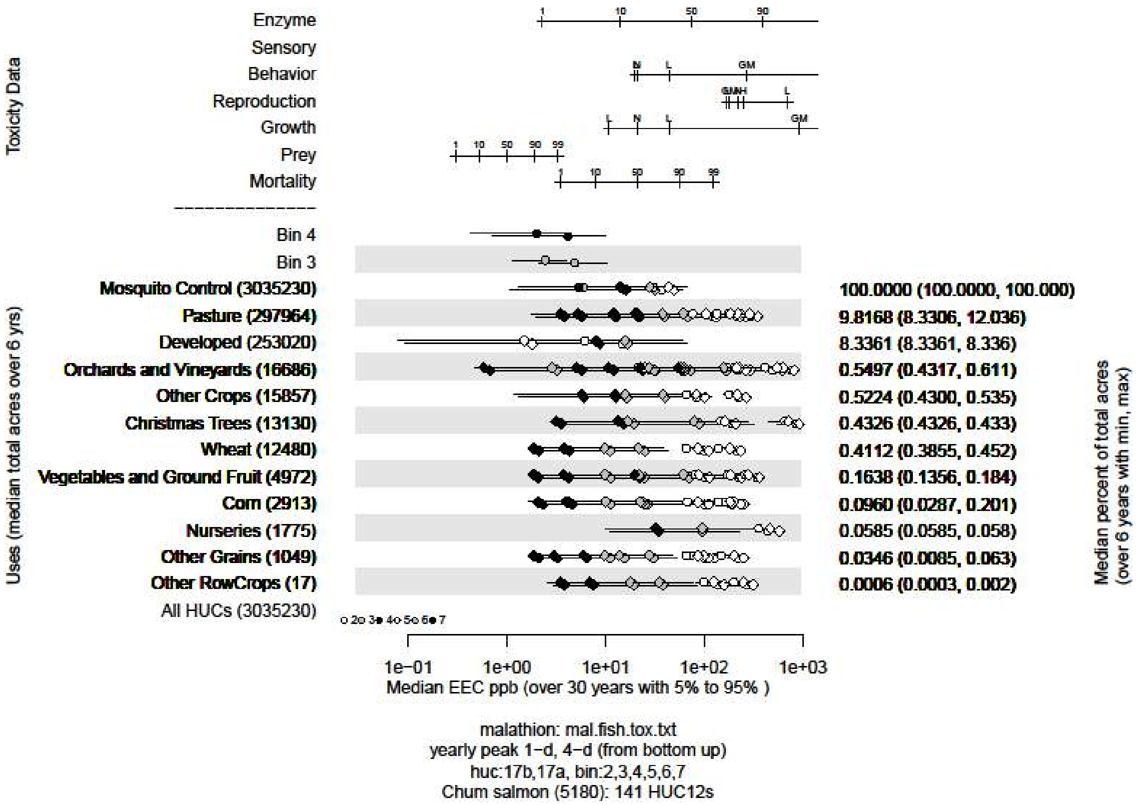


Figure 2. Effects analysis R-plot for Columbia River ESU chum salmon and malathion

Table 6. Likelihood of exposure determination for Columbia River ESU chum salmon and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Mosquito Control	3	yes	no	yes	NA	2	**Med**
Pasture	3	yes	no	yes	NA	2	**Med**
Developed	3	yes	no	yes	NA	2	**Med**
Orchards and Vineyards	1	yes	no	yes	no	2	**Low**
Other Crops	1	yes	no	yes	no	2	**Low**
Christmas Trees	1	yes	no	yes	no	2	**Low**
Wheat	1	yes	no	yes	no	2	**Low**
Vegetables and Ground Fruit	1	yes	no	yes	no	2	**Low**
Corn	1	yes	no	yes	no	2	**Low**
Nurseries	1	yes	no	yes	no	2	**Low**
Other Grains	1	yes	no	yes	no	2	**Low**
Other Row Crops	1	yes	no	yes	no	2	**Low**
Bin 3	3	yes	no	yes	NA	2	**High**
Bin 4	3	yes	no	yes	NA	2	**High**

Life Stage: Juvenile and Adult (full range)

Table 7. Direct mortality risk hypothesis; Columbia River ESU chum salmon and malathion

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	Med
Pasture	10	High	Med
Developed	8	High	Med
Orchards and Vineyards	1	High	Low
Other Crops	1	High	Low
Christmas Trees	<1	High	Low
Wheat	<1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Corn	<1	High	Low
Nurseries	<1	High	Low
Other Grains	<1	High	Low
Other Row Crops	<1	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile and adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 8. Prey risk hypothesis; Columbia River ESU chum salmon and malathion

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	Med
Pasture	10	High	Med
Developed	8	High	Med
Orchards and Vineyards	1	High	Low
Other Crops	1	High	Low
Christmas Trees	<1	High	Low
Wheat	<1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Corn	<1	High	Low
Nurseries	<1	High	Low
Other Grains	<1	High	Low
Other Row Crops	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 9. Behavior and sensory risk hypothesis; Columbia River ESU chum salmon and malathion

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	Med
Pasture	10	High	Med
Developed	8	Medium	Med
Orchards and Vineyards	1	High	Low
Other Crops	1	High	Low
Christmas Trees	<1	High	Low
Wheat	<1	Medium	Low
Vegetables and Ground Fruit	<1	High	Low
Corn	<1	Medium	Low
Nurseries	<1	High	Low
Other Grains	<1	High	Low
Other Row Crops	<1	High	Low
Bin 3		Low	High
Bin 4		Low	High
Endpoint: Sensory			

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Not Available	Med
Pasture	10	Not Available	Med
Developed	8	Not Available	Med
Orchards and Vineyards	1	Not Available	Low
Other Crops	1	Not Available	Low
Christmas Trees	<1	Not Available	Low
Wheat	<1	Not Available	Low
Vegetables and Ground Fruit	<1	Not Available	Low
Corn	<1	Not Available	Low
Nurseries	<1	Not Available	Low
Other Grains	<1	Not Available	Low
Other Row Crops	<1	Not Available	Low
Bin 3		Not Available	High
Bin 4		Not Available	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile and adult abundance and adult productivity via impairments to ecologically significant behaviors			
Risk	**Confidence**		
High	**High**		

Table 10. AChE risk hypothesis; Columbia River ESU chum salmon and malathion

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	Med
Pasture	10	High	Med
Developed	8	Medium	Med
Orchards and Vineyards	1	High	Low
Other Crops	1	High	Low
Christmas Trees	<1	High	Low
Wheat	<1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Corn	<1	High	Low
Nurseries	<1	High	Low
Other Grains	<1	High	Low
Other Row Crops	<1	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Table 11. Growth risk hypothesis; Columbia River ESU chum salmon and malathion

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	Med
Pasture	10	Medium	Med
Developed	8	Medium	Med
Orchards and Vineyards	1	Medium	Low
Other Crops	1	Medium	Low
Christmas Trees	<1	Medium	Low
Wheat	<1	Medium	Low
Vegetables and Ground Fruit	<1	Medium	Low
Corn	<1	Medium	Low
Nurseries	<1	Medium	Low
Other Grains	<1	Medium	Low
Other Row Crops	<1	Medium	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
Med	**High**		

Table 12. Reproduction risk hypothesis; Columbia River ESU chum salmon and malathion

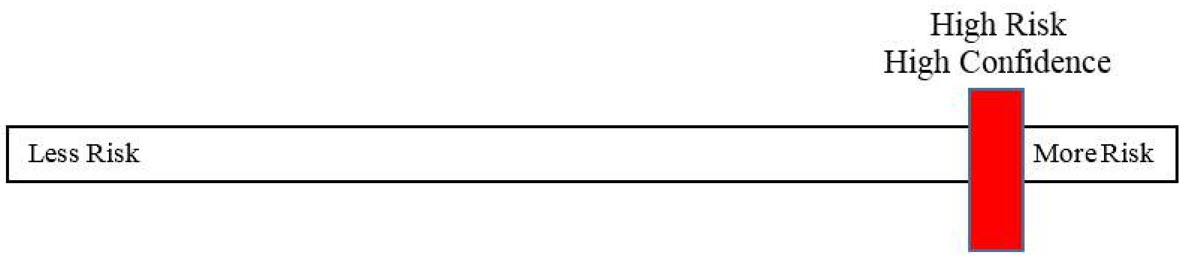
Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	Med
Pasture	10	High	Med
Developed	8	Medium	Med
Orchards and Vineyards	1	High	Low
Other Crops	1	Medium	Low
Christmas Trees	<1	High	Low
Wheat	<1	Medium	Low
Vegetables and Ground Fruit	<1	High	Low
Corn	<1	Medium	Low
Nurseries	<1	High	Low
Other Grains	<1	Medium	Low
Other Row Crops	<1	HIgh	Low
Bin 3		Low	High
Bin 4		Low	High

Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction		
Risk	**Confidence**	
High	**High**	

Table 13. Effects analysis summary table: Columbia River ESU chum salmon and malathion

	R-plot Derived		MagTool	Population Model	Risk
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	**Population Model Results**	**Hypothesis Supported? Yes/No**
Risk Hypothesis					
Exposure to malathion is sufficient to reduce juvenile and adult abundance via acute lethality.	High	High	4-day: 1-15	Not Applicable	Yes
Exposure to malathion is sufficient to reduce juvenile abundance via reduction in prey availability	High	High	4-day invert: 16-45	Not Applicable	Yes
Exposure to malathion is sufficient to reduce juvenile and adult abundance and adult productivity via impairments to ecologically significant behaviors	High	High	Not Available		Yes
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available		Yes
Exposure to malathion is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)	Medium	High	Not Available	Not Applicable	Yes
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable	Yes

Effects analysis summary: Adult and juvenile Columbia River ESU chum salmon are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where malathion achieves predicted levels. The MagTool results indicate that between 1-15 percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, chum will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed chum. The overall risk to Columbia River ESU chum salmon from the effects of the action is high and the confidence associated with that risk is high.



14.4 Chum Salmon, Hood Canal summer-run ESU (Oncorhynchus keta)

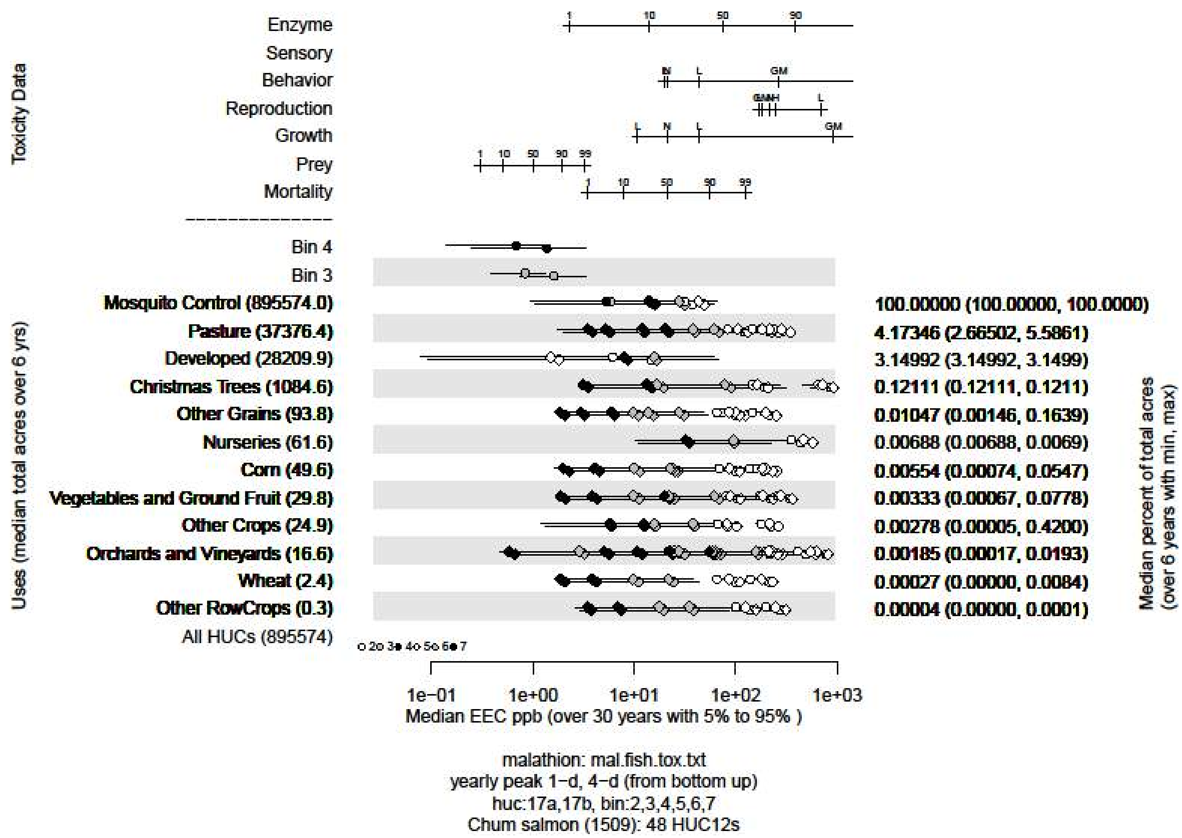


Figure 3. Effects analysis R-plot for Hood Canal summer-run ESU chum salmon and malathion

Table 14. Likelihood of exposure determination for Hood Canal summer-run ESU chum salmon and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Mosquito Control	3	yes	no	yes	NA	2	Med
Pasture	2	yes	no	yes	NA	2	Med
Developed	2	yes	no	yes	NA	2	Med
Christmas Tree	1	yes	no	yes	no	2	Low
Other Grains	1	yes	no	yes	no	2	Low
Nurseries	1	yes	no	yes	no	2	Low
Corn	1	yes	no	yes	no	2	Low
Vegetables and Ground Fruit	1	yes	no	yes	no	2	Low
Other Crops	1	yes	no	yes	no	2	Low
Orchards and Vineyards	1	yes	no	yes	no	2	Low
Wheat	1	yes	no	yes	no	2	Low
Other Row Crops	1	yes	no	yes	no	2	Low
Bin 3	3	yes	no	yes	no	2	High
Bin 4	3	yes	no	yes	no	2	High

Life Stage: Juvenile and Adult (full-range)

Table 15. Direct mortality risk hypothesis; Hood Canal summer-run chum salmon and malathion

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	Medium
Pasture	4	High	Medium
Developed	3	High	Medium
Christmas Tree	<1	High	Low
Other Grains	<1	High	Low
Nurseries	<1	High	Low
Corn	<1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Other Crops	<1	High	Low
Orchards and Vineyards	<1	High	Low
Wheat	<1	High	Low
Other Row Crops	<1	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile and adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 16. Prey risk hypothesis; Hood Canal summer-run chum salmon and malathion

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	Medium
Pasture	4	High	Medium
Developed	3	High	Medium
Christmas Tree	<1	High	Low
Other Grains	<1	High	Low
Nurseries	<1	High	Low
Corn	<1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Other Crops	<1	High	Low
Orchards and Vineyards	<1	High	Low
Wheat	<1	High	Low
Other Row Crops	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 17. Behavior and sensory risk hypothesis; Hood Canal summer-run chum salmon and malathion

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	Medium
Pasture	4	High	Medium
Developed	3	Medium	Medium
Christmas Tree	<1	High	Low
Other Grains	<1	High	Low
Nurseries	<1	High	Low
Corn	<1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Other Crops	<1	High	Low
Orchards and Vineyards	<1	High	Low
Wheat	<1	High	Low
Other Row Crops	<1	High	Low
Bin 3		Low	High
Bin 4		Low	High
Endpoint: Sensory			

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Not Available	Medium
Pasture	4	Not Available	Medium
Developed	3	Not Available	Medium
Christmas Tree	<1	Not Available	Low
Other Grains	<1	Not Available	Low
Nurseries	<1	Not Available	Low
Corn	<1	Not Available	Low
Vegetables and Ground Fruit	<1	Not Available	Low
Other Crops	<1	Not Available	Low
Orchards and Vineyards	<1	Not Available	Low
Wheat	<1	Not Available	Low
Other Row Crops	<1	Not Available	Low
Bin 3		Not Available	High
Bin 4		Not Available	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile and adult abundance and adult productivity via impairments to ecologically significant behaviors			
Risk	**Confidence**		
High	**Medium**		

Table 18. AChE risk hypothesis; Hood Canal summer-run chum salmon and malathion

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	Medium
Pasture	4	High	Medium
Developed	3	Medium	Medium
Christmas Tree	<1	High	Low
Other Grains	<1	High	Low
Nurseries	<1	High	Low
Corn	<1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Other Crops	<1	High	Low
Orchards and Vineyards	<1	High	Low
Wheat	<1	High	Low
Other Row Crops	<1	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Medium**		

Table 19. Growth risk hypothesis; Hood Canal summer-run chum salmon and malathion

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	Medium
Pasture	4	Medium	Medium
Developed	3	Medium	Medium
Christmas Tree	<1	Medium	Low
Other Grains	<1	Medium	Low
Nurseries	<1	Medium	Low
Corn	<1	Medium	Low
Vegetables and Ground Fruit	<1	Medium	Low
Other Crops	<1	Medium	Low
Orchards and Vineyards	<1	Medium	Low
Wheat	<1	Medium	Low
Other Row Crops	<1	Medium	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
Medium	**Medium**		

Table 20. Reproduction risk hypothesis; Hood Canal summer-run chum salmon and malathion

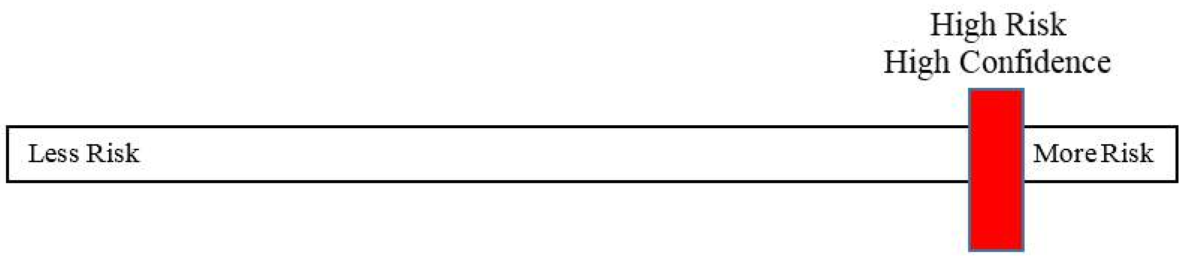
Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	Medium
Pasture	4	High	Medium
Developed	3	Low	Medium
Christmas Tree	<1	High	Low
Other Grains	<1	Low	Low
Nurseries	<1	High	Low
Corn	<1	Low	Low
Vegetables and Ground Fruit	<1	High	Low
Other Crops	<1	Low	Low
Orchards and Vineyards	<1	High	Low
Wheat	<1	Low	Low
Other Row Crops	<1	High	Low
Bin 3		Low	High
Bin 4		Low	High

Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction		
Risk	**Confidence**	
High	**Medium**	

Table 21. Effects analysis summary table: Hood Canal summer-run ESU chum salmon and malathion

	R-plot Derived		MagTool	Population Model Results	Risk Hypothesis Supported?
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		**Yes/No**
Risk Hypothesis					
Exposure to malathion is sufficient to reduce juvenile and adult abundance via acute lethality.	High	High	4-day: 1-5	Not Applicable	Yes
Exposure to malathion is sufficient to reduce juvenile abundance via reduction in prey availability	High	High	4-day fish: 1-4 4-day invert: 5-10	Not Applicable	Yes
Exposure to malathion is sufficient to reduce juvenile and adult abundance and adult productivity via impairments to ecologically significant behaviors	**High**	**Medium**	Not Available		Yes
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	**High**	**Medium**	Not Available		Yes
Exposure to malathion is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)	**Medium**	**Medium**	Not Available	Not Applicable	Yes
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	**High**	**Medium**	Not Available	Not Applicable	Yes

Effects analysis summary: Adult and juvenile Hood Canal summer-run ESU chum salmon are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where malathion achieves predicted levels. The MagTool results indicate that between 1-5 percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, chum will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed chum. The overall risk to Hood Canal summer-run ESU chum from the effects of the action is high and the confidence associated with that risk is high.



14.5 Chinook, California Coastal (Oncorhynchus tshawytscha)

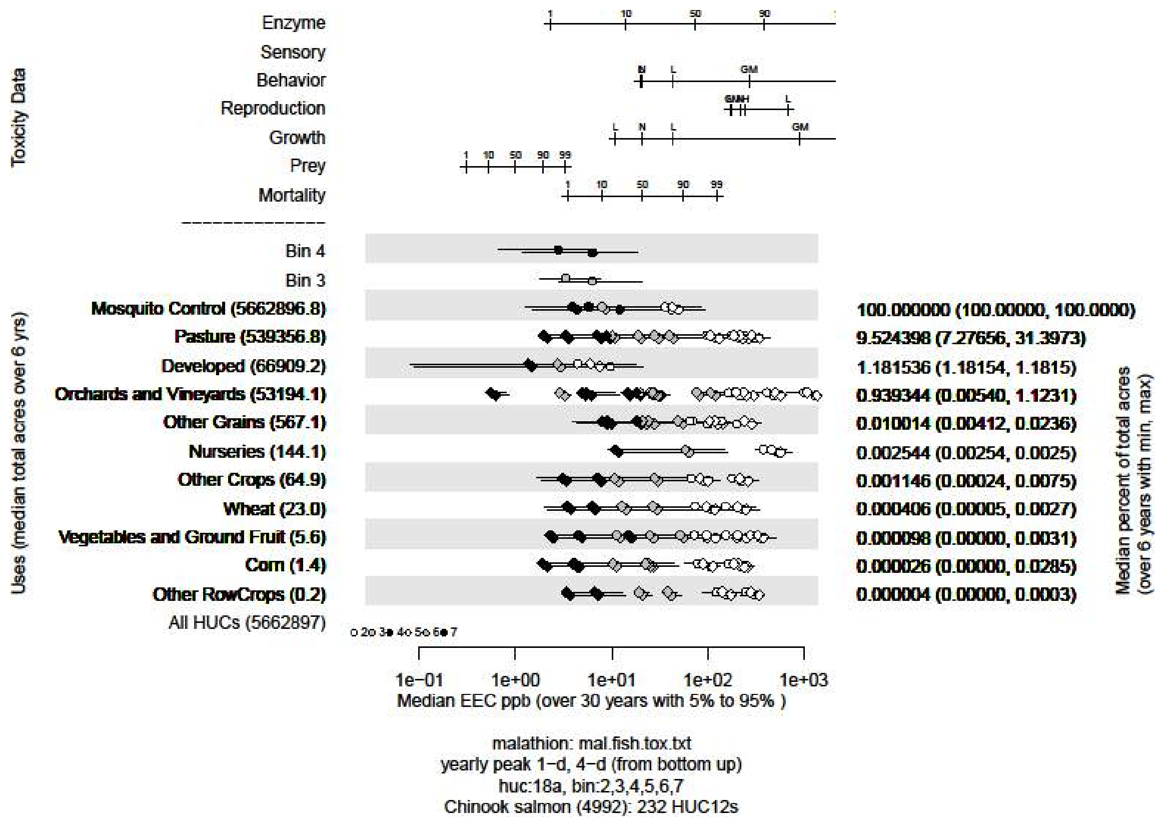


Figure 4. Effects analysis R-plot for California Coastal ESU chinook and malathion

Table 22. Likelihood of exposure determination for California Coastal ESU Chinook salmon and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Developed	2	yes	no	yes	NA	3	Med
Orchards and Vineyards	1	yes	no	yes	yes	3	High
Other grains	1	yes	no	yes	no	3	Low
Nurseries	1	yes	no	yes	no	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High
Juveniles							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Developed	2	yes	no	yes	NA	3	Med
Orchards and Vineyards	1	yes	no	yes	yes	3	High
Other grains	1	yes	no	yes	no	3	Low
Nurseries	1	yes	no	yes	no	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High

Life Stage: Adults (full-range)

Table 23. Direct mortality risk hypothesis; Adult California Coastal Chinook salmon and malathion

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	9.5	High	**High**
Developed	1.2	High	**Medium**
Orchards and Vineyards	0.9	High	**High**
Other grains	0.01	High	**Low**
Nurseries	0.003	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 24. Reproduction risk hypothesis; Adult California Coastal Chinook salmon and malathion

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	**High**
Pasture	9.5	High	**High**
Developed	1.2	Low	**Medium**
Orchards and Vineyards	0.9	High	**High**
Other grains	0.01	High	**Low**
Nurseries	0.003	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 25. Behavior and sensory risk hypothesis; Adult California Coastal Chinook salmon and malathion

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	9.5	High	**High**
Developed	1.2	Low	**Medium**
Orchards and Vineyards	0.9	High	**High**
Other grains	0.01	High	**Low**
Nurseries	0.003	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Pasture	9.5	Not Available	**High**
Developed	1.2	Not Available	**Medium**
Orchards and Vineyards	0.9	Not Available	**High**
Other grains	0.01	Not Available	**Low**
Nurseries	0.003	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		

High	**High**	

Table 26. AChE risk hypothesis; Adult California Coastal Chinook salmon and malathion

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	9.5	High	**High**
Developed	1.2	Medium	**Medium**
Orchards and Vineyards	0.9	High	**High**
Other grains	0.01	High	**Low**
Nurseries	0.003	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 27. Direct mortality risk hypothesis; Juvenile California Coastal Chinook salmon and malathion

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	9.5	High	High
Developed	1.2	High	Medium
Orchards and Vineyards	0.9	High	High
Other grains	0.01	High	Low
Nurseries	0.003	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 28. Growth risk hypothesis; Juvenile California Coastal Chinook salmon and malathion

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	9.5	Medium	High
Developed	1.2	Low	Medium

Orchards and Vineyards	0.9	Medium	High
Other grains	0.01	Medium	Low
Nurseries	0.003	Medium	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 29. Prey risk hypothesis; Juvenile California Coastal Chinook salmon and malathion

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	9.5	High	**High**
Developed	1.2	High	**Medium**
Orchards and Vineyards	0.9	High	**High**
Other grains	0.01	High	**Low**
Nurseries	0.003	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 30. AChE risk hypothesis; Juvenile California Coastal Chinook salmon and malathion

Endpoint: Enzyme			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	9.5	High	High
Developed	1.2	Medium	Medium
Orchards and Vineyards	0.9	High	High
Other grains	0.01	High	Low
Nurseries	0.003	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 31. Behavior and sensory risk hypothesis; Juvenile California Coastal Chinook salmon and malathion

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	9.5	High	**High**
Developed	1.2	Low	**Medium**
Orchards and Vineyards	0.9	High	**High**
Other grains	0.01	High	**Low**
Nurseries	0.003	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Pasture	9.5	Not Available	**High**
Developed	1.2	Not Available	**Medium**
Orchards and Vineyards	0.9	Not Available	**High**
Other grains	0.01	Not Available	**Low**
Nurseries	0.003	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce juveniles abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

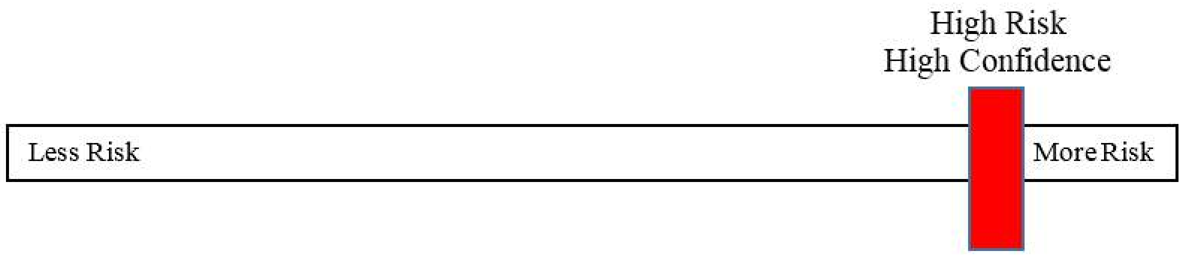
Table 32. Effects analysis summary table: California Coastal ESU Chinook salmon and malathion

	R-plot Derived		**MagTool**	**Population Model Results: Chinook Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 1-11	Not Applicable	Yes
Exposure to malathion is sufficient to reduce adult productivity	High	High	Not Available	Not Applicable	Yes

via impairments to reproduction					
Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	Yes
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	Not Applicable	Yes
	R-plot Derived		**MagTool**	**Population Model Results**	**Risk Hypothesis Supported?** Yes/No
Life Stage: Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities of aquatic bins**		
Risk Hypothesis					
Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 1-11	**Ocean-Type Chinook** Portion of juveniles exposed to malathion EECs; 10-1000 µg/l — Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles 25% — 1-12% (13-23) 50% — 1-23% (13-26) 75% — 2-35% (13-24) 100% — 3-97% (13-0) **Stream-Type Chinook** Portion of juveniles exposed to malathion EECs; 10-1000 µg/l — Mean percent reduction (STD) in a population's intrinsic growth, lambda, from	Yes

				death of juveniles 25% 1-11% (5-18) 50% 1-21% (5-22) 75% 2-31% (4-21) 100% 2-96% (4-0)	
Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**	Yes
Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day invert: 11-57	**Ocean-Type Chinook:** 3-25% (8-10)	Yes
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Stream-Type Chinook:** 2-24% (3-5)	Yes
Exposure to malathion is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	**Yes**

Effects analysis summary: Adult and juvenile California Coastal Chinook salmon are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Population modelling results indicate that malathion-induced mortality to juveniles may lead to severe reductions in lambda up to 97%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 1-11 percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, Chinook will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed Chinook. The overall risk to California Coastal Chinook salmon from the effects of the action is high and the confidence associated with that risk is high.


High Risk
High Confidence
Less Risk
More Risk

14.6 Chinook Salmon, Central Valley spring-run ESU (Oncorhynchus tshawytscha)

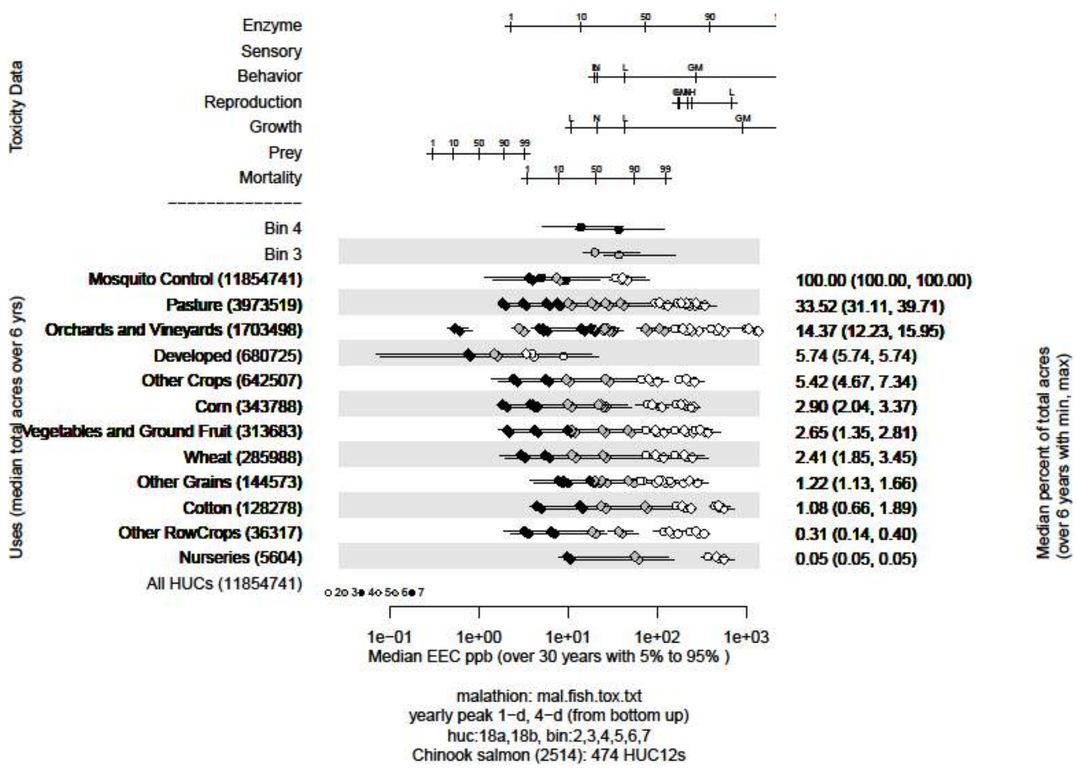


Figure 5. Effects analysis R-plot for Chinook salmon, Central Valley spring-run ESU and malathion

Table 33. Likelihood of exposure determination for Chinook salmon, Central Valley spring-run ESU and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Orchards and Vineyards	3	yes	no	yes	NA	3	High
Developed	3	yes	no	yes	NA	3	High
Other Crops	3	yes	no	yes	NA	3	High
Corn	2	yes	no	yes	NA	3	Med
Vegetables and Ground fruits	2	yes	no	yes	NA	3	Med
Wheat	2	yes	no	yes	NA	3	Med
Other Grains	2	yes	no	yes	NA	3	Med
Cotton	2	yes	no	yes	NA	3	Med
Other Row Crops	1	yes	no	yes	yes	3	High
Nurseries	1	yes	no	yes	no	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High
Juveniles							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Orchards and Vineyards	3	yes	no	yes	NA	3	High
Developed	3	yes	no	yes	NA	3	High
Other Crops	3	yes	no	yes	NA	3	High
Corn	2	yes	no	yes	NA	3	Med
Vegetables and Ground fruits	2	yes	no	yes	NA	3	Med
Wheat	2	yes	no	yes	NA	3	Med
Other Grains	2	yes	no	yes	NA	3	Med
Cotton	2	yes	no	yes	NA	3	Med
Other Row Crops	1	yes	no	yes	yes	3	High
Nurseries	1	yes	no	yes	no	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High

Life Stage: Adults (full-range)

Table 34. Direct mortality risk hypothesis; Adult Chinook salmon, Central Valley spring-run ESU and malathion

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	33.5	High	**High**
Orchards and Vineyards	14.4	High	**High**
Developed	5.7	High	**High**
Other Crops	5.4	High	**High**
Corn	2.9	High	**Medium**

Vegetables and Ground fruits	2.7	High	**Medium**
Wheat	2.4	High	**Medium**
Other Grains	1.2	High	**Medium**
Cotton	1.1	High	**Medium**
Other Row Crops	0.3	High	**High**
Nurseries	0.05	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 35. Reproduction risk hypothesis; Adult Chinook salmon, Central Valley spring-run ESU and malathion

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	**High**
Pasture	33.5	High	**High**
Orchards and Vineyards	14.4	High	**High**
Developed	5.7	Low	**High**
Other Crops	5.4	Low	**High**
Corn	2.9	Low	**Medium**
Vegetables and Ground fruits	2.7	High	**Medium**
Wheat	2.4	High	**Medium**
Other Grains	1.2	High	**Medium**
Cotton	1.1	High	**Medium**
Other Row Crops	0.3	High	**High**
Nurseries	0.05	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 36. Behavior and sensory risk hypothesis; Adult Chinook salmon, Central Valley spring-run ESU and malathion

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**

Pasture	33.5	High	**High**
Orchards and Vineyards	14.4	High	**High**
Developed	5.7	Medium	**High**
Other Crops	5.4	High	**High**
Corn	2.9	High	**Medium**
Vegetables and Ground fruits	2.7	High	**Medium**
Wheat	2.4	High	**Medium**
Other Grains	1.2	High	**Medium**
Cotton	1.1	High	**Medium**
Other Row Crops	0.3	High	**High**
Nurseries	0.05	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Pasture	33.5	Not Available	**High**
Orchards and Vineyards	14.4	Not Available	**High**
Developed	5.7	Not Available	**High**
Other Crops	5.4	Not Available	**High**
Corn	2.9	Not Available	**Medium**
Vegetables and Ground fruits	2.7	Not Available	**Medium**
Wheat	2.4	Not Available	**Medium**
Other Grains	1.2	Not Available	**Medium**
Cotton	1.1	Not Available	**Medium**
Other Row Crops	0.3	Not Available	**High**
Nurseries	0.05	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 37. AChE risk hypothesis; Adult Chinook salmon, Central Valley spring-run ESU and malathion

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	33.5	High	**High**
Orchards and Vineyards	14.4	High	**High**

Developed	5.7	Medium	**High**
Other Crops	5.4	High	**High**
Corn	2.9	High	**Medium**
Vegetables and Ground fruits	2.7	High	**Medium**
Wheat	2.4	High	**Medium**
Other Grains	1.2	High	**Medium**
Cotton	1.1	High	**Medium**
Other Row Crops	0.3	High	**High**
Nurseries	0.05	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 38. Direct mortality risk hypothesis; Juvenile Chinook salmon, Central Valley spring-run ESU and malathion

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	33.5	High	High
Orchards and Vineyards	14.4	High	High
Developed	5.7	High	High
Other Crops	5.4	High	High
Corn	2.9	High	Medium
Vegetables and Ground fruits	2.7	High	Medium
Wheat	2.4	High	Medium
Other Grains	1.2	High	Medium
Cotton	1.1	High	Medium
Other Row Crops	0.3	High	High
Nurseries	0.05	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 39. Growth risk hypothesis; Juvenile Chinook salmon, Central Valley spring-run ESU and malathion

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	33.5	Medium	High
Orchards and Vineyards	14.4	Medium	High
Developed	5.7	Low	High
Other Crops	5.4	Medium	High
Corn	2.9	Medium	Medium
Vegetables and Ground fruits	2.7	Medium	Medium
Wheat	2.4	Medium	Medium
Other Grains	1.2	Medium	Medium
Cotton	1.1	Medium	Medium
Other Row Crops	0.3	Medium	High
Nurseries	0.05	Medium	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 40. Prey risk hypothesis; Juvenile Chinook salmon, Central Valley spring-run ESU and malathion

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	33.5	High	**High**
Orchards and Vineyards	14.4	High	**High**
Developed	5.7	High	**High**
Other Crops	5.4	High	**High**
Corn	2.9	High	**Medium**
Vegetables and Ground fruits	2.7	High	**Medium**
Wheat	2.4	High	**Medium**
Other Grains	1.2	High	**Medium**
Cotton	1.1	High	**Medium**
Other Row Crops	0.3	High	**High**
Nurseries	0.05	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			

Risk	**Confidence**	
High	**High**	

Table 41. AChE risk hypothesis; Juvenile Chinook salmon, Central Valley spring-run ESU and malathion

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	33.5	High	High
Orchards and Vineyards	14.4	High	High
Developed	5.7	Medium	High
Other Crops	5.4	High	High
Corn	2.9	High	Medium
Vegetables and Ground fruits	2.7	High	Medium
Wheat	2.4	High	Medium
Other Grains	1.2	High	Medium
Cotton	1.1	High	Medium
Other Row Crops	0.3	High	High
Nurseries	0.05	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 42. Behavior and sensory risk hypothesis; Juvenile Chinook salmon, Central Valley spring-run ESU and malathion

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	33.5	High	**High**
Orchards and Vineyards	14.4	High	**High**
Developed	5.7	Medium	**High**
Other Crops	5.4	High	**High**
Corn	2.9	High	**Medium**
Vegetables and Ground fruits	2.7	High	**Medium**
Wheat	2.4	High	**Medium**
Other Grains	1.2	High	**Medium**
Cotton	1.1	High	**Medium**
Other Row Crops	0.3	High	**High**
Nurseries	0.05	High	**Low**

Bin 3		Medium	**High**
Bin 4		Medium	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Pasture	33.5	Not Available	**High**
Orchards and Vineyards	14.4	Not Available	**High**
Developed	5.7	Not Available	**High**
Other Crops	5.4	Not Available	**High**
Corn	2.9	Not Available	**Medium**
Vegetables and Ground fruits	2.7	Not Available	**Medium**
Wheat	2.4	Not Available	**Medium**
Other Grains	1.2	Not Available	**Medium**
Cotton	1.1	Not Available	**Medium**
Other Row Crops	0.3	Not Available	**High**
Nurseries	0.05	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce juveniles abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

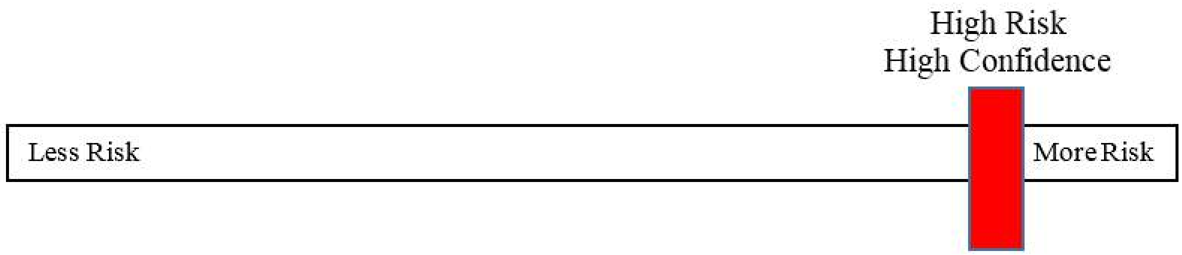
Table 43. Effects analysis summary table: Chinook salmon, Central Valley spring-run ESU and malathion

	R-plot Derived		**MagTool**	**Population Model Results: Chinook Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 17-65	Not Applicable	Yes
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable	Yes
Exposure to malathion is sufficient to reduce	High	High	Not Available	Not Applicable	Yes

adult abundance and productivity via impairments to ecologically significant behaviors.					
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	Not Applicable	Yes
Life Stage: Juveniles	**R-plot Derived** **Risk**	 **Confidence**	**MagTool** **Range in median percent mortalities of aquatic bins**	**Population Model Results**	**Risk Hypothesis Supported? Yes/No**
Risk Hypothesis					
Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 17-65	**Ocean-Type Chinook** Portion of juveniles exposed to malathion EECs; 10-1000 µg/l — Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles 25% — 1-12% (13-23) 50% — 1-23% (13-26) 75% — 2-35% (13-24) 100% — 3-97% (13-0) **Stream-Type Chinook** Portion of juveniles exposed to malathion EECs; 10-1000 µg/l — Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles 25% — 1-11% (5-18) 50% — 1-21% (5-22) 75% — 2-31% (4-21)	Yes

				100% 2-96% (4-0)	
Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**	Yes
Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day invert: 66-92	**Ocean-Type Chinook:** 3-25% (8-10)	Yes
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Stream-Type Chinook:** 2-24% (3-5)	Yes
Exposure to malathion is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	**Yes**

Effects analysis summary: Adult and juvenile Central Valley spring-run Chinook salmon are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Population modelling results indicate that malathion-induced mortality to juveniles may lead to severe reductions in lambda up to 97%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 17-65 percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, Chinook will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed Chinook. The overall risk to Central Valley spring-run Chinook salmon from the effects of the action is high and the confidence associated with that risk is high.


High Risk
High Confidence
Less Risk
More Risk

14.7 Chinook Salmon, Lower Columbia River ESU (Oncorhynchus tshawytscha)

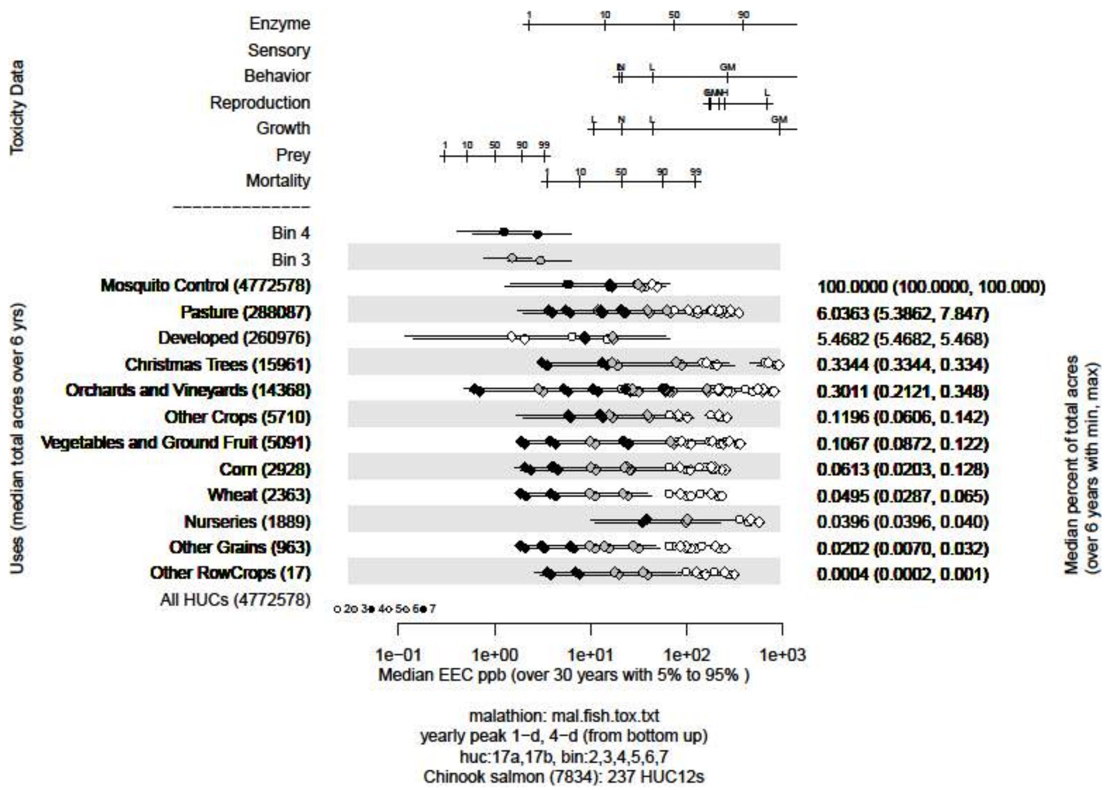


Figure 6. Effects analysis R-plot for Lower Columbia River ESU, Chinook salmon and malathion

Table 44. Likelihood of exposure determination for Lower Columbia River ESU, Chinook salmon and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Developed	3	yes	no	yes	NA	3	High
Christmas Trees	1	yes	no	yes	yes	3	High
Orchards and Vineyards	1	yes	no	yes	yes	3	High
Other Crops	1	yes	no	yes	yes	3	High
Vegetables and Ground fruit	1	yes	no	yes	yes	3	High
Corn	1	yes	no	yes	yes	3	High
Wheat	1	yes	no	yes	yes	3	High
Nurseries	1	yes	no	yes	no	3	Low
Other Grains	1	yes	no	yes	yes	3	High
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High
Juveniles							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Developed	3	yes	no	yes	NA	3	High
Christmas Trees	1	yes	no	yes	yes	3	High
Orchards and Vineyards	1	yes	no	yes	yes	3	High
Other Crops	1	yes	no	yes	yes	3	High
Vegetables and Ground fruit	1	yes	no	yes	yes	3	High
Corn	1	yes	no	yes	yes	3	High
Wheat	1	yes	no	yes	yes	3	High
Nurseries	1	yes	no	yes	no	3	Low
Other Grains	1	yes	no	yes	yes	3	High
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High

Life Stage: Adults (full-range)

Table 45. Direct mortality risk hypothesis; Adult Chinook salmon, Lower Columbia River ESU and malathion

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	6.0	High	**High**
Developed	5.5	High	**High**
Christmas Trees	0.3	High	**High**
Orchards and Vineyards	0.3	High	**High**
Other Crops	0.1	High	**High**
Vegetables and Ground fruit	0.1	High	**High**
Corn	0.06	High	**High**

Wheat	0.05	High	**High**
Nurseries	0.04	High	**Low**
Other Grains	0.02	High	**High**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 46. Reproduction risk hypothesis; Adult Chinook salmon, Lower Columbia River ESU and malathion

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	**High**
Pasture	6.0	High	**High**
Developed	5.5	Low	**High**
Christmas Trees	0.3	High	**High**
Orchards and Vineyards	0.3	High	**High**
Other Crops	0.1	Low	**High**
Vegetables and Ground fruit	0.1	High	**High**
Corn	0.06	Low	**High**
Wheat	0.05	Low	**High**
Nurseries	0.04	High	**Low**
Other Grains	0.02	Low	**High**
Bin 3		Low	**High**
Bin 4		Low	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 47. Behavior and sensory risk hypothesis; Adult Chinook salmon, Lower Columbia River ESU and malathion

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	6.0	High	**High**
Developed	5.5	Low	**High**
Christmas Trees	0.3	High	**High**
Orchards and Vineyards	0.3	High	**High**
Other Crops	0.1	High	**High**

Vegetables and Ground fruit	0.1	High	**High**
Corn	0.06	High	**High**
Wheat	0.05	Medium	**High**
Nurseries	0.04	High	**Low**
Other Grains	0.02	High	**High**
Bin 3		Low	**High**
Bin 4		Low	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Pasture	6.0	Not Available	**High**
Developed	5.5	Not Available	**High**
Christmas Trees	0.3	Not Available	**High**
Orchards and Vineyards	0.3	Not Available	**High**
Other Crops	0.1	Not Available	**High**
Vegetables and Ground fruit	0.1	Not Available	**High**
Corn	0.06	Not Available	**High**
Wheat	0.05	Not Available	**High**
Nurseries	0.04	Not Available	**Low**
Other Grains	0.02	Not Available	**High**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 48. AChE risk hypothesis; Adult Chinook salmon, Lower Columbia River ESU and malathion

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	6.0	High	**High**
Developed	5.5	Medium	**High**
Christmas Trees	0.3	High	**High**
Orchards and Vineyards	0.3	High	**High**
Other Crops	0.1	High	**High**
Vegetables and Ground fruit	0.1	High	**High**
Corn	0.06	High	**High**
Wheat	0.05	Medium	**High**
Nurseries	0.04	High	**Low**

Other Grains	0.02	High	**High**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 49. Direct mortality risk hypothesis; Juvenile Chinook salmon, Lower Columbia River ESU and malathion

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	6.0	High	High
Developed	5.5	High	High
Christmas Trees	0.3	High	High
Orchards and Vineyards	0.3	High	High
Other Crops	0.1	High	High
Vegetables and Ground fruit	0.1	High	High
Corn	0.06	High	High
Wheat	0.05	High	High
Nurseries	0.04	High	Low
Other Grains	0.02	High	High
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 50. Growth risk hypothesis; Juvenile Chinook salmon, Lower Columbia River ESU and malathion

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	6.0	Medium	High
Developed	5.5	Medium	High
Christmas Trees	0.3	Medium	High
Orchards and Vineyards	0.3	Medium	High
Other Crops	0.1	Medium	High

Vegetables and Ground fruit	0.1	Medium	High
Corn	0.06	Medium	High
Wheat	0.05	Medium	High
Nurseries	0.04	Medium	Low
Other Grains	0.02	Medium	High
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 51. Prey risk hypothesis; Juvenile Chinook salmon, Lower Columbia River ESU and malathion

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	6.0	High	**High**
Developed	5.5	High	**High**
Christmas Trees	0.3	High	**High**
Orchards and Vineyards	0.3	High	**High**
Other Crops	0.1	High	**High**
Vegetables and Ground fruit	0.1	High	**High**
Corn	0.06	High	**High**
Wheat	0.05	High	**High**
Nurseries	0.04	High	**Low**
Other Grains	0.02	High	**High**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 52. AChE risk hypothesis; Juvenile Chinook salmon, Lower Columbia River ESU and malathion

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	6.0	High	High
Developed	5.5	Medium	High
Christmas Trees	0.3	High	High
Orchards and Vineyards	0.3	High	High

Other Crops	0.1	High	High
Vegetables and Ground fruit	0.1	High	High
Corn	0.06	High	High
Wheat	0.05	Medium	High
Nurseries	0.04	High	Low
Other Grains	0.02	High	High
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 53. Behavior and sensory risk hypothesis; Juvenile Chinook salmon, Lower Columbia River ESU and malathion

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	6.0	High	**High**
Developed	5.5	Low	**High**
Christmas Trees	0.3	High	**High**
Orchards and Vineyards	0.3	High	**High**
Other Crops	0.1	High	**High**
Vegetables and Ground fruit	0.1	High	**High**
Corn	0.06	High	**High**
Wheat	0.05	Medium	**High**
Nurseries	0.04	High	**Low**
Other Grains	0.02	High	**High**
Bin 3		Low	**High**
Bin 4		Low	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Pasture	6.0	Not Available	**High**
Developed	5.5	Not Available	**High**
Christmas Trees	0.3	Not Available	**High**
Orchards and Vineyards	0.3	Not Available	**High**
Other Crops	0.1	Not Available	**High**
Vegetables and Ground fruit	0.1	Not Available	**High**
Corn	0.06	Not Available	**High**

Wheat	0.05	Not Available	**High**
Nurseries	0.04	Not Available	**Low**
Other Grains	0.02	Not Available	**High**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 54. Effects analysis summary table: Chinook salmon, Lower Columbia River ESU and malathion

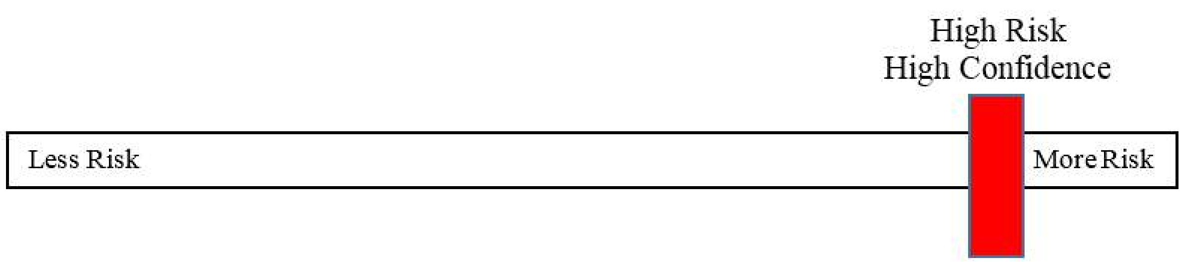
	R-plot Derived		**MagTool**	**Population Model Results: Chinook Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 0-7	Not Applicable	Yes
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable	Yes
Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	Yes
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	Not Applicable	Yes
	R-plot Derived		**MagTool**	**Population Model Results**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities of aquatic bins**		

<table>
<tr><th>Risk Hypothesis</th><th></th><th></th><th></th><th></th><th></th></tr>
<tr><td>Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.</td><td>High</td><td>High</td><td>4-day:
0-7</td><td><table>
<tr><th colspan="2">Ocean-Type Chinook</th></tr>
<tr><td>Portion of juveniles exposed to malathion EECs; 10-1000 µg/l</td><td>Mean percent reduction (STD) in a population’s intrinsic growth, lambda, from death of juveniles</td></tr>
<tr><td>25%
50%
75%
100%</td><td>1-12% (13-23)
1-23% (13-26)
2-35% (13-24)
3-97% (13-0)</td></tr>
<tr><th colspan="2">Stream-Type Chinook</th></tr>
<tr><td>Portion of juveniles exposed to malathion EECs; 10-1000 µg/l</td><td>Mean percent reduction (STD) in a population’s intrinsic growth, lambda, from death of juveniles</td></tr>
<tr><td>25%
50%
75%
100%</td><td>1-11% (5-18)
1-21% (5-22)
2-31% (4-21)
2-96% (4-0)</td></tr>
</table></td><td>Yes</td></tr>
<tr><td>Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)</td><td>High</td><td>High</td><td>Not Available</td><td>Anticipated reductions in a population’s intrinsic rate of growth (lambda) (± 1 STD)</td><td>Yes</td></tr>
<tr><td>Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability</td><td>High</td><td>High</td><td>4-day invert:
10-29</td><td rowspan="2">Ocean-Type Chinook:
3-25% (8-10)

Stream-Type Chinook:</td><td>Yes</td></tr>
<tr><td>Exposure to malathion is sufficient to reduce ChE activity; the</td><td>High</td><td>High</td><td>Not Available</td><td>Yes</td></tr>
</table>

identified mechanism of toxicity				2-24% (3-5)	
Exposure to malathion is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	**Yes**

Effects analysis summary: Adult and juvenile Chinook salmon, Lower Columbia River ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Population modelling results indicate that malathion-induced mortality to juveniles may lead to severe reductions in lambda up to 97%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 0-7 percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, Chinook will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed Chinook. The overall risk to Chinook salmon, Lower Columbia River ESU from the effects of the action is high and the confidence associated with that risk is high



14.8 Chinook Salmon, Puget Sound ESU (Oncorhynchus tshawytscha)

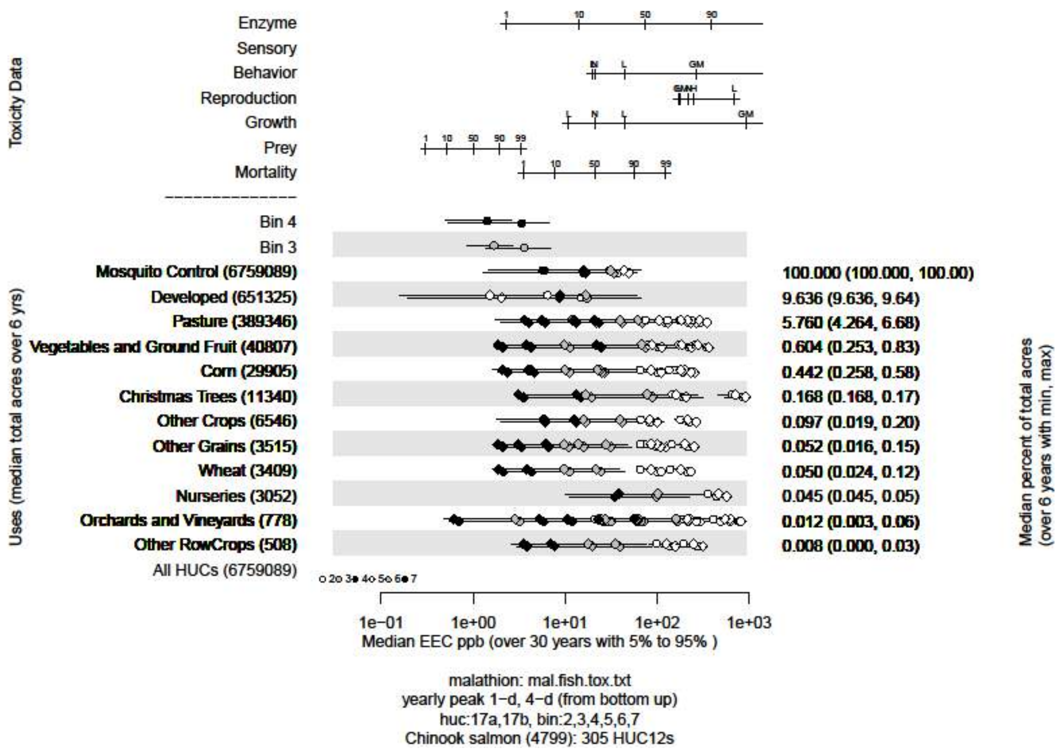


Figure 7. Effects analysis R-plot for Chinook salmon, Puget Sound ESU and malathion

Table 55. Likelihood of exposure determination for Chinook salmon, Puget Sound ESU and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adult							
Mosquito Control	3	yes	no	yes	NA	3	High
Developed	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Vegetables and Ground Fruit	1	yes	no	yes	yes	3	High
Corn	1	yes	no	yes	yes	3	High
Christmas Trees	1	yes	no	yes	no	3	Low
Other Crops	1	yes	no	yes	no	3	Low
Other Grains	1	yes	no	yes	yes	3	High
Wheat	1	yes	no	yes	yes	3	High
Nurseries	1	yes	no	yes	no	3	Low
Orchards and Vineyards	1	yes	no	yes	no	3	Low
Other Row Crops	1	yes	no	yes	no	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High
Juvenile							
Mosquito Control	3	yes	no	yes	NA	3	High
Developed	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Vegetables and Ground Fruit	1	yes	no	yes	yes	3	High
Corn	1	yes	no	yes	yes	3	High
Christmas Trees	1	yes	no	yes	no	3	Low
Other Crops	1	yes	no	yes	no	3	Low
Other Grains	1	yes	no	yes	yes	3	High
Wheat	1	yes	no	yes	yes	3	High
Nurseries	1	yes	no	yes	no	3	Low
Orchards and Vineyards	1	yes	no	yes	no	3	Low
Other Row Crops	1	yes	no	yes	no	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High

Life Stage: Adults (full-range)

Table 56. Direct mortality risk hypothesis; Chinook salmon, Puget Sound ESU and malathion; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Developed	9.6	High	**High**
Pasture	5.8	High	**High**
Vegetables and Ground Fruit	0.6	High	**High**
Corn	0.4	High	**High**
Christmas Trees	0.2	High	**Low**
Other Crops	0.1	High	**Low**
Other Grains	0.05	High	**High**
Wheat	0.05	High	**High**
Nurseries	0.05	High	**Low**

Orchards and Vineyards	0.01	High	**Low**
Other Row Crops	0.01	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 57. Reproduction risk hypothesis; Chinook salmon, Puget Sound ESU and malathion; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	**High**
Developed	9.6	Low	**High**
Pasture	5.8	High	**High**
Vegetables and Ground Fruit	0.6	High	**High**
Corn	0.4	Low	**High**
Christmas Trees	0.2	High	**Low**
Other Crops	0.1	Low	**Low**
Other Grains	0.05	Low	**High**
Wheat	0.05	Low	**High**
Nurseries	0.05	High	**Low**
Orchards and Vineyards	0.01	High	**Low**
Other Row Crops	0.01	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 58. Behavior and sensory risk hypothesis; Chinook salmon, Puget Sound ESU and malathion; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Developed	9.6	Low	**High**
Pasture	5.8	High	**High**
Vegetables and Ground Fruit	0.6	High	**High**
Corn	0.4	High	**High**
Christmas Trees	0.2	High	**Low**

Other Crops	0.1	High	**Low**
Other Grains	0.05	High	**High**
Wheat	0.05	High	**High**
Nurseries	0.05	High	**Low**
Orchards and Vineyards	0.01	High	**Low**
Other Row Crops	0.01	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Developed	9.6	Not Available	**High**
Pasture	5.8	Not Available	**High**
Vegetables and Ground Fruit	0.6	Not Available	**High**
Corn	0.4	Not Available	**High**
Christmas Trees	0.2	Not Available	**Low**
Other Crops	0.1	Not Available	**Low**
Other Grains	0.05	Not Available	**High**
Wheat	0.05	Not Available	**High**
Nurseries	0.05	Not Available	**Low**
Orchards and Vineyards	0.01	Not Available	**Low**
Other Row Crops	0.01	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 59. AChE risk hypothesis; Chinook salmon, Puget Sound ESU and malathion; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Developed	9.6	Medium	**High**
Pasture	5.8	High	**High**
Vegetables and Ground Fruit	0.6	High	**High**
Corn	0.4	High	**High**
Christmas Trees	0.2	High	**Low**
Other Crops	0.1	High	**Low**
Other Grains	0.05	High	**High**
Wheat	0.05	High	**High**

Nurseries	0.05	High	**Low**
Orchards and Vineyards	0.01	High	**Low**
Other Row Crops	0.01	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 60. Direct mortality risk hypothesis; Chinook salmon, Puget Sound ESU and malathion; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Developed	9.6	High	High
Pasture	5.8	High	High
Vegetables and Ground Fruit	0.6	High	High
Corn	0.4	High	High
Christmas Trees	0.2	High	Low
Other Crops	0.1	High	Low
Other Grains	0.05	High	High
Wheat	0.05	High	High
Nurseries	0.05	High	Low
Orchards and Vineyards	0.01	High	Low
Other Row Crops	0.01	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 61. Growth risk hypothesis; Chinook salmon, Puget Sound ESU and malathion; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Developed	9.6	Medium	High
Pasture	5.8	Medium	High
Vegetables and Ground Fruit	0.6	Medium	High

Corn	0.4	Medium	High
Christmas Trees	0.2	Medium	Low
Other Crops	0.1	Medium	Low
Other Grains	0.05	Medium	High
Wheat	0.05	Medium	High
Nurseries	0.05	Medium	Low
Orchards and Vineyards	0.01	Medium	Low
Other Row Crops	0.01	Medium	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 62. Prey risk hypothesis; Chinook salmon, Puget Sound ESU and malathion; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Developed	9.6	High	**High**
Pasture	5.8	High	**High**
Vegetables and Ground Fruit	0.6	High	**High**
Corn	0.4	High	**High**
Christmas Trees	0.2	High	**Low**
Other Crops	0.1	High	**Low**
Other Grains	0.05	High	**High**
Wheat	0.05	High	**High**
Nurseries	0.05	High	**Low**
Orchards and Vineyards	0.01	High	**Low**
Other Row Crops	0.01	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 63. AChE risk hypothesis; Chinook salmon, Puget Sound ESU and malathion; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Developed	9.6	Medium	High

Pasture	5.8	High	High
Vegetables and Ground Fruit	0.6	High	High
Corn	0.4	High	High
Christmas Trees	0.2	High	Low
Other Crops	0.1	High	Low
Other Grains	0.05	High	High
Wheat	0.05	High	High
Nurseries	0.05	High	Low
Orchards and Vineyards	0.01	High	Low
Other Row Crops	0.01	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 64. Behavior and sensory risk hypothesis; Chinook salmon, Puget Sound ESU and malathion; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Developed	9.6	Low	**High**
Pasture	5.8	High	**High**
Vegetables and Ground Fruit	0.6	High	**High**
Corn	0.4	High	**High**
Christmas Trees	0.2	High	**Low**
Other Crops	0.1	High	**Low**
Other Grains	0.05	High	**High**
Wheat	0.05	High	**High**
Nurseries	0.05	High	**Low**
Orchards and Vineyards	0.01	High	**Low**
Other Row Crops	0.01	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Developed	9.6	Not Available	**High**
Pasture	5.8	Not Available	**High**
Vegetables and Ground Fruit	0.6	Not Available	**High**

Corn	0.4	Not Available	**High**
Christmas Trees	0.2	Not Available	**Low**
Other Crops	0.1	Not Available	**Low**
Other Grains	0.05	Not Available	**High**
Wheat	0.05	Not Available	**High**
Nurseries	0.05	Not Available	**Low**
Orchards and Vineyards	0.01	Not Available	**Low**
Other Row Crops	0.01	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

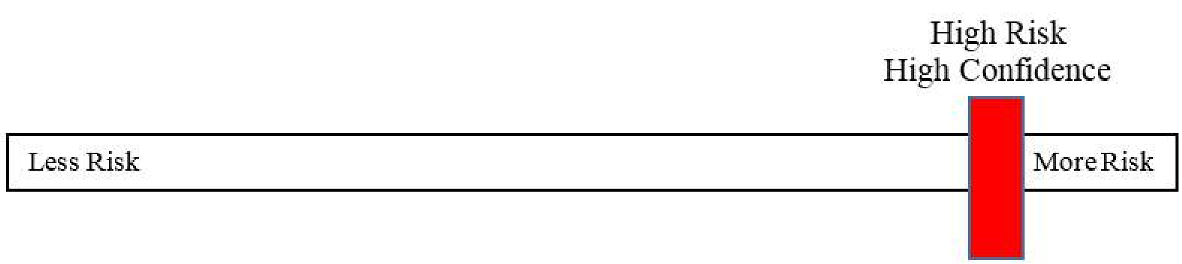
Table 65. Effects analysis summary table: Chinook salmon, Puget Sound ESU and malathion

	R-plot Derived		**MagTool**	**Population Model Results: Chinook Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 1-11	Not Applicable	Yes
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable	Yes
Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	Yes
Exposure to malathion is sufficient to reduce ChE activity; the identified	High	High	Not Available	Not Applicable	Yes

<table>
<tr><td>mechanism of toxicity</td><td></td><td></td><td></td><td colspan="2"></td><td></td></tr>
<tr><td rowspan="2">Life Stage: Juveniles</td><td colspan="2">R-plot Derived</td><td rowspan="2">MagTool
Range in median percent mortalities of aquatic bins</td><td colspan="2" rowspan="2">Population Model Results</td><td rowspan="2">Risk Hypothesis Supported? Yes/No</td></tr>
<tr><td>Risk</td><td>Confidence</td></tr>
<tr><td>Risk Hypothesis</td><td></td><td></td><td></td><td colspan="2"></td><td></td></tr>
<tr><td rowspan="7">Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.</td><td rowspan="7">High</td><td rowspan="7">High</td><td rowspan="7">4-day:
1-11</td><td colspan="2">Ocean-Type Chinook</td><td rowspan="7">Yes</td></tr>
<tr><td>Portion of juveniles exposed to malathion EECs; 10-1000 µg/l</td><td>Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles</td></tr>
<tr><td>25%
50%
75%
100%</td><td>1-12% (13-23)
1-23% (13-26)
2-35% (13-24)
3-97% (13-0)</td></tr>
<tr><td colspan="2">Stream-Type Chinook</td></tr>
<tr><td>Portion of juveniles exposed to malathion EECs; 10-1000 µg/l</td><td>Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles</td></tr>
<tr><td>25%
50%
75%
100%</td><td>1-11% (5-18)
1-21% (5-22)
2-31% (4-21)
2-96% (4-0)</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td>Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)</td><td>High</td><td>High</td><td>Not Available</td><td colspan="2">Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)</td><td>Yes</td></tr>
<tr><td>Exposure to malathion is sufficient to reduce Juvenile abundance</td><td>High</td><td>High</td><td>4-day invert:
12-34</td><td colspan="2">Ocean-Type Chinook:</td><td>Yes</td></tr>
</table>

via reduction in prey availability				3-25% (8-10)	
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Stream-Type Chinook:** 2-24% (3-5)	Yes
Exposure to malathion is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	**Yes**

Effects analysis summary: Adult and juvenile Chinook salmon, Puget Sound ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Population modelling results indicate that malathion-induced mortality to juveniles may lead to severe reductions in lambda up to 97%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 1-11 percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, Chinook will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed Chinook. The overall risk to Chinook salmon, Puget Sound ESU from the effects of the action is high and the confidence associated with that risk is high.



14.9 Chinook Salmon, Sacramento River winter-run (Oncorhynchus tshawytscha)

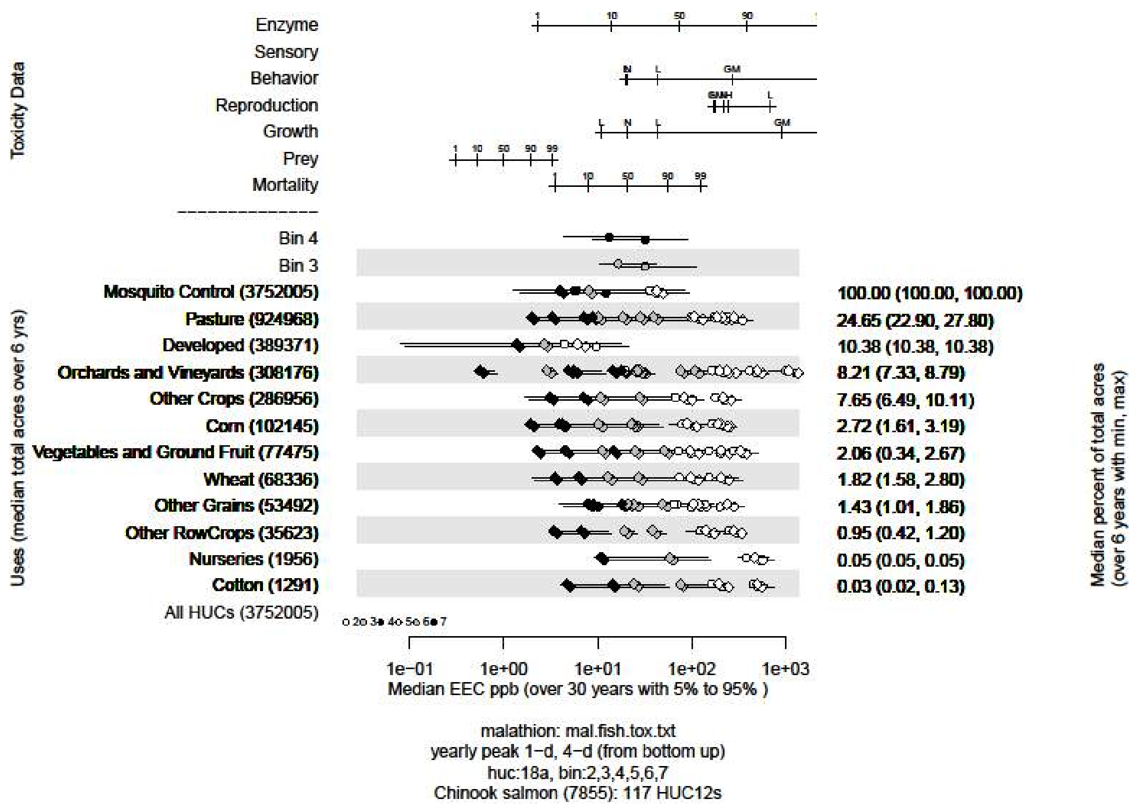


Figure 8. Effects analysis R-plot for Chinook salmon, Sacramento River winter-run ESU and malathion

Table 66. Likelihood of exposure determination for Chinook salmon, Sacramento River winter-run ESU and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Developed	3	yes	no	yes	NA	3	High
Orchards and Vineyards	3	yes	no	yes	NA	3	High
Other Crops	3	yes	no	yes	NA	3	High
Corn	2	yes	no	yes	NA	3	Med
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	Med
Wheat	2	yes	no	yes	NA	3	Med
Other Grains	2	yes	no	yes	NA	3	Med
Other Row Crops	2	yes	no	yes	NA	3	Med
Nurseries	1	yes	no	yes	no	3	Low
Cotton	1	yes	no	yes	no	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High
Juveniles							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Developed	3	yes	no	yes	NA	3	High
Orchards and Vineyards	3	yes	no	yes	NA	3	High
Other Crops	3	yes	no	yes	NA	3	High
Corn	2	yes	no	yes	NA	3	Med
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	Med
Wheat	2	yes	no	yes	NA	3	Med
Other Grains	2	yes	no	yes	NA	3	Med
Other Row Crops	2	yes	no	yes	NA	3	Med
Nurseries	1	yes	no	yes	no	3	Low
Cotton	1	yes	no	yes	no	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High

Life Stage: Adults (full-range)

Table 67. Direct mortality risk hypothesis; Chinook salmon, Sacramento River winter-run ESU and malathion; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	24.7	High	**High**
Developed	10.4	High	**High**
Orchards and Vineyards	8.2	High	**High**
Other Crops	7.7	High	**High**
Corn	2.7	High	**Medium**
Vegetables and Ground Fruit	2.1	High	**Medium**
Wheat	1.8	High	**Medium**

Other Grains	1.4	High	**Medium**
Other Row Crops	1.0	High	**Medium**
Nurseries	0.05	High	**Low**
Cotton	0.03	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 68. Reproduction risk hypothesis; Chinook salmon, Sacramento River winter-run ESU and malathion; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	**High**
Pasture	24.7	High	**High**
Developed	10.4	Low	**High**
Orchards and Vineyards	8.2	High	**High**
Other Crops	7.7	Low	**High**
Corn	2.7	Low	**Medium**
Vegetables and Ground Fruit	2.1	High	**Medium**
Wheat	1.8	Low	**Medium**
Other Grains	1.4	High	**Medium**
Other Row Crops	1.0	High	**Medium**
Nurseries	0.05	High	**Low**
Cotton	0.03	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 69. Behavior and sensory risk hypothesis; Chinook salmon, Sacramento River winter-run ESU and malathion; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	24.7	High	**High**
Developed	10.4	Low	**High**

Orchards and Vineyards	8.2	High	**High**
Other Crops	7.7	High	**High**
Corn	2.7	High	**Medium**
Vegetables and Ground Fruit	2.1	High	**Medium**
Wheat	1.8	High	**Medium**
Other Grains	1.4	High	**Medium**
Other Row Crops	1.0	High	**Medium**
Nurseries	0.05	High	**Low**
Cotton	0.03	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Pasture	24.7	Not Available	**High**
Developed	10.4	Not Available	**High**
Orchards and Vineyards	8.2	Not Available	**High**
Other Crops	7.7	Not Available	**High**
Corn	2.7	Not Available	**Medium**
Vegetables and Ground Fruit	2.1	Not Available	**Medium**
Wheat	1.8	Not Available	**Medium**
Other Grains	1.4	Not Available	**Medium**
Other Row Crops	1.0	Not Available	**Medium**
Nurseries	0.05	Not Available	**Low**
Cotton	0.03	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 70. AChE risk hypothesis; Chinook salmon, Sacramento River winter-run ESU and malathion; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	24.7	High	**High**
Developed	10.4	Medium	**High**
Orchards and Vineyards	8.2	High	**High**
Other Crops	7.7	High	**High**

Corn	2.7	High	**Medium**
Vegetables and Ground Fruit	2.1	High	**Medium**
Wheat	1.8	High	**Medium**
Other Grains	1.4	High	**Medium**
Other Row Crops	1.0	High	**Medium**
Nurseries	0.05	High	**Low**
Cotton	0.03	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 71. Direct mortality risk hypothesis; Chinook salmon, Sacramento River winter-run ESU and malathion; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	24.7	High	High
Developed	10.4	High	High
Orchards and Vineyards	8.2	High	High
Other Crops	7.7	High	High
Corn	2.7	High	Medium
Vegetables and Ground Fruit	2.1	High	Medium
Wheat	1.8	High	Medium
Other Grains	1.4	High	Medium
Other Row Crops	1.0	High	Medium
Nurseries	0.05	High	Low
Cotton	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 72. Growth risk hypothesis; Chinook salmon, Sacramento River winter-run ESU and malathion; Juveniles

Endpoint: Growth

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	24.7	Medium	High
Developed	10.4	Low	High
Orchards and Vineyards	8.2	Medium	High
Other Crops	7.7	Medium	High
Corn	2.7	Medium	Medium
Vegetables and Ground Fruit	2.1	Medium	Medium
Wheat	1.8	Medium	Medium
Other Grains	1.4	Medium	Medium
Other Row Crops	1.0	Medium	Medium
Nurseries	0.05	Medium	Low
Cotton	0.03	Medium	Low
Bin 3		Medium	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 73. Prey risk hypothesis; Chinook salmon, Sacramento River winter-run ESU and malathion; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	24.7	High	**High**
Developed	10.4	High	**High**
Orchards and Vineyards	8.2	High	**High**
Other Crops	7.7	High	**High**
Corn	2.7	High	**Medium**
Vegetables and Ground Fruit	2.1	High	**Medium**
Wheat	1.8	High	**Medium**
Other Grains	1.4	High	**Medium**
Other Row Crops	1.0	High	**Medium**
Nurseries	0.05	High	**Low**
Cotton	0.03	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 74. AChE risk hypothesis; Chinook salmon, Sacramento River winter-run ESU and malathion; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	24.7	High	High
Developed	10.4	Medium	High
Orchards and Vineyards	8.2	High	High
Other Crops	7.7	High	High
Corn	2.7	High	Medium
Vegetables and Ground Fruit	2.1	High	Medium
Wheat	1.8	High	Medium
Other Grains	1.4	High	Medium
Other Row Crops	1.0	High	Medium
Nurseries	0.05	High	Low
Cotton	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 75. Behavior and sensory risk hypothesis; Chinook salmon, Sacramento River winter-run ESU and malathion; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	24.7	High	**High**
Developed	10.4	Low	**High**
Orchards and Vineyards	8.2	High	**High**
Other Crops	7.7	High	**High**
Corn	2.7	High	**Medium**
Vegetables and Ground Fruit	2.1	High	**Medium**
Wheat	1.8	High	**Medium**
Other Grains	1.4	High	**Medium**
Other Row Crops	1.0	High	**Medium**
Nurseries	0.05	High	**Low**
Cotton	0.03	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**

Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Pasture	24.7	Not Available	**High**
Developed	10.4	Not Available	**High**
Orchards and Vineyards	8.2	Not Available	**High**
Other Crops	7.7	Not Available	**High**
Corn	2.7	Not Available	**Medium**
Vegetables and Ground Fruit	2.1	Not Available	**Medium**
Wheat	1.8	Not Available	**Medium**
Other Grains	1.4	Not Available	**Medium**
Other Row Crops	1.0	Not Available	**Medium**
Nurseries	0.05	Not Available	**Low**
Cotton	0.03	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

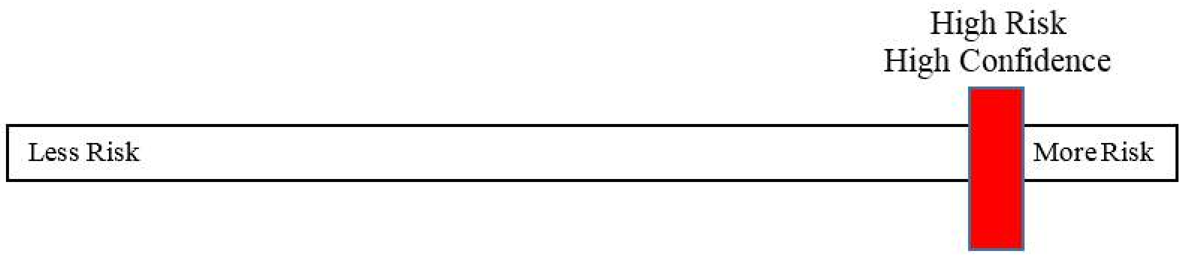
Table 76. Effects analysis summary table: Chinook salmon, Sacramento River winter-run ESU and malathion

	R-plot Derived		**MagTool**	**Population Model Results: Chinook Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 9-51	Not Applicable	Yes
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable	Yes
Exposure to malathion is sufficient to reduce adult abundance and	High	High	Not Available	Not Applicable	Yes

productivity via impairments to ecologically significant behaviors.					
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	Not Applicable	Yes
	R-plot Derived		**MagTool**	**Population Model Results**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities of aquatic bins**		
Risk Hypothesis					
Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 9-51	**Ocean-Type Chinook** Portion of juveniles exposed to malathion EECs; 10-1000 µg/l / Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles 25% 1-12% (13-23) 50% 1-23% (13-26) 75% 2-35% (13-24) 100% 3-97% (13-0) **Stream-Type Chinook** Portion of juveniles exposed to malathion EECs; 10-1000 µg/l / Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles 25% 1-11% (5-18) 50% 1-21% (5-22) 75% 2-31% (4-21) 100% 2-96% (4-0)	Yes

Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**	Yes
Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day invert: 53-86	**Ocean-Type Chinook:** 3-25% (8-10) **Stream-Type Chinook:** 2-24% (3-5)	Yes
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available		Yes
Exposure to malathion is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	**Yes**

Effects analysis summary: Adult and juvenile Chinook salmon, Sacramento River winter-run ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Population modelling results indicate that malathion-induced mortality to juveniles may lead to severe reductions in lambda up to 97%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 9-51 percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, Chinook will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed Chinook. The overall risk to Chinook salmon, Sacramento River winter-run ESU from the effects of the action is high and the confidence associated with that risk is high.


High Risk
High Confidence
Less Risk
More Risk

14.10 Chinook Salmon, Snake River fall-run ESU (Oncorhynchus tshawytscha)

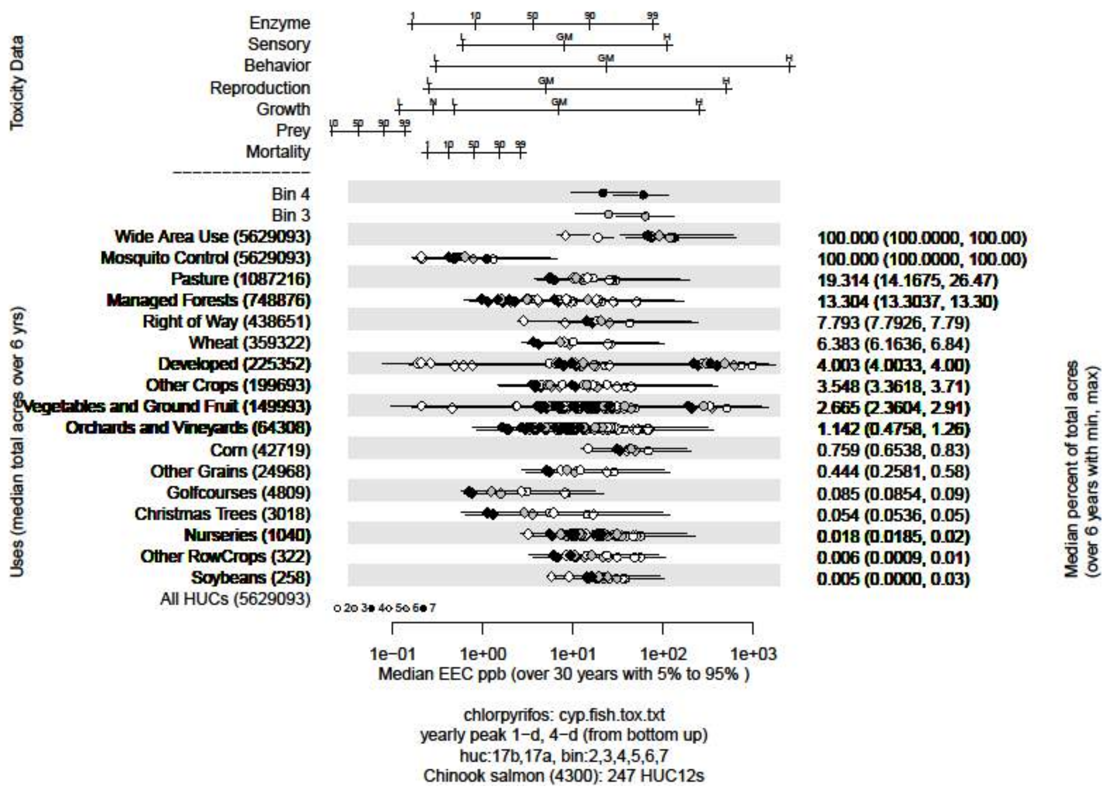


Figure 9. Effects analysis R-plot for Chinook salmon, Snake River fall-run ESU and malathion

Table 77. Likelihood of exposure determination for Chinook salmon, Snake River fall-run ESU and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Wheat	3	yes	no	yes	NA	3	High
Developed	2	yes	no	yes	NA	3	Med
Other Crops	2	yes	no	yes	NA	3	Med
Vegetables and Ground fruit	2	yes	no	yes	NA	3	Med
Orchards and Vineyards	2	yes	no	yes	NA	3	Med
Corn	1	yes	no	yes	yes	3	High
Other Grains	1	no	no	yes	yes	3	Low
Christmas Trees	1	yes	no	yes	no	3	Low
Nurseries	1	yes	no	yes	no	3	Low
Other Row Crops	1	yes	no	yes	no	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High
Juveniles							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Wheat	3	yes	no	yes	NA	3	High
Developed	2	yes	no	yes	NA	3	Med
Other Crops	2	yes	no	yes	NA	3	Med
Vegetables and Ground fruit	2	yes	no	yes	NA	3	Med
Orchards and Vineyards	2	yes	no	yes	NA	3	Med
Corn	1	yes	no	yes	yes	3	High
Other Grains	1	yes	no	yes	yes	3	High
Christmas Trees	1	yes	no	yes	no	3	Low
Nurseries	1	yes	no	yes	no	3	Low
Other Row Crops	1	yes	no	yes	no	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High

Life Stage: Adults (full-range)

Table 78. Direct mortality risk hypothesis; Chinook salmon, Snake River fall-run ESU and malathion; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	19.3	High	**High**
Wheat	6.4	High	**High**
Developed	4.0	High	**Medium**
Other Crops	3.5	High	**Medium**
Vegetables and Ground fruit	2.7	High	**Medium**
Orchards and Vineyards	1.1	High	**Medium**
Corn	0.8	High	**High**
Other Grains	0.4	High	**Low**

Christmas Trees	0.05	High	**Low**
Nurseries	0.02	High	**Low**
Other Row Crops	0.006	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 79. Reproduction risk hypothesis; Chinook salmon, Snake River fall-run ESU and malathion; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	**High**
Pasture	19.3	High	**High**
Wheat	6.4	Low	**High**
Developed	4.0	Low	**Medium**
Other Crops	3.5	Low	**Medium**
Vegetables and Ground fruit	2.7	High	**Medium**
Orchards and Vineyards	1.1	High	**Medium**
Corn	0.8	Low	**High**
Other Grains	0.4	Low	**Low**
Christmas Trees	0.05	High	**Low**
Nurseries	0.02	High	**Low**
Other Row Crops	0.006	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 80. Behavior and sensory risk hypothesis; Chinook salmon, Snake River fall-run ESU and malathion; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	19.3	High	**High**
Wheat	6.4	High	**High**
Developed	4.0	Medium	**Medium**
Other Crops	3.5	High	**Medium**

Vegetables and Ground fruit	2.7	High	**Medium**
Orchards and Vineyards	1.1	High	**Medium**
Corn	0.8	High	**High**
Other Grains	0.4	High	**Low**
Christmas Trees	0.05	High	**Low**
Nurseries	0.02	High	**Low**
Other Row Crops	0.006	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Pasture	19.3	Not Available	**High**
Wheat	6.4	Not Available	**High**
Developed	4.0	Not Available	**Medium**
Other Crops	3.5	Not Available	**Medium**
Vegetables and Ground fruit	2.7	Not Available	**Medium**
Orchards and Vineyards	1.1	Not Available	**Medium**
Corn	0.8	Not Available	**High**
Other Grains	0.4	Not Available	**Low**
Christmas Trees	0.05	Not Available	**Low**
Nurseries	0.02	Not Available	**Low**
Other Row Crops	0.006	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 81. AChE risk hypothesis; Chinook salmon, Snake River fall-run ESU and malathion; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	19.3	High	**High**
Wheat	6.4	High	**High**
Developed	4.0	Medium	**Medium**
Other Crops	3.5	High	**Medium**
Vegetables and Ground fruit	2.7	High	**Medium**

Orchards and Vineyards	1.1	High	**Medium**
Corn	0.8	High	**High**
Other Grains	0.4	High	**Low**
Christmas Trees	0.05	High	**Low**
Nurseries	0.02	High	**Low**
Other Row Crops	0.006	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 82. Direct mortality risk hypothesis; Chinook salmon, Snake River fall-run ESU and malathion; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	19.3	High	High
Wheat	6.4	High	High
Developed	4.0	High	Medium
Other Crops	3.5	High	Medium
Vegetables and Ground fruit	2.7	High	Medium
Orchards and Vineyards	1.1	High	Medium
Corn	0.8	High	High
Other Grains	0.4	High	High
Christmas Trees	0.05	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.006	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 83. Growth risk hypothesis; Chinook salmon, Snake River fall-run ESU and malathion; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High

Pasture	19.3	Medium	High
Wheat	6.4	Medium	High
Developed	4.0	Medium	Medium
Other Crops	3.5	Medium	Medium
Vegetables and Ground fruit	2.7	Medium	Medium
Orchards and Vineyards	1.1	Medium	Medium
Corn	0.8	Medium	High
Other Grains	0.4	Medium	High
Christmas Trees	0.05	Medium	Low
Nurseries	0.02	Medium	Low
Other Row Crops	0.006	Medium	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 84. Prey risk hypothesis; Chinook salmon, Snake River fall-run ESU and malathion; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	19.3	High	**High**
Wheat	6.4	High	**High**
Developed	4.0	High	**Medium**
Other Crops	3.5	High	**Medium**
Vegetables and Ground fruit	2.7	High	**Medium**
Orchards and Vineyards	1.1	High	**Medium**
Corn	0.8	High	High
Other Grains	0.4	High	High
Christmas Trees	0.05	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.006	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 85. AChE risk hypothesis; Chinook salmon, Snake River fall-run ESU and malathion; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	19.3	High	High
Wheat	6.4	High	High
Developed	4.0	Medium	Medium
Other Crops	3.5	High	Medium
Vegetables and Ground fruit	2.7	High	Medium
Orchards and Vineyards	1.1	High	Medium
Corn	0.8	High	High
Other Grains	0.4	High	High
Christmas Trees	0.05	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.006	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 86. Behavior and sensory risk hypothesis; Chinook salmon, Snake River fall-run ESU and malathion; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	19.3	High	**High**
Wheat	6.4	High	**High**
Developed	4.0	Medium	**Medium**
Other Crops	3.5	High	**Medium**
Vegetables and Ground fruit	2.7	High	**Medium**
Orchards and Vineyards	1.1	High	**Medium**
Corn	0.8	High	High
Other Grains	0.4	High	High
Christmas Trees	0.05	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.006	High	Low
Bin 3		Low	High
Bin 4		Low	High
Endpoint: Sensory			

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Not Available	**High**
Pasture	19.3	Not Available	**High**
Wheat	6.4	Not Available	**High**
Developed	4.0	Not Available	**Medium**
Other Crops	3.5	Not Available	**Medium**
Vegetables and Ground fruit	2.7	Not Available	**Medium**
Orchards and Vineyards	1.1	Not Available	**Medium**
Corn	0.8	Not Available	High
Other Grains	0.4	Not Available	High
Christmas Trees	0.05	Not Available	Low
Nurseries	0.02	Not Available	Low
Other Row Crops	0.006	Not Available	Low
Bin 3		Not Available	High
Bin 4		Not Available	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

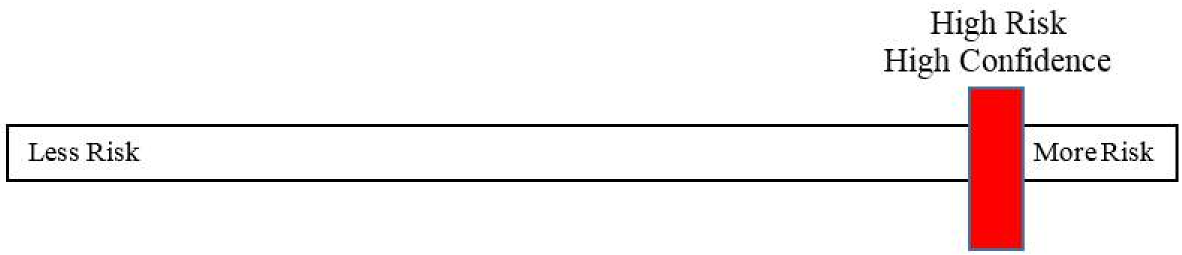
Table 87. Effects analysis summary table: Chinook salmon, Snake River fall-run ESU and malathion

	R-plot Derived		**MagTool**	**Population Model Results: Chinook Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 0-35	Not Applicable	Yes
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable	Yes
Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically	High	High	Not Available	Not Applicable	Yes

significant behaviors.					
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	Not Applicable	Yes
	R-plot Derived		**MagTool** **Range in median percent mortalities of aquatic bins**	**Population Model Results**	**Risk Hypothesis Supported?** **Yes/No**
Life Stage: Juveniles	**Risk**	**Confidence**			
Risk Hypothesis					
Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 0-35	**Ocean-Type Chinook** Portion of juveniles exposed to malathion EECs; 10-1000 µg/l — Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles 25% — 1-12% (13-23) 50% — 1-23% (13-26) 75% — 2-35% (13-24) 100% — 3-97% (13-0) **Stream-Type Chinook** Portion of juveniles exposed to malathion EECs; 10-1000 µg/l — Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles 25% — 1-11% (5-18) 50% — 1-21% (5-22) 75% — 2-31% (4-21) 100% — 2-96% (4-0)	Yes

Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**	Yes
Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day invert: 30-68	**Ocean-Type Chinook:** 3-25% (8-10)	Yes
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Stream-Type Chinook:** 2-24% (3-5)	Yes
Exposure to malathion is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	**Yes**

Effects analysis summary: Adult and juvenile Chinook salmon, Snake River fall-run ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Population modelling results indicate that malathion-induced mortality to juveniles may lead to severe reductions in lambda up to 97%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 0-35 percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, Chinook will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed Chinook. The overall risk to Chinook salmon, Snake River fall-run ESU from the effects of the action is high and the confidence associated with that risk is high.


High Risk
High Confidence
Less Risk
More Risk

14.11 Chinook Salmon, Snake River spring/summer-run ESU (Oncorhynchus tshawytscha)

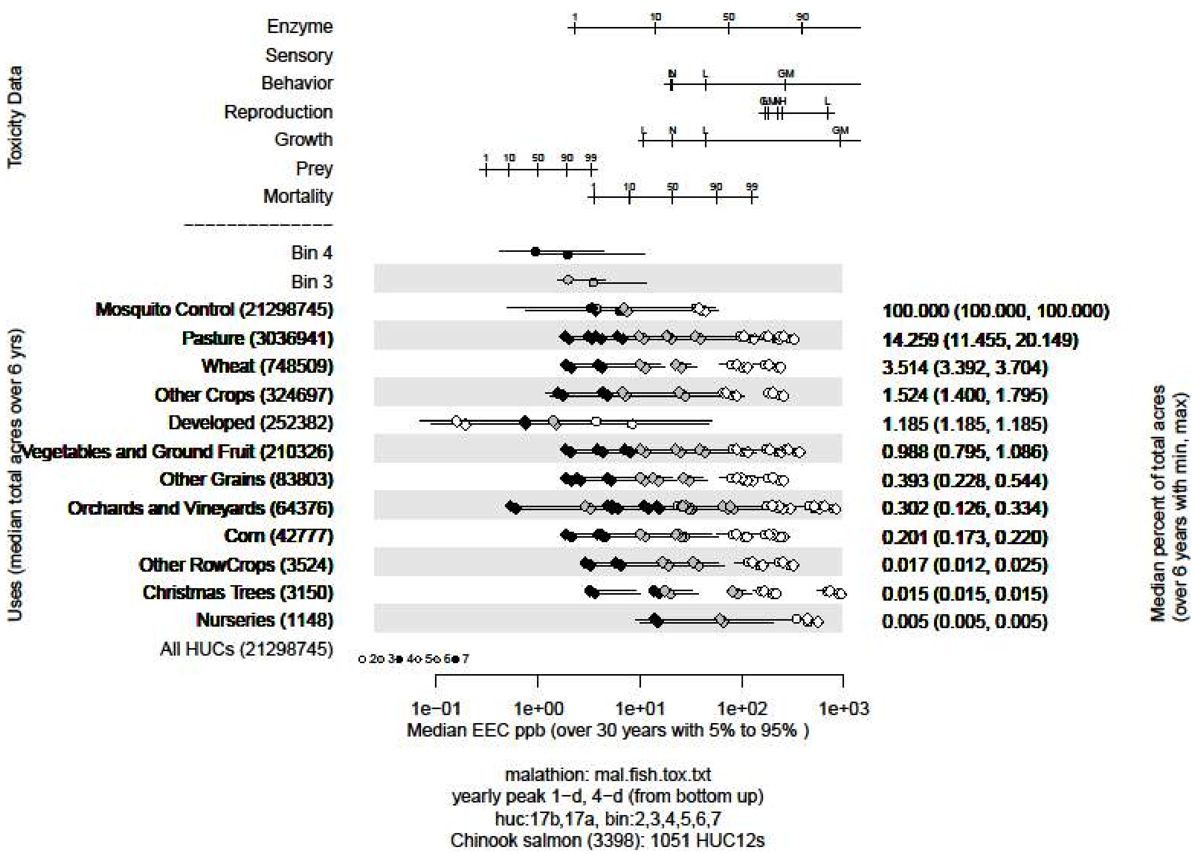


Figure 10. Effects analysis R-plot for Chinook salmon, Snake River spring/summer-run ESU and malathion

Table 88. Likelihood of exposure determination for Chinook salmon, Snake River spring/summer-run ESU and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Wheat	2	yes	no	yes	NA	3	Med
Other Crops	2	yes	no	yes	NA	3	Med
Developed	2	yes	no	yes	NA	3	Med
Vegetables and Ground fruit	2	yes	no	yes	NA	3	Med
Other Grains	1	yes	no	yes	no	3	Low
Orchards and Vineyards	1	yes	no	yes	yes	3	High
Corn	1	yes	no	yes	yes	3	High
Other Row crops	1	yes	no	yes	no	3	Low
Christmas Trees	1	yes	no	yes	no	3	Low
Nurseries	1	yes	no	yes	no	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High
Juveniles							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Wheat	2	yes	no	yes	NA	3	Med
Other Crops	2	yes	no	yes	NA	3	Med
Developed	2	yes	no	yes	NA	3	Med
Vegetables and Ground fruit	2	yes	no	yes	NA	3	Med
Other Grains	1	yes	no	yes	no	3	Low
Orchards and Vineyards	1	yes	no	yes	yes	3	High
Corn	1	yes	no	yes	yes	3	High
Other Row crops	1	yes	no	yes	no	3	Low
Christmas Trees	1	yes	no	yes	no	3	Low
Nurseries	1	yes	no	yes	no	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High

Life Stage: Adults (full-range)

Table 89. Direct mortality risk hypothesis; Chinook salmon, Snake River spring/summer-run ESU and malathion; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	14.3	High	**High**
Wheat	3.5	High	**Medium**
Other Crops	1.5	High	**Medium**
Developed	1.2	High	**Medium**
Vegetables and Ground fruit	1.0	High	**Medium**
Other Grains	0.4	High	**Low**

Orchards and Vineyards	0.3	High	**High**
Corn	0.2	High	**High**
Other Row crops	0.02	High	**Low**
Christmas Trees	0.02	High	**Low**
Nurseries	0.005	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 90. Reproduction risk hypothesis; Chinook salmon, Snake River spring/summer-run ESU and malathion; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	**High**
Pasture	14.3	High	**High**
Wheat	3.5	Low	**Medium**
Other Crops	1.5	Low	**Medium**
Developed	1.2	Low	**Medium**
Vegetables and Ground fruit	1.0	High	**Medium**
Other Grains	0.4	Low	**Low**
Orchards and Vineyards	0.3	High	**High**
Corn	0.2	Low	**High**
Other Row crops	0.02	High	**Low**
Christmas Trees	0.02	High	**Low**
Nurseries	0.005	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 91. Behavior and sensory risk hypothesis; Chinook salmon, Snake River spring/summer-run ESU and malathion; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	14.3	High	**High**

Wheat	3.5	High	**Medium**
Other Crops	1.5	High	**Medium**
Developed	1.2	Medium	**Medium**
Vegetables and Ground fruit	1.0	High	**Medium**
Other Grains	0.4	High	**Low**
Orchards and Vineyards	0.3	High	**High**
Corn	0.2	High	**High**
Other Row crops	0.02	High	**Low**
Christmas Trees	0.02	High	**Low**
Nurseries	0.005	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Pasture	14.3	Not Available	**High**
Wheat	3.5	Not Available	**Medium**
Other Crops	1.5	Not Available	**Medium**
Developed	1.2	Not Available	**Medium**
Vegetables and Ground fruit	1.0	Not Available	**Medium**
Other Grains	0.4	Not Available	**Low**
Orchards and Vineyards	0.3	Not Available	**High**
Corn	0.2	Not Available	**High**
Other Row crops	0.02	Not Available	**Low**
Christmas Trees	0.02	Not Available	**Low**
Nurseries	0.005	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 92. AChE risk hypothesis; Chinook salmon, Snake River spring/summer-run ESU and malathion; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	14.3	High	**High**
Wheat	3.5	High	**Medium**
Other Crops	1.5	High	**Medium**

Developed	1.2	Medium	**Medium**
Vegetables and Ground fruit	1.0	High	**Medium**
Other Grains	0.4	High	**Low**
Orchards and Vineyards	0.3	High	**High**
Corn	0.2	High	**High**
Other Row crops	0.02	High	**Low**
Christmas Trees	0.02	High	**Low**
Nurseries	0.005	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 93. Direct mortality risk hypothesis; Chinook salmon, Snake River spring/summer-run ESU and malathion; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	14.3	High	High
Wheat	3.5	High	Medium
Other Crops	1.5	High	Medium
Developed	1.2	High	Medium
Vegetables and Ground fruit	1.0	High	Medium
Other Grains	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Corn	0.2	High	High
Other Row crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.005	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 94. Growth risk hypothesis; Chinook salmon, Snake River spring/summer-run ESU and malathion; Juveniles

Endpoint: Growth

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	14.3	Medium	High
Wheat	3.5	Medium	Medium
Other Crops	1.5	Medium	Medium
Developed	1.2	Medium	Medium
Vegetables and Ground fruit	1.0	Medium	Medium
Other Grains	0.4	Medium	Low
Orchards and Vineyards	0.3	Medium	High
Corn	0.2	Medium	High
Other Row crops	0.02	Medium	Low
Christmas Trees	0.02	Medium	Low
Nurseries	0.005	Medium	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 95. Prey risk hypothesis; Chinook salmon, Snake River spring/summer-run ESU and malathion; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	14.3	High	**High**
Wheat	3.5	High	**Medium**
Other Crops	1.5	High	**Medium**
Developed	1.2	High	**Medium**
Vegetables and Ground fruit	1.0	High	**Medium**
Other Grains	0.4	High	**Low**
Orchards and Vineyards	0.3	High	**High**
Corn	0.2	High	**High**
Other Row crops	0.02	High	**Low**
Christmas Trees	0.02	High	**Low**
Nurseries	0.005	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 96. AChE risk hypothesis; Chinook salmon, Snake River spring/summer-run ESU and malathion; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	14.3	High	High
Wheat	3.5	High	Medium
Other Crops	1.5	High	Medium
Developed	1.2	Medium	Medium
Vegetables and Ground fruit	1.0	High	Medium
Other Grains	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Corn	0.2	High	High
Other Row crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.005	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 97. Behavior and sensory risk hypothesis; Chinook salmon, Snake River spring/summer-run ESU and malathion; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	14.3	High	**High**
Wheat	3.5	High	**Medium**
Other Crops	1.5	High	**Medium**
Developed	1.2	Medium	**Medium**
Vegetables and Ground fruit	1.0	High	**Medium**
Other Grains	0.4	High	**Low**
Orchards and Vineyards	0.3	High	**High**
Corn	0.2	High	**High**
Other Row crops	0.02	High	**Low**
Christmas Trees	0.02	High	**Low**
Nurseries	0.005	High	**Low**
Bin 3		Low	**High**

Bin 4		Low	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Pasture	14.3	Not Available	**High**
Wheat	3.5	Not Available	**Medium**
Other Crops	1.5	Not Available	**Medium**
Developed	1.2	Not Available	**Medium**
Vegetables and Ground fruit	1.0	Not Available	**Medium**
Other Grains	0.4	Not Available	**Low**
Orchards and Vineyards	0.3	Not Available	**High**
Corn	0.2	Not Available	**High**
Other Row crops	0.02	Not Available	**Low**
Christmas Trees	0.02	Not Available	**Low**
Nurseries	0.005	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

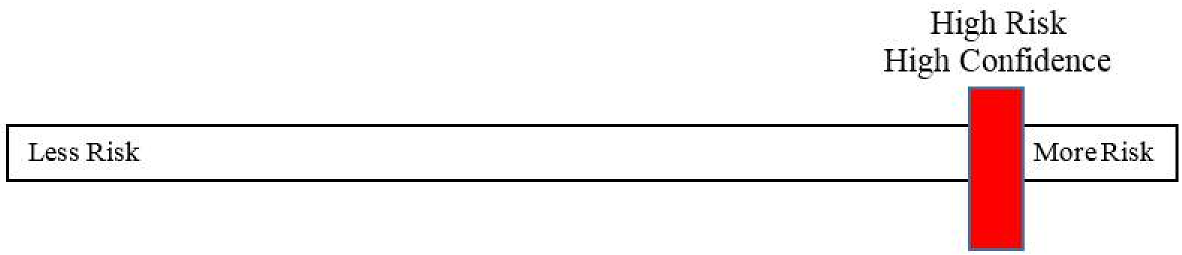
Table 98. Effects analysis summary table: Chinook salmon, Snake River spring/summer-run ESU and malathion

	R-plot Derived		**MagTool**	**Population Model Results: Chinook Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 0-21	Not Applicable	Yes
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable	Yes
Exposure to malathion is sufficient to reduce	High	High	Not Available	Not Applicable	Yes

adult abundance and productivity via impairments to ecologically significant behaviors.					
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	Not Applicable	Yes
	R-plot Derived		**MagTool**	**Population Model Results**	**Risk Hypothesis Supported?** **Yes/No**
Life Stage: Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities of aquatic bins**		
Risk Hypothesis					
Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 0-21	**Ocean-Type Chinook** Portion of juveniles exposed to malathion EECs; 10-1000 µg/l — Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles 25% — 1-12% (13-23) 50% — 1-23% (13-26) 75% — 2-35% (13-24) 100% — 3-97% (13-0) **Stream-Type Chinook** Portion of juveniles exposed to malathion EECs; 10-1000 µg/l — Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles 25% — 1-11% (5-18) 50% — 1-21% (5-22) 75% — 2-31% (4-21)	Yes

				100% 2-96% (4-0)	
Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**	Yes
Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day invert: 20-42	**Ocean-Type Chinook:** 3-25% (8-10) **Stream-Type Chinook:** 2-24% (3-5)	Yes
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available		Yes
Exposure to malathion is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	**Yes**

Effects analysis summary: Adult and juvenile Chinook salmon, Snake River spring/summer-run ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Population modelling results indicate that malathion-induced mortality to juveniles may lead to severe reductions in lambda up to 97%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 0-21 percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, Chinook will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed Chinook. The overall risk to Chinook salmon, Snake River spring/summer-run ESU from the effects of the action is high and the confidence associated with that risk is high.


High Risk
High Confidence
Less Risk
More Risk

14.12 Chinook salmon, Upper Columbia River spring-run ESU (Oncorhynchus tshawytscha)

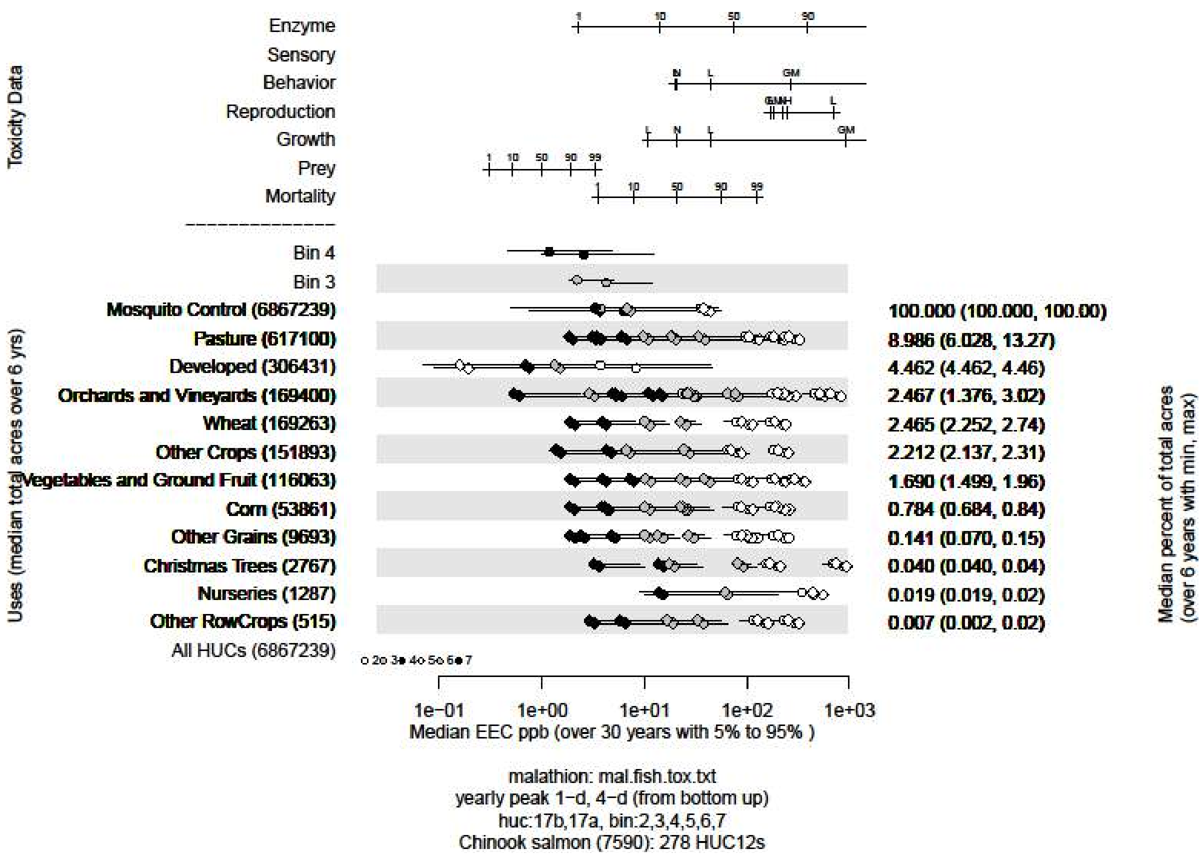


Figure 11. Effects analysis R-plot for Chinook salmon, upper Columbia spring-run ESU and malathion

Table 99. Likelihood of exposure determination for Chinook salmon, upper Columbia spring-run ESU and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Developed	2	yes	no	yes	NA	3	Med
Orchards and Vineyards	2	yes	no	yes	NA	3	Med
Wheat	2	yes	no	yes	NA	3	Med
Other Crops	2	yes	no	yes	NA	3	Med
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	Med
Corn	1	yes	no	yes	yes	3	High
Other Grains	1	yes	no	yes	no	3	Low
Christmas Trees	1	yes	no	yes	no	3	Low
Nurseries	1	yes	no	yes	no	3	Low
Other Row Crops	1	yes	no	yes	no	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High
Juveniles							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Developed	2	yes	no	yes	NA	3	Med
Orchards and Vineyards	2	yes	no	yes	NA	3	Med
Wheat	2	yes	no	yes	NA	3	Med
Other Crops	2	yes	no	yes	NA	3	Med
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	Med
Corn	1	yes	no	yes	yes	3	High
Other Grains	1	yes	no	yes	no	3	Low
Christmas Trees	1	yes	no	yes	no	3	Low
Nurseries	1	yes	no	yes	no	3	Low
Other Row Crops	1	yes	no	yes	no	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High

Life Stage: Adults (full-range)

Table 100. Direct mortality risk hypothesis; Chinook salmon, upper Columbia spring-run ESU and malathion; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	9.0	High	**High**
Developed	4.5	High	**Medium**
Orchards and Vineyards	2.5	High	**Medium**
Wheat	2.5	High	**Medium**
Other Crops	2.2	High	**Medium**
Vegetables and Ground Fruit	1.7	High	**Medium**
Corn	0.8	High	**High**

Other Grains	0.1	High	**Low**
Christmas Trees	0.04	High	**Low**
Nurseries	0.02	High	**Low**
Other Row Crops	0.01	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 101. Reproduction risk hypothesis; Chinook salmon, upper Columbia spring-run ESU and malathion; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	**High**
Pasture	9.0	High	**High**
Developed	4.5	Low	**Medium**
Orchards and Vineyards	2.5	High	**Medium**
Wheat	2.5	Low	**Medium**
Other Crops	2.2	Low	**Medium**
Vegetables and Ground Fruit	1.7	High	**Medium**
Corn	0.8	Low	**High**
Other Grains	0.1	Low	**Low**
Christmas Trees	0.04	High	**Low**
Nurseries	0.02	High	**Low**
Other Row Crops	0.01	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 102. Behavior and sensory risk hypothesis; Chinook salmon, upper Columbia spring-run ESU and malathion; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	9.0	High	**High**
Developed	4.5	Medium	**Medium**

Orchards and Vineyards	2.5	High	**Medium**
Wheat	2.5	High	**Medium**
Other Crops	2.2	High	**Medium**
Vegetables and Ground Fruit	1.7	High	**Medium**
Corn	0.8	High	**High**
Other Grains	0.1	High	**Low**
Christmas Trees	0.04	High	**Low**
Nurseries	0.02	High	**Low**
Other Row Crops	0.01	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Pasture	9.0	Not Available	**High**
Developed	4.5	Not Available	**Medium**
Orchards and Vineyards	2.5	Not Available	**Medium**
Wheat	2.5	Not Available	**Medium**
Other Crops	2.2	Not Available	**Medium**
Vegetables and Ground Fruit	1.7	Not Available	**Medium**
Corn	0.8	Not Available	**High**
Other Grains	0.1	Not Available	**Low**
Christmas Trees	0.04	Not Available	**Low**
Nurseries	0.02	Not Available	**Low**
Other Row Crops	0.01	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 103. AChE risk hypothesis; Chinook salmon, upper Columbia spring-run ESU and malathion; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	9.0	High	**High**
Developed	4.5	Medium	**Medium**
Orchards and Vineyards	2.5	High	**Medium**
Wheat	2.5	High	**Medium**

Other Crops	2.2	High	**Medium**
Vegetables and Ground Fruit	1.7	High	**Medium**
Corn	0.8	High	**High**
Other Grains	0.1	High	**Low**
Christmas Trees	0.04	High	**Low**
Nurseries	0.02	High	**Low**
Other Row Crops	0.01	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 104. Direct mortality risk hypothesis; Chinook salmon, upper Columbia spring-run ESU and malathion; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	9.0	High	High
Developed	4.5	High	Medium
Orchards and Vineyards	2.5	High	Medium
Wheat	2.5	High	Medium
Other Crops	2.2	High	Medium
Vegetables and Ground Fruit	1.7	High	Medium
Corn	0.8	High	High
Other Grains	0.1	High	Low
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 105. Growth risk hypothesis; Chinook salmon, upper Columbia spring-run ESU and malathion; Juveniles

Endpoint: Growth

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	9.0	Medium	High
Developed	4.5	Medium	Medium
Orchards and Vineyards	2.5	Medium	Medium
Wheat	2.5	Medium	Medium
Other Crops	2.2	Medium	Medium
Vegetables and Ground Fruit	1.7	Medium	Medium
Corn	0.8	Medium	High
Other Grains	0.1	Medium	Low
Christmas Trees	0.04	Medium	Low
Nurseries	0.02	Medium	Low
Other Row Crops	0.01	Medium	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 106. Prey risk hypothesis; Chinook salmon, upper Columbia spring-run ESU and malathion; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	9.0	High	**High**
Developed	4.5	High	**Medium**
Orchards and Vineyards	2.5	High	**Medium**
Wheat	2.5	High	**Medium**
Other Crops	2.2	High	**Medium**
Vegetables and Ground Fruit	1.7	High	**Medium**
Corn	0.8	High	**High**
Other Grains	0.1	High	**Low**
Christmas Trees	0.04	High	**Low**
Nurseries	0.02	High	**Low**
Other Row Crops	0.01	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 107. AChE risk hypothesis; Chinook salmon, upper Columbia spring-run ESU and malathion; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	9.0	High	High
Developed	4.5	Medium	Medium
Orchards and Vineyards	2.5	High	Medium
Wheat	2.5	High	Medium
Other Crops	2.2	High	Medium
Vegetables and Ground Fruit	1.7	High	Medium
Corn	0.8	High	High
Other Grains	0.1	High	Low
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 108. Behavior and sensory risk hypothesis; Chinook salmon, upper Columbia spring-run ESU and malathion; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	9.0	High	**High**
Developed	4.5	Medium	**Medium**
Orchards and Vineyards	2.5	High	**Medium**
Wheat	2.5	High	**Medium**
Other Crops	2.2	High	**Medium**
Vegetables and Ground Fruit	1.7	High	**Medium**
Corn	0.8	High	**High**
Other Grains	0.1	High	**Low**
Christmas Trees	0.04	High	**Low**
Nurseries	0.02	High	**Low**
Other Row Crops	0.01	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**

Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Pasture	9.0	Not Available	**High**
Developed	4.5	Not Available	**Medium**
Orchards and Vineyards	2.5	Not Available	**Medium**
Wheat	2.5	Not Available	**Medium**
Other Crops	2.2	Not Available	**Medium**
Vegetables and Ground Fruit	1.7	Not Available	**Medium**
Corn	0.8	Not Available	**High**
Other Grains	0.1	Not Available	**Low**
Christmas Trees	0.04	Not Available	**Low**
Nurseries	0.02	Not Available	**Low**
Other Row Crops	0.01	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

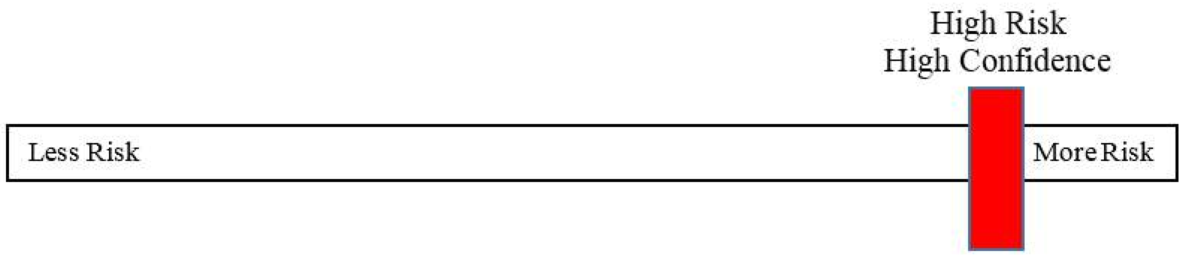
Table 109. Effects analysis summary table: Chinook salmon, upper Columbia spring-run ESU and malathion

	R-plot Derived		**MagTool**	**Population Model Results: Chinook Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 0-19	Not Applicable	Yes
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable	Yes
Exposure to malathion is sufficient to reduce adult abundance and productivity via	High	High	Not Available	Not Applicable	Yes

impairments to ecologically significant behaviors.					
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	Not Applicable	Yes
	R-plot Derived		**MagTool** **Range in median percent mortalities of aquatic bins**	**Population Model Results**	**Risk Hypothesis Supported?** **Yes/No**
Life Stage: Juveniles	**Risk**	**Confidence**			
Risk Hypothesis					
Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 0-19	**Ocean-Type Chinook** Portion of juveniles exposed to malathion EECs; 10-1000 µg/l — Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles 25% — 1-12% (13-23) 50% — 1-23% (13-26) 75% — 2-35% (13-24) 100% — 3-97% (13-0) **Stream-Type Chinook** Portion of juveniles exposed to malathion EECs; 10-1000 µg/l — Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles 25% — 1-11% (5-18) 50% — 1-21% (5-22) 75% — 2-31% (4-21) 100% — 2-96% (4-0)	Yes

Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**	Yes
Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day invert: 20-49	**Ocean-Type Chinook:** 3-25% (8-10) **Stream-Type Chinook:** 2-24% (3-5)	Yes
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available		Yes
Exposure to malathion is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	**Yes**

Effects analysis summary: Adult and juvenile Chinook salmon, upper Columbia spring-run ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Population modelling results indicate that malathion-induced mortality to juveniles may lead to severe reductions in lambda up to 97%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 0-19 percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, Chinook will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed Chinook. The overall risk to Chinook salmon, upper Columbia spring-run ESU from the effects of the action is high and the confidence associated with that risk is high.


High Risk
High Confidence
Less Risk
More Risk

14.13 Chinook Salmon, Upper Willamette River ESU (Oncorhynchus tshawytscha)

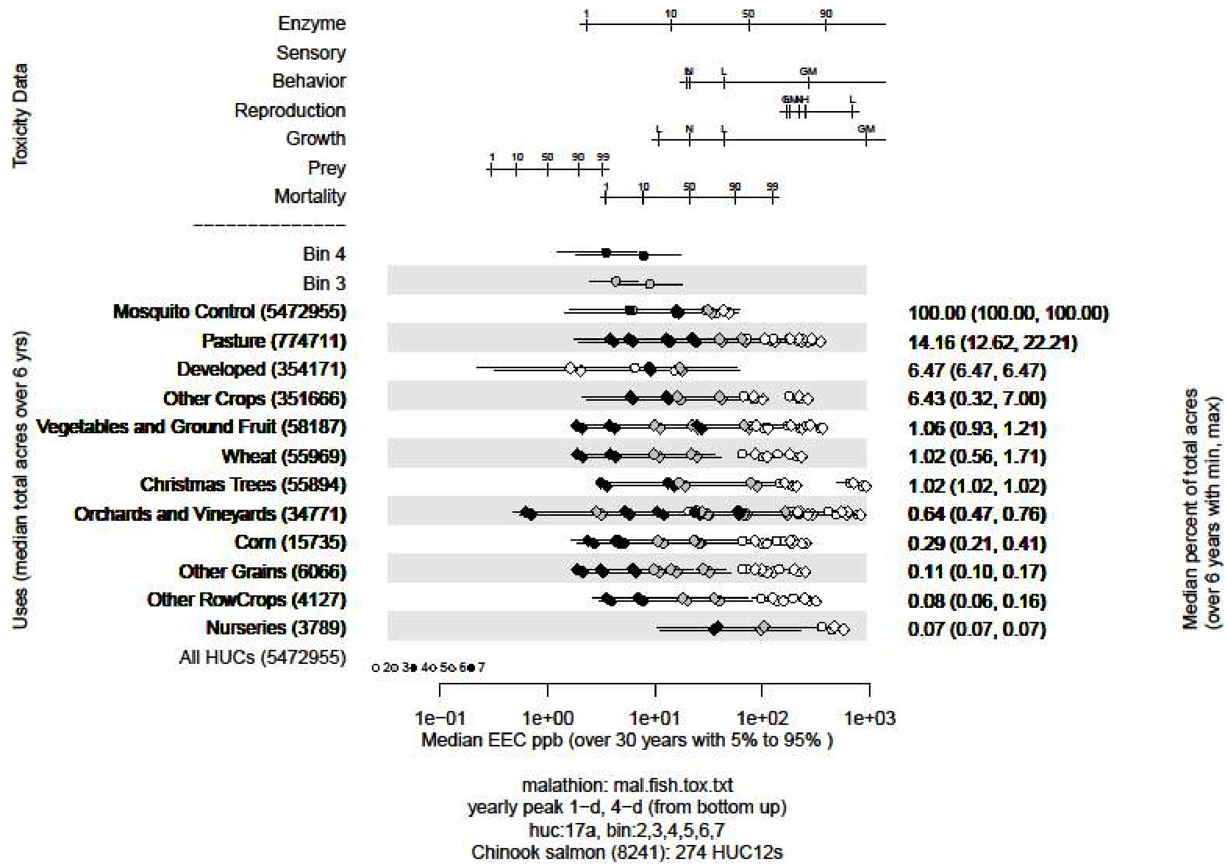


Figure 12. Effects analysis R-plot for Chinook salmon, upper Willamette River ESU and malathion

Table 110. Likelihood of exposure determination for Chinook salmon, upper Willamette River ESU and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Developed	3	yes	no	yes	NA	3	High
Other Crops	3	yes	no	yes	NA	3	High
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	Med
Wheat	2	yes	no	yes	NA	3	Med
Christmas Trees	2	yes	no	yes	NA	3	Med
Orchards and Vineyards	1	yes	no	yes	yes	3	High
Corn	1	yes	no	yes	yes	3	High
Other Grains	1	yes	no	yes	yes	3	High
Other Row Crops	1	yes	no	yes	yes	3	High
Nurseries	1	yes	no	yes	no	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High
Juveniles							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Developed	3	yes	no	yes	NA	3	High
Other Crops	3	yes	no	yes	NA	3	High
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	Med
Wheat	2	yes	no	yes	NA	3	Med
Christmas Trees	2	yes	no	yes	NA	3	Med
Orchards and Vineyards	1	yes	no	yes	yes	3	High
Corn	1	yes	no	yes	yes	3	High
Other Grains	1	yes	no	yes	yes	3	High
Other Row Crops	1	yes	no	yes	yes	3	High
Nurseries	1	yes	no	yes	no	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High

Life Stage: Adults (full-range)

Table 111. Direct mortality risk hypothesis; Chinook salmon, upper Willamette River ESU and malathion; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Pasture	14.2	High	High
Developed	6.5	High	High
Other Crops	6.4	High	High
Vegetables and Ground Fruit	1.1	High	Medium
Wheat	1.0	High	Medium
Christmas Trees	1.0	High	Medium

Orchards and Vineyards	0.6	High	High
Corn	0.3	High	High
Other Grains	0.1	High	High
Other Row Crops	0.1	High	High
Nurseries	0.1	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 112. Reproduction risk hypothesis; Chinook salmon, upper Willamette River ESU and malathion; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	High
Pasture	14.2	Medium	High
Developed	6.5	Low	High
Other Crops	6.4	Medium	High
Vegetables and Ground Fruit	1.1	Medium	Medium
Wheat	1.0	Medium	Medium
Christmas Trees	1.0	High	Medium
Orchards and Vineyards	0.6	High	High
Corn	0.3	Medium	High
Other Grains	0.1	Medium	High
Other Row Crops	0.1	Medium	High
Nurseries	0.1	High	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 113. Behavior and sensory risk hypothesis; Chinook salmon, upper Willamette River ESU and malathion; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Pasture	14.2	High	High

Developed	6.5	Low	High
Other Crops	6.4	High	High
Vegetables and Ground Fruit	1.1	High	Medium
Wheat	1.0	Medium	Medium
Christmas Trees	1.0	High	Medium
Orchards and Vineyards	0.6	High	High
Corn	0.3	High	High
Other Grains	0.1	High	High
Other Row Crops	0.1	High	High
Nurseries	0.1	High	Low
Bin 3		Low	High
Bin 4		Low	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	High
Pasture	14.2	Not Available	High
Developed	6.5	Not Available	High
Other Crops	6.4	Not Available	High
Vegetables and Ground Fruit	1.1	Not Available	Medium
Wheat	1.0	Not Available	Medium
Christmas Trees	1.0	Not Available	Medium
Orchards and Vineyards	0.6	Not Available	High
Corn	0.3	Not Available	High
Other Grains	0.1	Not Available	High
Other Row Crops	0.1	Not Available	High
Nurseries	0.1	Not Available	Low
Bin 3		Not Available	High
Bin 4		Not Available	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 114. AChE risk hypothesis; Chinook salmon, upper Willamette River ESU and malathion; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Pasture	14.2	High	High
Developed	6.5	Medium	High
Other Crops	6.4	High	High

Vegetables and Ground Fruit	1.1	High	Medium
Wheat	1.0	High	Medium
Christmas Trees	1.0	High	Medium
Orchards and Vineyards	0.6	High	High
Corn	0.3	High	High
Other Grains	0.1	High	High
Other Row Crops	0.1	High	High
Nurseries	0.1	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 115. Direct mortality risk hypothesis; Chinook salmon, upper Willamette River ESU and malathion; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	14.2	High	High
Developed	6.5	High	High
Other Crops	6.4	High	High
Vegetables and Ground Fruit	1.1	High	Medium
Wheat	1.0	High	Medium
Christmas Trees	1.0	High	Medium
Orchards and Vineyards	0.6	High	High
Corn	0.3	High	High
Other Grains	0.1	High	High
Other Row Crops	0.1	High	High
Nurseries	0.1	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 116. Growth risk hypothesis; Chinook salmon, upper Willamette River ESU and malathion; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	14.2	Medium	High
Developed	6.5	Medium	High
Other Crops	6.4	Medium	High
Vegetables and Ground Fruit	1.1	Medium	Medium
Wheat	1.0	Medium	Medium
Christmas Trees	1.0	Medium	Medium
Orchards and Vineyards	0.6	Medium	High
Corn	0.3	Medium	High
Other Grains	0.1	Medium	High
Other Row Crops	0.1	Medium	High
Nurseries	0.1	Medium	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 117. Prey risk hypothesis; Chinook salmon, upper Willamette River ESU and malathion; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Pasture	14.2	High	High
Developed	6.5	High	High
Other Crops	6.4	High	High
Vegetables and Ground Fruit	1.1	High	Medium
Wheat	1.0	High	Medium
Christmas Trees	1.0	High	Medium
Orchards and Vineyards	0.6	High	High
Corn	0.3	High	High
Other Grains	0.1	High	High
Other Row Crops	0.1	High	High
Nurseries	0.1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			

Risk	**Confidence**	
High	**High**	

Table 118. AChE risk hypothesis; Chinook salmon, upper Willamette River ESU and malathion; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	14.2	High	High
Developed	6.5	Medium	High
Other Crops	6.4	High	High
Vegetables and Ground Fruit	1.1	High	Medium
Wheat	1.0	High	Medium
Christmas Trees	1.0	High	Medium
Orchards and Vineyards	0.6	High	High
Corn	0.3	High	High
Other Grains	0.1	High	High
Other Row Crops	0.1	High	High
Nurseries	0.1	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 119. Behavior and sensory risk hypothesis; Chinook salmon, upper Willamette River ESU and malathion; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	14.2	High	High
Developed	6.5	Medium	High
Other Crops	6.4	High	High
Vegetables and Ground Fruit	1.1	High	Medium
Wheat	1.0	High	Medium
Christmas Trees	1.0	High	Medium
Orchards and Vineyards	0.6	High	High
Corn	0.3	High	High
Other Grains	0.1	High	High
Other Row Crops	0.1	High	High
Nurseries	0.1	High	Low
Bin 3		Medium	High

Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

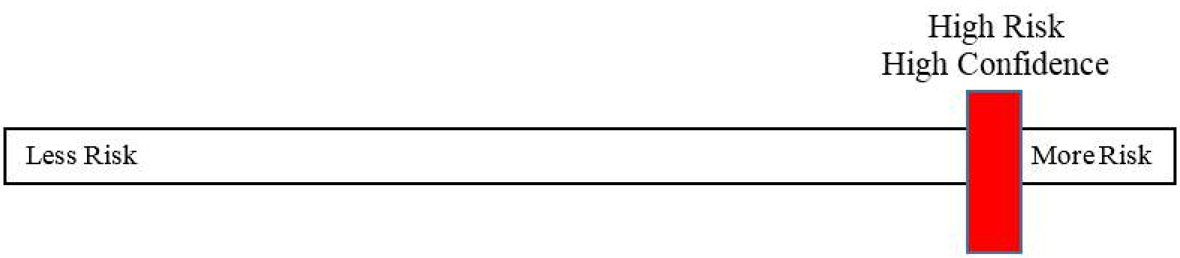
Table 120. Effects analysis summary table: Chinook salmon, upper Willamette River ESU and malathion

	R-plot Derived		MagTool	Population Model Results: Chinook Salmon	Risk Hypothesis Supported? Yes/No
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 4-26	Not Applicable	Yes
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable	Yes
Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	Yes
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	Not Applicable	Yes
	R-plot Derived		**MagTool** Range in median percent mortalities of aquatic bins	**Population Model Results**	**Risk Hypothesis Supported?** Yes/No
Life Stage: Juveniles	**Risk**	**Confidence**			
Risk Hypothesis					
Exposure to malathion is sufficient to reduce	High	High	4-day: 4-26	**Ocean-Type Chinook** Portion of juveniles / Mean percent reduction	Yes

juvenile abundance via acute lethality.				exposed to malathion EECs; 10-1000 µg/l — (STD) in a population's intrinsic growth, lambda, from death of juveniles 25% — 1-12% (13-23) 50% — 1-23% (13-26) 75% — 2-35% (13-24) 100% — 3-97% (13-0) **Stream-Type Chinook** Portion of juveniles exposed to malathion EECs; 10-1000 µg/l — Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles 25% — 1-11% (5-18) 50% — 1-21% (5-22) 75% — 2-31% (4-21) 100% — 2-96% (4-0)	
Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**	Yes
Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day invert: 28-51	**Ocean-Type Chinook:** 3-25% (8-10) **Stream-Type Chinook:** 2-24% (3-5)	Yes
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available		Yes
Exposure to malathion is	High	High	Not Available	Not Applicable	**Yes**

sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.					

Effects analysis summary: Adult and juvenile Chinook salmon, upper Willamette River ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Population modelling results indicate that malathion-induced mortality to juveniles may lead to severe reductions in lambda up to 97%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 4-26 percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, Chinook will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed Chinook. The overall risk to Chinook salmon, upper Willamette River ESU from the effects of the action is high and the confidence associated with that risk is high.



14.14 Coho Salmon, Central California Coast ESU (Oncorhynchus kisutch)

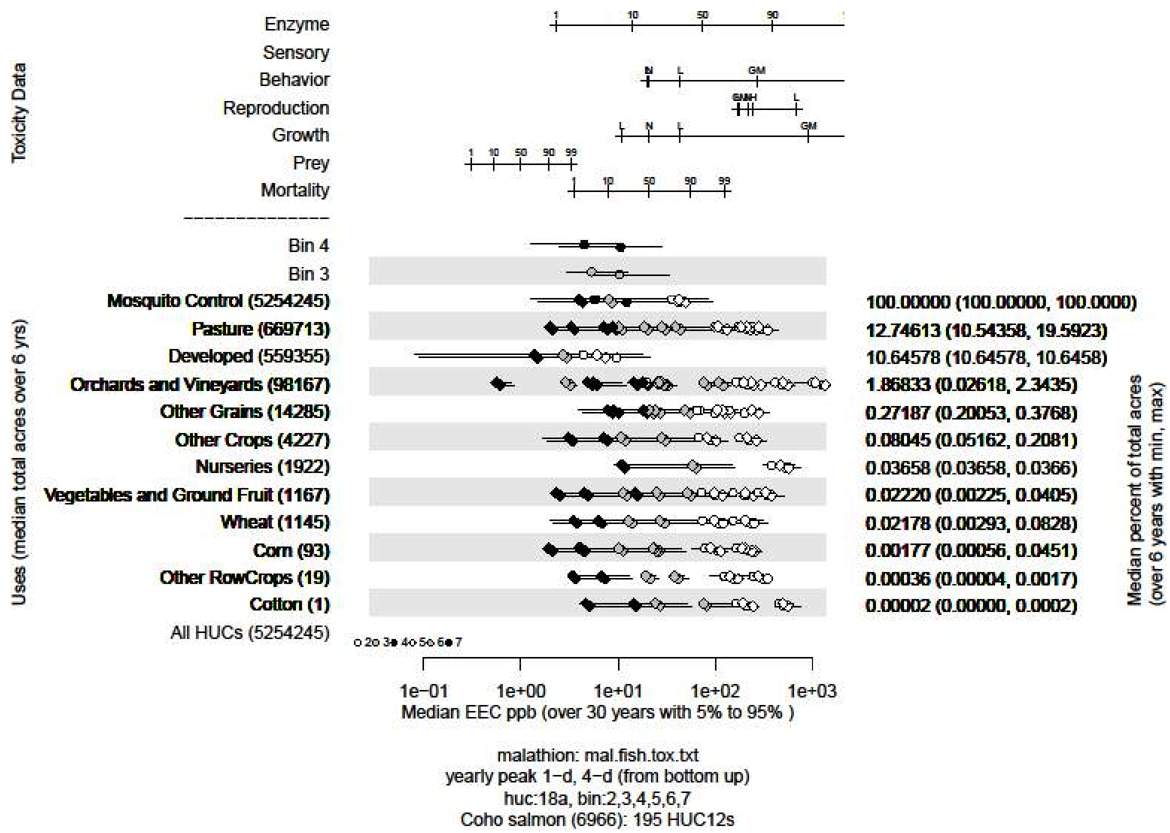


Figure 13. Effects analysis R-plot for Coho salmon, Central California Coast ESU and malathion

Table 121. Likelihood of exposure determination for Coho salmon, Central California Coast ESU and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Developed	3	yes	no	yes	NA	3	High
Orchards and Vineyards	2	yes	no	yes	NA	3	Med
Other Grains	1	yes	no	yes	NA	3	Low
Other Crops	1	yes	no	yes	NA	3	Low
Nurseries	1	yes	no	yes	NA	3	Low
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	Low
Wheat	1	no	no	yes	NA	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High
Juveniles							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Developed	3	yes	no	yes	NA	3	High
Orchards and Vineyards	2	yes	no	yes	NA	3	Med
Other Grains	1	yes	no	yes	NA	3	Low
Other Crops	1	yes	no	yes	NA	3	Low
Nurseries	1	yes	no	yes	NA	3	Low
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	Low
Wheat	1	yes	no	yes	NA	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High

Life Stage: Adults (full-range)

Table 122. Direct mortality risk hypothesis; Coho salmon, Central California Coast ESU and malathion; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	12.7	High	**High**
Developed	10.6	Medium	**High**
Orchards and Vineyards	1.9	High	**Medium**
Other Grains	0.3	High	**Low**
Other Crops	0.08	High	**Low**
Nurseries	0.04	High	**Low**
Vegetables and Ground Fruit	0.02	High	**Low**
Wheat	0.02	High	**Low**

Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 123. Reproduction risk hypothesis; Coho salmon, Central California Coast ESU and malathion; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	**High**
Pasture	12.7	High	**High**
Developed	10.6	Low	**High**
Orchards and Vineyards	1.9	High	**Medium**
Other Grains	0.3	Low	**Low**
Other Crops	0.08	Low	**Low**
Nurseries	0.04	High	**Low**
Vegetables and Ground Fruit	0.02	High	**Low**
Wheat	0.02	Low	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 124. Behavior and sensory risk hypothesis; Coho salmon, Central California Coast ESU and malathion; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	12.7	High	**High**
Developed	10.6	Low	**High**
Orchards and Vineyards	1.9	High	**Medium**
Other Grains	0.3	Medium	**Low**
Other Crops	0.08	Medium	**Low**
Nurseries	0.04	High	**Low**
Vegetables and Ground Fruit	0.02	High	**Low**
Wheat	0.02	Medium	**Low**
Bin 3		Low	**High**

Bin 4		Low	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Pasture	12.7	Not Available	**High**
Developed	10.6	Not Available	**High**
Orchards and Vineyards	1.9	Not Available	**Medium**
Other Grains	0.3	Not Available	**Low**
Other Crops	0.08	Not Available	**Low**
Nurseries	0.04	Not Available	**Low**
Vegetables and Ground Fruit	0.02	Not Available	**Low**
Wheat	0.02	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 125. AChE risk hypothesis; Coho salmon, Central California Coast ESU and malathion; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	12.7	High	**High**
Developed	10.6	Medium	**High**
Orchards and Vineyards	1.9	High	**Medium**
Other Grains	0.3	High	**Low**
Other Crops	0.08	High	**Low**
Nurseries	0.04	High	**Low**
Vegetables and Ground Fruit	0.02	High	**Low**
Wheat	0.02	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 126. Direct mortality risk hypothesis; Coho salmon, Central California Coast ESU and malathion; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	12.7	High	High
Developed	10.6	Medium	High
Orchards and Vineyards	1.9	High	Medium
Other Grains	0.3	High	Low
Other Crops	0.08	High	Low
Nurseries	0.04	High	Low
Vegetables and Ground Fruit	0.02	High	Low
Wheat	0.02	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 127. Growth risk hypothesis; Coho salmon, Central California Coast ESU and malathion; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	12.7	Medium	High
Developed	10.6	Low	High
Orchards and Vineyards	1.9	Medium	Medium
Other Grains	0.3	Medium	Low
Other Crops	0.08	Medium	Low
Nurseries	0.04	Medium	Low
Vegetables and Ground Fruit	0.02	Medium	Low
Wheat	0.02	Medium	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 128. Prey risk hypothesis; Coho salmon, Central California Coast ESU and malathion; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100		**High**
Pasture	12.7		**High**
Developed	10.6		**High**
Orchards and Vineyards	1.9		**Medium**
Other Grains	0.3		**Low**
Other Crops	0.08		**Low**
Nurseries	0.04		**Low**
Vegetables and Ground Fruit	0.02		**Low**
Wheat	0.02		**Low**
Bin 3			**High**
Bin 4			**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 129. AChE risk hypothesis; Coho salmon, Central California Coast ESU and malathion; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	12.7	High	High
Developed	10.6	Medium	High
Orchards and Vineyards	1.9	High	Medium
Other Grains	0.3	High	Low
Other Crops	0.08	High	Low
Nurseries	0.04	High	Low
Vegetables and Ground Fruit	0.02	High	Low
Wheat	0.02	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 130. Behavior and sensory risk hypothesis; Coho salmon, Central California Coast ESU and malathion; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	12.7	High	**High**
Developed	10.6	Low	**High**
Orchards and Vineyards	1.9	High	**Medium**
Other Grains	0.3	Medium	**Low**
Other Crops	0.08	Medium	**Low**
Nurseries	0.04	High	**Low**
Vegetables and Ground Fruit	0.02	High	**Low**
Wheat	0.02	Medium	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Pasture	12.7	Not Available	**High**
Developed	10.6	Not Available	**High**
Orchards and Vineyards	1.9	Not Available	**Medium**
Other Grains	0.3	Not Available	**Low**
Other Crops	0.08	Not Available	**Low**
Nurseries	0.04	Not Available	**Low**
Vegetables and Ground Fruit	0.02	Not Available	**Low**
Wheat	0.02	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

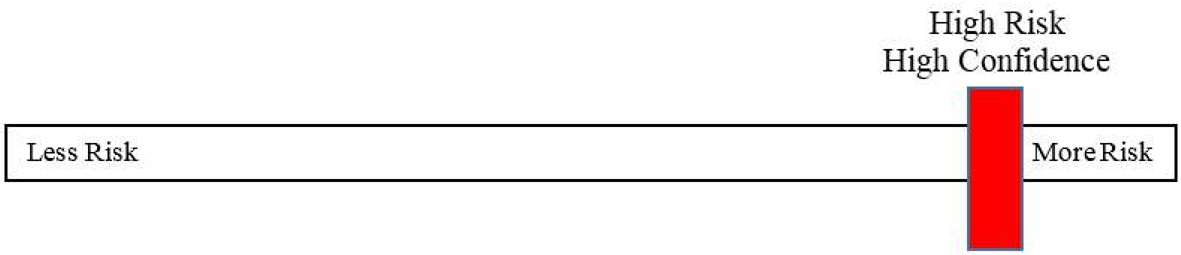
Table 131. Effects analysis summary table: Coho salmon, Central California Coast ESU and malathion

	R-plot Derived		**MagTool**	**Population Model Results: Coho Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					

Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 2-15	Not Applicable		Yes
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable		Yes
Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable		Yes
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	Not Applicable		Yes
	R-plot Derived		**MagTool** **Range in median percent mortalities of aquatic bins**	**Population Model Results: Coho Salmon**		**Risk Hypothesis Supported? Yes/No**
Life Stage: Juveniles	**Risk**	**Confidence**				
Risk Hypothesis						
Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 2-15	**Portion of juveniles exposed to malathion EECs; 0.75-100 µg/l**	**Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles**	Yes
				25%	1-14% (8-23)	
				50%	1-27% (8-28)	
				75%	2-40% (7-27)	

				100% 3-99% (7-0)	
Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**	Yes
Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day invert: 20-63	3-27% (7-8)	Yes
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available		Yes
Exposure to malathion is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	**Yes**

Effects analysis summary: Adult and juvenile Coho salmon, Central California Coast ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Population modelling results indicate that malathion-induced mortality to juveniles may lead to severe reductions in lambda up to 99%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 2-15 percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, Coho will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed Coho. The overall risk to Coho salmon, Central California Coast ESU from the effects of the action is high and the confidence associated with that risk is high.


High Risk
High Confidence
Less Risk
More Risk

14.15 Coho Salmon, Lower Columbia River ESU (Oncorhynchus kisutch)

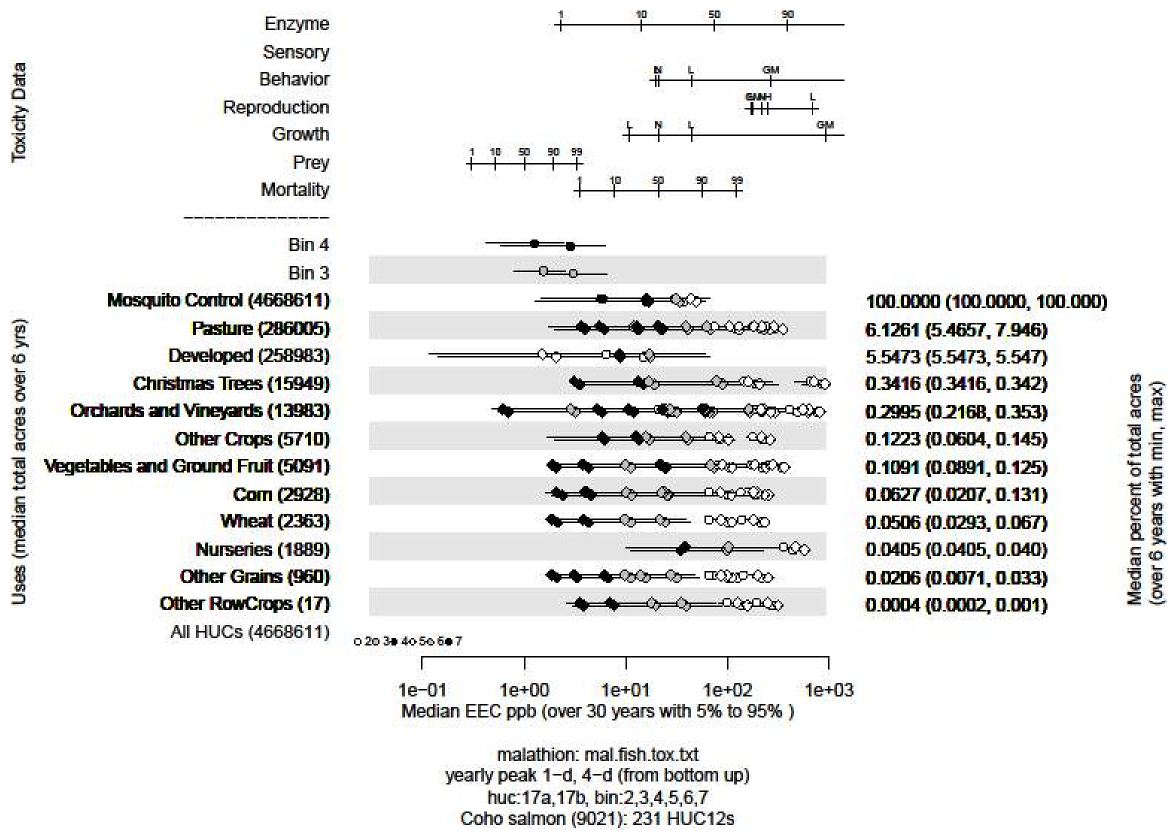


Figure 14. Effects analysis R-plot for Coho salmon, lower Columbia River ESU and malathion

Table 132. Likelihood of exposure determination for Coho salmon, lower Columbia River ESU and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Developed	3	yes	no	yes	NA	3	High
Christmas Trees	1	yes	no	yes	NA	3	Low
Orchards and Vineyards	1	yes	no	yes	NA	3	Low
Other Crops	1	yes	no	yes	NA	3	Low
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	Low
Corn	1	yes	no	yes	NA	3	Low
Wheat	1	yes	no	yes	NA	3	Low
Nurseries	1	yes	no	yes	NA	3	Low
Other Grain	1	yes	no	yes	NA	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High
Juveniles							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Developed	3	yes	no	yes	NA	3	High
Christmas Trees	1	yes	no	yes	NA	3	Low
Orchards and Vineyards	1	yes	no	yes	NA	3	Low
Other Crops	1	yes	no	yes	NA	3	Low
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	Low
Corn	1	yes	no	yes	NA	3	Low
Wheat	1	yes	no	yes	NA	3	Low
Nurseries	1	yes	no	yes	NA	3	Low
Other Grain	1	yes	no	yes	NA	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High

Life Stage: Adults (full-range)

Table 133. Direct mortality risk hypothesis; Coho salmon, lower Columbia River ESU and malathion; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	6.1	High	**High**
Developed	5.5	High	**High**
Christmas Trees	0.3	High	**Low**
Orchards and Vineyards	0.3	High	**Low**
Other Crops	0.1	High	**Low**
Vegetables and Ground Fruit	0.1	High	**Low**
Corn	0.06	High	**Low**

Wheat	0.05	High	**Low**
Nurseries	0.04	High	**Low**
Other Grain	0.02	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 134. Reproduction risk hypothesis; Coho salmon, lower Columbia River ESU and malathion; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	**High**
Pasture	6.1	High	**High**
Developed	5.5	Low	**High**
Christmas Trees	0.3	High	**Low**
Orchards and Vineyards	0.3	High	**Low**
Other Crops	0.1	Low	**Low**
Vegetables and Ground Fruit	0.1	High	**Low**
Corn	0.06	Low	**Low**
Wheat	0.05	Low	**Low**
Nurseries	0.04	High	**Low**
Other Grain	0.02	Low	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 135. Behavior and sensory risk hypothesis; Coho salmon, lower Columbia River ESU and malathion; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	6.1	High	**High**
Developed	5.5	Low	**High**
Christmas Trees	0.3	High	**Low**
Orchards and Vineyards	0.3	High	**Low**
Other Crops	0.1	High	**Low**

Vegetables and Ground Fruit	0.1	High	**Low**
Corn	0.06	High	**Low**
Wheat	0.05	Medium	**Low**
Nurseries	0.04	High	**Low**
Other Grain	0.02	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	6.1	High	**High**
Developed	5.5	Low	**High**
Christmas Trees	0.3	High	**Low**
Orchards and Vineyards	0.3	High	**Low**
Other Crops	0.1	High	**Low**
Vegetables and Ground Fruit	0.1	High	**Low**
Corn	0.06	High	**Low**
Wheat	0.05	Medium	**Low**
Nurseries	0.04	High	**Low**
Other Grain	0.02	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 136. AChE risk hypothesis; Coho salmon, lower Columbia River ESU and malathion; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	6.1	High	**High**
Developed	5.5	Medium	**High**
Christmas Trees	0.3	High	**Low**
Orchards and Vineyards	0.3	High	**Low**
Other Crops	0.1	High	**Low**
Vegetables and Ground Fruit	0.1	High	**Low**
Corn	0.06	High	**Low**
Wheat	0.05	High	**Low**
Nurseries	0.04	High	**Low**

Other Grain	0.02	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 137. Direct mortality risk hypothesis; Coho salmon, lower Columbia River ESU and malathion; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	6.1	High	High
Developed	5.5	High	High
Christmas Trees	0.3	High	Low
Orchards and Vineyards	0.3	High	Low
Other Crops	0.1	High	Low
Vegetables and Ground Fruit	0.1	High	Low
Corn	0.06	High	Low
Wheat	0.05	High	Low
Nurseries	0.04	High	Low
Other Grain	0.02	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 138. Growth risk hypothesis; Coho salmon, lower Columbia River ESU and malathion; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	6.1	Medium	High
Developed	5.5	Low	High
Christmas Trees	0.3	Medium	Low
Orchards and Vineyards	0.3	Medium	Low
Other Crops	0.1	Medium	Low

Vegetables and Ground Fruit	0.1	Medium	Low
Corn	0.06	Medium	Low
Wheat	0.05	Medium	Low
Nurseries	0.04	Medium	Low
Other Grain	0.02	Medium	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 139. Prey risk hypothesis; Coho salmon, lower Columbia River ESU and malathion; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	6.1	High	**High**
Developed	5.5	High	**High**
Christmas Trees	0.3	High	**Low**
Orchards and Vineyards	0.3	High	**Low**
Other Crops	0.1	High	**Low**
Vegetables and Ground Fruit	0.1	High	**Low**
Corn	0.06	High	**Low**
Wheat	0.05	High	**Low**
Nurseries	0.04	High	**Low**
Other Grain	0.02	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 140. AChE risk hypothesis; Coho salmon, lower Columbia River ESU and malathion; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	6.1	High	High
Developed	5.5	Medium	High
Christmas Trees	0.3	High	Low
Orchards and Vineyards	0.3	High	Low

Other Crops	0.1	High	Low
Vegetables and Ground Fruit	0.1	High	Low
Corn	0.06	High	Low
Wheat	0.05	High	Low
Nurseries	0.04	High	Low
Other Grain	0.02	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 141. Behavior and sensory risk hypothesis; Coho salmon, lower Columbia River ESU and malathion; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	6.1	High	**High**
Developed	5.5	Low	**High**
Christmas Trees	0.3	High	**Low**
Orchards and Vineyards	0.3	High	**Low**
Other Crops	0.1	High	**Low**
Vegetables and Ground Fruit	0.1	High	**Low**
Corn	0.06	High	**Low**
Wheat	0.05	Medium	**Low**
Nurseries	0.04	High	**Low**
Other Grain	0.02	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	6.1	High	**High**
Developed	5.5	Low	**High**
Christmas Trees	0.3	High	**Low**
Orchards and Vineyards	0.3	High	**Low**
Other Crops	0.1	High	**Low**
Vegetables and Ground Fruit	0.1	High	**Low**
Corn	0.06	High	**Low**

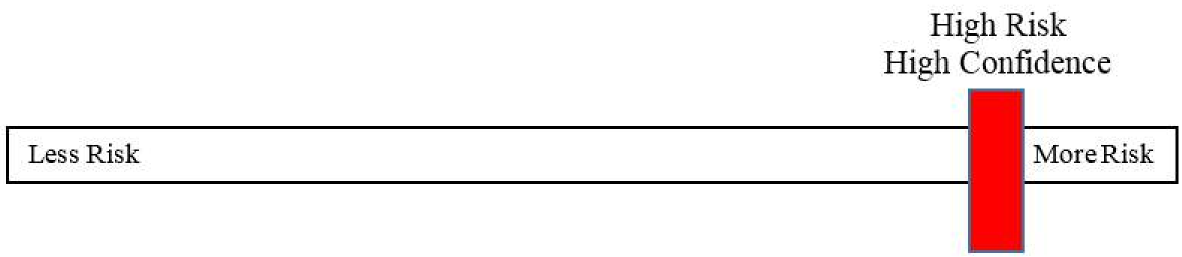
Wheat	0.05	Medium	**Low**
Nurseries	0.04	High	**Low**
Other Grain	0.02	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 142. Effects analysis summary table: Coho salmon, lower Columbia River ESU and malathion

	R-plot Derived		**MagTool**	**Population Model Results: Coho Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 0-10	Not Applicable	Yes
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable	Yes
Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	Yes
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	Not Applicable	Yes
	R-plot Derived		**MagTool**	**Population Model Results: Coho Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities of aquatic bins**		

<table>
<tr><th>Risk Hypothesis</th><th></th><th></th><th></th><th></th><th></th></tr>
<tr><td>Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.</td><td>High</td><td>High</td><td>4-day:
0-10</td><td><table><tr><th>Portion of juveniles exposed to malathion EECs; 0.75-100 µg/l</th><th>Mean percent reduction (STD) in a population’s intrinsic growth, lambda, from death of juveniles</th></tr><tr><td>25%</td><td>1-14% (8-23)</td></tr><tr><td>50%</td><td>1-27% (8-28)</td></tr><tr><td>75%</td><td>2-40% (7-27)</td></tr><tr><td>100%</td><td>3-99% (7-0)</td></tr></table></td><td>Yes</td></tr>
<tr><td>Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)</td><td>High</td><td>High</td><td>Not Available</td><td>Anticipated reductions in a population’s intrinsic rate of growth (lambda) (± 1 STD)</td><td>Yes</td></tr>
<tr><td>Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability</td><td>High</td><td>High</td><td>4-day invert:
10-29</td><td rowspan="2">3-27% (7-8)</td><td>Yes</td></tr>
<tr><td>Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity</td><td>High</td><td>High</td><td>Not Available</td><td>Yes</td></tr>
<tr><td>Exposure to malathion is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.</td><td>High</td><td>High</td><td>Not Available</td><td>Not Applicable</td><td>Yes</td></tr>
<tr><td colspan="6"></td></tr>
</table>

Effects analysis summary: Adult and juvenile Coho salmon, lower Columbia River ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Population modelling results indicate that malathion-induced mortality to juveniles may lead to severe reductions in lambda up to 99%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 0-10 percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, Coho will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed Coho. The overall risk to Coho salmon, lower Columbia River ESU from the effects of the action is high and the confidence associated with that risk is high.



14.16 Coho Salmon, Oregon Coast ESU (Oncorhynchus kisutch)

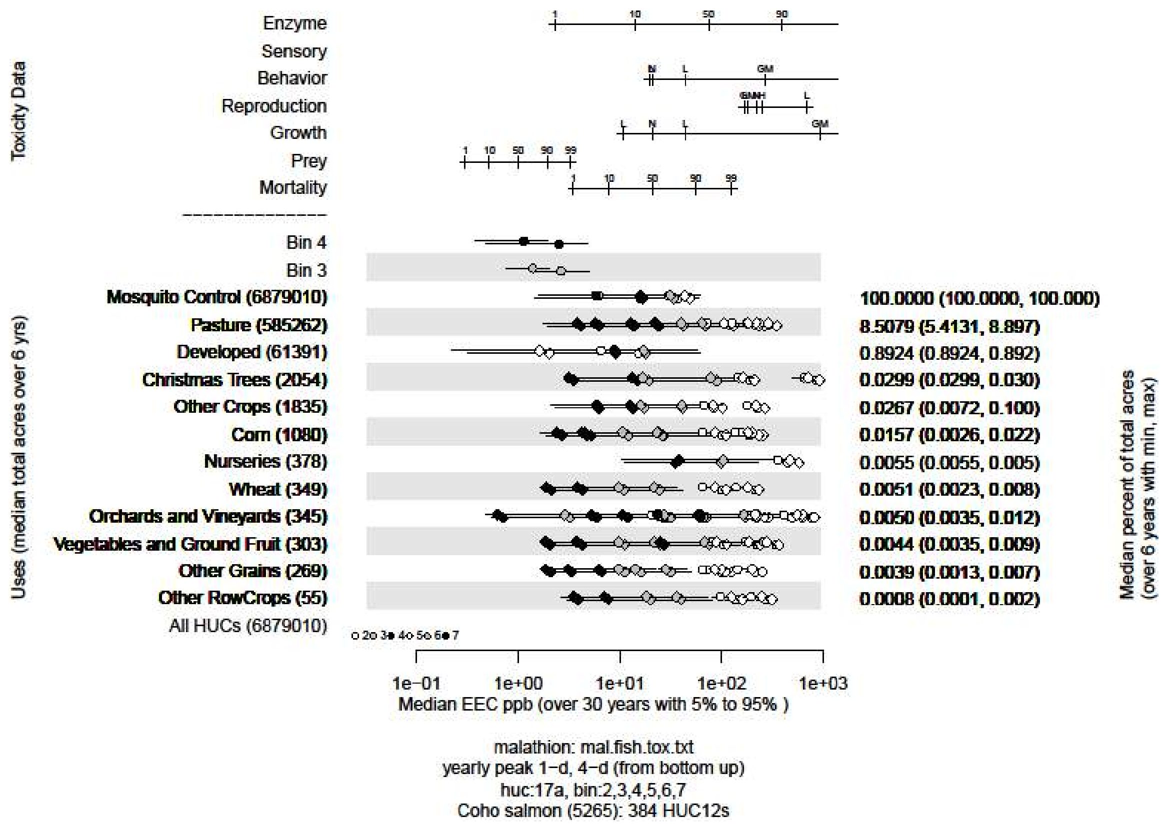


Figure 15. Effects analysis R-plot for Coho salmon, Oregon coast ESU and malathion

Table 143. Likelihood of exposure determination for Coho salmon, Oregon coast ESU and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Developed	1	yes	no	yes	yes	3	High
Christmas Trees	1	yes	no	yes	noi	3	Low
Other Crops	1	yes	no	yes	no	3	Low
Corn	1	yes	no	yes	no	3	Low
Nurseries	1	yes	no	yes	no	3	Low
Wheat	1	yes	no	yes	no	3	Low
Orchards and Vineyards	1	yes	no	yes	no	3	Low
Vegetables and Groung fruit	1	yes	no	yes	no	3	Low
Other Gains	1	yes	no	yes	no	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High
Juveniles							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Developed	1	yes	no	yes	yes	3	High
Christmas Trees	1	yes	no	yes	noi	3	Low
Other Crops	1	yes	no	yes	no	3	Low
Corn	1	yes	no	yes	no	3	Low
Nurseries	1	yes	no	yes	no	3	Low
Wheat	1	yes	no	yes	no	3	Low
Orchards and Vineyards	1	yes	no	yes	no	3	Low
Vegetables and Groung fruit	1	yes	no	yes	no	3	Low
Other Gains	1	yes	no	yes	no	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High

Life Stage: Adults (full-range)

Table 144. Direct mortality risk hypothesis; Coho salmon, Oregon coast ESU and malathion; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	8.5	High	**High**
Developed	0.9	High	**High**
Christmas Trees	0.03	High	**Low**
Other Crops	0.03	High	**Low**
Corn	0.02	High	**Low**
Nurseries	0.006	High	**Low**
Wheat	0.005	High	**Low**
Orchards and Vineyards	0.005	High	**Low**

Vegetables and Groung fruit	0.004	High	**Low**
Other Gains	0.004	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 145. Reproduction risk hypothesis; Coho salmon, Oregon coast ESU and malathion; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	**High**
Pasture	8.5	Medium	**High**
Developed	0.9	Low	**High**
Christmas Trees	0.03	High	**Low**
Other Crops	0.03	Medium	**Low**
Corn	0.02	Medium	**Low**
Nurseries	0.006	High	**Low**
Wheat	0.005	Medium	**Low**
Orchards and Vineyards	0.005	High	**Low**
Vegetables and Ground fruit	0.004	Medium	**Low**
Other Grains	0.004	Medium	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 146. Behavior and sensory risk hypothesis; Coho salmon, Oregon coast ESU and malathion; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	8.5	High	**High**
Developed	0.9	Medium	**High**
Christmas Trees	0.03	High	**Low**
Other Crops	0.03	High	**Low**
Corn	0.02	High	**Low**
Nurseries	0.006	High	**Low**
Wheat	0.005	Medium	**Low**

Orchards and Vineyards	0.005	High	**Low**
Vegetables and Ground fruit	0.004	High	**Low**
Other Grains	0.004	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Pasture	8.5	Not Available	**High**
Developed	0.9	Not Available	**High**
Christmas Trees	0.03	Not Available	**Low**
Other Crops	0.03	Not Available	**Low**
Corn	0.02	Not Available	**Low**
Nurseries	0.006	Not Available	**Low**
Wheat	0.005	Not Available	**Low**
Orchards and Vineyards	0.005	Not Available	**Low**
Vegetables and Ground fruit	0.004	Not Available	**Low**
Other Grains	0.004	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 147. AChE risk hypothesis; Coho salmon, Oregon coast ESU and malathion; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	8.5	High	**High**
Developed	0.9	Medium	**High**
Christmas Trees	0.03	High	**Low**
Other Crops	0.03	High	**Low**
Corn	0.02	High	**Low**
Nurseries	0.006	High	**Low**
Wheat	0.005	High	**Low**
Orchards and Vineyards	0.005	High	**Low**
Vegetables and Ground fruit	0.004	High	**Low**
Other Grains	0.004	High	**Low**

Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 148. Direct mortality risk hypothesis; Coho salmon, Oregon coast ESU and malathion; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	8.5	High	High
Developed	0.9	High	High
Christmas Trees	0.03	High	Low
Other Crops	0.03	High	Low
Corn	0.02	High	Low
Nurseries	0.006	High	Low
Wheat	0.005	High	Low
Orchards and Vineyards	0.005	High	Low
Vegetables and Ground fruit	0.004	High	Low
Other Gains	0.004	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 149. Growth risk hypothesis; Coho salmon, Oregon coast ESU and malathion; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Low	High
Pasture	8.5	High	High
Developed	0.9	Low	High
Christmas Trees	0.03	High	Low
Other Crops	0.03	High	Low
Corn	0.02	High	Low
Nurseries	0.006	High	Low
Wheat	0.005	High	Low
Orchards and Vineyards	0.005	High	Low

Vegetables and Ground fruit	0.004	High	Low
Other Grains	0.004	High	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	Medium		

Table 150. Prey risk hypothesis; Coho salmon, Oregon coast ESU and malathion; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	8.5	High	**High**
Developed	0.9	High	**High**
Christmas Trees	0.03	High	**Low**
Other Crops	0.03	High	**Low**
Corn	0.02	High	**Low**
Nurseries	0.006	High	**Low**
Wheat	0.005	High	**Low**
Orchards and Vineyards	0.005	High	**Low**
Vegetables and Ground fruit	0.004	High	**Low**
Other Grains	0.004	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 151. AChE risk hypothesis; Coho salmon, Oregon coast ESU and malathion; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	8.5	High	High
Developed	0.9	Medium	High
Christmas Trees	0.03	High	Low
Other Crops	0.03	High	Low
Corn	0.02	High	Low
Nurseries	0.006	High	Low
Wheat	0.005	High	Low

Orchards and Vineyards	0.005	High	Low
Vegetables and Ground fruit	0.004	High	Low
Other Grains	0.004	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 152. Behavior and sensory risk hypothesis; Coho salmon, Oregon coast ESU and malathion; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	8.5	High	**High**
Developed	0.9	Medium	**High**
Christmas Trees	0.03	High	**Low**
Other Crops	0.03	High	**Low**
Corn	0.02	High	**Low**
Nurseries	0.006	High	**Low**
Wheat	0.005	Medium	**Low**
Orchards and Vineyards	0.005	High	**Low**
Vegetables and Ground fruit	0.004	High	**Low**
Other Grains	0.004	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Pasture	8.5	Not Available	**High**
Developed	0.9	Not Available	**High**
Christmas Trees	0.03	Not Available	**Low**
Other Crops	0.03	Not Available	**Low**
Corn	0.02	Not Available	**Low**
Nurseries	0.006	Not Available	**Low**
Wheat	0.005	Not Available	**Low**
Orchards and Vineyards	0.005	Not Available	**Low**
Vegetables and Ground fruit	0.004	Not Available	**Low**
Other Grains	0.004	Not Available	**Low**

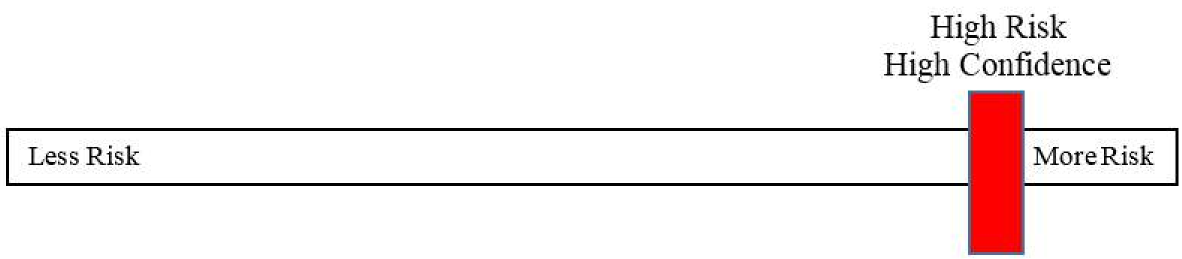
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 153. Effects analysis summary table: Coho salmon, Oregon coast ESU and malathion

	R-plot Derived		**MagTool**	**Population Model Results: Coho Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 0-9	Not Applicable	Yes
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable	Yes
Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	Yes
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	Not Applicable	Yes
	R-plot Derived		**MagTool**	**Population Model Results: Coho Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities of aquatic bins**		
Risk Hypothesis					

<table>
<tr><td rowspan="6">Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.</td><td rowspan="6">High</td><td rowspan="6">High</td><td rowspan="6">4-day: 0-9</td><td>Portion of juveniles exposed to malathion EECs; 0.75-100 µg/l</td><td>Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles</td><td rowspan="6">Yes</td></tr>
<tr><td>25%</td><td>1-14% (8-23)</td></tr>
<tr><td>50%</td><td>1-27% (8-28)</td></tr>
<tr><td>75%</td><td>2-40% (7-27)</td></tr>
<tr><td>100%</td><td>3-99% (7-0)</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td>Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)</td><td>High</td><td>High</td><td>Not Available</td><td colspan="2">Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)</td><td>Yes</td></tr>
<tr><td>Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability</td><td>High</td><td>High</td><td>4-day invert: 9-26</td><td colspan="2" rowspan="2">3-27% (7-8)</td><td>Yes</td></tr>
<tr><td>Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity</td><td>High</td><td>High</td><td>Not Available</td><td>Yes</td></tr>
<tr><td>Exposure to malathion is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.</td><td>High</td><td>High</td><td>Not Available</td><td colspan="2">Not Applicable</td><td>Yes</td></tr>
<tr><td colspan="7"></td></tr>
</table>

Effects analysis summary: Adult and juvenile Coho salmon, Oregon coast ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Population modelling results indicate that malathion-induced mortality to juveniles may lead to severe reductions in lambda up to 99%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 0-9 percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, Coho will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed Coho. The overall risk to Coho salmon, Oregon coast ESU from the effects of the action is high and the confidence associated with that risk is high.



14.17 Coho Salmon, Southern Oregon/Northern California Coast ESU (Oncorhynchus kisutch)

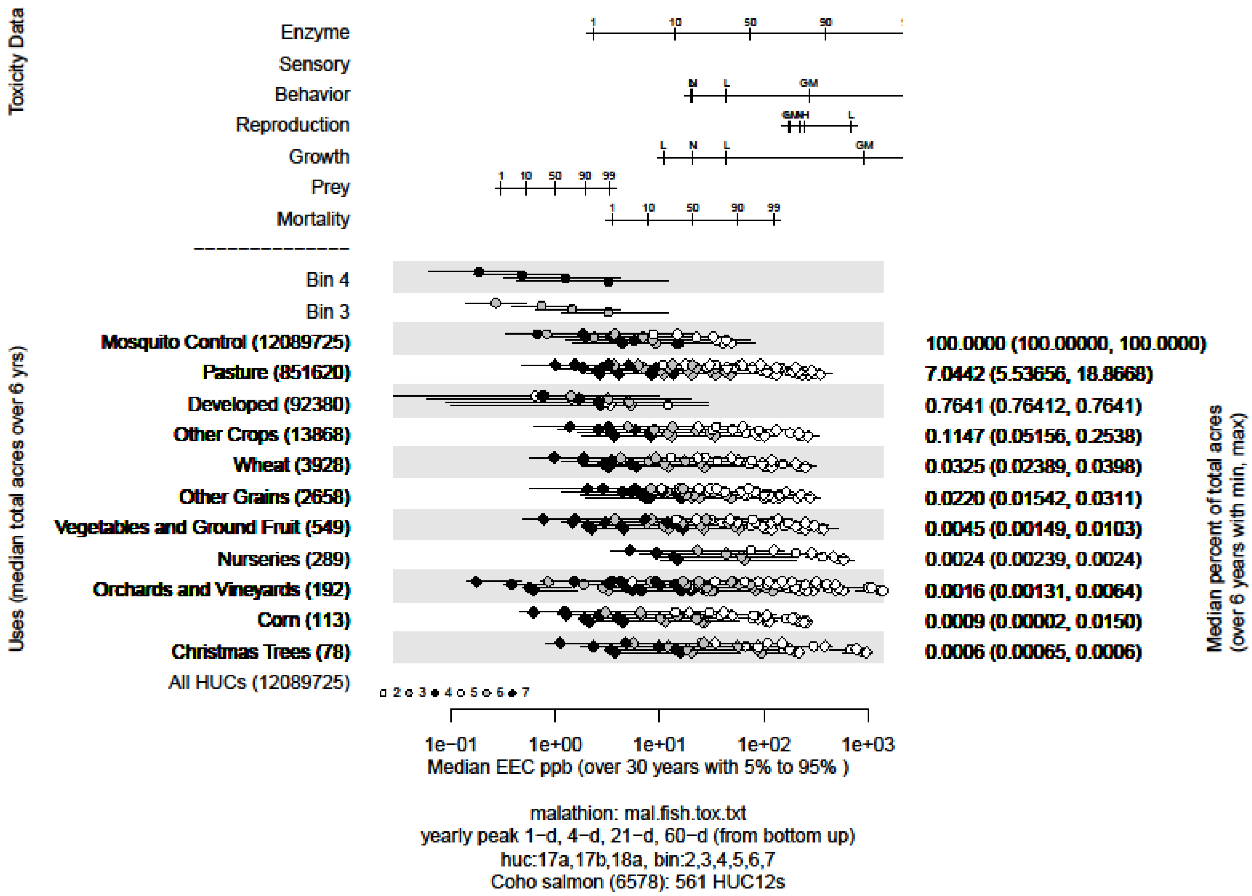


Figure 16. Effects analysis R-plot for Coho salmon, southern Oregon/northern California coast ESU and malathion

Table 154. Likelihood of exposure determination for Coho salmon, southern Oregon/northern California coast ESU and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Developed	1	yes	no	yes	yes	3	High
Other Crops	1	yes	no	yes	yes	3	High
Wheat	1	yes	no	yes	no	3	Low
Other Grains	1	yes	no	yes	no	3	Low
Vegetables and Ground Fruit	1	yes	no	yes	no	3	Low
Nurseries	1	yes	no	yes	no	3	Low
Orchards and Vineyards	1	no	no	yes	no	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High
Juveniles							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Developed	1	yes	no	yes	yes	3	High
Other Crops	1	yes	no	yes	yes	3	High
Wheat	1	yes	no	yes	no	3	Low
Other Grains	1	yes	no	yes	no	3	Low
Vegetables and Ground Fruit	1	yes	no	yes	no	3	Low
Nurseries	1	yes	no	yes	no	3	Low
Orchards and Vineyards	1	yes	no	yes	no	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High

Life Stage: Adults (full-range)

Table 155. Direct mortality risk hypothesis; Coho salmon, southern Oregon/northern California coast ESU and malathion; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	7.0	High	**High**
Developed	0.8	Medium	**High**
Other Crops	0.1	High	**High**
Wheat	0.03	High	**Low**
Other Grains	0.02	High	**Low**
Vegetables and Ground Fruit	0.005	High	**Low**
Nurseries	0.002	High	**Low**

Orchards and Vineyards	0.002	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 156. Reproduction risk hypothesis; Coho salmon, southern Oregon/northern California coast ESU and malathion; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	**High**
Pasture	7.0	High	**High**
Developed	0.8	Low	**High**
Other Crops	0.1	Low	**High**
Wheat	0.03	High	**Low**
Other Grains	0.02	High	**Low**
Vegetables and Ground Fruit	0.005	High	**Low**
Nurseries	0.002	High	**Low**
Orchards and Vineyards	0.002	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**Medium**		

Table 157. Behavior and sensory risk hypothesis; Coho salmon, southern Oregon/northern California coast ESU and malathion; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	7.0	High	**High**
Developed	0.8	Low	**High**
Other Crops	0.1	High	**High**
Wheat	0.03	High	**Low**
Other Grains	0.02	High	**Low**
Vegetables and Ground Fruit	0.005	High	**Low**
Nurseries	0.002	High	**Low**

Orchards and Vineyards	0.002	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Pasture	7.0	Not Available	**High**
Developed	0.8	Not Available	**High**
Other Crops	0.1	Not Available	**High**
Wheat	0.03	Not Available	**Low**
Other Grains	0.02	Not Available	**Low**
Vegetables and Ground Fruit	0.005	Not Available	**Low**
Nurseries	0.002	Not Available	**Low**
Orchards and Vineyards	0.002	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 158. AChE risk hypothesis; Coho salmon, southern Oregon/northern California coast ESU and malathion; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	7.0	High	**High**
Developed	0.8	Medium	**High**
Other Crops	0.1	High	**High**
Wheat	0.03	High	**Low**
Other Grains	0.02	High	**Low**
Vegetables and Ground Fruit	0.005	High	**Low**
Nurseries	0.002	High	**Low**
Orchards and Vineyards	0.002	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 159. Direct mortality risk hypothesis; Coho salmon, southern Oregon/northern California coast ESU and malathion; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	7.0	High	High
Developed	0.8	Medium	High
Other Crops	0.1	High	High
Wheat	0.03	High	Low
Other Grains	0.02	High	Low
Vegetables and Ground Fruit	0.005	High	Low
Nurseries	0.002	High	Low
Orchards and Vineyards	0.002	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 160. Growth risk hypothesis; Coho salmon, southern Oregon/northern California coast ESU and malathion; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	7.0	Medium	High
Developed	0.8	Low	High
Other Crops	0.1	Medium	High
Wheat	0.03	Medium	Low
Other Grains	0.02	Medium	Low
Vegetables and Ground Fruit	0.005	Medium	Low
Nurseries	0.002	Medium	Low
Orchards and Vineyards	0.002	Medium	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		

High	High	

Table 161. Prey risk hypothesis; Coho salmon, southern Oregon/northern California coast ESU and malathion; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	7.0	High	**High**
Developed	0.8	High	**High**
Other Crops	0.1	High	**High**
Wheat	0.03	High	**Low**
Other Grains	0.02	High	**Low**
Vegetables and Ground Fruit	0.005	High	**Low**
Nurseries	0.002	High	**Low**
Orchards and Vineyards	0.002	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 162. AChE risk hypothesis; Coho salmon, southern Oregon/northern California coast ESU and malathion; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	7.0	High	High
Developed	0.8	Medium	High
Other Crops	0.1	High	High
Wheat	0.03	High	Low
Other Grains	0.02	High	Low
Vegetables and Ground Fruit	0.005	High	Low
Nurseries	0.002	High	Low
Orchards and Vineyards	0.002	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 163. Behavior and sensory risk hypothesis; Coho salmon, southern Oregon/northern California coast ESU and malathion; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	7.0	High	**High**
Developed	0.8	Low	**High**
Other Crops	0.1	High	**High**
Wheat	0.03	High	**Low**
Other Grains	0.02	High	**Low**
Vegetables and Ground Fruit	0.005	High	**Low**
Nurseries	0.002	High	**Low**
Orchards and Vineyards	0.002	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Pasture	7.0	Not Available	**High**
Developed	0.8	Not Available	**High**
Other Crops	0.1	Not Available	**High**
Wheat	0.03	Not Available	**Low**
Other Grains	0.02	Not Available	**Low**
Vegetables and Ground Fruit	0.005	Not Available	**Low**
Nurseries	0.002	Not Available	**Low**
Orchards and Vineyards	0.002	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 164. Effects analysis summary table: Coho salmon, southern Oregon/northern California coast ESU and malathion

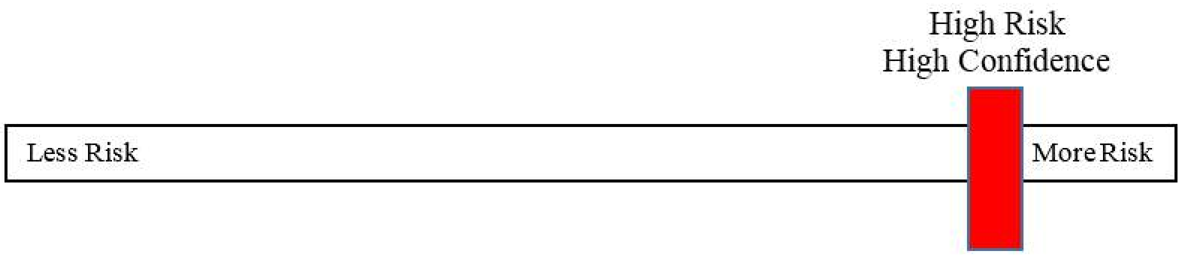
	R-plot Derived	**MagTool**	**Population Model Results: Coho Salmon**	

Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**			**Risk Hypothesis Supported? Yes/No**
Risk Hypothesis						
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 1-7	Not Applicable		Yes
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	Not Applicable		Yes
Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable		Yes
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	Not Applicable		Yes
	R-plot Derived		**MagTool** Range in median percent mortalities of aquatic bins	**Population Model Results: Coho Salmon**		**Risk Hypothesis Supported? Yes/No**
Life Stage: Juveniles	**Risk**	**Confidence**				
Risk Hypothesis						
Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 1-7	**Portion of juveniles exposed to malathion EECs; 0.75-100 µg/l**	**Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles**	Yes

				25% 1-14% (8-23) 50% 1-27% (8-28) 75% 2-40% (7-27) 100% 3-99% (7-0)	
Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**	Yes
Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day invert: 8-29	3-27% (7-8)	Yes
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available		Yes
Exposure to malathion is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	**Yes**

Effects analysis summary: Adult and juvenile Coho salmon, southern Oregon/northern California coast ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Population modelling results indicate that malathion-induced mortality to juveniles may lead to severe reductions in lambda up to 99%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 1-7 percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, Coho will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed Coho. The overall risk to Coho salmon, southern

Oregon/northern California coast ESU from the effects of the action is high and the confidence associated with that risk is high.



14.18 Sockeye Salmon, Ozette Lake ESU (Oncorhynchus nerka)

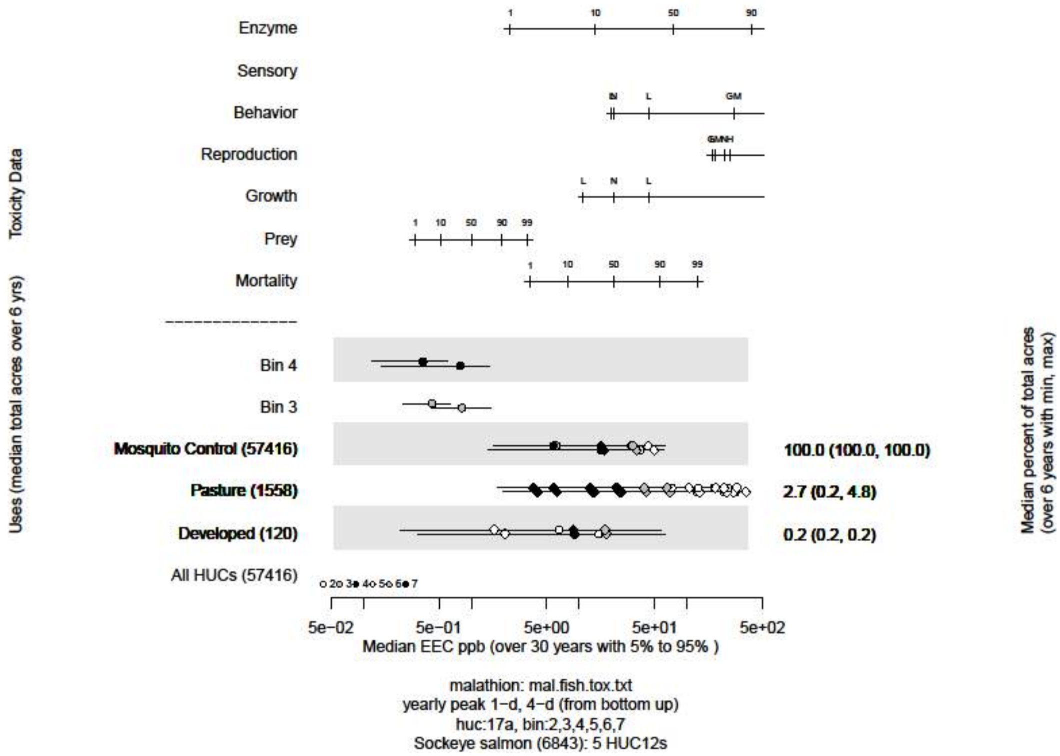


Figure 17. Effects analysis R-plot for Sockeye salmon, Ozette Lake ESU and malathion

Table 165. Likelihood of exposure determination for Sockeye salmon, Ozette Lake ESU and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Mosquito Control	3	yes	no	yes	NA	2	**Med**
Pasture	2	yes	no	yes	NA	2	**Med**
Developed	1	yes	no	yes	no	2	**Low**
Bin 3	3	yes	no	yes	NA	2	**Med**
Bin 4	3	yes	no	yes	NA	2	**Med**
Juveniles							
Mosquito Control	3	yes	no	yes	NA	3	**High**
Pasture	2	yes	no	yes	NA	3	**Med**
Developed	1	yes	no	yes	no	3	**Low**
Bin 3	3	yes	no	yes	NA	3	**High**
Bin 4	3	yes	no	yes	NA	3	**High**

Life Stage: Adults (full-range)

Table 166. Direct mortality risk hypothesis; Sockeye salmon, Ozette Lake ESU and malathion; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	Medium
Pasture	3	High	Medium
Developed	<1	High	Low
Bin 3		Low	Medium
Bin 4		Low	Medium
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 167. Reproduction risk hypothesis; Sockeye salmon, Ozette Lake ESU and malathion; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	Medium
Pasture	3	High	Medium
Developed	<1	Low	Low
Bin 3		Low	Medium

Bin 4		Low	Medium
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 168. Behavior and sensory risk hypothesis; Sockeye salmon, Ozette Lake ESU and malathion; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	Medium
Pasture	3	High	Medium
Developed	<1	Medium	Low
Bin 3		Low	Medium
Bin 4		Low	Medium
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	NA	Medium
Pasture	3	NA	Medium
Developed	<1	NA	Low
Bin 3			Medium
Bin 4			Medium
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 169. AChE risk hypothesis; Sockeye salmon, Ozette Lake ESU and malathion; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	Medium
Pasture	3	High	Medium
Developed	<1	Medium	Low
Bin 3		Low	Medium
Bin 4		Low	Medium
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 170. Direct mortality risk hypothesis; Sockeye salmon, Ozette Lake ESU and malathion; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	3	High	Medium
Developed	<1	High	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 171. Growth risk hypothesis; Sockeye salmon, Ozette Lake ESU and malathion; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	3	Medium	Medium
Developed	<1	Medium	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 172. Prey risk hypothesis; Sockeye salmon, Ozette Lake ESU and malathion; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Pasture	3	High	Medium
Developed	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 173. AChE risk hypothesis; Sockeye salmon, Ozette Lake ESU and malathion; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure

Mosquito Control	100	Medium	High
Pasture	3	High	Medium
Developed	<1	Medium	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 174. Behavior and sensory risk hypothesis; Sockeye salmon, Ozette Lake ESU and malathion; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Pasture	3	High	Medium
Developed	<1	Medium	Low
Bin 3		Low	High
Bin 4		Low	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	NA	
Pasture	3	NA	
Developed	<1	NA	
Bin 3			
Bin 4			
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

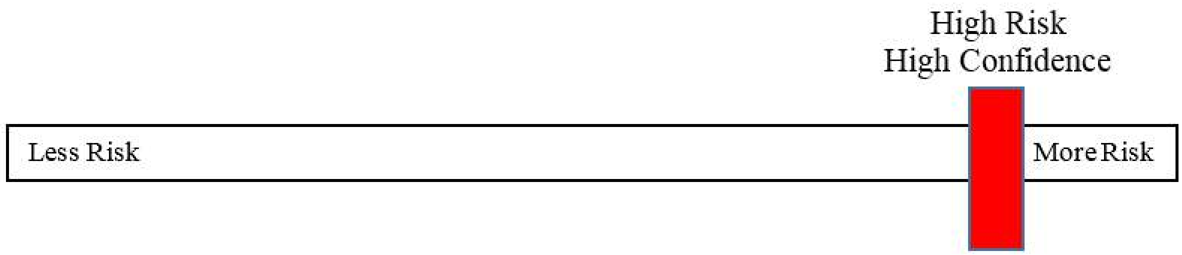
Table 175. Effects analysis summary table: Sockeye salmon, Ozette Lake ESU and malathion

	R-plot Derived		**MagTool**	**Population Model Results: Sockeye Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 0-3	Not Applicable	Yes

<table>
<tr><td>Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction</td><td>High</td><td>High</td><td>Not Available</td><td colspan="2">Not Applicable</td><td>Yes</td></tr>
<tr><td>Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.</td><td>High</td><td>High</td><td>Not Available</td><td colspan="2">Not Applicable</td><td>Yes</td></tr>
<tr><td>Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity</td><td>High</td><td>High</td><td>Not Available</td><td colspan="2">Not Applicable</td><td>Yes</td></tr>
<tr><td rowspan="2">Life Stage: Juveniles</td><td colspan="2">R-plot Derived</td><td rowspan="2">MagTool
Range in median percent mortalities of aquatic bins</td><td rowspan="2" colspan="2">Population Model Results: Sockeye Salmon</td><td rowspan="2">Risk Hypothesis Supported?
Yes/No</td></tr>
<tr><td>Risk</td><td>Confidence</td></tr>
<tr><td>Risk Hypothesis</td><td></td><td></td><td></td><td colspan="2"></td><td></td></tr>
<tr><td rowspan="5">Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.</td><td rowspan="5">High</td><td rowspan="5">High</td><td rowspan="5">4-day:
0-3</td><td>Portion of juveniles exposed to malathion EECs; 10-1000 µg/l</td><td>Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles</td><td rowspan="5">Yes</td></tr>
<tr><td>25%</td><td>1-11% (8-19)</td></tr>
<tr><td>50%</td><td>1-20% (8-21)</td></tr>
<tr><td>75%</td><td>2-29% (8-20)</td></tr>
<tr><td>100%</td><td>2-96% (8-0)</td></tr>
<tr><td>Exposure to malathion is sufficient to reduce abundance via</td><td>High</td><td>High</td><td>Not Available</td><td colspan="2">Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)</td><td>Yes</td></tr>
</table>

impacts to growth (direct toxicity)					
Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day invert: 1-3	2-24% (5-6)	Yes
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available		Yes
Exposure to malathion is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	Not Applicable	**Yes**

Effects analysis summary: Adult and juvenile Sockeye salmon, Ozette Lake ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Population modelling results indicate that malathion-induced mortality to juveniles may lead to severe reductions in lambda up to 96%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 0-3 percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, sockeye will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed sockeye. The overall risk to Sockeye salmon, Ozette Lake ESU from the effects of the action is high and the confidence associated with that risk is high.


High Risk
High Confidence
Less Risk
More Risk

14.19 Sockeye Salmon, Snake River ESU (Oncorhynchus nerka)

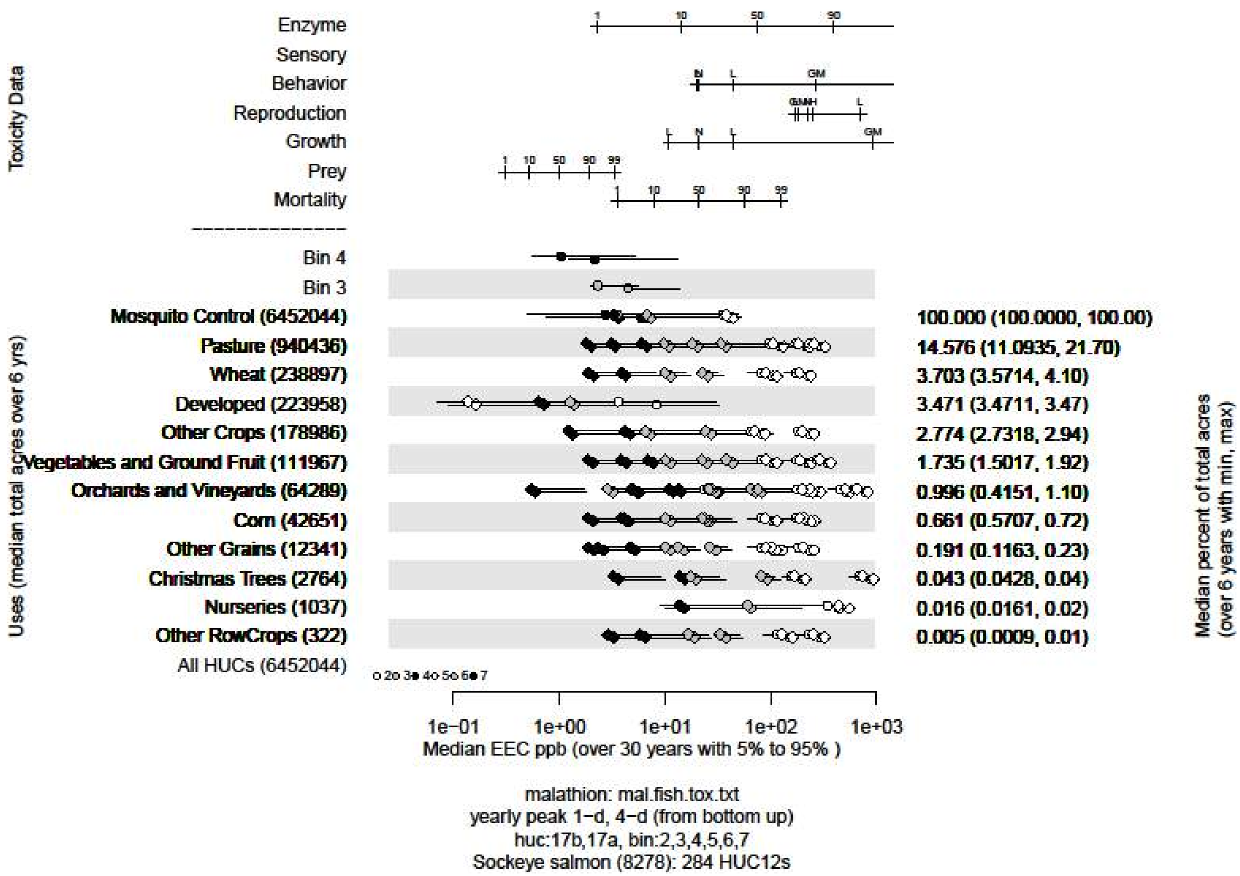


Figure 18. Effects analysis R-plot for Sockeye salmon, Snake River ESU and malathion; full range

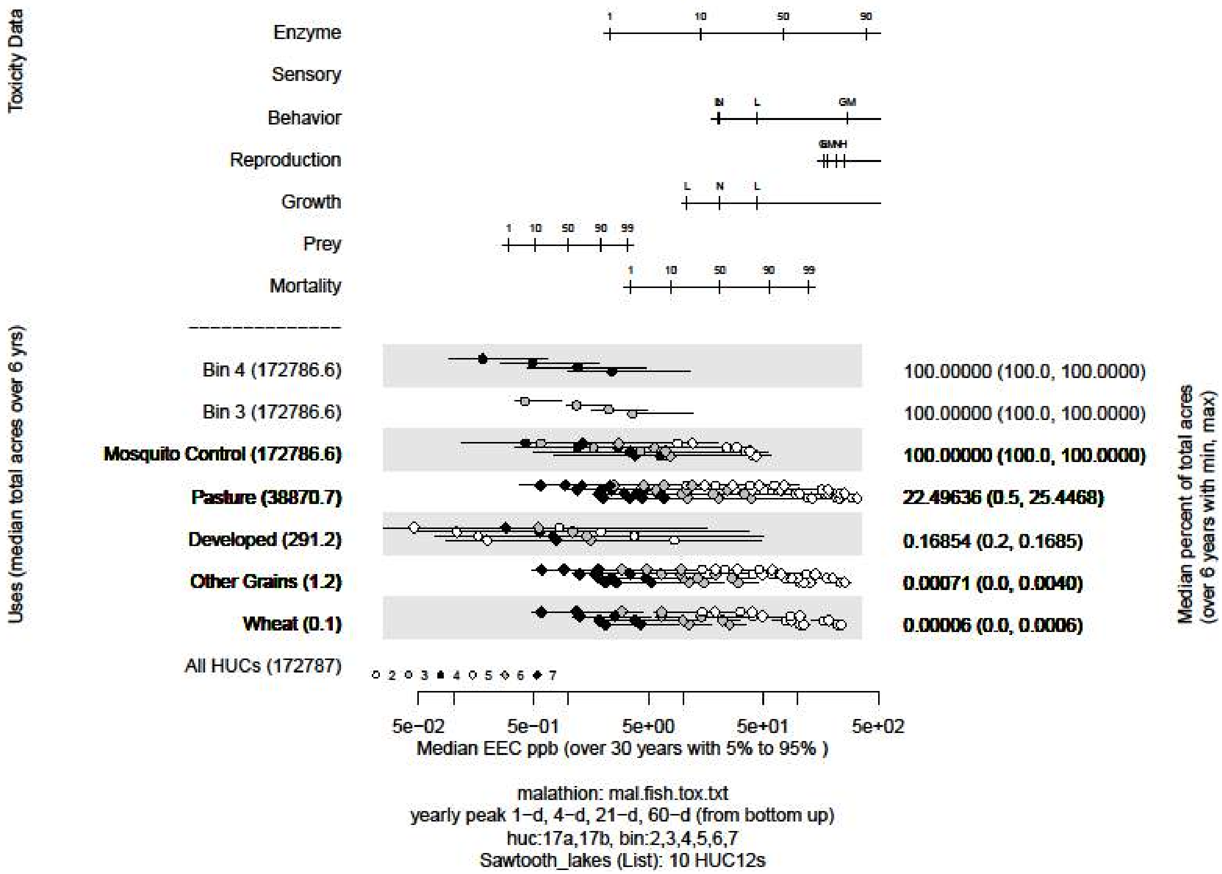


Figure 19. Effects analysis R-plot for Sockeye salmon, Snake River ESU and malathion; sawtooth lakes

Table 176. Likelihood of exposure determination for Sockeye salmon, Snake River ESU and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Full Range							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	Na	3	High
Wheat	2	yes	no	yes	Na	3	Med
Developed	2	yes	no	yes	Na	3	Med
Other Crops	2	yes	no	yes	Na	3	Med
Vegetables & Ground Fruit	2	yes	no	yes	Na	3	Med
Orchards and Vineyards	2	yes	no	yes	Na	3	Med
Corn	1	yes	no	yes	yes	3	High
Other Grains	1	yes	no	yes	yes	3	High
Christmas Trees	1	yes	no	yes	yes	3	High
Nurseries	1	yes	no	yes	no	3	Low
Other Row Crops	1	yes	no	yes	no	3	Low
Bin 3	3	yes	no	yes	Na	3	High
Bin 4	3	yes	no	yes	Na	3	High
Sawtooth Lakes							
Mosquito Control	3	yes	no	yes	Na	3	High
Pasture	3	yes	no	yes	Na	3	High
Developed	1	yes	no	yes	no	3	Low
Other Grains	1	yes	no	yes	no	3	Low
Wheat	1	yes	no	yes	no	3	Low
Bin 3	3	yes	no	yes	Na	3	High
Bin 4	3	yes	no	yes	NA	3	High

Life Stage: Juvenile and adult migration (full-range)

Table 177. Direct mortality risk hypothesis; Sockeye salmon, Snake River ESU and malathion; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	15	High	**High**
Wheat	4	High	**Medium**
Developed	3	High	**Medium**
Other Crops	3	High	**Medium**
Vegetables & Ground Fruit	2	High	**Medium**
Orchards and Vineyards	1	High	**Medium**
Corn	1	High	**High**
Other Grains	<1	High	**High**
Christmas Trees	<1	High	**High**
Nurseries	<1	High	**Low**
Other Row Crops	<1	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**

Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via acute lethality.		
Risk	**Confidence**	
High	**Medium**	

Table 178. Prey risk hypothesis; Sockeye salmon, Snake River ESU and malathion; Adults

Endpoint: Prey (juveniles)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	15	High	**High**
Wheat	4	High	**Medium**
Developed	3	High	**Medium**
Other Crops	3	High	**Medium**
Vegetables & Ground Fruit	2	High	**Medium**
Orchards and Vineyards	1	High	**Medium**
Corn	1	High	**High**
Other Grains	<1	High	**High**
Christmas Trees	<1	High	**High**
Nurseries	<1	High	**Low**
Other Row Crops	<1	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**Medium**		

Table 179. Behavior and sensory risk hypothesis; Sockeye salmon, Snake River ESU and malathion; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	15	High	**High**
Wheat	4	Medium	**Medium**
Developed	3	Medium	**Medium**
Other Crops	3	Medium	**Medium**
Vegetables & Ground Fruit	2	High	**Medium**
Orchards and Vineyards	1	High	**Medium**
Corn	1	Medium	**High**
Other Grains	<1	Medium	**High**
Christmas Trees	<1	High	**High**
Nurseries	<1	High	**Low**
Other Row Crops	<1	High	**Low**

Bin 3		Low	**High**
Bin 4		Low	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	NA	**High**
Pasture	15	NA	**High**
Wheat	4	NA	**Medium**
Developed	3	NA	**Medium**
Other Crops	3	NA	**Medium**
Vegetables & Ground Fruit	2	NA	**Medium**
Orchards and Vineyards	1	NA	**Medium**
Corn	1	NA	**High**
Other Grains	<1	NA	**High**
Christmas Trees	<1	NA	**High**
Nurseries	<1	NA	**Low**
Other Row Crops	<1	NA	**Low**
Bin 3		NA	**High**
Bin 4		NA	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance and productivity via impairments to ecologically significant behaviors			
Risk	**Confidence**		
High	**Medium**		

Table 180. AChE risk hypothesis; Sockeye salmon, Snake River ESU and malathion; Adults

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	15	High	**High**
Wheat	4	High	**Medium**
Developed	3	Medium	**Medium**
Other Crops	3	High	**Medium**
Vegetables & Ground Fruit	2	High	**Medium**
Orchards and Vineyards	1	High	**Medium**
Corn	1	High	**High**
Other Grains	<1	High	**High**
Christmas Trees	<1	High	**High**
Nurseries	<1	High	**Low**
Other Row Crops	<1	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**

Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity		
Risk	**Confidence**	
High	**Medium**	

Table 181. Growth risk hypothesis; Sockeye salmon, Snake River ESU and malathion; Adults

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	15	Medium	**High**
Wheat	4	Medium	**Medium**
Developed	3	Medium	**Medium**
Other Crops	3	Medium	**Medium**
Vegetables & Ground Fruit	2	Medium	**Medium**
Orchards and Vineyards	1	Medium	**Medium**
Corn	1	Medium	**High**
Other Grains	<1	Medium	**High**
Christmas Trees	<1	Medium	**High**
Nurseries	<1	Medium	**Low**
Other Row Crops	<1	Medium	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
High	**Medium**		

Life Stage: Juvenile rearing and adult spawning (Sawtooth Lakes)

Table 182. Direct mortality risk hypothesis; Sockeye salmon, Snake River ESU and malathion; Adults and Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	22	High	High
Developed	<1	High	Low
Other Grains	<1	High	Low
Wheat	<1	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 183. Growth risk hypothesis; Sockeye salmon, Snake River ESU and malathion; Adults and Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	22	Medium	High
Developed	<1	Medium	Low
Other Grains	<1	Medium	Low
Wheat	<1	Medium	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	Medium		

Table 184. Prey risk hypothesis; Sockeye salmon, Snake River ESU and malathion; Adults and Juveniles

Endpoint: Prey			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	22	High	High
Developed	<1	High	Low
Other Grains	<1	High	Low
Wheat	<1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via reduction in prey availability			
Risk	Confidence		
High	High		

Table 185. AChE risk hypothesis; Sockeye salmon, Snake River ESU and malathion; Adults and Juveniles

Endpoint: Enzyme			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	22	High	High
Developed	<1	Medium	Low
Other Grains	<1	High	Low
Wheat	<1	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		

High	High	

Table 186. Reproduction risk hypothesis; Sockeye salmon, Snake River ESU and malathion; Adults

Endpoint: Reproduction			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Low	High
Pasture	22	High	High
Developed	<1	Low	Low
Other Grains	<1	High	Low
Wheat	<1	High	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	Confidence		
High	Low		

Table 187. Behavior and sensory risk hypothesis; Sockeye salmon, Snake River ESU and malathion; Adults and Juveniles

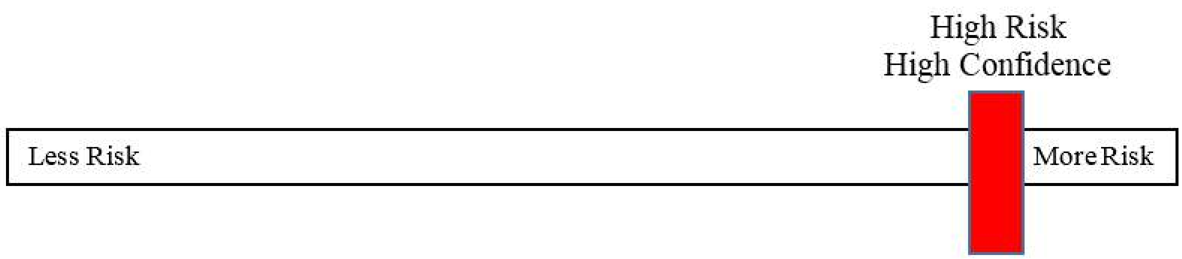
Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	22	High	**High**
Developed	<1	Medium	**Low**
Other Grains	<1	Medium	**Low**
Wheat	<1	Medium	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	NA	**High**
Pasture	22	NA	**High**
Developed	<1	NA	**Low**
Other Grains	<1	NA	**Low**
Wheat	<1	NA	**Low**
Bin 3		NA	**High**
Bin 4		NA	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**Medium**		

Table 188. Effects analysis summary table: Sockeye salmon, Snake River ESU and malathion

	R-plot Derived		**MagTool**	**Population Model Results: Sockeye Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Juvenile and adult migration (full-range)	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**		
Risk Hypothesis					
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	High	Medium	4-day: 0-25	Not Applicable	Yes
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	Medium	Not Available	Not Applicable	Yes
Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	Medium	Not Available	Not Applicable	Yes
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Medium	Not Available	Not Applicable	Yes
	R-plot Derived		**MagTool** Range in median percent mortalities of aquatic bins	**Population Model Results: Sockeye Salmon**	**Risk Hypothesis Supported? Yes/No**
Life Stage: Juvenile rearing and adult spawning (Sawtooth Lakes)	**Risk**	**Confidence**			
Risk Hypothesis					

Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 0-25	**Portion of juveniles exposed to malathion EECs; 10-1000 µg/l** 25% 50% 75% 100%	**Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles** 1-11% (8-19) 1-20% (8-21) 2-29% (8-20) 2-96% (8-0)	Yes
Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	Medium	Not Available	**Anticipated reductions in a population's intrinsic rate of growth (lambda) (± 1 STD)**		Yes
Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day invert: 24-50	2-24% (5-6)		Yes
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available			Yes
Exposure to malathion is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	Medium	Not Available	Not Applicable		**Yes**

Effects analysis summary: Adult and juvenile Sockeye salmon, Snake River ESU are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Population modelling results indicate that malathion-induced mortality to juveniles may lead to severe reductions in lambda up to 96%. Also, lambda may also be reduced due to reductions in juvenile growth via reduced prey abundance, cholinesterase activity, and impaired swimming. The MagTool results indicate that between 0-25 percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, sockeye will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed sockeye. The overall risk to Sockeye salmon, Snake River ESU from the effects of the action is high and the confidence associated with that risk is high.



14.20 Steelhead, California Central Valley DPS (Oncorhynchus mykiss)

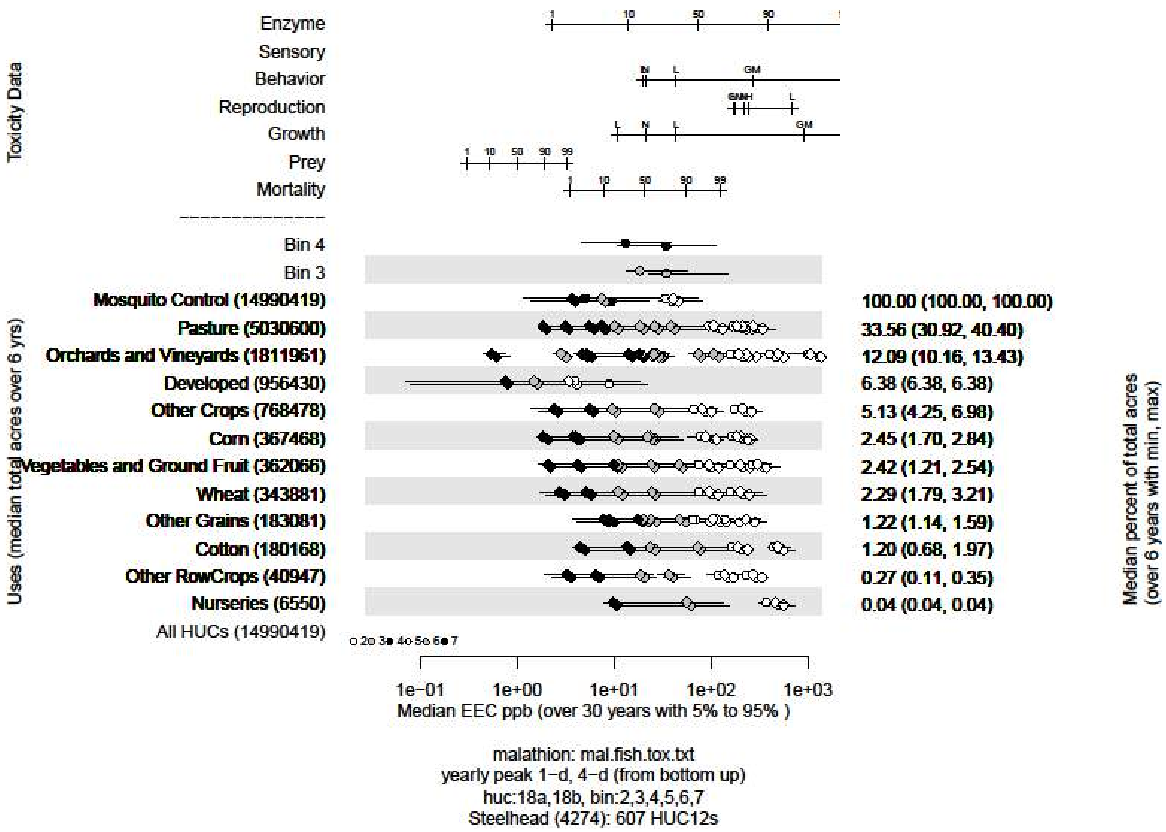


Figure 20. Effects analysis R-plot for Steelhead, California Central Valley DPS and malathion

Table 189. Likelihood of exposure determination for Steelhead, California Central Valley DPS and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Mosquito Control	3	yes	no	yes	NA	3	**High**
Pasture	3	yes	no	yes	NA	3	**High**
Orchards and Vineyards	3	yes	no	yes	NA	3	**High**
Developed	3	yes	no	yes	NA	3	**High**
Other Crops	3	yes	no	yes	NA	3	**High**
Corn	2	yes	no	yes	NA	3	**Med**
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	**Med**
Wheat	2	yes	no	yes	NA	3	**Med**
Other Grains	2	yes	no	yes	NA	3	**Med**
Cotton	2	yes	no	yes	NA	3	**Med**
Other Row Crops	1	yes	no	yes	yes	3	**High**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	3	yes	no	yes	NA	3	**High**
Bin 4	3	yes	no	yes	NA	3	**High**
Juveniles							
Mosquito Control	3	yes	no	yes	NA	3	**High**
Pasture	3	yes	no	yes	NA	3	**High**
Orchards and Vineyards	3	yes	no	yes	NA	3	**High**
Developed	3	yes	no	yes	NA	3	**High**
Other Crops	3	yes	no	yes	NA	3	**High**
Corn	2	yes	no	yes	NA	3	**Med**
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	**Med**
Wheat	2	yes	no	yes	NA	3	**Med**
Other Grains	2	yes	no	yes	NA	3	**Med**
Cotton	2	yes	no	yes	NA	3	**Med**
Other Row Crops	1	yes	no	yes	yes	3	**High**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	3	yes	no	yes	NA	3	**High**
Bin 4	3	yes	no	yes	NA	3	**High**

Life Stage: Adults (full-range)

Table 190. Direct mortality risk hypothesis; Steelhead, California Central Valley DPS and malathion; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	33.6	High	**High**
Orchards and Vineyards	12.1	High	**High**
Developed	6.4	High	**High**
Other Crops	5.1	High	**High**
Corn	2.5	High	**Medium**
Vegetables and Ground Fruit	2.4	High	**Medium**
Wheat	2.3	High	**Medium**

Other Grains	1.2	High	**Medium**
Cotton	1.2	High	**Medium**
Other Row Crops	0.3	High	**High**
Nurseries	0.04	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 191. Reproduction risk hypothesis; Steelhead, California Central Valley DPS and malathion; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	**High**
Pasture	33.6	High	**High**
Orchards and Vineyards	12.1	High	**High**
Developed	6.4	Low	**High**
Other Crops	5.1	Low	**High**
Corn	2.5	Low	**Medium**
Vegetables and Ground Fruit	2.4	High	**Medium**
Wheat	2.3	Medium	**Medium**
Other Grains	1.2	High	**Medium**
Cotton	1.2	High	**Medium**
Other Row Crops	0.3	High	**High**
Nurseries	0.04	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 192. Behavior and sensory risk hypothesis; Steelhead, California Central Valley DPS and malathion; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	33.6	High	**High**
Orchards and Vineyards	12.1	High	**High**
Developed	6.4	Medium	**High**

Other Crops	5.1	High	**High**
Corn	2.5	High	**Medium**
Vegetables and Ground Fruit	2.4	High	**Medium**
Wheat	2.3	High	**Medium**
Other Grains	1.2	High	**Medium**
Cotton	1.2	High	**Medium**
Other Row Crops	0.3	High	**High**
Nurseries	0.04	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Pasture	33.6	Not Available	**High**
Orchards and Vineyards	12.1	Not Available	**High**
Developed	6.4	Not Available	**High**
Other Crops	5.1	Not Available	**High**
Corn	2.5	Not Available	**Medium**
Vegetables and Ground Fruit	2.4	Not Available	**Medium**
Wheat	2.3	Not Available	**Medium**
Other Grains	1.2	Not Available	**Medium**
Cotton	1.2	Not Available	**Medium**
Other Row Crops	0.3	Not Available	**High**
Nurseries	0.04	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 193. AChE risk hypothesis; Steelhead, California Central Valley DPS and malathion; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	33.6	High	**High**
Orchards and Vineyards	12.1	High	**High**
Developed	6.4	Medium	**High**
Other Crops	5.1	High	**High**
Corn	2.5	High	**Medium**

Vegetables and Ground Fruit	2.4	High	**Medium**
Wheat	2.3	High	**Medium**
Other Grains	1.2	High	**Medium**
Cotton	1.2	High	**Medium**
Other Row Crops	0.3	High	**High**
Nurseries	0.04	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 194. Direct mortality risk hypothesis; Steelhead, California Central Valley DPS and malathion; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	33.6	High	High
Orchards and Vineyards	12.1	High	High
Developed	6.4	High	High
Other Crops	5.1	High	High
Corn	2.5	High	Medium
Vegetables and Ground Fruit	2.4	High	Medium
Wheat	2.3	High	Medium
Other Grains	1.2	High	Medium
Cotton	1.2	High	Medium
Other Row Crops	0.3	High	High
Nurseries	0.04	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 195. Growth risk hypothesis; Steelhead, California Central Valley DPS and malathion; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High

Pasture	33.6	Medium	High
Orchards and Vineyards	12.1	Medium	High
Developed	6.4	Low	High
Other Crops	5.1	Medium	High
Corn	2.5	Medium	Medium
Vegetables and Ground Fruit	2.4	Medium	Medium
Wheat	2.3	Medium	Medium
Other Grains	1.2	Medium	Medium
Cotton	1.2	Medium	Medium
Other Row Crops	0.3	Medium	High
Nurseries	0.04	Medium	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 196. Prey risk hypothesis; Steelhead, California Central Valley DPS and malathion; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	33.6	High	**High**
Orchards and Vineyards	12.1	High	**High**
Developed	6.4	High	**High**
Other Crops	5.1	High	**High**
Corn	2.5	High	**Medium**
Vegetables and Ground Fruit	2.4	High	**Medium**
Wheat	2.3	High	**Medium**
Other Grains	1.2	High	**Medium**
Cotton	1.2	High	**Medium**
Other Row Crops	0.3	High	**High**
Nurseries	0.04	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 197. AChE risk hypothesis; Steelhead, California Central Valley DPS and malathion; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	33.6	High	High
Orchards and Vineyards	12.1	High	High
Developed	6.4	Medium	High
Other Crops	5.1	High	High
Corn	2.5	High	Medium
Vegetables and Ground Fruit	2.4	High	Medium
Wheat	2.3	High	Medium
Other Grains	1.2	High	Medium
Cotton	1.2	High	Medium
Other Row Crops	0.3	High	High
Nurseries	0.04	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 198. Behavior and sensory risk hypothesis; Steelhead, California Central Valley DPS and malathion; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	33.6	High	**High**
Orchards and Vineyards	12.1	High	**High**
Developed	6.4	Medium	**High**
Other Crops	5.1	High	**High**
Corn	2.5	High	**Medium**
Vegetables and Ground Fruit	2.4	High	**Medium**
Wheat	2.3	High	**Medium**
Other Grains	1.2	High	**Medium**
Cotton	1.2	High	**Medium**
Other Row Crops	0.3	High	**High**
Nurseries	0.04	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Endpoint: Sensory			

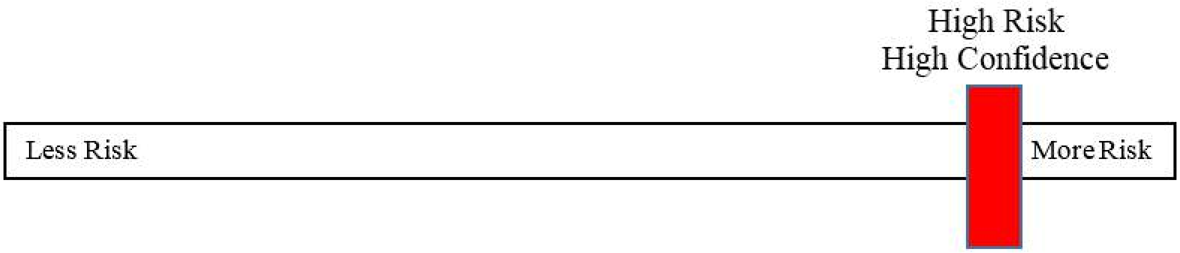
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Not Available	**High**
Pasture	33.6	Not Available	**High**
Orchards and Vineyards	12.1	Not Available	**High**
Developed	6.4	Not Available	**High**
Other Crops	5.1	Not Available	**High**
Corn	2.5	Not Available	**Medium**
Vegetables and Ground Fruit	2.4	Not Available	**Medium**
Wheat	2.3	Not Available	**Medium**
Other Grains	1.2	Not Available	**Medium**
Cotton	1.2	Not Available	**Medium**
Other Row Crops	0.3	Not Available	**High**
Nurseries	0.04	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 199. Effects analysis summary table: Steelhead, California Central Valley DPS and malathion

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 16-61	**Yes**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**

	R-plot Derived		MagTool	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 16-61	**Yes**
Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day fish: 6-61 4-day invert: 63-91	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, California Central Valley DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where malathion achieves predicted levels. The MagTool results indicate that between 16-61 percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed steelhead. The overall risk to Steelhead, California Central Valley DPS from the effects of the action is high and the confidence associated with that risk is high.



14.21 Steelhead, Central California Coast DPS (Oncorhynchus mykiss)

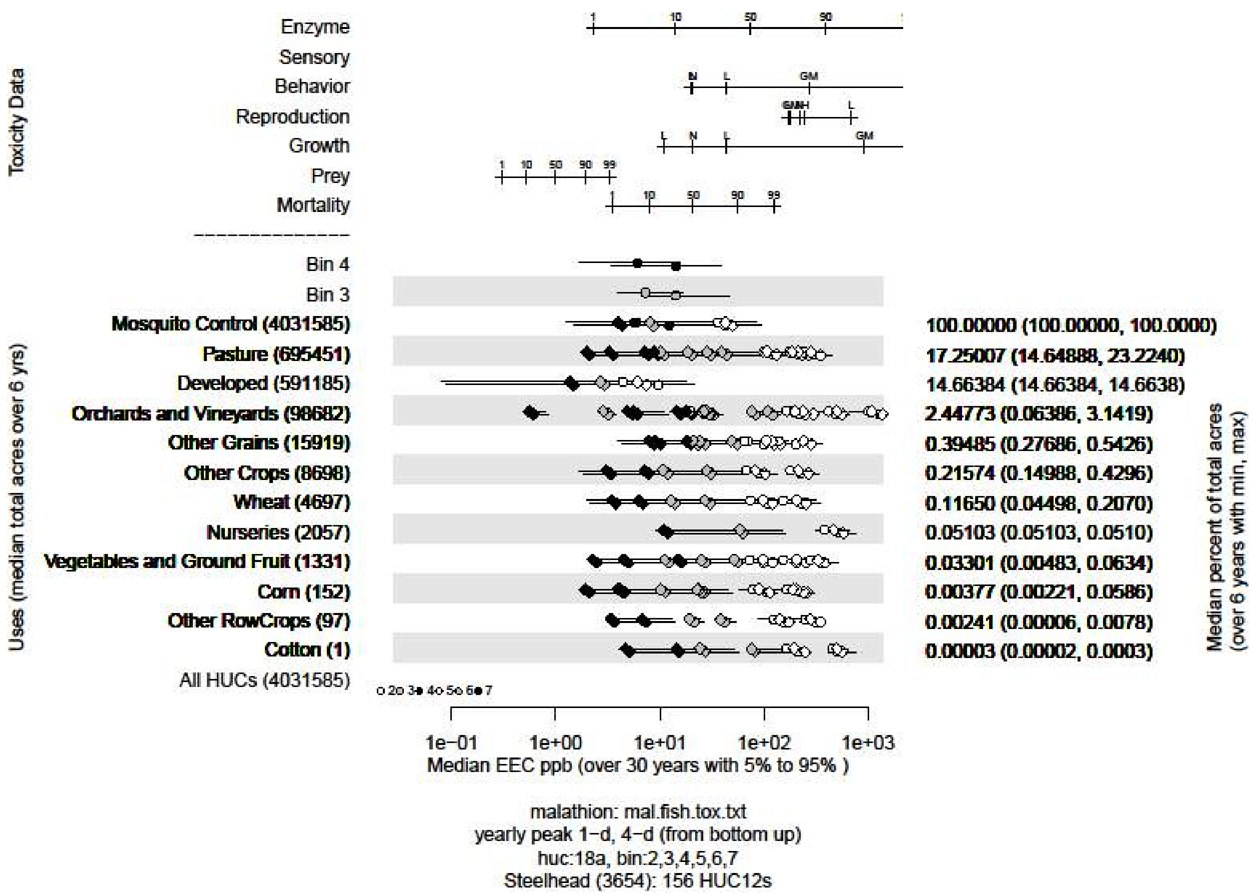


Figure 21. Effects analysis R-plot for Steelhead, Central California Coast DPS and malathion

Table 200. Likelihood of exposure determination for Steelhead, Central California Coast DPS and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Developed	3	yes	no	yes	NA	3	High
Orchards and Vineyards	2	yes	no	yes	NA	3	Med
Other Grains	1	yes	no	yes	yes	3	High
Other Crops	1	yes	no	yes	yes	3	High
Wheat	1	yes	no	yes	yes	3	High
Nurseries	1	yes	no	yes	no	3	Low
Vegetables and Ground Fruit	1	yes	no	yes	no	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High
Juveniles							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Developed	3	yes	no	yes	NA	3	High
Orchards and Vineyards	2	yes	no	yes	NA	3	Med
Other Grains	1	yes	no	yes	yes	3	High
Other Crops	1	yes	no	yes	yes	3	High
Wheat	1	yes	no	yes	yes	3	High
Nurseries	1	yes	no	yes	no	3	Low
Vegetables and Ground Fruit	1	yes	no	yes	no	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High

Life Stage: Adults (full-range)

Table 201. Direct mortality risk hypothesis; Steelhead, Central California Coast DPS and malathion; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	17.3	High	**High**
Developed	14.7	High	**High**
Orchards and Vineyards	2.4	High	**Medium**
Other Grains	0.4	High	**High**
Other Crops	0.2	High	**High**
Wheat	0.1	High	**High**
Nurseries	0.05	High	**Low**
Vegetables and Ground Fruit	0.03	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**

Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.		
Risk	**Confidence**	
High	**High**	

Table 202. Reproduction risk hypothesis; Steelhead, Central California Coast DPS and malathion; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	**High**
Pasture	17.3	High	**High**
Developed	14.7	Low	**High**
Orchards and Vineyards	2.4	High	**Medium**
Other Grains	0.4	High	**High**
Other Crops	0.2	Low	**High**
Wheat	0.1	Medium	**High**
Nurseries	0.05	High	**Low**
Vegetables and Ground Fruit	0.03	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 203. Behavior and sensory risk hypothesis; Steelhead, Central California Coast DPS and malathion; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	17.3	High	**High**
Developed	14.7	Low	**High**
Orchards and Vineyards	2.4	High	**Medium**
Other Grains	0.4	High	**High**
Other Crops	0.2	High	**High**
Wheat	0.1	High	**High**
Nurseries	0.05	High	**Low**
Vegetables and Ground Fruit	0.03	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Endpoint: Sensory			

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Not Available	**High**
Pasture	17.3	Not Available	**High**
Developed	14.7	Not Available	**High**
Orchards and Vineyards	2.4	Not Available	**Medium**
Other Grains	0.4	Not Available	**High**
Other Crops	0.2	Not Available	**High**
Wheat	0.1	Not Available	**High**
Nurseries	0.05	Not Available	**Low**
Vegetables and Ground Fruit	0.03	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 204. AChE risk hypothesis; Steelhead, Central California Coast DPS and malathion; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	17.3	High	**High**
Developed	14.7	Medium	**High**
Orchards and Vineyards	2.4	High	**Medium**
Other Grains	0.4	High	**High**
Other Crops	0.2	High	**High**
Wheat	0.1	High	**High**
Nurseries	0.05	High	**Low**
Vegetables and Ground Fruit	0.03	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 205. Direct mortality risk hypothesis; Steelhead, Central California Coast DPS and malathion; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	17.3	High	High
Developed	14.7	High	High
Orchards and Vineyards	2.4	High	Medium
Other Grains	0.4	High	High
Other Crops	0.2	High	High
Wheat	0.1	High	High
Nurseries	0.05	High	Low
Vegetables and Ground Fruit	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 206. Growth risk hypothesis; Steelhead, Central California Coast DPS and malathion; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	17.3	Medium	High
Developed	14.7	Low	High
Orchards and Vineyards	2.4	High	Medium
Other Grains	0.4	High	High
Other Crops	0.2	High	High
Wheat	0.1	High	High
Nurseries	0.05	High	Low
Vegetables and Ground Fruit	0.03	High	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 207. Prey risk hypothesis; Steelhead, Central California Coast DPS and malathion; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	17.3	High	**High**
Developed	14.7	High	**High**
Orchards and Vineyards	2.4	High	**Medium**
Other Grains	0.4	High	**High**
Other Crops	0.2	High	**High**
Wheat	0.1	High	**High**
Nurseries	0.05	High	**Low**
Vegetables and Ground Fruit	0.03	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 208. AChE risk hypothesis; Steelhead, Central California Coast DPS and malathion; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	17.3	High	High
Developed	14.7	Medium	High
Orchards and Vineyards	2.4	High	Medium
Other Grains	0.4	High	High
Other Crops	0.2	High	High
Wheat	0.1	High	High
Nurseries	0.05	High	Low
Vegetables and Ground Fruit	0.03	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 209. Behavior and sensory risk hypothesis; Steelhead, Central California Coast DPS and malathion; Juveniles

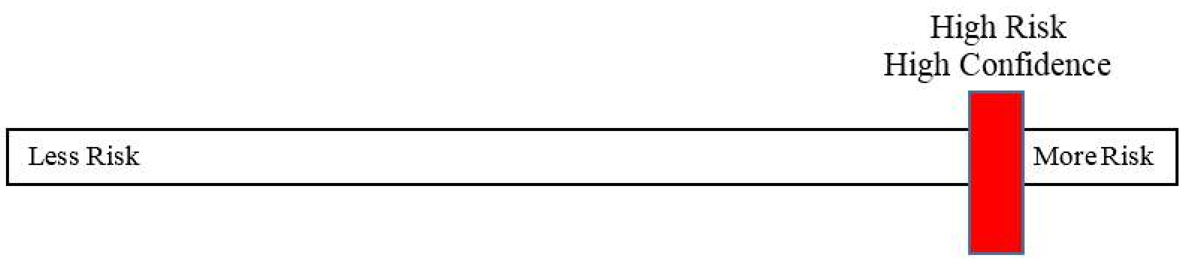
Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	17.3	High	**High**
Developed	14.7	Low	**High**
Orchards and Vineyards	2.4	High	**Medium**
Other Grains	0.4	High	**High**
Other Crops	0.2	High	**High**
Wheat	0.1	High	**High**
Nurseries	0.05	High	**Low**
Vegetables and Ground Fruit	0.03	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Pasture	17.3	Not Available	**High**
Developed	14.7	Not Available	**High**
Orchards and Vineyards	2.4	Not Available	**Medium**
Other Grains	0.4	Not Available	**High**
Other Crops	0.2	Not Available	**High**
Wheat	0.1	Not Available	**High**
Nurseries	0.05	Not Available	**Low**
Vegetables and Ground Fruit	0.03	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 210. Effects analysis summary table: Steelhead, Central California Coast DPS and malathion

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				

Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 3-21	**Yes**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 3-21	**Yes**
Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day fish: 2-21 4-day invert: 26-74	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, Central California Coast DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where malathion achieves predicted levels. The MagTool results indicate that between 57-98 percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed steelhead. The overall risk to Steelhead, Central California Coast DPS from the effects of the action is high and the confidence associated with that risk is high.



14.22 Steelhead, Lower Columbia River DPS (Oncorhynchus mykiss)

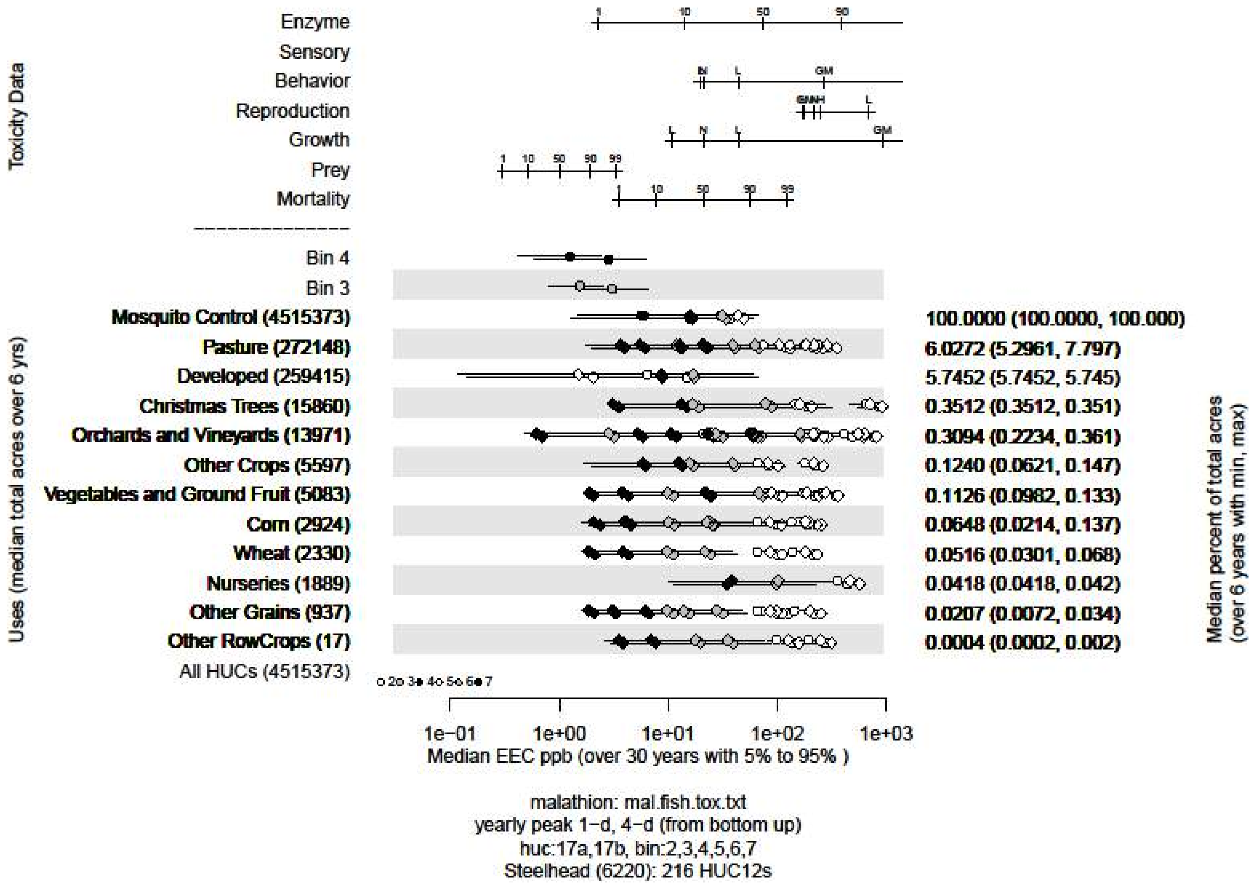


Figure 22. Effects analysis R-plot for Steelhead, Lower Columbia River DPS and malathion

Table 211. Likelihood of exposure determination for Steelhead, Lower Columbia River DPS and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Developed	3	yes	no	yes	NA	3	High
Christmas Trees	1	yes	no	yes	no	3	Low
Orchards and Vineyards	1	yes	no	yes	yes	3	High
Other Crops	1	yes	no	yes	yes	3	High
Vegetables and Ground Fruit	1	yes	no	yes	yes	3	High
Corn	1	yes	no	yes	yes	3	High
Wheat	1	yes	no	yes	yes	3	High
Nurseries	1	yes	no	yes	no	3	Low
Other Grains	1	yes	no	yes	yes	3	High
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High
Juveniles							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Developed	3	yes	no	yes	NA	3	High
Christmas Trees	1	yes	no	yes	no	3	Low
Orchards and Vineyards	1	yes	no	yes	yes	3	High
Other Crops	1	yes	no	yes	yes	3	High
Vegetables and Ground Fruit	1	yes	no	yes	yes	3	High
Corn	1	yes	no	yes	yes	3	High
Wheat	1	yes	no	yes	yes	3	High
Nurseries	1	yes	no	yes	no	3	Low
Other Grains	1	yes	no	yes	yes	3	High
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High

Life Stage: Adults (full-range)

Table 212. Direct mortality risk hypothesis; Steelhead, Lower Columbia River DPS and malathion; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Pasture	6.0	High	High
Developed	5.7	High	High
Christmas Trees	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Other Crops	0.1	High	High
Vegetables and Ground Fruit	0.1	High	High
Corn	0.06	High	High

Wheat	0.05	High	High
Nurseries	0.04	High	Low
Other Grains	0.02	High	High
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 213. Reproduction risk hypothesis; Steelhead, Lower Columbia River DPS and malathion; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	High
Pasture	6.0	High	High
Developed	5.7	Low	High
Christmas Trees	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Other Crops	0.1	Low	High
Vegetables and Ground Fruit	0.1	High	High
Corn	0.06	Low	High
Wheat	0.05	Low	High
Nurseries	0.04	High	Low
Other Grains	0.02	Low	High
Bin 3		Low	High
Bin 4			High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 214. Behavior and sensory risk hypothesis; Steelhead, Lower Columbia River DPS and malathion; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Pasture	6.0	High	High
Developed	5.7	Low	High
Christmas Trees	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Other Crops	0.1	High	High

Vegetables and Ground Fruit	0.1	High	High
Corn	0.06	High	High
Wheat	0.05	Medium	High
Nurseries	0.04	High	Low
Other Grains	0.02	High	High
Bin 3		Low	High
Bin 4		Low	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	High
Pasture	6.0	High	High
Developed	5.7	High	High
Christmas Trees	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Other Crops	0.1	High	High
Vegetables and Ground Fruit	0.1	High	High
Corn	0.06	High	High
Wheat	0.05	High	High
Nurseries	0.04	High	Low
Other Grains	0.02	High	High
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 215. AChE risk hypothesis; Steelhead, Lower Columbia River DPS and malathion; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Pasture	6.0	High	High
Developed	5.7	Medium	High
Christmas Trees	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Other Crops	0.1	High	High
Vegetables and Ground Fruit	0.1	High	High
Corn	0.06	High	High
Wheat	0.05	High	High
Nurseries	0.04	High	Low

Other Grains	0.02	High	High
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 216. Direct mortality risk hypothesis; Steelhead, Lower Columbia River DPS and malathion; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	6.0	High	High
Developed	5.7	High	High
Christmas Trees	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Other Crops	0.1	High	High
Vegetables and Ground Fruit	0.1	High	High
Corn	0.06	High	High
Wheat	0.05	High	High
Nurseries	0.04	High	Low
Other Grains	0.02	High	High
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 217. Growth risk hypothesis; Steelhead, Lower Columbia River DPS and malathion; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	6.0	Medium	High
Developed	5.7	Medium	High
Christmas Trees	0.4	Medium	Low
Orchards and Vineyards	0.3	Medium	High
Other Crops	0.1	Medium	High
Vegetables and Ground Fruit	0.1	Medium	High

Corn	0.06	Medium	High
Wheat	0.05	Medium	High
Nurseries	0.04	Medium	Low
Other Grains	0.02	Medium	High
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 218. Prey risk hypothesis; Steelhead, Lower Columbia River DPS and malathion; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Pasture	6.0	High	High
Developed	5.7	High	High
Christmas Trees	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Other Crops	0.1	High	High
Vegetables and Ground Fruit	0.1	High	High
Corn	0.06	High	High
Wheat	0.05	High	High
Nurseries	0.04	High	Low
Other Grains	0.02	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 219. AChE risk hypothesis; Steelhead, Lower Columbia River DPS and malathion; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	6.0	High	High
Developed	5.7	Medium	High
Christmas Trees	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Other Crops	0.1	High	High

Vegetables and Ground Fruit	0.1	High	High
Corn	0.06	High	High
Wheat	0.05	High	High
Nurseries	0.04	High	Low
Other Grains	0.02	High	High
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 220. Behavior and sensory risk hypothesis; Steelhead, Lower Columbia River DPS and malathion; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Pasture	6.0	High	High
Developed	5.7	Low	High
Christmas Trees	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Other Crops	0.1	High	High
Vegetables and Ground Fruit	0.1	High	High
Corn	0.06	High	High
Wheat	0.05	Medium	High
Nurseries	0.04	High	Low
Other Grains	0.02	High	High
Bin 3		Low	High
Bin 4		Low	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	High
Pasture	6.0	High	High
Developed	5.7	High	High
Christmas Trees	0.4	High	Low
Orchards and Vineyards	0.3	High	High
Other Crops	0.1	High	High
Vegetables and Ground Fruit	0.1	High	High
Corn	0.06	High	High
Wheat	0.05	High	High

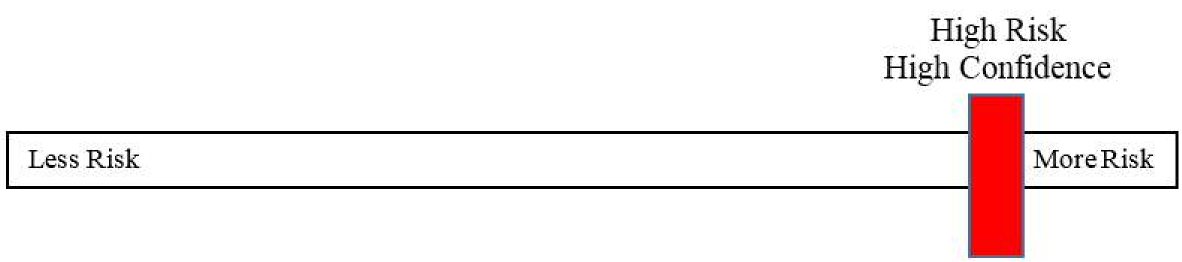
Nurseries	0.04	High	Low
Other Grains	0.02	High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 221. Effects analysis summary table: Steelhead, Lower Columbia River DPS and malathion

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 0-9	**Yes**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 0-9	**Yes**
Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce Juvenile	High	High	4-day fish: 0-8 4-day invert:	**Yes**

abundance via reduction in prey availability			10-30	
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, Lower Columbia River DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where malathion achieves predicted levels. The MagTool results indicate that between 0-9 percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed steelhead. The overall risk to Steelhead, Lower Columbia River DPS from the effects of the action is high and the confidence associated with that risk is high.



14.23 Steelhead, Middle Columbia River DPS

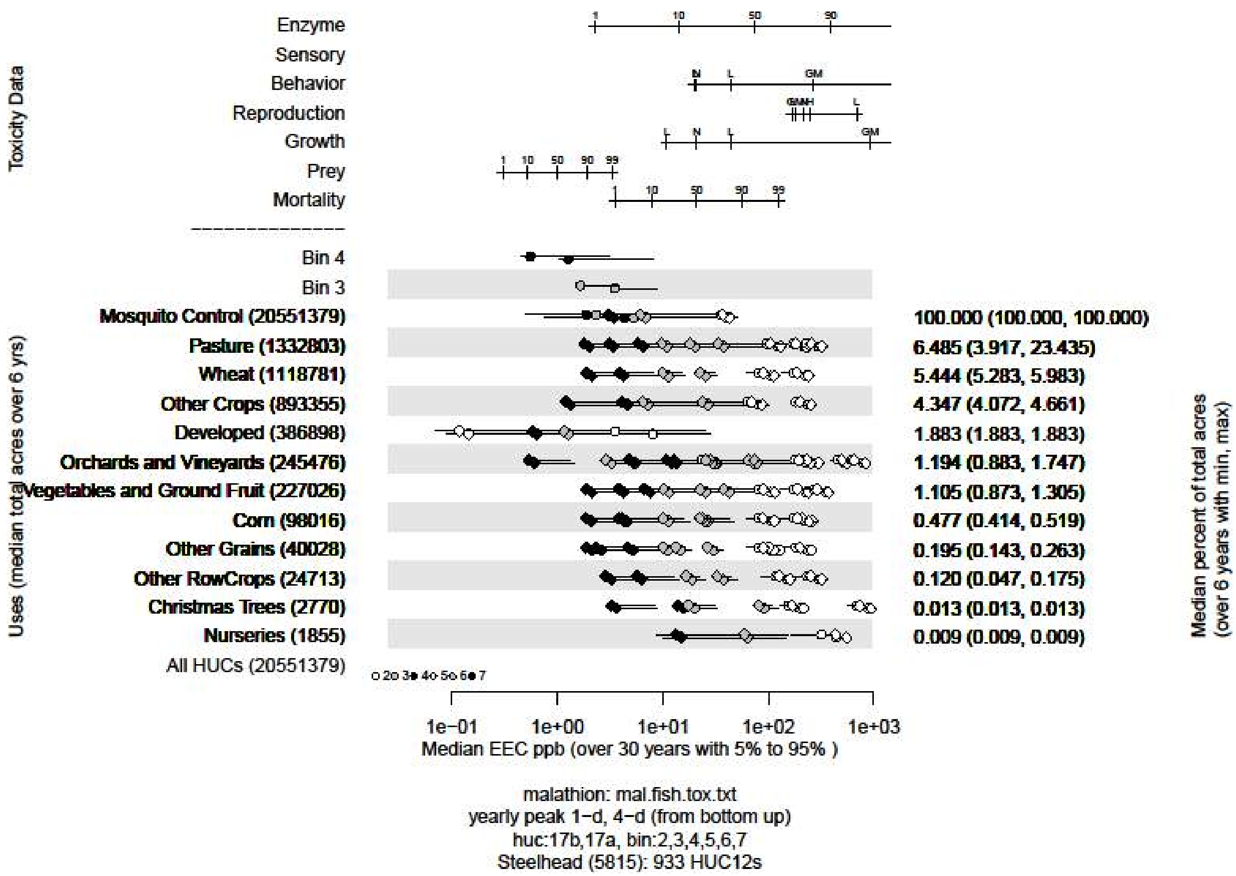


Figure 23. Effects analysis R-plot for Steelhead, Middle Columbia River DPS and malathion

Table 222. Likelihood of exposure determination for Steelhead, Middle Columbia River DPS and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Wheat	3	yes	no	yes	NA	3	High
Other Crops	2	yes	no	yes	NA	3	Med
Developed	2	yes	no	yes	NA	3	Med
Orchards and Vineyards	2	yes	no	yes	NA	3	Med
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	Med
Corn	1	yes	no	yes	yes	3	High
Other Grains	1	yes	no	yes	no	3	Low
Other Row Crops	1	yes	no	yes	yes	3	High
Christmas Trees	1	yes	no	yes	no	3	Low
Nurseries	1	yes	no	yes	no	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High
Juveniles							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Wheat	3	yes	no	yes	NA	3	High
Other Crops	2	yes	no	yes	NA	3	Med
Developed	2	yes	no	yes	NA	3	Med
Orchards and Vineyards	2	yes	no	yes	NA	3	Med
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	Med
Corn	1	yes	no	yes	yes	3	High
Other Grains	1	yes	no	yes	no	3	Low
Other Row Crops	1	yes	no	yes	yes	3	High
Christmas Trees	1	yes	no	yes	no	3	Low
Nurseries	1	yes	no	yes	no	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High

Life Stage: Adults (full-range)

Table 223. Direct mortality risk hypothesis; Steelhead, Middle Columbia River DPS and malathion; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	6.5	High	**High**
Wheat	5.4	High	**High**
Other Crops	4.3	High	**Medium**
Developed	1.9	Medium	**Medium**
Orchards and Vineyards	1.2	High	**Medium**
Vegetables and Ground Fruit	1.1	High	**Medium**

Corn	0.5	High	**High**
Other Grains	0.2	High	**Low**
Other Row Crops	0.1	High	**High**
Christmas Trees	0.01	High	**Low**
Nurseries	0.01	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 224. Reproduction risk hypothesis; Steelhead, Middle Columbia River DPS and malathion; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	**High**
Pasture	6.5	High	**High**
Wheat	5.4	Low	**High**
Other Crops	4.3	Low	**Medium**
Developed	1.9	Low	**Medium**
Orchards and Vineyards	1.2	High	**Medium**
Vegetables and Ground Fruit	1.1	High	**Medium**
Corn	0.5	Low	**High**
Other Grains	0.2	Low	**Low**
Other Row Crops	0.1	High	**High**
Christmas Trees	0.01	High	**Low**
Nurseries	0.01	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 225. Behavior and sensory risk hypothesis; Steelhead, Middle Columbia River DPS and malathion; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	6.5	High	**High**
Wheat	5.4	High	**High**
Other Crops	4.3	High	**Medium**

Developed	1.9	Medium	**Medium**
Orchards and Vineyards	1.2	High	**Medium**
Vegetables and Ground Fruit	1.1	High	**Medium**
Corn	0.5	High	**High**
Other Grains	0.2	High	**Low**
Other Row Crops	0.1	High	**High**
Christmas Trees	0.01	High	**Low**
Nurseries	0.01	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Pasture	6.5	Not Available	**High**
Wheat	5.4	Not Available	**High**
Other Crops	4.3	Not Available	**Medium**
Developed	1.9	Not Available	**Medium**
Orchards and Vineyards	1.2	Not Available	**Medium**
Vegetables and Ground Fruit	1.1	Not Available	**Medium**
Corn	0.5	Not Available	**High**
Other Grains	0.2	Not Available	**Low**
Other Row Crops	0.1	Not Available	**High**
Christmas Trees	0.01	Not Available	**Low**
Nurseries	0.01	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 226. AChE risk hypothesis; Steelhead, Middle Columbia River DPS and malathion; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	6.5	High	**High**
Wheat	5.4	High	**High**
Other Crops	4.3	High	**Medium**
Developed	1.9	Medium	**Medium**
Orchards and Vineyards	1.2	High	**Medium**

Vegetables and Ground Fruit	1.1	High	**Medium**
Corn	0.5	High	**High**
Other Grains	0.2	High	**Low**
Other Row Crops	0.1	High	**High**
Christmas Trees	0.01	High	**Low**
Nurseries	0.01	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 227. Direct mortality risk hypothesis; Steelhead, Middle Columbia River DPS and malathion; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	6.5	High	High
Wheat	5.4	High	High
Other Crops	4.3	High	Medium
Developed	1.9	Medium	Medium
Orchards and Vineyards	1.2	High	Medium
Vegetables and Ground Fruit	1.1	High	Medium
Corn	0.5	High	High
Other Grains	0.2	High	Low
Other Row Crops	0.1	High	High
Christmas Trees	0.01	High	Low
Nurseries	0.01	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 228. Growth risk hypothesis; Steelhead, Middle Columbia River DPS and malathion; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	6.5	Medium	High

Wheat	5.4	Medium	High
Other Crops	4.3	Medium	Medium
Developed	1.9	Low	Medium
Orchards and Vineyards	1.2	Medium	Medium
Vegetables and Ground Fruit	1.1	Medium	Medium
Corn	0.5	Medium	High
Other Grains	0.2	Medium	Low
Other Row Crops	0.1	Medium	High
Christmas Trees	0.01	Medium	Low
Nurseries	0.01	Medium	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 229. Prey risk hypothesis; Steelhead, Middle Columbia River DPS and malathion; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	6.5	High	**High**
Wheat	5.4	High	**High**
Other Crops	4.3	High	**Medium**
Developed	1.9	High	**Medium**
Orchards and Vineyards	1.2	High	**Medium**
Vegetables and Ground Fruit	1.1	High	**Medium**
Corn	0.5	High	**High**
Other Grains	0.2	High	**Low**
Other Row Crops	0.1	High	**High**
Christmas Trees	0.01	High	**Low**
Nurseries	0.01	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 230. AChE risk hypothesis; Steelhead, Middle Columbia River DPS and malathion; Juveniles

Endpoint: AChE

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	6.5	High	High
Wheat	5.4	High	High
Other Crops	4.3	High	Medium
Developed	1.9	Medium	Medium
Orchards and Vineyards	1.2	High	Medium
Vegetables and Ground Fruit	1.1	High	Medium
Corn	0.5	High	High
Other Grains	0.2	High	Low
Other Row Crops	0.1	High	High
Christmas Trees	0.01	High	Low
Nurseries	0.01	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 231. Behavior and sensory risk hypothesis; Steelhead, Middle Columbia River DPS and malathion; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	6.5	High	**High**
Wheat	5.4	High	**High**
Other Crops	4.3	High	**Medium**
Developed	1.9	Medium	**Medium**
Orchards and Vineyards	1.2	High	**Medium**
Vegetables and Ground Fruit	1.1	High	**Medium**
Corn	0.5	High	**High**
Other Grains	0.2	High	**Low**
Other Row Crops	0.1	High	**High**
Christmas Trees	0.01	High	**Low**
Nurseries	0.01	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**

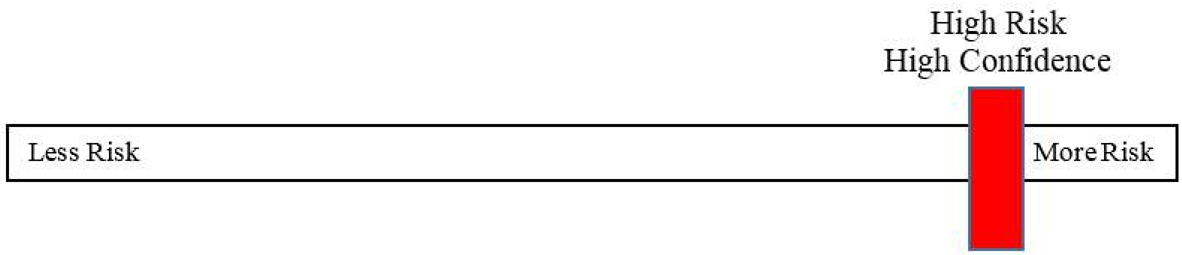
Pasture	6.5	Not Available	**High**
Wheat	5.4	Not Available	**High**
Other Crops	4.3	Not Available	**Medium**
Developed	1.9	Not Available	**Medium**
Orchards and Vineyards	1.2	Not Available	**Medium**
Vegetables and Ground Fruit	1.1	Not Available	**Medium**
Corn	0.5	Not Available	**High**
Other Grains	0.2	Not Available	**Low**
Other Row Crops	0.1	Not Available	**High**
Christmas Trees	0.01	Not Available	**Low**
Nurseries	0.01	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 232. Effects analysis summary table: Steelhead, Middle Columbia River DPS and malathion

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 1-20	**Yes**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	

Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	**Risk Hypothesis Supported? Yes/No**
Risk Hypothesis				
Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 1-20	**Yes**
Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day fish: 1-20 4-day invert: 20-46	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, Middle Columbia River DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where malathion achieves predicted levels. The MagTool results indicate that between 1-20 percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed steelhead. The overall risk to Steelhead, Middle Columbia River DPS from the effects of the action is high and the confidence associated with that risk is high.



14.24 Steelhead, Northern California DPS (Oncorhynchus mykiss)

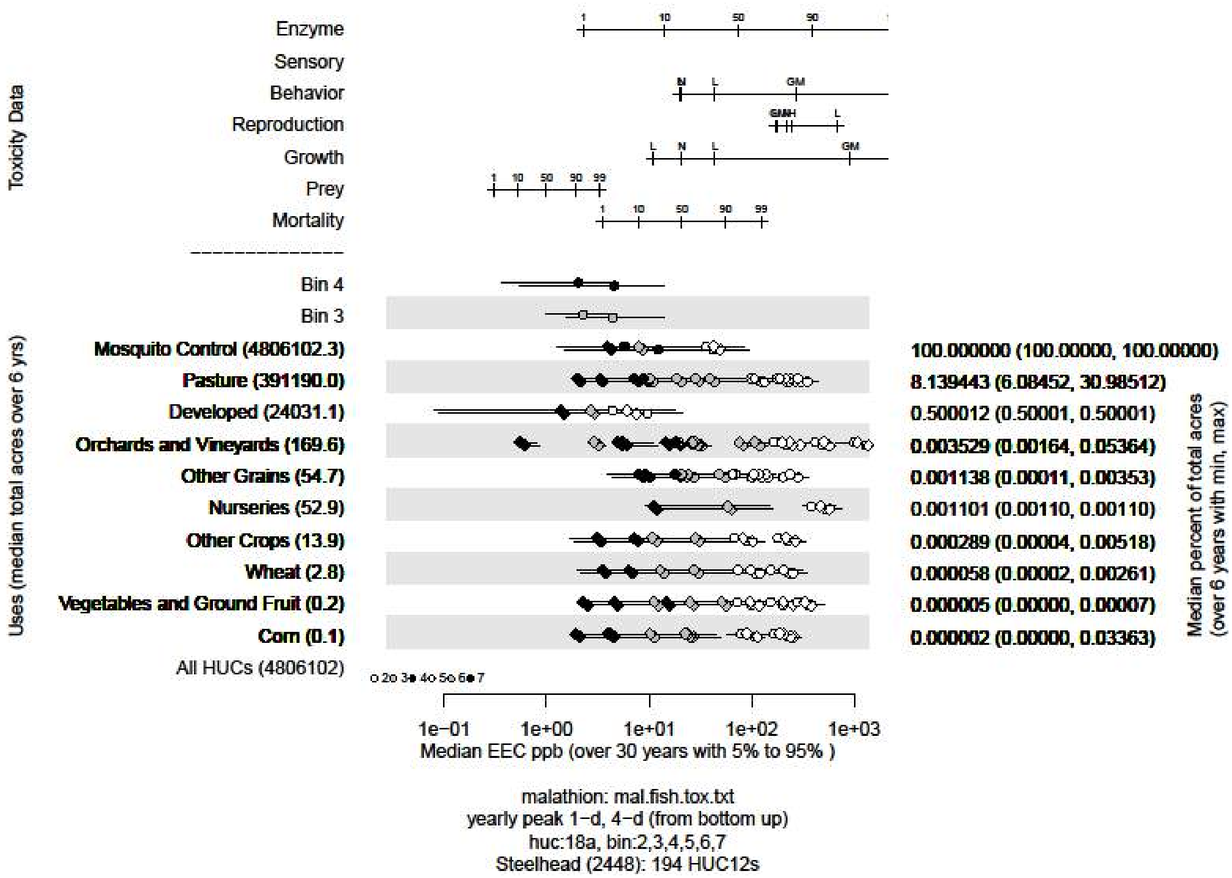


Figure 24. Effects analysis R-plot for Steelhead, Northern California DPS and malathion

Table 233. Likelihood of exposure determination for Steelhead, Northern California DPS and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Mosquito Control	3	yes	no	yes	NA	3	**High**
Pasture	3	yes	no	yes	NA	3	**High**
Developed	1	yes	no	yes	yes	3	**High**
Orchards and Vineyards	1	yes	no	yes	yes	3	**High**
Bin 3	3	yes	no	yes	NA	3	**High**
Bin 4	3	yes	no	yes	NA	3	**High**
Juveniles							
Mosquito Control	3	yes	no	yes	NA	3	**High**
Pasture	3	yes	no	yes	NA	3	**High**
Developed	1	yes	no	yes	yes	3	**High**
Orchards and Vineyards	1	yes	no	yes	yes	3	**High**
Bin 3	3	yes	no	yes	NA	3	**High**
Bin 4	3	yes	no	yes	NA	3	**High**

Life Stage: Adults (full-range)

Table 234. Direct mortality risk hypothesis; Steelhead, Northern California DPS and malathion; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Pasture	8.1	High	High
Developed	0.5	High	High
Orchards and Vineyards	0.004	High	High
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 235. Reproduction risk hypothesis; Steelhead, Northern California DPS and malathion; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Pasture	8.1	High	High
Developed	0.5	Low	High

Orchards and Vineyards	0.004	High	High
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 236. Behavior and sensory risk hypothesis; Steelhead, Northern California DPS and malathion; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Pasture	8.1	High	High
Developed	0.5	Low	High
Orchards and Vineyards	0.004	High	High
Bin 3		Low	High
Bin 4		Low	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	High
Pasture	8.1	Not Available	High
Developed	0.5	Not Available	High
Orchards and Vineyards	0.004	Not Available	High
Bin 3		Not Available	High
Bin 4		Not Available	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 237. AChE risk hypothesis; Steelhead, Northern California DPS and malathion; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Pasture	8.1	High	High
Developed	0.5	Medium	High
Orchards and Vineyards	0.004	High	High
Bin 3		Medium	High

Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 238. Direct mortality risk hypothesis; Steelhead, Northern California DPS and malathion; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	8.1	High	High
Developed	0.5	High	High
Orchards and Vineyards	0.004	High	High
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 239. Growth risk hypothesis; Steelhead, Northern California DPS and malathion; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	8.1	Medium	High
Developed	0.5	Low	High
Orchards and Vineyards	0.004	Medium	High
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 240. Prey risk hypothesis; Steelhead, Northern California DPS and malathion; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Pasture	8.1	High	High

Developed	0.5	High	High
Orchards and Vineyards	0.004	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 241. AChE risk hypothesis; Steelhead, Northern California DPS and malathion; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	8.1	High	High
Developed	0.5	Medium	High
Orchards and Vineyards	0.004	High	High
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 242. Behavior and sensory risk hypothesis; Steelhead, Northern California DPS and malathion; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Pasture	8.1	High	High
Developed	0.5	Low	High
Orchards and Vineyards	0.004	High	High
Bin 3		Low	High
Bin 4		Low	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	High
Pasture	8.1	Not Available	High
Developed	0.5	Not Available	High
Orchards and Vineyards	0.004	Not Available	High
Bin 3		Not Available	High

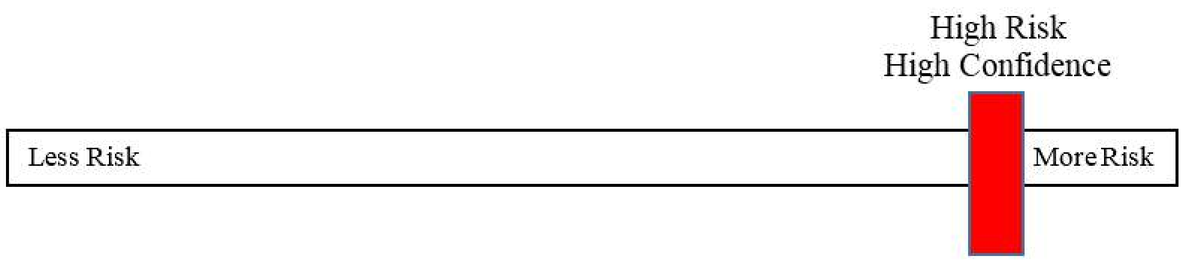
Bin 4		Not Available	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 243. Effects analysis summary table: Steelhead, Northern California DPS and malathion

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 1-8	**Yes**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 1-8	**Yes**
Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day fish: 0-8 4-day invert: 8-47	**Yes**

Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, Northern California DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where malathion achieves predicted levels. The MagTool results indicate that between 1-8 percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed steelhead. The overall risk to Steelhead, Northern California DPS from the effects of the action is high and the confidence associated with that risk is high.



14.25 Steelhead, Puget Sound DPS (Oncorhynchus mykiss)

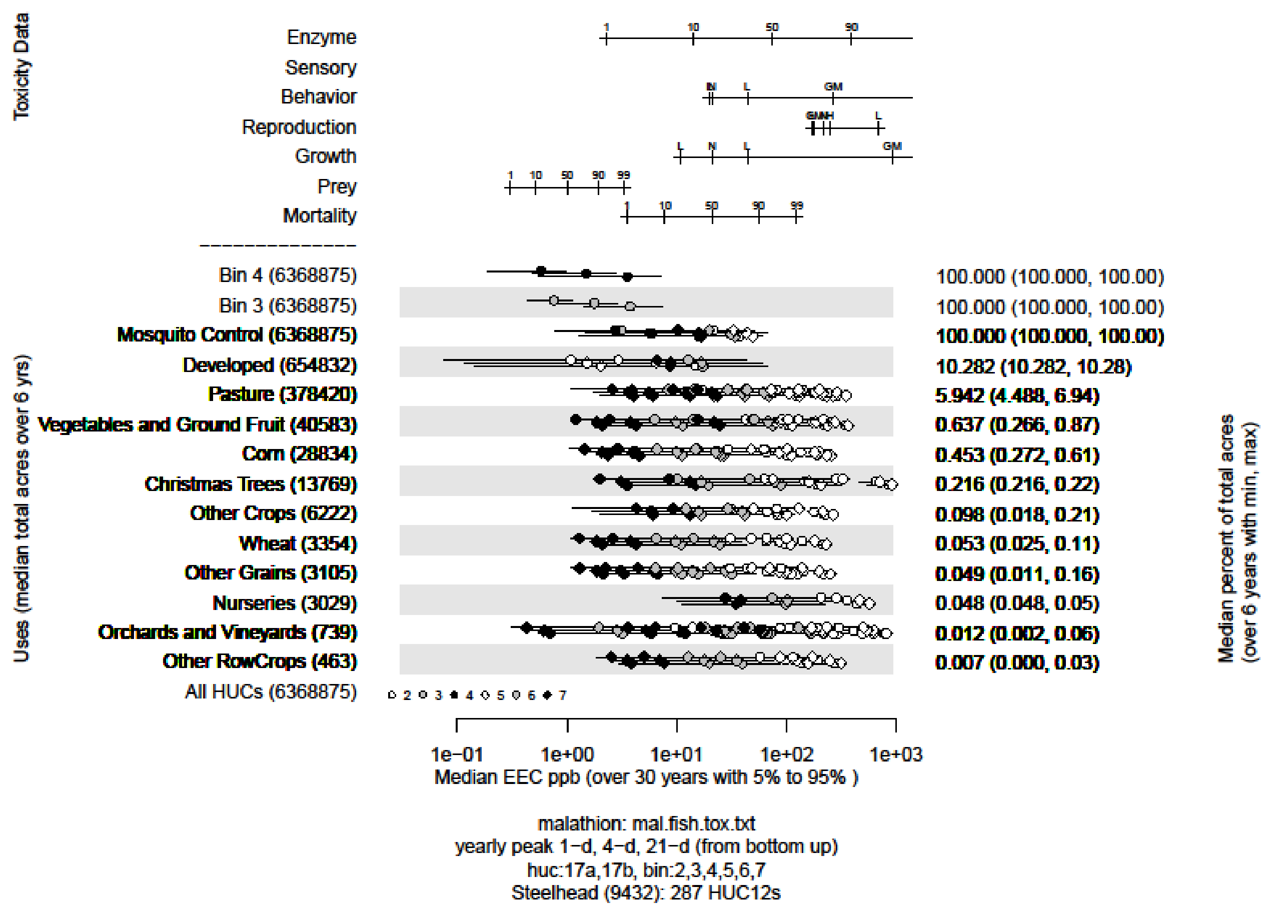


Figure 25. Effects analysis R-plot for Steelhead, Puget Sound DPS and malathion

Table 244. Likelihood of exposure determination for Steelhead, Puget Sound DPS and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Mosquito Control	3	yes	no	yes	NA	3	High
Developed	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	Low
Corn	1	yes	no	yes	NA	3	Low
Christmas Trees	1	yes	no	yes	NA	3	Low
Other Crops	1	yes	no	yes	NA	3	Low
Wheat	1	yes	no	yes	NA	3	Low
Other Grains	1	yes	no	yes	NA	3	Low
Nurseries	1	yes	no	yes	NA	3	Low
Orchards and Vineyards	1	yes	no	yes	NA	3	Low
Other Row Crops	1	yes	no	yes	NA	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High
Juveniles							
Mosquito Control	3	yes	no	yes	NA	3	High
Developed	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	Low
Corn	1	yes	no	yes	NA	3	Low
Christmas Trees	1	yes	no	yes	NA	3	Low
Other Crops	1	yes	no	yes	NA	3	Low
Wheat	1	yes	no	yes	NA	3	Low
Other Grains	1	yes	no	yes	NA	3	Low
Nurseries	1	yes	no	yes	NA	3	Low
Orchards and Vineyards	1	yes	no	yes	NA	3	Low
Other Row Crops	1	yes	no	yes	NA	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High

Life Stage: Adults (full-range)

Table 245. Direct mortality risk hypothesis; Steelhead, Puget Sound DPS and malathion; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Developed	10.3	High	High
Pasture	5.9	High	High
Vegetables and Ground Fruit	0.6	High	Low
Corn	0.5	High	Low
Christmas Trees	0.3	High	Low
Other Crops	0.1	High	Low
Wheat	0.5	High	Low
Other Grains	0.5	High	Low

Nurseries	0.5	High	Low
Orchards and Vineyards	0.1	High	Low
Other Row Crops	0.007	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 246. Reproduction risk hypothesis; Steelhead, Puget Sound DPS and malathion; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	High
Developed	10.3	Low	High
Pasture	5.9	High	High
Vegetables and Ground Fruit	0.6	High	Low
Corn	0.5	Low	Low
Christmas Trees	0.3	High	Low
Other Crops	0.1	Low	Low
Wheat	0.5	Low	Low
Other Grains	0.5	Low	Low
Nurseries	0.5	High	Low
Orchards and Vineyards	0.1	High	Low
Other Row Crops	0.007	High	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 247. Behavior and sensory risk hypothesis; Steelhead, Puget Sound DPS and malathion; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Developed	10.3	Medium	**High**
Pasture	5.9	High	**High**
Vegetables and Ground Fruit	0.6	High	**Low**
Corn	0.5	High	**Low**

Christmas Trees	0.3	High	**Low**
Other Crops	0.1	High	**Low**
Wheat	0.5	Medium	**Low**
Other Grains	0.5	High	**Low**
Nurseries	0.5	High	**Low**
Orchards and Vineyards	0.1	High	**Low**
Other Row Crops	0.007	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Developed	10.3	Not Available	**High**
Pasture	5.9	Not Available	**High**
Vegetables and Ground Fruit	0.6	Not Available	**Low**
Corn	0.5	Not Available	**Low**
Christmas Trees	0.3	Not Available	**Low**
Other Crops	0.1	Not Available	**Low**
Wheat	0.5	Not Available	**Low**
Other Grains	0.5	Not Available	**Low**
Nurseries	0.5	Not Available	**Low**
Orchards and Vineyards	0.1	Not Available	**Low**
Other Row Crops	0.007	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 248. AChE risk hypothesis; Steelhead, Puget Sound DPS and malathion; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Developed	10.3	Medium	**High**
Pasture	5.9	High	**High**
Vegetables and Ground Fruit	0.6	High	**Low**
Corn	0.5	High	**Low**
Christmas Trees	0.3	High	**Low**
Other Crops	0.1	High	**Low**
Wheat	0.5	High	**Low**

Other Grains	0.5	High	**Low**
Nurseries	0.5	High	**Low**
Orchards and Vineyards	0.1	High	**Low**
Other Row Crops	0.007	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 249. Direct mortality risk hypothesis; Steelhead, Puget Sound DPS and malathion; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Developed	10.3	High	High
Pasture	5.9	High	High
Vegetables and Ground Fruit	0.6	High	Low
Corn	0.5	High	Low
Christmas Trees	0.3	High	Low
Other Crops	0.1	High	Low
Wheat	0.5	High	Low
Other Grains	0.5	High	Low
Nurseries	0.5	High	Low
Orchards and Vineyards	0.1	High	Low
Other Row Crops	0.007	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 250. Growth risk hypothesis; Steelhead, Puget Sound DPS and malathion; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Developed	10.3	Medium	High
Pasture	5.9	Medium	High

Vegetables and Ground Fruit	0.6	Medium	Low
Corn	0.5	Medium	Low
Christmas Trees	0.3	Medium	Low
Other Crops	0.1	Medium	Low
Wheat	0.5	Medium	Low
Other Grains	0.5	Medium	Low
Nurseries	0.5	Medium	Low
Orchards and Vineyards	0.1	Medium	Low
Other Row Crops	0.007	Medium	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 251. Prey risk hypothesis; Steelhead, Puget Sound DPS and malathion; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Developed	10.3	High	**High**
Pasture	5.9	High	**High**
Vegetables and Ground Fruit	0.6	High	**Low**
Corn	0.5	High	**Low**
Christmas Trees	0.3	High	**Low**
Other Crops	0.1	High	**Low**
Wheat	0.5	High	**Low**
Other Grains	0.5	High	**Low**
Nurseries	0.5	High	**Low**
Orchards and Vineyards	0.1	High	**Low**
Other Row Crops	0.007	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 252. AChE risk hypothesis; Steelhead, Puget Sound DPS and malathion; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure

Mosquito Control	100	Medium	High
Developed	10.3	Medium	High
Pasture	5.9	High	High
Vegetables and Ground Fruit	0.6	High	Low
Corn	0.5	High	Low
Christmas Trees	0.3	High	Low
Other Crops	0.1	High	Low
Wheat	0.5	High	Low
Other Grains	0.5	High	Low
Nurseries	0.5	High	Low
Orchards and Vineyards	0.1	High	Low
Other Row Crops	0.007	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 253. Behavior and sensory risk hypothesis; Steelhead, Puget Sound DPS and malathion; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Developed	10.3	Medium	**High**
Pasture	5.9	High	**High**
Vegetables and Ground Fruit	0.6	High	**Low**
Corn	0.5	High	**Low**
Christmas Trees	0.3	High	**Low**
Other Crops	0.1	High	**Low**
Wheat	0.5	Medium	**Low**
Other Grains	0.5	High	**Low**
Nurseries	0.5	High	**Low**
Orchards and Vineyards	0.1	High	**Low**
Other Row Crops	0.007	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Developed	10.3	Not Available	**High**
Pasture	5.9	Not Available	**High**

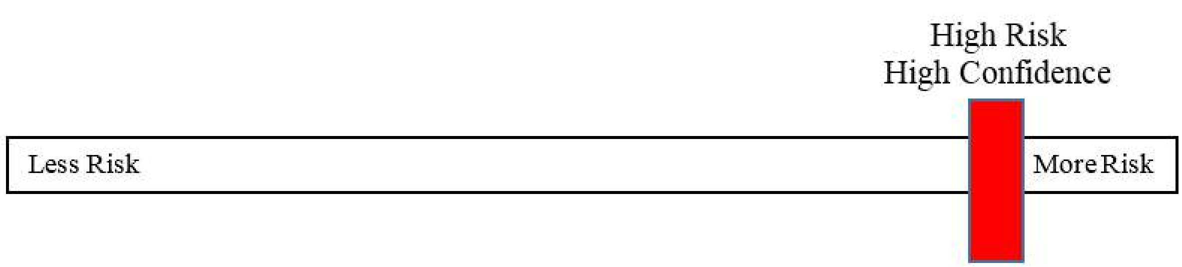
Vegetables and Ground Fruit	0.6	Not Available	**Low**
Corn	0.5	Not Available	**Low**
Christmas Trees	0.3	Not Available	**Low**
Other Crops	0.1	Not Available	**Low**
Wheat	0.5	Not Available	**Low**
Other Grains	0.5	Not Available	**Low**
Nurseries	0.5	Not Available	**Low**
Orchards and Vineyards	0.1	Not Available	**Low**
Other Row Crops	0.007	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 254. Effects analysis summary table: Steelhead, Puget Sound DPS and malathion

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: pending	**Yes**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				

Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: pending	**Yes**
Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day fish: pending 4-day invert: pending	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, Puget Sound DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where malathion achieves predicted levels. The MagTool results indicate that between [pending] percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed steelhead. The overall risk to Steelhead, Puget Sound DPS from the effects of the action is high and the confidence associated with that risk is high.



14.26 Steelhead, Snake River Basin DPS

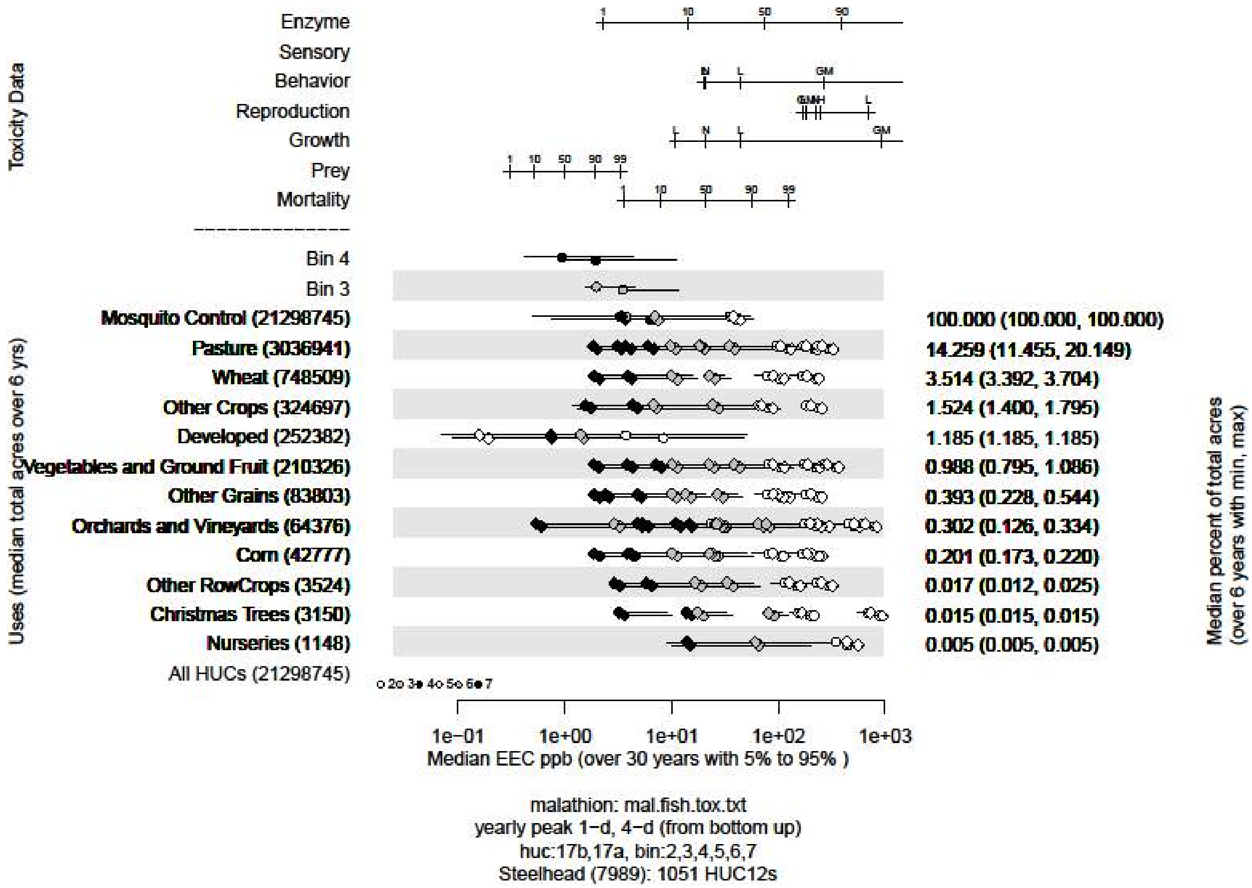


Figure 26. Effects analysis R-plot for Steelhead, Snake River Basin DPS and malathion

Table 255. Likelihood of exposure determination for Steelhead, Snake River Basin DPS and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Wheat	2	yes	no	yes	NA	3	Med
Other Crops	2	yes	no	yes	NA	3	Med
Developed	2	yes	no	yes	NA	3	Med
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	Med
Other Grains	1	yes	no	yes	yes	3	High
Orchards and Vineyards	1	yes	no	yes	yes	3	High
Corn	1	yes	no	yes	yes	3	High
Other Row Crops	1	yes	no	yes	no	3	Low
Christmas Trees	1	yes	no	yes	no	3	Low
Nurseries	1	yes	no	yes	no	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin4	3	yes	no	yes	NA	3	High
Juveniles							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Wheat	2	yes	no	yes	NA	3	Med
Other Crops	2	yes	no	yes	NA	3	Med
Developed	2	yes	no	yes	NA	3	Med
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	Med
Other Grains	1	yes	no	yes	yes	3	High
Orchards and Vineyards	1	yes	no	yes	yes	3	High
Corn	1	yes	no	yes	yes	3	High
Other Row Crops	1	yes	no	yes	no	3	Low
Christmas Trees	1	yes	no	yes	no	3	Low
Nurseries	1	yes	no	yes	no	3	Low
Bin 3	3	yes	no	yes	NA	3	High
Bin4	3	yes	no	yes	NA	3	High

Life Stage: Adults (full-range)

Table 256. Direct mortality risk hypothesis; Steelhead, Snake River Basin DPS and malathion; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Pasture	14.3	High	High
Wheat	3.5	High	Medium
Other Crops	1.5	High	Medium
Developed	1.2	Medium	Medium
Vegetables and Ground Fruit	1.0	High	Medium
Other Grains	0.4	High	High
Orchards and Vineyards	0.3	High	High
Corn	0.2	High	High

Other Row Crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.005	High	Low
Bin 3		Medium	High
Bin4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 257. Reproduction risk hypothesis; Steelhead, Snake River Basin DPS and malathion; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	High
Pasture	14.3	Medium	High
Wheat	3.5	Low	Medium
Other Crops	1.5	Low	Medium
Developed	1.2	Low	Medium
Vegetables and Ground Fruit	1.0	Medium	Medium
Other Grains	0.4	Low	High
Orchards and Vineyards	0.3	Medium	High
Corn	0.2	Low	High
Other Row Crops	0.02	Medium	Low
Christmas Trees	0.02	Medium	Low
Nurseries	0.005	Medium	Low
Bin 3		Low	High
Bin4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 258. Behavior and sensory risk hypothesis; Steelhead, Snake River Basin DPS and malathion; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Pasture	14.3	High	High
Wheat	3.5	High	Medium
Other Crops	1.5	High	Medium
Developed	1.2	Medium	Medium
Vegetables and Ground Fruit	1.0	High	Medium

Other Grains	0.4	High	High
Orchards and Vineyards	0.3	High	High
Corn	0.2	High	High
Other Row Crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.005	High	Low
Bin 3		Low	High
Bin4		Low	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	High
Pasture	14.3	Not Available	High
Wheat	3.5	Not Available	Medium
Other Crops	1.5	Not Available	Medium
Developed	1.2	Not Available	Medium
Vegetables and Ground Fruit	1.0	Not Available	Medium
Other Grains	0.4	Not Available	High
Orchards and Vineyards	0.3	Not Available	High
Corn	0.2	Not Available	High
Other Row Crops	0.02	Not Available	Low
Christmas Trees	0.02	Not Available	Low
Nurseries	0.005	Not Available	Low
Bin 3		Not Available	High
Bin4		Not Available	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 259. AChE risk hypothesis; Steelhead, Snake River Basin DPS and malathion; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Pasture	14.3	High	High
Wheat	3.5	High	Medium
Other Crops	1.5	High	Medium
Developed	1.2	Medium	Medium
Vegetables and Ground Fruit	1.0	High	Medium
Other Grains	0.4	High	High
Orchards and Vineyards	0.3	High	High

Corn	0.2	High	High
Other Row Crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.005	High	Low
Bin 3		Medium	High
Bin4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 260. Direct mortality risk hypothesis; Steelhead, Snake River Basin DPS and malathion; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	14.3	High	High
Wheat	3.5	High	Medium
Other Crops	1.5	High	Medium
Developed	1.2	Medium	Medium
Vegetables and Ground Fruit	1.0	High	Medium
Other Grains	0.4	High	High
Orchards and Vineyards	0.3	High	High
Corn	0.2	High	High
Other Row Crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.005	High	Low
Bin 3		Medium	High
Bin4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 261. Growth risk hypothesis; Steelhead, Snake River Basin DPS and malathion; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	14.3	Medium	High
Wheat	3.5	Medium	Medium
Other Crops	1.5	Medium	Medium
Developed	1.2	Medium	Medium

Vegetables and Ground Fruit	1.0	Medium	Medium
Other Grains	0.4	Medium	High
Orchards and Vineyards	0.3	Medium	High
Corn	0.2	Medium	High
Other Row Crops	0.02	Medium	Low
Christmas Trees	0.02	Medium	Low
Nurseries	0.005	Medium	Low
Bin 3		Low	High
Bin4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 262. Prey risk hypothesis; Steelhead, Snake River Basin DPS and malathion; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Pasture	14.3	High	High
Wheat	3.5	High	Medium
Other Crops	1.5	High	Medium
Developed	1.2	High	Medium
Vegetables and Ground Fruit	1.0	High	Medium
Other Grains	0.4	High	High
Orchards and Vineyards	0.3	High	High
Corn	0.2	High	High
Other Row Crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.005	High	Low
Bin 3		High	High
Bin4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 263. AChE risk hypothesis; Steelhead, Snake River Basin DPS and malathion; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	14.3	High	High

Wheat	3.5	High	Medium
Other Crops	1.5	High	Medium
Developed	1.2	Medium	Medium
Vegetables and Ground Fruit	1.0	High	Medium
Other Grains	0.4	High	High
Orchards and Vineyards	0.3	High	High
Corn	0.2	High	High
Other Row Crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.005	High	Low
Bin 3		Medium	High
Bin4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 264. Behavior and sensory risk hypothesis; Steelhead, Snake River Basin DPS and malathion; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Pasture	14.3	High	High
Wheat	3.5	High	Medium
Other Crops	1.5	High	Medium
Developed	1.2	Medium	Medium
Vegetables and Ground Fruit	1.0	High	Medium
Other Grains	0.4	High	High
Orchards and Vineyards	0.3	High	High
Corn	0.2	High	High
Other Row Crops	0.02	High	Low
Christmas Trees	0.02	High	Low
Nurseries	0.005	High	Low
Bin 3		Low	High
Bin4		Low	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	High
Pasture	14.3	Not Available	High
Wheat	3.5	Not Available	Medium
Other Crops	1.5	Not Available	Medium
Developed	1.2	Not Available	Medium

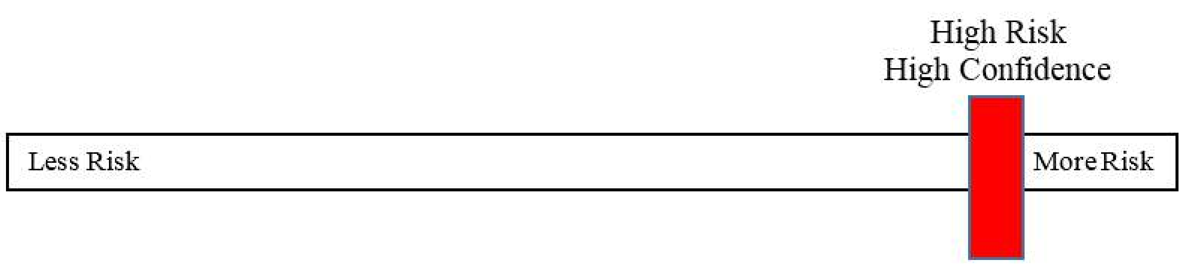
Vegetables and Ground Fruit	1.0	Not Available	Medium
Other Grains	0.4	Not Available	High
Orchards and Vineyards	0.3	Not Available	High
Corn	0.2	Not Available	High
Other Row Crops	0.02	Not Available	Low
Christmas Trees	0.02	Not Available	Low
Nurseries	0.005	Not Available	Low
Bin 3		Not Available	High
Bin 4		Not Available	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 265. Effects analysis summary table: Steelhead, Snake River Basin DPS and malathion

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 0-21	**Yes**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce juvenile	High	High	4-day: 0-21	**Yes**

abundance via acute lethality.				
Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day fish: 0-21 4-day invert: 22-40	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, Snake River Basin DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where malathion achieves predicted levels. The MagTool results indicate that between 0-21 percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed steelhead. The overall risk to Steelhead, Snake River Basin DPS from the effects of the action is high and the confidence associated with that risk is high.



14.27 Steelhead, South-Central California Coast DPS (Oncorhynchus mykiss)

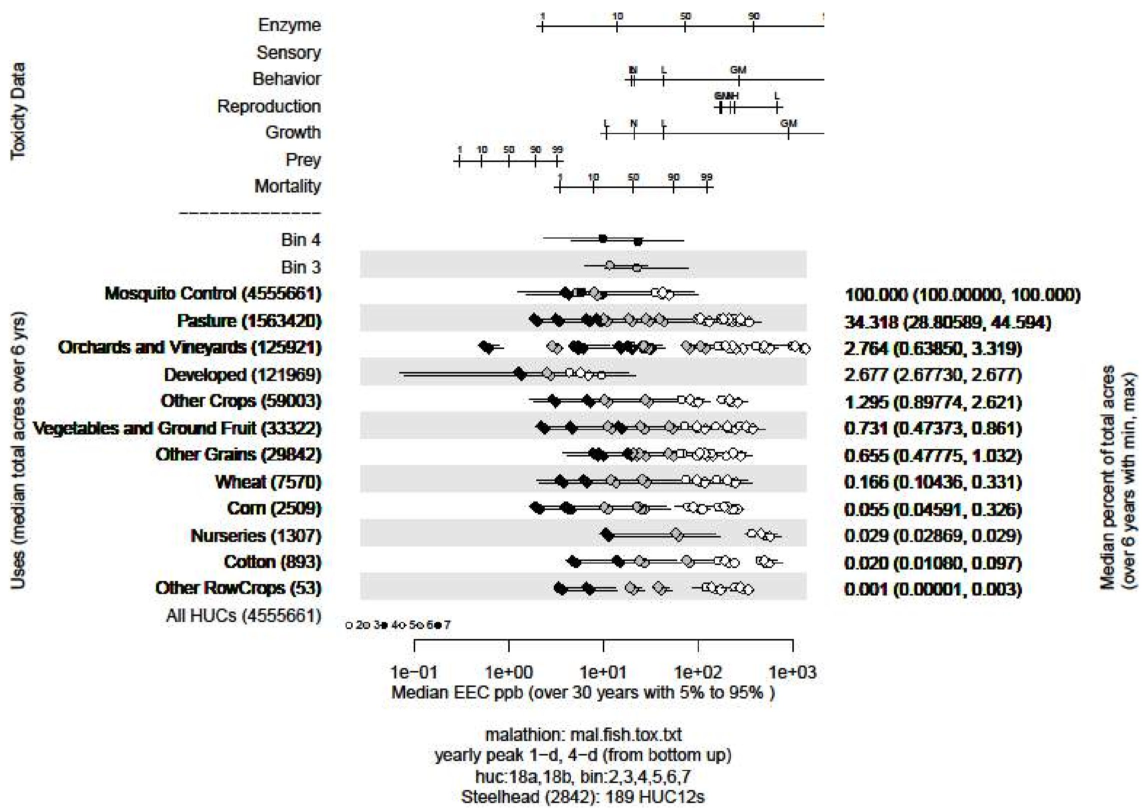


Figure 27. Effects analysis R-plot for Steelhead, South-Central California Coast DPS and malathion

Table 266. Likelihood of exposure determination for Steelhead, South-Central California Coast DPS and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Orchards and Vineyards	2	yes	no	yes	NA	3	Med
Developed	2	yes	no	yes	NA	3	Med
Other Crops	2	yes	no	yes	NA	3	Med
Vegetables and Ground Fruit	1	yes	no	yes	yes	3	High
Other Grains	1	yes	no	yes	yes	3	High
Wheat	1	yes	no	yes	yes	3	High
Corn	1	yes	no	yes	yes	3	High
Nurseries	1	yes	no	yes	no	3	Low
Cotton	1	yes	no	yes	yes	3	High
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High
Juveniles							
Mosquito Control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Orchards and Vineyards	2	yes	no	yes	NA	3	Med
Developed	2	yes	no	yes	NA	3	Med
Other Crops	2	yes	no	yes	NA	3	Med
Vegetables and Ground Fruit	1	yes	no	yes	yes	3	High
Other Grains	1	yes	no	yes	yes	3	High
Wheat	1	yes	no	yes	yes	3	High
Corn	1	yes	no	yes	yes	3	High
Nurseries	1	yes	no	yes	no	3	Low
Cotton	1	yes	no	yes	yes	3	High
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High

Life Stage: Adults (full-range)

Table 267. Direct mortality risk hypothesis; Steelhead, South-Central California Coast DPS and malathion; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Pasture	34.3	High	High
Orchards and Vineyards	2.8	High	Medium
Developed	2.7	High	Medium
Other Crops	1.3	High	Medium
Vegetables and Ground Fruit	0.7	High	High

Other Grains	0.7	High	High
Wheat	0.2	High	High
Corn	0.1	High	High
Nurseries	0.03	High	Low
Cotton	0.02	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 268. Reproduction risk hypothesis; Steelhead, South-Central California Coast DPS and malathion; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	High
Pasture	34.3	High	High
Orchards and Vineyards	2.8	High	Medium
Developed	2.7	Low	Medium
Other Crops	1.3	Medium	Medium
Vegetables and Ground Fruit	0.7	High	High
Other Grains	0.7	High	High
Wheat	0.2	Medium	High
Corn	0.1	Low	High
Nurseries	0.03	High	Low
Cotton	0.02	High	High
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 269. Behavior and sensory risk hypothesis; Steelhead, South-Central California Coast DPS and malathion; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Pasture	34.3	High	High
Orchards and Vineyards	2.8	High	Medium

Developed	2.7	Low	Medium
Other Crops	1.3	High	Medium
Vegetables and Ground Fruit	0.7	High	High
Other Grains	0.7	High	High
Wheat	0.2	High	High
Corn	0.1	High	High
Nurseries	0.03	High	Low
Cotton	0.02	High	High
Bin 3		Medium	High
Bin 4		Medium	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	High
Pasture	34.3	Not Available	High
Orchards and Vineyards	2.8	Not Available	Medium
Developed	2.7	Not Available	Medium
Other Crops	1.3	Not Available	Medium
Vegetables and Ground Fruit	0.7	Not Available	High
Other Grains	0.7	Not Available	High
Wheat	0.2	Not Available	High
Corn	0.1	Not Available	High
Nurseries	0.03	Not Available	Low
Cotton	0.02	Not Available	High
Bin 3		Not Available	High
Bin 4		Not Available	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 270. AChE risk hypothesis; Steelhead, South-Central California Coast DPS and malathion; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Pasture	34.3	High	High
Orchards and Vineyards	2.8	High	Medium
Developed	2.7	Medium	Medium
Other Crops	1.3	High	Medium
Vegetables and Ground Fruit	0.7	High	High
Other Grains	0.7	High	High

Wheat	0.2	High	High
Corn	0.1	High	High
Nurseries	0.03	High	Low
Cotton	0.02	High	High
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 271. Direct mortality risk hypothesis; Steelhead, South-Central California Coast DPS and malathion; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	34.3	High	High
Orchards and Vineyards	2.8	High	Medium
Developed	2.7	High	Medium
Other Crops	1.3	High	Medium
Vegetables and Ground Fruit	0.7	High	High
Other Grains	0.7	High	High
Wheat	0.2	High	High
Corn	0.1	High	High
Nurseries	0.03	High	Low
Cotton	0.02	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 272. Growth risk hypothesis; Steelhead, South-Central California Coast DPS and malathion; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	34.3	Medium	High
Orchards and Vineyards	2.8	Medium	Medium
Developed	2.7	Low	Medium

Other Crops	1.3	Medium	Medium
Vegetables and Ground Fruit	0.7	Medium	High
Other Grains	0.7	Medium	High
Wheat	0.2	Medium	High
Corn	0.1	Medium	High
Nurseries	0.03	Medium	Low
Cotton	0.02	Medium	High
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 273. Prey risk hypothesis; Steelhead, South-Central California Coast DPS and malathion; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Pasture	34.3	High	High
Orchards and Vineyards	2.8	High	Medium
Developed	2.7	High	Medium
Other Crops	1.3	High	Medium
Vegetables and Ground Fruit	0.7	High	High
Other Grains	0.7	High	High
Wheat	0.2	High	High
Corn	0.1	High	High
Nurseries	0.03	High	Low
Cotton	0.02	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 274. AChE risk hypothesis; Steelhead, South-Central California Coast DPS and malathion; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	34.3	High	High
Orchards and Vineyards	2.8	High	Medium

Developed	2.7	Medium	Medium
Other Crops	1.3	High	Medium
Vegetables and Ground Fruit	0.7	High	High
Other Grains	0.7	High	High
Wheat	0.2	High	High
Corn	0.1	High	High
Nurseries	0.03	High	Low
Cotton	0.02	High	High
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 275. Behavior and sensory risk hypothesis; Steelhead, South-Central California Coast DPS and malathion; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Pasture	34.3	High	High
Orchards and Vineyards	2.8	High	Medium
Developed	2.7	Low	Medium
Other Crops	1.3	High	Medium
Vegetables and Ground Fruit	0.7	High	High
Other Grains	0.7	High	High
Wheat	0.2	High	High
Corn	0.1	High	High
Nurseries	0.03	High	Low
Cotton	0.02	High	High
Bin 3		Medium	High
Bin 4		Medium	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	High
Pasture	34.3	Not Available	High
Orchards and Vineyards	2.8	Not Available	Medium
Developed	2.7	Not Available	Medium
Other Crops	1.3	Not Available	Medium
Vegetables and Ground Fruit	0.7	Not Available	High

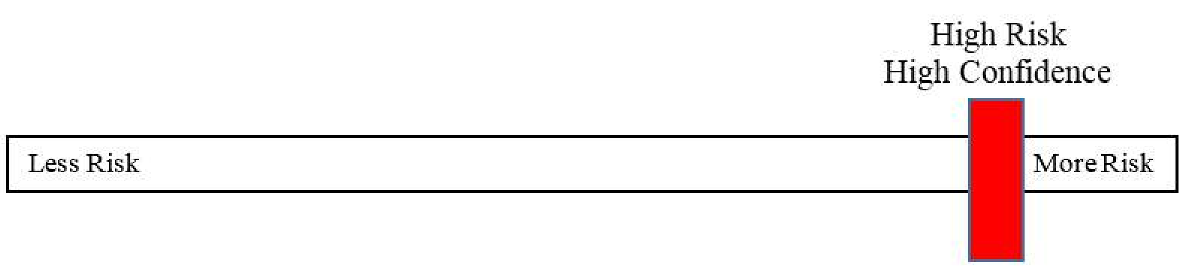
Other Grains	0.7	Not Available	High
Wheat	0.2	Not Available	High
Corn	0.1	Not Available	High
Nurseries	0.03	Not Available	Low
Cotton	0.02	Not Available	High
Bin 3		Not Available	High
Bin 4		Not Available	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 276. Effects analysis summary table: Steelhead, South-Central California Coast DPS and malathion

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 4-40	**Yes**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 4-40	**Yes**
Exposure to malathion is sufficient to reduce	High	High	Not Available	**Yes**

abundance via impacts to growth (direct toxicity)				
Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day fish: 2-40 4-day invert: 41-83	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, South-Central California Coast DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where malathion achieves predicted levels. The MagTool results indicate that between 4-40 percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed steelhead. The overall risk to Steelhead, South-Central California Coast DPS from the effects of the action is high and the confidence associated with that risk is high.



14.28 Steelhead, Southern California DPS (Oncorhynchus mykiss)

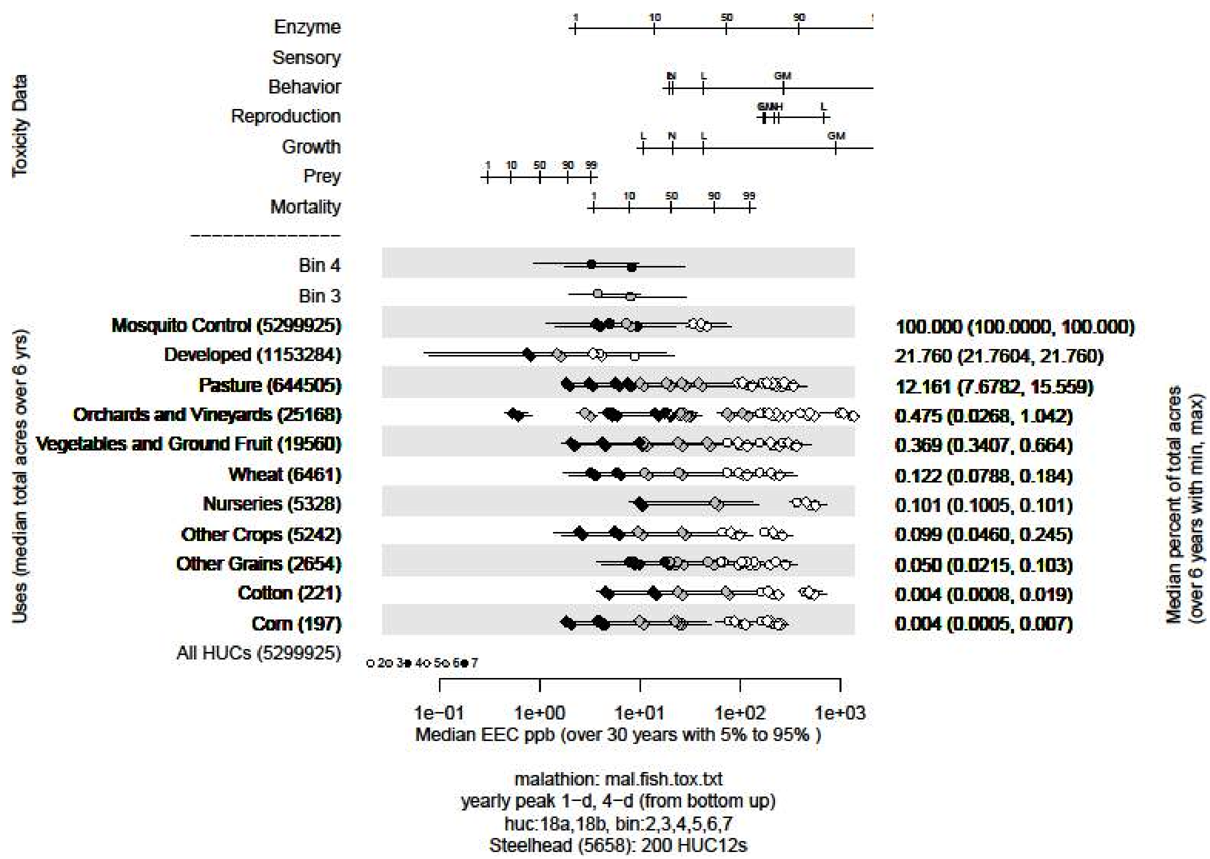


Figure 28. Effects analysis R-plot for Steelhead, Southern California DPS and malathion

Table 277. Likelihood of exposure determination for Steelhead, Southern California DPS and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Mosquito Control	3	yes	no	yes	NA	3	High
Developed	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Orchards and Vineyards	1	yes	no	yes	yes	3	High
Vegetables and Ground Fruit	1	yes	no	yes	yes	3	High
Wheat	1	yes	no	yes	no	3	Low
Nurseries	1	yes	no	yes	no	3	Low
Other Crops	1	yes	no	yes	no	3	Low
Other Grains	1	yes	no	yes	no	3	Low
Cotton	1	yes	no	yes	yes	3	High
Corn	1	yes	no	yes	yes	3	High
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High
Juveniles							
Mosquito Control	3	yes	no	yes	NA	3	High
Developed	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Orchards and Vineyards	1	yes	no	yes	yes	3	High
Vegetables and Ground Fruit	1	yes	no	yes	yes	3	High
Wheat	1	yes	no	yes	no	3	Low
Nurseries	1	yes	no	yes	no	3	Low
Other Crops	1	yes	no	yes	no	3	Low
Other Grains	1	yes	no	yes	no	3	Low
Cotton	1	yes	no	yes	yes	3	High
Corn	1	yes	no	yes	yes	3	High
Bin 3	3	yes	no	yes	NA	3	High
Bin 4	3	yes	no	yes	NA	3	High

Life Stage: Adults (full-range)

Table 278. Direct mortality risk hypothesis; Steelhead, Southern California DPS and malathion; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Developed	21.8	High	High
Pasture	12.2	High	High
Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High
Wheat	0.1	High	Low
Nurseries	0.1	High	Low
Other Crops	0.1	High	Low

Other Grains	0.05	High	Low
Cotton	0.04	High	High
Corn	0.04	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 279. Reproduction risk hypothesis; Steelhead, Southern California DPS and malathion; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	High
Developed	21.8	Low	High
Pasture	12.2	High	High
Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High
Wheat	0.1	High	Low
Nurseries	0.1	High	Low
Other Crops	0.1	Medium	Low
Other Grains	0.05	High	Low
Cotton	0.04	High	High
Corn	0.04	Low	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 280. Behavior and sensory risk hypothesis; Steelhead, Southern California DPS and malathion; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Developed	21.8	Medium	High
Pasture	12.2	High	High
Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High
Wheat	0.1	High	Low

Nurseries	0.1	High	Low
Other Crops	0.1	High	Low
Other Grains	0.05	High	Low
Cotton	0.04	High	High
Corn	0.04	High	High
Bin 3		Medium	High
Bin 4		Medium	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	High
Developed	21.8	Not Available	High
Pasture	12.2	Not Available	High
Orchards and Vineyards	0.5	Not Available	High
Vegetables and Ground Fruit	0.4	Not Available	High
Wheat	0.1	Not Available	Low
Nurseries	0.1	Not Available	Low
Other Crops	0.1	Not Available	Low
Other Grains	0.05	Not Available	Low
Cotton	0.04	Not Available	High
Corn	0.04	Not Available	High
Bin 3		Not Available	High
Bin 4		Not Available	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 281. AChE risk hypothesis; Steelhead, Southern California DPS and malathion; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Developed	21.8	Medium	High
Pasture	12.2	High	High
Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High
Wheat	0.1	High	Low
Nurseries	0.1	High	Low
Other Crops	0.1	High	Low
Other Grains	0.05	High	Low
Cotton	0.04	High	High
Corn	0.04	High	High

Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 282. Direct mortality risk hypothesis; Steelhead, Southern California DPS and malathion; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Developed	21.8	High	High
Pasture	12.2	High	High
Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High
Wheat	0.1	High	Low
Nurseries	0.1	High	Low
Other Crops	0.1	High	Low
Other Grains	0.05	High	Low
Cotton	0.04	High	High
Corn	0.04	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 283. Growth risk hypothesis; Steelhead, Southern California DPS and malathion; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Developed	21.8	Low	High
Pasture	12.2	High	High
Orchards and Vineyards	0.5	Medium	High
Vegetables and Ground Fruit	0.4	Medium	High
Wheat	0.1	Medium	Low
Nurseries	0.1	Medium	Low
Other Crops	0.1	Medium	Low

Other Grains	0.05	Medium	Low
Cotton	0.04	Medium	High
Corn	0.04	Medium	High
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 284. Prey risk hypothesis; Steelhead, Southern California DPS and malathion; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Developed	21.8	High	High
Pasture	12.2	High	High
Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High
Wheat	0.1	High	Low
Nurseries	0.1	High	Low
Other Crops	0.1	High	Low
Other Grains	0.05	High	Low
Cotton	0.04	High	High
Corn	0.04	High	High
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 285. AChE risk hypothesis; Steelhead, Southern California DPS and malathion; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Developed	21.8	Medium	High
Pasture	12.2	High	High
Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High
Wheat	0.1	High	Low
Nurseries	0.1	High	Low

Other Crops	0.1	High	Low
Other Grains	0.05	High	Low
Cotton	0.04	High	High
Corn	0.04	High	High
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 286. Behavior and sensory risk hypothesis; Steelhead, Southern California DPS and malathion; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Developed	21.8	Medium	High
Pasture	12.2	High	High
Orchards and Vineyards	0.5	High	High
Vegetables and Ground Fruit	0.4	High	High
Wheat	0.1	High	Low
Nurseries	0.1	High	Low
Other Crops	0.1	High	Low
Other Grains	0.05	High	Low
Cotton	0.04	High	High
Corn	0.04	High	High
Bin 3		Medium	High
Bin 4		Medium	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	High
Developed	21.8	Not Available	High
Pasture	12.2	Not Available	High
Orchards and Vineyards	0.5	Not Available	High
Vegetables and Ground Fruit	0.4	Not Available	High
Wheat	0.1	Not Available	Low
Nurseries	0.1	Not Available	Low
Other Crops	0.1	Not Available	Low
Other Grains	0.05	Not Available	Low
Cotton	0.04	Not Available	High
Corn	0.04	Not Available	High

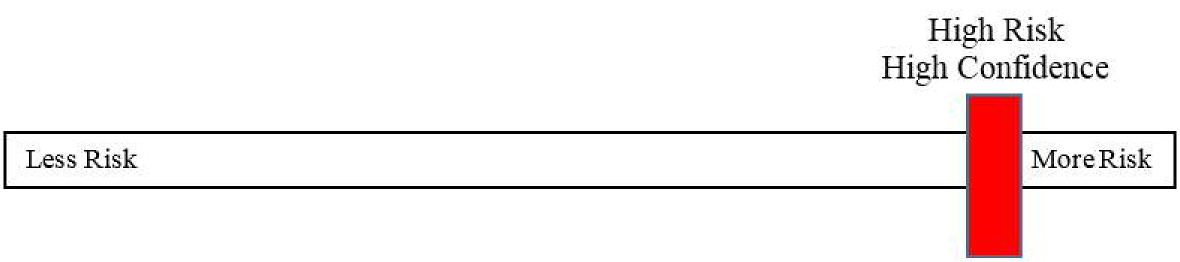
Bin 3		Not Available	High
Bin 4		Not Available	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 287. Effects analysis summary table: Steelhead, Southern California DPS and malathion

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 3-15	**Yes**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 3-15	**Yes**
Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce Juvenile	High	High	4-day fish: 1-14 4-day invert:	**Yes**

abundance via reduction in prey availability			20-66	
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, Southern California DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where malathion achieves predicted levels. The MagTool results indicate that between 3-15 percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed steelhead. The overall risk to Steelhead, Southern California DPS from the effects of the action is high and the confidence associated with that risk is high.



14.29 Steelhead, Upper Columbia River DPS (Oncorhynchus mykiss)

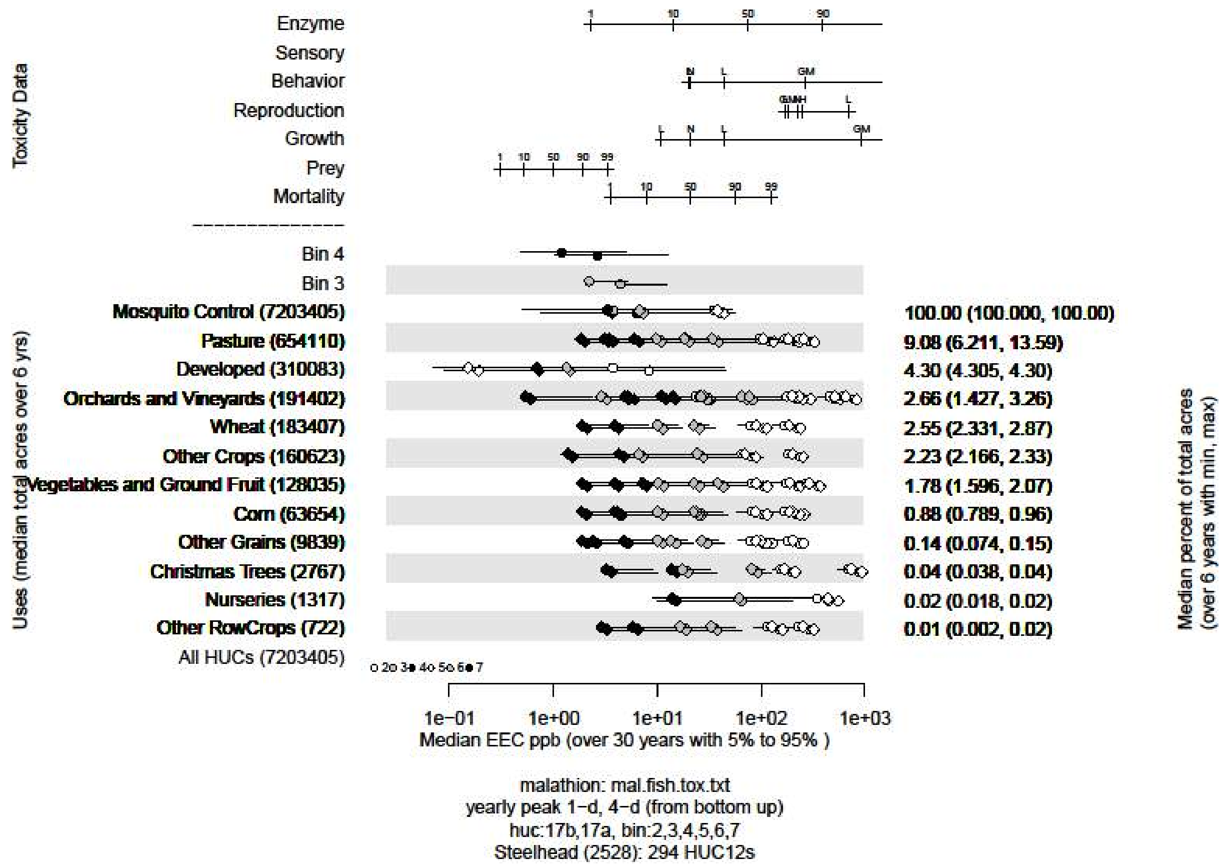


Figure 29. Effects analysis R-plot for Steelhead, Upper Columbia River DPS and malathion

Table 288. Likelihood of exposure determination for Steelhead, Upper Columbia River DPS and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Mosquito control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Developed	2	yes	no	yes	NA	3	Med
Orchards and Vineyards	2	yes	no	yes	NA	3	Med
Wheat	2	yes	no	yes	NA	3	Med
Other Crops	2	yes	no	yes	NA	3	Med
Vegetables and Ground fruit	2	yes	no	yes	NA	3	Med
Corn	1	yes	no	yes	yes	3	High
Other Grains	1	yes	no	yes	no	3	Low
Christmas Trees	1	yes	no	yes	no	3	Low
Nurseries	1	yes	no	yes	no	3	Low
Other Row Crops	1	yes	no	yes	no	3	Low
Bin 3	3	yes	no	yes	no	3	High
Bin 4	3	yes	no	yes	no	3	High
Juveniles							
Mosquito control	3	yes	no	yes	NA	3	High
Pasture	3	yes	no	yes	NA	3	High
Developed	2	yes	no	yes	NA	3	Med
Orchards and Vineyards	2	yes	no	yes	NA	3	Med
Wheat	2	yes	no	yes	NA	3	Med
Other Crops	2	yes	no	yes	NA	3	Med
Vegetables and Ground fruit	2	yes	no	yes	NA	3	Med
Corn	1	yes	no	yes	yes	3	High
Other Grains	1	yes	no	yes	no	3	Low
Christmas Trees	1	yes	no	yes	no	3	Low
Nurseries	1	yes	no	yes	no	3	Low
Other Row Crops	1	yes	no	yes	no	3	Low
Bin 3	3	yes	no	yes	no	3	High
Bin 4	3	yes	no	yes	no	3	High

Life Stage: Adults (full-range)

Table 289. Direct mortality risk hypothesis; Steelhead, Upper Columbia River DPS and malathion; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito control	100	High	High
Pasture	9.1	High	High
Developed	4.3	High	Medium
Orchards and Vineyards	2.7	High	Medium
Wheat	2.6	High	Medium
Other Crops	2.2	High	Medium
Vegetables and Ground fruit	1.8	High	Medium
Corn	0.9	High	High

Other Grains	0.1	High	Low
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 290. Reproduction risk hypothesis; Steelhead, Upper Columbia River DPS and malathion; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito control	100	Medium	High
Pasture	9.1	Medium	High
Developed	4.3	Low	Medium
Orchards and Vineyards	2.7	High	Medium
Wheat	2.6	Medium	Medium
Other Crops	2.2	Medium	Medium
Vegetables and Ground fruit	1.8	Medium	Medium
Corn	0.9	Medium	High
Other Grains	0.1	Medium	Low
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	Medium	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 291. Behavior and sensory risk hypothesis; Steelhead, Upper Columbia River DPS and malathion; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito control	100	Medium	High
Pasture	9.1	High	High
Developed	4.3	Medium	Medium
Orchards and Vineyards	2.7	High	Medium

Wheat	2.6	Medium	Medium
Other Crops	2.2	High	Medium
Vegetables and Ground fruit	1.8	High	Medium
Corn	0.9	High	High
Other Grains	0.1	High	Low
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Bin 3		Low	High
Bin 4		Low	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito control	100	Not Available	High
Pasture	9.1	Not Available	High
Developed	4.3	Not Available	Medium
Orchards and Vineyards	2.7	Not Available	Medium
Wheat	2.6	Not Available	Medium
Other Crops	2.2	Not Available	Medium
Vegetables and Ground fruit	1.8	Not Available	Medium
Corn	0.9	Not Available	High
Other Grains	0.1	Not Available	Low
Christmas Trees	0.04	Not Available	Low
Nurseries	0.02	Not Available	Low
Other Row Crops	0.01	Not Available	Low
Bin 3		Not Available	High
Bin 4		Not Available	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 292. AChE risk hypothesis; Steelhead, Upper Columbia River DPS and malathion; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito control	100	Medium	High
Pasture	9.1	High	High
Developed	4.3	Medium	Medium
Orchards and Vineyards	2.7	High	Medium
Wheat	2.6	High	Medium
Other Crops	2.2	High	Medium

Vegetables and Ground fruit	1.8	High	Medium
Corn	0.9	High	High
Other Grains	0.1	High	Low
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 293. Direct mortality risk hypothesis; Steelhead, Upper Columbia River DPS and malathion; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito control	100	High	High
Pasture	9.1	High	High
Developed	4.3	High	Medium
Orchards and Vineyards	2.7	High	Medium
Wheat	2.6	High	Medium
Other Crops	2.2	High	Medium
Vegetables and Ground fruit	1.8	High	Medium
Corn	0.9	High	High
Other Grains	0.1	High	Low
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 294. Growth risk hypothesis; Steelhead, Upper Columbia River DPS and malathion; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito control	100	Medium	High
Pasture	9.1	Medium	High

Developed	4.3	Medium	Medium
Orchards and Vineyards	2.7	Medium	Medium
Wheat	2.6	Medium	Medium
Other Crops	2.2	Medium	Medium
Vegetables and Ground fruit	1.8	Medium	Medium
Corn	0.9	Medium	High
Other Grains	0.1	Medium	Low
Christmas Trees	0.04	Medium	Low
Nurseries	0.02	Medium	Low
Other Row Crops	0.01	Medium	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 295. Prey risk hypothesis; Steelhead, Upper Columbia River DPS and malathion; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito control	100	High	High
Pasture	9.1	High	High
Developed	4.3	High	Medium
Orchards and Vineyards	2.7	High	Medium
Wheat	2.6	High	Medium
Other Crops	2.2	High	Medium
Vegetables and Ground fruit	1.8	High	Medium
Corn	0.9	High	High
Other Grains	0.1	High	Low
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 296. AChE risk hypothesis; Steelhead, Upper Columbia River DPS and malathion; Juveniles

Endpoint: AChE

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito control	100	Medium	High
Pasture	9.1	High	High
Developed	4.3	Medium	Medium
Orchards and Vineyards	2.7	High	Medium
Wheat	2.6	High	Medium
Other Crops	2.2	High	Medium
Vegetables and Ground fruit	1.8	High	Medium
Corn	0.9	High	High
Other Grains	0.1	High	Low
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 297. Behavior and sensory risk hypothesis; Steelhead, Upper Columbia River DPS and malathion; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito control	100	Medium	High
Pasture	9.1	High	High
Developed	4.3	Medium	Medium
Orchards and Vineyards	2.7	High	Medium
Wheat	2.6	Medium	Medium
Other Crops	2.2	High	Medium
Vegetables and Ground fruit	1.8	High	Medium
Corn	0.9	High	High
Other Grains	0.1	High	Low
Christmas Trees	0.04	High	Low
Nurseries	0.02	High	Low
Other Row Crops	0.01	High	Low
Bin 3		Low	High
Bin 4		Low	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito control	100	Not Available	High

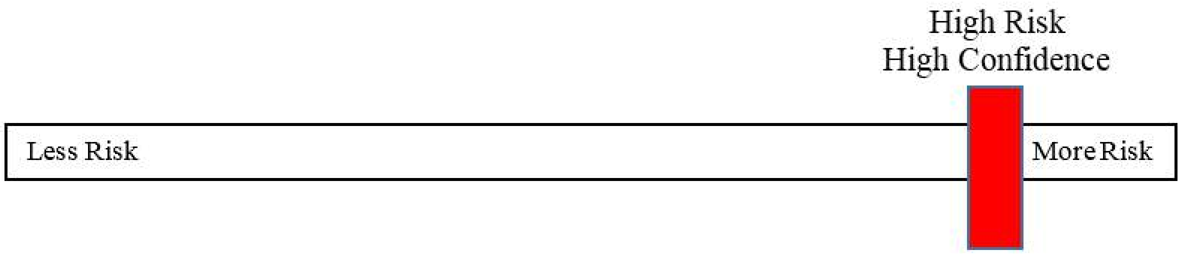
Pasture	9.1	Not Available	High
Developed	4.3	Not Available	Medium
Orchards and Vineyards	2.7	Not Available	Medium
Wheat	2.6	Not Available	Medium
Other Crops	2.2	Not Available	Medium
Vegetables and Ground fruit	1.8	Not Available	Medium
Corn	0.9	Not Available	High
Other Grains	0.1	Not Available	Low
Christmas Trees	0.04	Not Available	Low
Nurseries	0.02	Not Available	Low
Other Row Crops	0.01	Not Available	Low
Bin 3		Not Available	High
Bin 4		Not Available	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 298. Effects analysis summary table: Steelhead, Upper Columbia River DPS and malathion

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 0-19	**Yes**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	

Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	**Risk Hypothesis Supported? Yes/No**
Risk Hypothesis				
Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 0-19	**Yes**
Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day fish: 0-19 4-day invert: 21-50	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, Upper Columbia River DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where malathion achieves predicted levels. The MagTool results indicate that between 0-19 percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed steelhead. The overall risk to Steelhead, Upper Columbia River DPS from the effects of the action is high and the confidence associated with that risk is high.



14.30 Steelhead, Upper Willamette River DPS (Oncorhynchus mykiss)

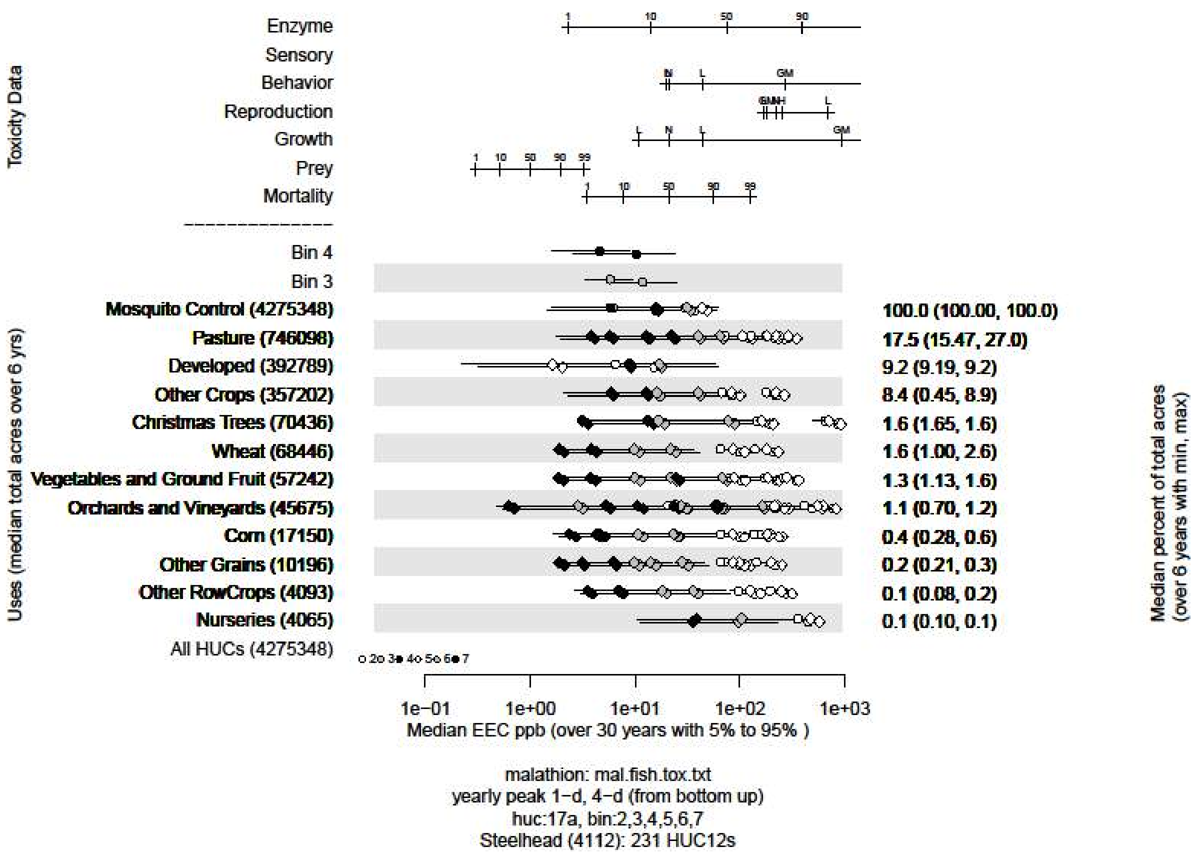


Figure 30. Effects analysis R-plot for Steelhead, Upper Willamette River DPS and malathion

Table 299. Likelihood of exposure determination for Steelhead, Upper Willamette River DPS and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults							
Mosquito Control	3	yes	no	yes	NA	3	**High**
Pasture	3	yes	no	yes	NA	3	**High**
Developed	3	yes	no	yes	NA	3	**High**
Other Crops	3	yes	no	yes	NA	3	**High**
Christmas Trees	2	yes	no	yes	NA	3	**Med**
Wheat	2	yes	no	yes	NA	3	**Med**
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	**Med**
Orchards and Vineyards	2	yes	no	yes	NA	3	**Med**
Corn	1	yes	no	yes	yes	3	**High**
Other Grains	1	yes	no	yes	yes	3	**High**
Other Row Crops	1	yes	no	yes	yes	3	**High**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	3	yes	no	yes	NA	3	**High**
Bin 4	3	yes	no	yes	NA	3	**High**
Juveniles							
Mosquito Control	3	yes	no	yes	NA	3	**High**
Pasture	3	yes	no	yes	NA	3	**High**
Developed	3	yes	no	yes	NA	3	**High**
Other Crops	3	yes	no	yes	NA	3	**High**
Christmas Trees	2	yes	no	yes	NA	3	**Med**
Wheat	2	yes	no	yes	NA	3	**Med**
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	**Med**
Orchards and Vineyards	2	yes	no	yes	NA	3	**Med**
Corn	1	yes	no	yes	yes	3	**High**
Other Grains	1	yes	no	yes	yes	3	**High**
Other Row Crops	1	yes	no	yes	yes	3	**High**
Nurseries	1	yes	no	yes	no	3	**Low**
Bin 3	3	yes	no	yes	NA	3	**High**
Bin 4	3	yes	no	yes	NA	3	**High**

Life Stage: Adults (full-range)

Table 300. Direct mortality risk hypothesis; Steelhead, Upper Willamette River DPS and malathion; Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Pasture	17.5	High	High
Developed	9.2	High	High
Other Crops	8.4	High	High
Christmas Trees	1.6	High	Medium
Wheat	1.6	High	Medium
Vegetables and Ground Fruit	1.3	High	Medium
Orchards and Vineyards	1.1	High	Medium
Corn	0.4	High	High

Other Grains	0.2	High	High
Other Row Crops	0.1	High	High
Nurseries	0.1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 301. Reproduction risk hypothesis; Steelhead, Upper Willamette River DPS and malathion; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	High
Pasture	17.5	High	High
Developed	9.2	Low	High
Other Crops	8.4	Low	High
Christmas Trees	1.6	High	Medium
Wheat	1.6	Low	Medium
Vegetables and Ground Fruit	1.3	High	Medium
Orchards and Vineyards	1.1	High	Medium
Corn	0.4	Low	High
Other Grains	0.2	Low	High
Other Row Crops	0.1	High	High
Nurseries	0.1	High	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 302. Behavior and sensory risk hypothesis; Steelhead, Upper Willamette River DPS and malathion; Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Pasture	17.5	High	High
Developed	9.2	Medium	High
Other Crops	8.4	High	High
Christmas Trees	1.6	High	Medium
Wheat	1.6	High	Medium

Vegetables and Ground Fruit	1.3	High	Medium
Orchards and Vineyards	1.1	High	Medium
Corn	0.4	High	High
Other Grains	0.2	High	High
Other Row Crops	0.1	High	High
Nurseries	0.1	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	High
Pasture	17.5	Not Available	High
Developed	9.2	Not Available	High
Other Crops	8.4	Not Available	High
Christmas Trees	1.6	Not Available	Medium
Wheat	1.6	Not Available	Medium
Vegetables and Ground Fruit	1.3	Not Available	Medium
Orchards and Vineyards	1.1	Not Available	Medium
Corn	0.4	Not Available	High
Other Grains	0.2	Not Available	High
Other Row Crops	0.1	Not Available	High
Nurseries	0.1	Not Available	Low
Bin 3		Not Available	High
Bin 4		Not Available	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 303. AChE risk hypothesis; Steelhead, Upper Willamette River DPS and malathion; Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Pasture	17.5	High	High
Developed	9.2	Medium	High
Other Crops	8.4	High	High
Christmas Trees	1.6	High	Medium
Wheat	1.6	High	Medium
Vegetables and Ground Fruit	1.3	High	Medium

Orchards and Vineyards	1.1	High	Medium
Corn	0.4	High	High
Other Grains	0.2	High	High
Other Row Crops	0.1	High	High
Nurseries	0.1	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles (full-range)

Table 304. Direct mortality risk hypothesis; Steelhead, Upper Willamette River DPS and malathion; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	17.5	High	High
Developed	9.2	High	High
Other Crops	8.4	High	High
Christmas Trees	1.6	High	Medium
Wheat	1.6	High	Medium
Vegetables and Ground Fruit	1.3	High	Medium
Orchards and Vineyards	1.1	High	Medium
Corn	0.4	High	High
Other Grains	0.2	High	High
Other Row Crops	0.1	High	High
Nurseries	0.1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 305. Growth risk hypothesis; Steelhead, Upper Willamette River DPS and malathion; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	17.5	Medium	High
Developed	9.2	Medium	High
Other Crops	8.4	Medium	High

Christmas Trees	1.6	Medium	Medium
Wheat	1.6	Medium	Medium
Vegetables and Ground Fruit	1.3	Medium	Medium
Orchards and Vineyards	1.1	Medium	Medium
Corn	0.4	Medium	High
Other Grains	0.2	Medium	High
Other Row Crops	0.1	Medium	High
Nurseries	0.1	Medium	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	Confidence		
High	High		

Table 306. Prey risk hypothesis; Steelhead, Upper Willamette River DPS and malathion; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Pasture	17.5	High	High
Developed	9.2	High	High
Other Crops	8.4	High	High
Christmas Trees	1.6	High	Medium
Wheat	1.6	High	Medium
Vegetables and Ground Fruit	1.3	High	Medium
Orchards and Vineyards	1.1	High	Medium
Corn	0.4	High	High
Other Grains	0.2	High	High
Other Row Crops	0.1	High	High
Nurseries	0.1	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 307. AChE risk hypothesis; Steelhead, Upper Willamette River DPS and malathion; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High

Pasture	17.5	High	High
Developed	9.2	Medium	High
Other Crops	8.4	High	High
Christmas Trees	1.6	High	Medium
Wheat	1.6	High	Medium
Vegetables and Ground Fruit	1.3	High	Medium
Orchards and Vineyards	1.1	High	Medium
Corn	0.4	High	High
Other Grains	0.2	High	High
Other Row Crops	0.1	High	High
Nurseries	0.1	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	Confidence		
High	High		

Table 308. Behavior and sensory risk hypothesis; Steelhead, Upper Willamette River DPS and malathion; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Pasture	17.5	High	High
Developed	9.2	Medium	High
Other Crops	8.4	High	High
Christmas Trees	1.6	High	Medium
Wheat	1.6	High	Medium
Vegetables and Ground Fruit	1.3	High	Medium
Orchards and Vineyards	1.1	High	Medium
Corn	0.4	High	High
Other Grains	0.2	High	High
Other Row Crops	0.1	High	High
Nurseries	0.1	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	High
Pasture	17.5	Not Available	High
Developed	9.2	Not Available	High

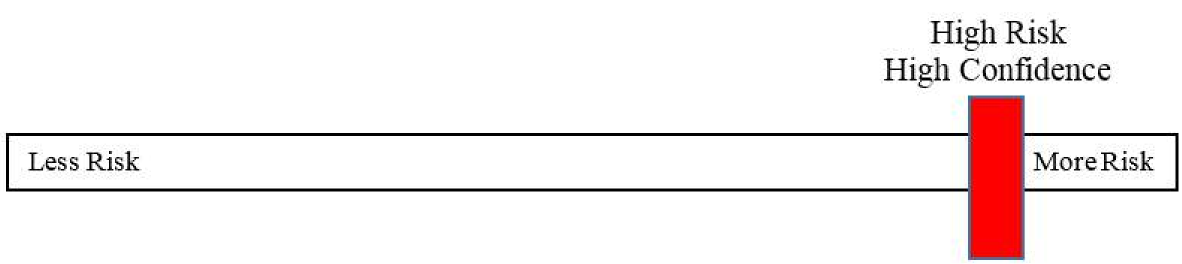
Other Crops	8.4	Not Available	High
Christmas Trees	1.6	Not Available	Medium
Wheat	1.6	Not Available	Medium
Vegetables and Ground Fruit	1.3	Not Available	Medium
Orchards and Vineyards	1.1	Not Available	Medium
Corn	0.4	Not Available	High
Other Grains	0.2	Not Available	High
Other Row Crops	0.1	Not Available	High
Nurseries	0.1	Not Available	Low
Bin 3		Not Available	High
Bin 4		Not Available	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 309. Effects analysis summary table: Steelhead, Upper Willamette River DPS and malathion

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	High	High	4-day: 5-34	**Yes**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				

Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.	High	High	4-day: 5-34	**Yes**
Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	4-day fish: 1-32 4-day invert: 41-68	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Steelhead, Upper Willamette River DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where malathion achieves predicted levels. The MagTool results indicate that between 5-34 percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, steelhead will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed steelhead. The overall risk to Steelhead, Upper Willamette River DPS from the effects of the action is high and the confidence associated with that risk is high.



14.31 Eulachon, Southern DPS (Thaleichthys pacificus)

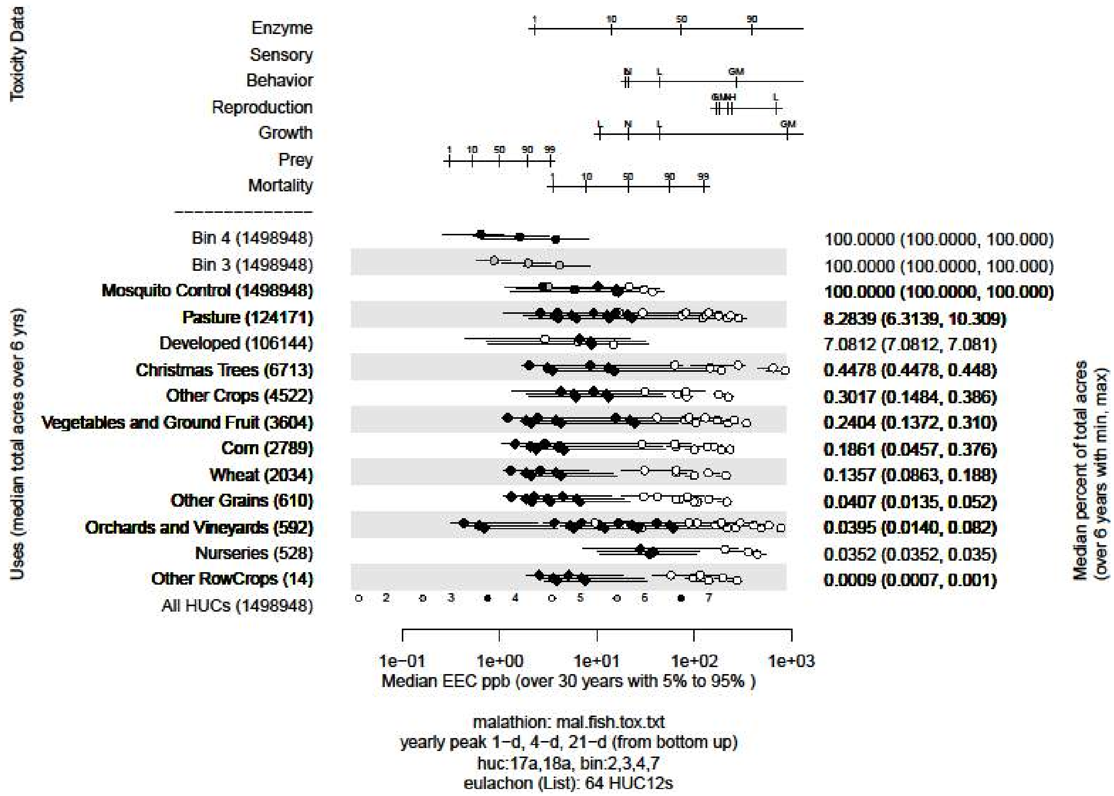


Figure 31. Effects analysis R-plot for Eulachon, Southern DPS and malathion

Table 310. Likelihood of exposure determination for Eulachon, Southern DPS and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Mosquito Control	3	yes	no	yes	NA	2	**Med**
Pasture	3	yes	no	yes	NA	2	**Med**
Developed	3	yes	no	yes	NA	2	**Med**
Christmas Tree	1	yes	no	yes	no	2	**Low**
Other Crops	1	yes	no	yes	no	2	**Low**
Vegetables and Ground Fruit	1	yes	no	yes	no	2	**Low**
Corn	1	yes	no	yes	no	2	**Low**
Wheat	1	yes	no	yes	no	2	**Low**
Other Grains	1	yes	no	yes	no	2	**Low**
Orchards and Vineyards	1	yes	no	yes	no	2	**Low**
Nurseries	1	yes	no	yes	no	2	**Low**
Bin 3	3	yes	no	yes	no	2	**Med**
Bin 4	3	yes	no	yes	no	2	**Med**

Life Stage: Juvenile and Adult (full-range)

Table 311. Direct mortality risk hypothesis; Eulachon, Southern DPS and malathion; Adults and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	Medium
Pasture	8.3	High	Medium
Developed	7.1	High	Medium
Christmas Tree	.4	High	Low
Other Crops	.3	High	Low
Vegetables and Ground Fruit	.2	High	Low
Corn	.2	High	Low
Wheat	.1	High	Low
Other Grains	.04	High	Low
Orchards and Vineyards	.04	High	Low
Nurseries	.04	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile and adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 312. Prey risk hypothesis; Eulachon, Southern DPS and malathion; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	Medium
Pasture	8.3	High	Medium
Developed	7.1	High	Medium
Christmas Tree	.4	High	Low
Other Crops	.3	High	Low
Vegetables and Ground Fruit	.2	High	Low
Corn	.2	High	Low
Wheat	.1	High	Low
Other Grains	.04	High	Low
Orchards and Vineyards	.04	High	Low
Nurseries	.04	High	Low
Bin 3		High	Medium
Bin 4		High	Medium
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 313. Behavior and sensory risk hypothesis; Eulachon, Southern DPS and malathion; Adults and Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	Medium
Pasture	8.3	High	Medium
Developed	7.1	Medium	Medium
Christmas Tree	.4	High	Low
Other Crops	.3	Medium	Low
Vegetables and Ground Fruit	.2	High	Low
Corn	.2	Medium	Low
Wheat	.1	Medium	Low
Other Grains	.04	Medium	Low
Orchards and Vineyards	.04	High	Low
Nurseries	.04	High	Low
Bin 3		Low	Medium
Bin 4		Low	Medium
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Mosquito Control	100	Not Available	Medium
Pasture	8.3	Not Available	Medium
Developed	7.1	Not Available	Medium
Christmas Tree	.4	Not Available	Low
Other Crops	.3	Not Available	Low
Vegetables and Ground Fruit	.2	Not Available	Low
Corn	.2	Not Available	Low
Wheat	.1	Not Available	Low
Other Grains	.04	Not Available	Low
Orchards and Vineyards	.04	Not Available	Low
Nurseries	.04	Not Available	Low
Bin 3		Not Available	Medium
Bin 4		Not Available	Medium
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile and adult abundance and adult productivity via impairments to ecologically significant behaviors			
Risk	**Confidence**		
High	**Medium**		

Table 314. AChE risk hypothesis; Eulachon, Southern DPS and malathion; Adults and Juveniles

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	Medium
Pasture	8.3	High	Medium
Developed	7.1	Medium	Medium
Christmas Tree	.4	High	Low
Other Crops	.3	High	Low
Vegetables and Ground Fruit	.2	High	Low
Corn	.2	High	Low
Wheat	.1	High	Low
Other Grains	.04	High	Low
Orchards and Vineyards	.04	High	Low
Nurseries	.04	High	Low
Bin 3		Medium	Medium
Bin 4		Medium	Medium
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Medium**		

Table 315. Growth risk hypothesis; Eulachon, Southern DPS and malathion; Juveniles

Endpoint: Growth

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	Medium
Pasture	8.3	Medium	Medium
Developed	7.1	Medium	Medium
Christmas Tree	.4	Medium	Low
Other Crops	.3	Medium	Low
Vegetables and Ground Fruit	.2	Medium	Low
Corn	.2	Medium	Low
Wheat	.1	Medium	Low
Other Grains	.04	Medium	Low
Orchards and Vineyards	.04	Medium	Low
Nurseries	.04	Medium	Low
Bin 3		Low	Medium
Bin 4		Low	Medium
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
Medium	**High**		

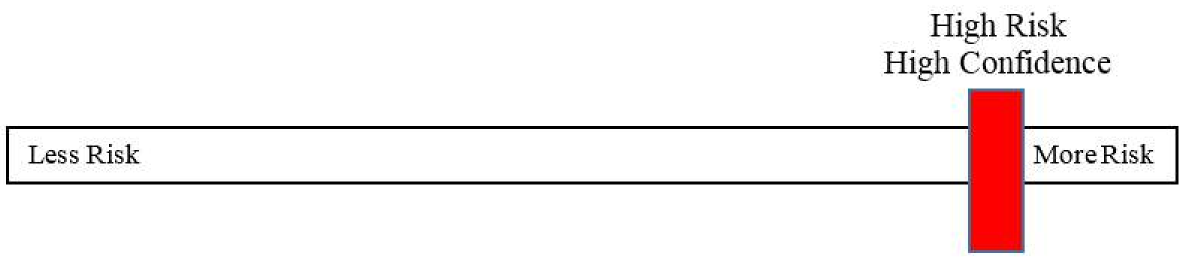
Table 316. Reproduction risk hypothesis; Eulachon, Southern DPS and malathion; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	Medium
Pasture	8.3	High	Medium
Developed	7.1	Low	Medium
Christmas Tree	.4	High	Low
Other Crops	.3	Low	Low
Vegetables and Ground Fruit	.2	High	Low
Corn	.2	Low	Low
Wheat	.1	Low	Low
Other Grains	.04	Low	Low
Orchards and Vineyards	.04	High	Low
Nurseries	.04	High	Low
Bin 3		Low	Medium
Bin 4		Low	Medium
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**Medium**		

Table 317. Effects analysis summary table: Eulachon, Southern DPS and malathion

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Juveniles and Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce juvenile and adult abundance via acute lethality.	High	High	Not Available	Yes
Exposure to malathion is sufficient to reduce juvenile abundance via reduction in prey availability	High	High	Not Available	Yes
Exposure to malathion is sufficient to reduce juvenile and adult abundance and adult productivity via impairments to ecologically significant behaviors	High	Medium	Not Available	Yes
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Medium	Not Available	Yes
Exposure to malathion is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)	High	Medium	Not Available	Yes
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	Medium	Not Available	Yes

Effects analysis summary: Adult and juvenile Eulachon, Southern DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where malathion achieves predicted levels. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, eulachon will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed eulachon. The overall risk to Eulachon, Southern DPS from the effects of the action is high and the confidence associated with that risk is high.



14.32 Green Sturgeon, Southern DPS (Acipenser medirostris)

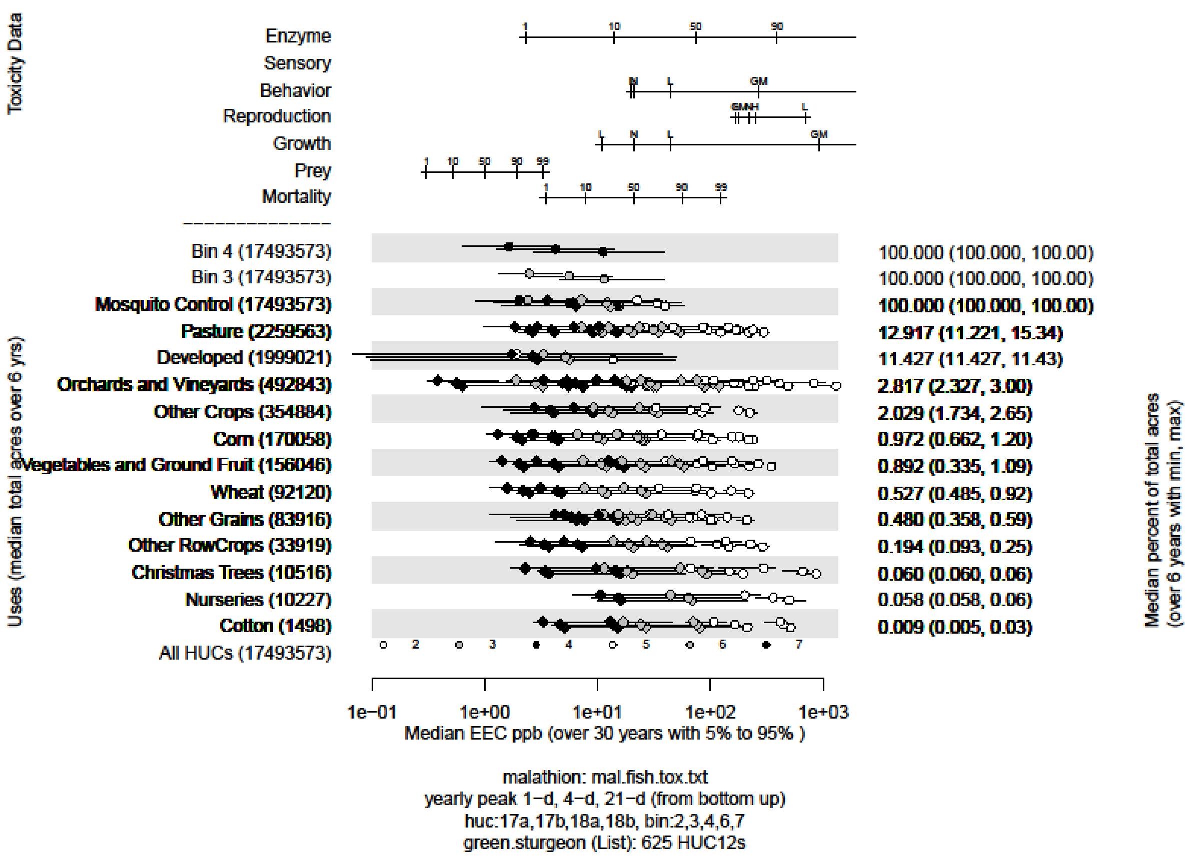


Figure 32. Effects analysis R-plot for Adult and Sub-Adult Green Sturgeon, Southern DPS and malathion

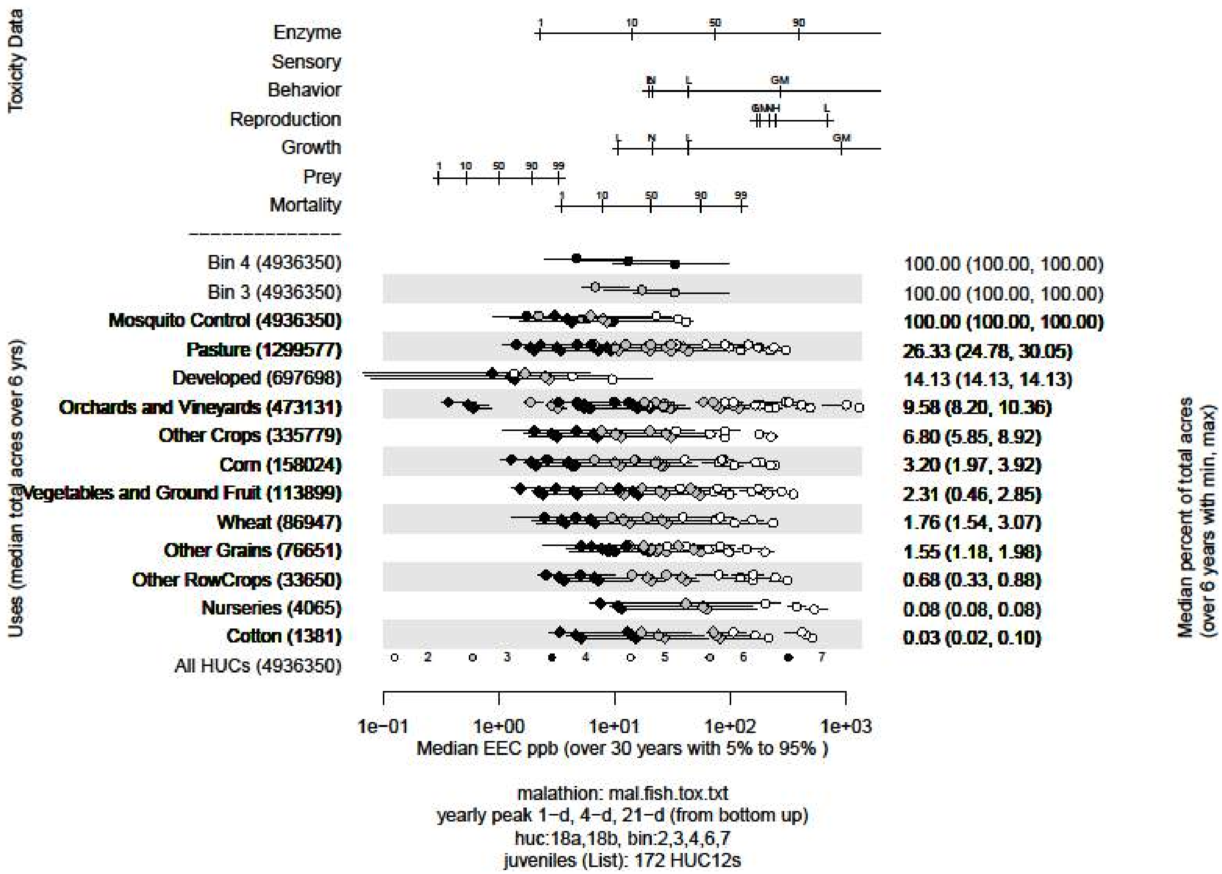


Figure 33. Effects analysis R-plot for Juvenile Green Sturgeon, Southern DPS and malathion

Table 318. Likelihood of exposure determination for Green Sturgeon, Southern DPS and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Adults (full range)							
Mosquito Control	3	yes	no	yes	NA	3	**High**
Pasture	3	yes	no	yes	NA	3	**High**
Developed	3	yes	no	yes	NA	3	**High**
Orchards and Vineyards	2	yes	no	yes	NA	3	**Med**
Other Crops	2	yes	no	yes	NA	3	**Med**
Corn	2	yes	no	yes	NA	3	**Med**
Vegetables and Ground Fruit	1	yes	no	yes	yes	3	**High**
Wheat	1	yes	no	yes	yes	3	**High**
Other Grains	1	yes	no	yes	yes	3	**High**
Other Row Crops	1	yes	no	yes	yes	3	**High**
Christmas Trees	1	yes	no	yes	no	3	**Low**
Nurseries	1	yes	no	yes	no	3	**Low**
Cotton	1	yes	no	yes	no	3	**Low**
Bin 3	3	yes	no	yes	yes	3	**High**
Bin 4	3	yes	no	yes	no	3	**High**
Juveniles and Adults (natal streams)							
Mosquito Control	3	yes	no	yes	NA	3	**High**
Pasture	3	yes	no	yes	NA	3	**High**
Developed	3	yes	no	yes	NA	3	**High**
Orchards and Vineyards	3	yes	no	yes	NA	3	**High**
Other Crops	3	yes	no	yes	NA	3	**High**
Corn	2	yes	no	yes	NA	3	**Med**
Vegetables and Ground Fruit	2	yes	no	yes	NA	3	**Med**
Wheat	2	yes	no	yes	NA	3	**Med**
Other Grains	2	yes	no	yes	NA	3	**Med**
Other Row Crops	1	yes	no	yes	yes	3	**High**
Nurseries	1	yes	no	yes	no	3	**Low**
Cotton	1	yes	no	yes	no	3	**Low**
Bin 3	3	yes	no	yes	NA	3	**High**
Bin 4	3	yes	no	yes	NA	3	**High**

Life Stage: Adults and Sub-Adults (full-range)

Table 319. Direct mortality risk hypothesis; Green Sturgeon, Southern DPS and malathion; Adults and Sub-Adults

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Pasture	12.9	High	High
Developed	11.4	High	High
Orchards and Vineyards	2.8	High	Medium
Other Crops	2.0	High	Medium
Corn	1.0	High	Medium
Vegetables and Ground Fruit	0.9	High	High
Wheat	0.5	High	High
Other Grains	0.5	High	High

Other Row Crops	0.2	High	High
Christmas Trees	0.06	High	Low
Nurseries	0.06	High	Low
Cotton	0.009	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult and sub-adult abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 320. Reproduction risk hypothesis; Green Sturgeon, Southern DPS and malathion; Adults

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	High
Pasture	12.9	High	High
Developed	11.4	Low	High
Orchards and Vineyards	2.8	High	Medium
Other Crops	2.0	Low	Medium
Corn	1.0	Low	Medium
Vegetables and Ground Fruit	0.9	High	High
Wheat	0.5	Low	High
Other Grains	0.5	Low	High
Other Row Crops	0.2	High	High
Christmas Trees	0.06	High	Low
Nurseries	0.06	High	Low
Cotton	0.009	High	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 321. Behavior and sensory risk hypothesis; Green Sturgeon, Southern DPS and malathion; Adults and Sub-Adults

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Pasture	12.9	High	High
Developed	11.4	Medium	High

Orchards and Vineyards	2.8	High	Medium
Other Crops	2.0	Medium	Medium
Corn	1.0	Medium	Medium
Vegetables and Ground Fruit	0.9	High	High
Wheat	0.5	Medium	High
Other Grains	0.5	Medium	High
Other Row Crops	0.2	High	High
Christmas Trees	0.06	High	Low
Nurseries	0.06	High	Low
Cotton	0.009	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	High
Pasture	12.9	Not Available	High
Developed	11.4	Not Available	High
Orchards and Vineyards	2.8	Not Available	Medium
Other Crops	2.0	Not Available	Medium
Corn	1.0	Not Available	Medium
Vegetables and Ground Fruit	0.9	Not Available	High
Wheat	0.5	Not Available	High
Other Grains	0.5	Not Available	High
Other Row Crops	0.2	Not Available	High
Christmas Trees	0.06	Not Available	Low
Nurseries	0.06	Not Available	Low
Cotton	0.009	Not Available	Low
Bin 3		Not Available	High
Bin 4		Not Available	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult and sub-adult abundance and adult productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 322. Prey risk hypothesis; Green Sturgeon, Southern DPS and malathion; Adults and Sub-Adults

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Pasture	12.9	High	High
Developed	11.4	High	High

Orchards and Vineyards	2.8	High	Medium
Other Crops	2.0	High	Medium
Corn	1.0	High	Medium
Vegetables and Ground Fruit	0.9	High	High
Wheat	0.5	High	High
Other Grains	0.5	High	High
Other Row Crops	0.2	High	High
Christmas Trees	0.06	High	Low
Nurseries	0.06	High	Low
Cotton	0.009	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult and sub-adult abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 323. AChE risk hypothesis; Green Sturgeon, Southern DPS and malathion; Adults and Sub-Adults

Endpoint: AChE			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Pasture	12.9	High	High
Developed	11.4	Medium	High
Orchards and Vineyards	2.8	High	Medium
Other Crops	2.0	High	Medium
Corn	1.0	High	Medium
Vegetables and Ground Fruit	0.9	High	High
Wheat	0.5	High	High
Other Grains	0.5	High	High
Other Row Crops	0.2	High	High
Christmas Trees	0.06	High	Low
Nurseries	0.06	High	Low
Cotton	0.009	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Life Stage: Juveniles

Table 324. Direct mortality risk hypothesis; Green Sturgeon, Southern DPS and malathion; Juveniles

Endpoint: Mortality			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Pasture	26.3	High	High
Developed	14.1	Medium	High
Orchards and Vineyards	9.6	High	High
Other Crops	6.8	High	High
Corn	3.2	High	Medium
Vegetables and Ground Fruit	2.3	High	Medium
Wheat	1.8	High	Medium
Other Grains	1.6	High	Medium
Other Row Crops	0.7	High	High
Nurseries	0.08	High	Low
Cotton	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.			
Risk	Confidence		
High	High		

Table 325. Growth risk hypothesis; Green Sturgeon, Southern DPS and malathion; Juveniles

Endpoint: Growth			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	26.3	Medium	High
Developed	14.1	Low	High
Orchards and Vineyards	9.6	Medium	High
Other Crops	6.8	Medium	High
Corn	3.2	Medium	Medium
Vegetables and Ground Fruit	2.3	Medium	Medium
Wheat	1.8	Medium	Medium
Other Grains	1.6	Medium	Medium
Other Row Crops	0.7	Medium	High
Nurseries	0.08	Medium	Low
Cotton	0.03	Medium	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)			
Risk	Confidence		

High	High	

Table 326. Prey risk hypothesis; Green Sturgeon, Southern DPS and malathion; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Pasture	26.3	High	High
Developed	14.1	High	High
Orchards and Vineyards	9.6	High	High
Other Crops	6.8	High	High
Corn	3.2	High	Medium
Vegetables and Ground Fruit	2.3	High	Medium
Wheat	1.8	High	Medium
Other Grains	1.6	High	Medium
Other Row Crops	0.7	High	High
Nurseries	0.08	High	Low
Cotton	0.03	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 327. AChE risk hypothesis; Green Sturgeon, Southern DPS and malathion; Juveniles

Endpoint: AChE			
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Medium	High
Pasture	26.3	High	High
Developed	14.1	Medium	High
Orchards and Vineyards	9.6	High	High
Other Crops	6.8	High	High
Corn	3.2	High	Medium
Vegetables and Ground Fruit	2.3	High	Medium
Wheat	1.8	High	Medium
Other Grains	1.6	High	Medium
Other Row Crops	0.7	High	High
Nurseries	0.08	High	Low
Cotton	0.03	High	Low
Bin 3		High	High
Bin 4		High	High

Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity		
Risk	Confidence	
High	High	

Table 328. Behavior and sensory risk hypothesis; Green Sturgeon, Southern DPS and malathion; Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Pasture	26.3	High	High
Developed	14.1	Medium	High
Orchards and Vineyards	9.6	High	High
Other Crops	6.8	Medium	High
Corn	3.2	Medium	Medium
Vegetables and Ground Fruit	2.3	High	Medium
Wheat	1.8	Medium	Medium
Other Grains	1.6	Medium	Medium
Other Row Crops	0.7	High	High
Nurseries	0.08	High	Low
Cotton	0.03	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	High
Pasture	26.3	Not Available	High
Developed	14.1	Not Available	High
Orchards and Vineyards	9.6	Not Available	High
Other Crops	6.8	Not Available	High
Corn	3.2	Not Available	Medium
Vegetables and Ground Fruit	2.3	Not Available	Medium
Wheat	1.8	Not Available	Medium
Other Grains	1.6	Not Available	Medium
Other Row Crops	0.7	Not Available	High
Nurseries	0.08	Not Available	Low
Cotton	0.03	Not Available	Low
Bin 3		Not Available	High
Bin 4		Not Available	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		

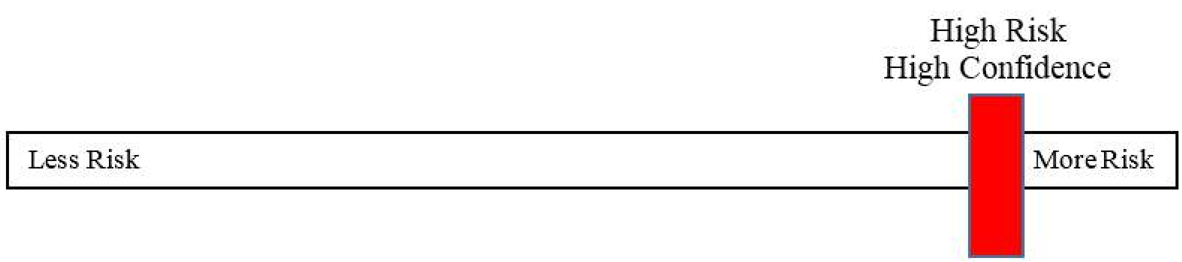
High	**High**	

Table 329. Effects analysis summary table: Green Sturgeon, Southern DPS and malathion

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Adults and Sub-Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce adult and sub-adult abundance via acute lethality.	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult and sub-adult abundance and adult productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult and sub-adult abundance via reduction in prey availability	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability	High	High	Not Available	**Yes**

Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce juvenile abundance and productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Green Sturgeon, Southern DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where malathion achieves predicted levels. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, sturgeon will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed sturgeon. The overall risk to Green Sturgeon, Southern DPS from the effects of the action is high and the confidence associated with that risk is high.



14.33 Shortnose Sturgeon (Acipenser brevirostrum)

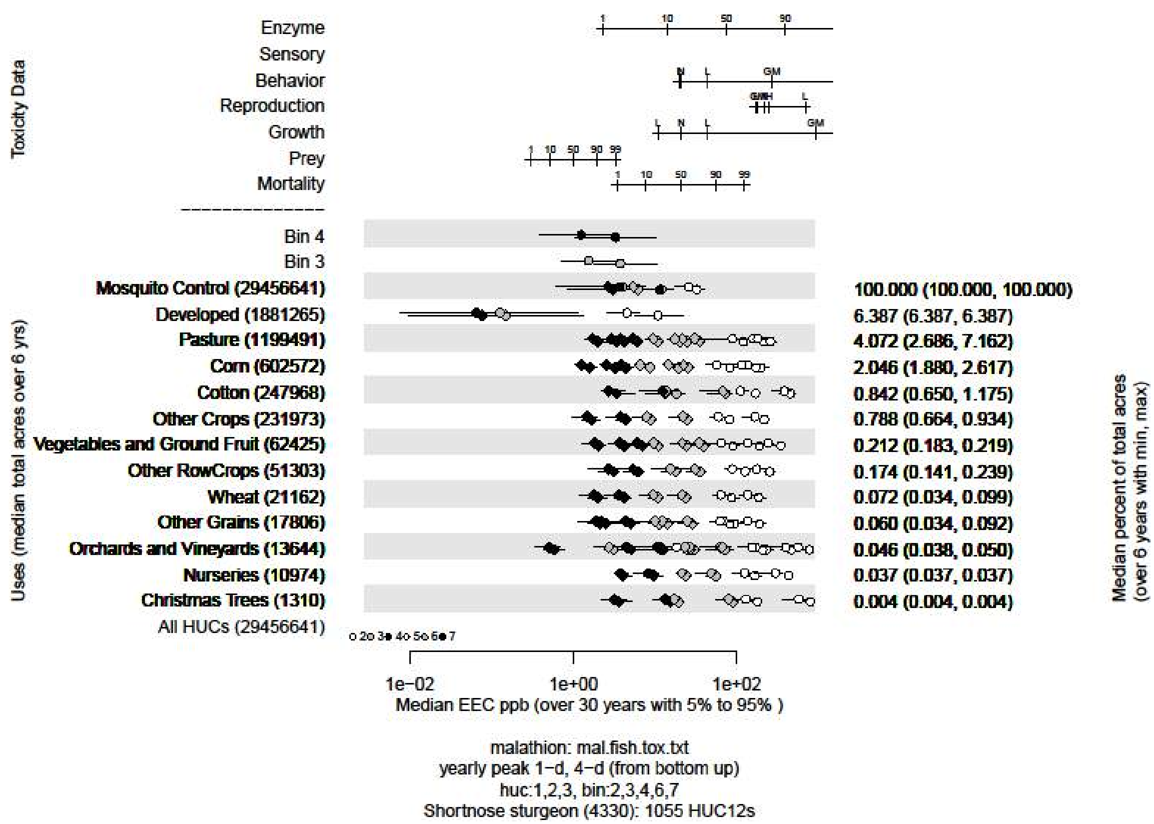


Figure 34. Effects analysis R-plot for Shortnose Sturgeon and malathion

Table 330. Likelihood of exposure determination for Shortnose Sturgeon and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Mosquito Control	3	yes	yes	yes	NA	3	**High**
Developed	3	yes	yes	yes	NA	3	**High**
Pasture	2	yes	yes	yes	NA	3	**Med**
Corn	2	yes	yes	yes	NA	3	**Med**
Cotton	1	yes	yes	yes	NA	3	**Low**
Other Crops	1	yes	yes	yes	NA	3	**Low**
Vegetables and Ground Fruit	1	yes	yes	yes	NA	3	**Low**
Other Row Crops	1	yes	yes	yes	NA	3	**Low**
Wheat	1	yes	yes	yes	NA	3	**Low**
Other Grains	1	yes	yes	yes	NA	3	**Low**
Orchards and Vineyards	1	yes	yes	yes	NA	3	**Low**
Nurseries	1	yes	yes	yes	NA	3	**Low**
Christmas Trees	1	yes	yes	yes	NA	3	**Low**
Bin 3	3	yes	yes	yes	NA	3	**High**
Bin 4	3	yes	yes	yes	NA	3	**High**

Life Stage: Juvenile and Adult (Full Range)

Table 331. Direct mortality risk hypothesis; Shortnose Sturgeon and malathion; Adults and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Developed	6.4	High	**High**
Pasture	4.1	High	**Medium**
Corn	2.0	High	**Medium**
Cotton	.8	High	**Low**
Other Crops	.8	High	**Low**
Vegetables and Ground Fruit	.2	High	**Low**
Other Row Crops	.2	High	**Low**
Wheat	.07	High	**Low**
Other Grains	.06	High	**Low**
Orchards and Vineyards	.05	High	**Low**
Nurseries	.04	High	**Low**
Christmas Trees	.004	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult and juvenile abundance via acute lethality.			

Risk	Confidence	
High	**High**	

Table 332. Prey risk hypothesis; Shortnose Sturgeon and malathion; Adults and Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Developed	6.4	High	**High**
Pasture	4.1	High	**Medium**
Corn	2.0	High	**Medium**
Cotton	.8	High	**Low**
Other Crops	.8	High	**Low**
Vegetables and Ground Fruit	.2	High	**Low**
Other Row Crops	.2	High	**Low**
Wheat	.07	High	**Low**
Other Grains	.06	High	**Low**
Orchards and Vineyards	.05	High	**Low**
Nurseries	.04	High	**Low**
Christmas Trees	.004	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult and juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 333. Behavior and sensory risk hypothesis; Shortnose Sturgeon and malathion; Adults and Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Developed	6.4	Medium	**High**
Pasture	4.1	High	**Medium**
Corn	2.0	Medium	**Medium**
Cotton	.8	High	**Low**
Other Crops	.8	Medium	**Low**
Vegetables and Ground Fruit	.2	High	**Low**
Other Row Crops	.2	High	**Low**
Wheat	.07	Medium	**Low**
Other Grains	.06	Medium	**Low**
Orchards and Vineyards	.05	High	**Low**
Nurseries	.04	High	**Low**

Christmas Trees	.004	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	NA	**High**
Developed	6.4		**High**
Pasture	4.1		**Medium**
Corn	2.0		**Medium**
Cotton	.8		**Low**
Other Crops	.8		**Low**
Vegetables and Ground Fruit	.2		**Low**
Other Row Crops	.2		**Low**
Wheat	.07		**Low**
Other Grains	.06		**Low**
Orchards and Vineyards	.05		**Low**
Nurseries	.04		**Low**
Christmas Trees	.004		**Low**
Bin 3			**High**
Bin 4			**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 334. AChE risk hypothesis; Shortnose Sturgeon and malathion; Adults and Juveniles

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Developed	6.4	Medium	**High**
Pasture	4.1	High	**Medium**
Corn	2.0	High	**Medium**
Cotton	.8	High	**Low**
Other Crops	.8	High	**Low**
Vegetables and Ground Fruit	.2	High	**Low**
Other Row Crops	.2	High	**Low**
Wheat	.07	High	**Low**
Other Grains	.06	High	**Low**
Orchards and Vineyards	.05	High	**Low**
Nurseries	.04	High	**Low**

Christmas Trees	.004	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Table 335. Growth risk hypothesis; Shortnose Sturgeon and malathion; Adults and Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Developed	6.4	Low	**High**
Pasture	4.1	Medium	**Medium**
Corn	2.0	Medium	**Medium**
Cotton	.8	Medium	**Low**
Other Crops	.8	Medium	**Low**
Vegetables and Ground Fruit	.2	Medium	**Low**
Other Row Crops	.2	Medium	**Low**
Wheat	.07	Medium	**Low**
Other Grains	.06	Medium	**Low**
Orchards and Vineyards	.05	Medium	**Low**
Nurseries	.04	Medium	**Low**
Christmas Trees	.004	Medium	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
High	**High**		

Table 336. Reproduction risk hypothesis; Shortnose Sturgeon and malathion; Adults

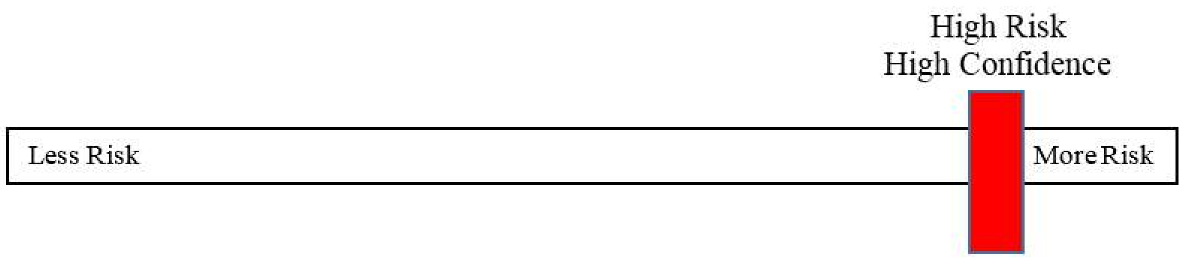
Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	**High**
Developed	6.4	Low	**High**
Pasture	4.1	Medium	**Medium**
Corn	2.0	Low	**Medium**
Cotton	.8	High	**Low**
Other Crops	.8	Low	**Low**
Vegetables and Ground Fruit	.2	High	**Low**

Other Row Crops	.2	Medium	**Low**
Wheat	.07	Low	**Low**
Other Grains	.06	Low	**Low**
Orchards and Vineyards	.05	High	**Low**
Nurseries	.04	Medium	**Low**
Christmas Trees	.004	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 337. Effects analysis summary table: Shortnose Sturgeon and malathion

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles and Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce adult and juvenile abundance via acute lethality.	High	High	4-day: 0-8	**Yes**
Exposure to malathion is sufficient to reduce adult and juvenile abundance via reduction in prey availability	High	High	4-day fish: 0-8 4-day invert: 0-38	**Yes**
Exposure to malathion is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Shortnose Sturgeon are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where malathion achieves predicted levels. The MagTool results indicate that between 0-8 percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, sturgeon will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed sturgeon in northern regions. The overall risk to Shortnose Sturgeon from the effects of the action is high and the confidence associated with that risk is high.



14.34 Atlantic Sturgeon, Carolina DPS (Acipenser oxyrinchus oxyrinchus)

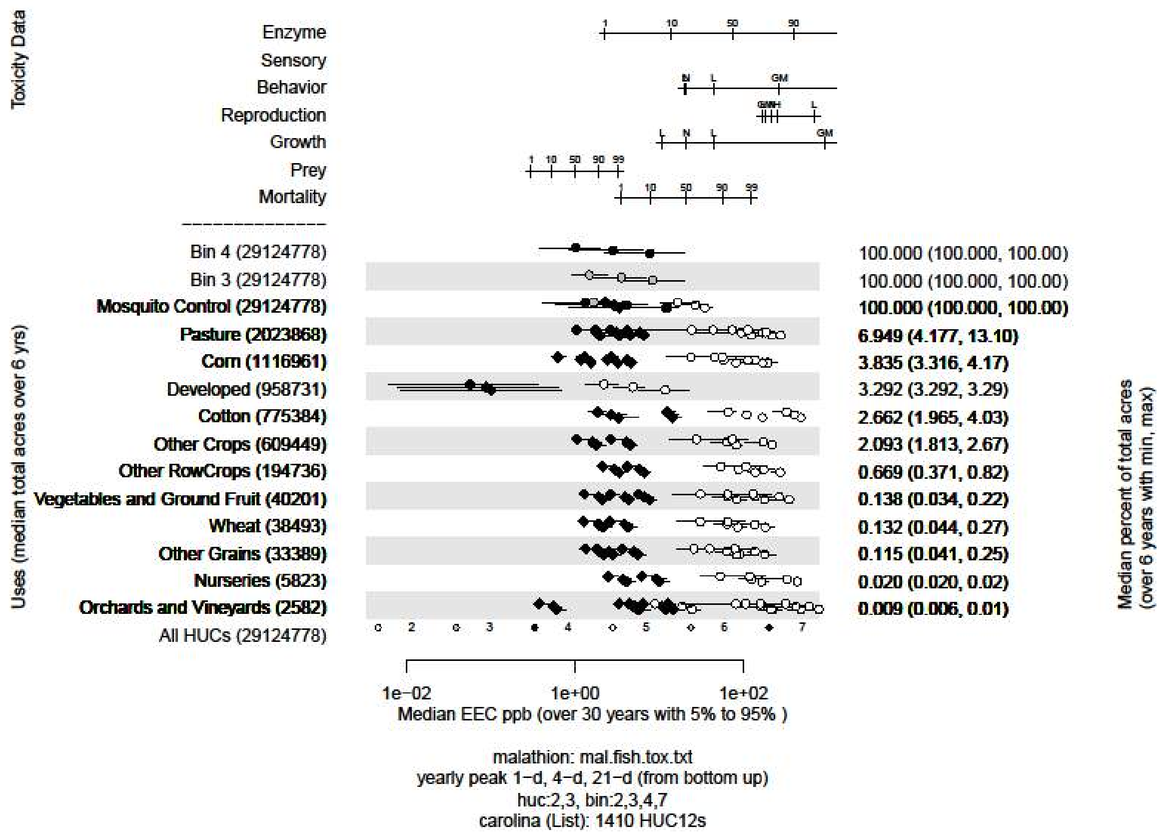


Figure 35. Effects analysis R-plot for Atlantic sturgeon, Carolina DPS and malathion

Table 338. Likelihood of exposure determination for Atlantic sturgeon, Carolina DPS and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Mosquito Control	3	yes	no	yes	NA	3	**High**
Pasture	3	yes	no	yes	NA	3	**High**
Corn	2	yes	no	yes	NA	3	**Med**
Developed	2	yes	no	yes	NA	3	**Med**
Cotton	2	yes	no	yes	NA	3	**Med**
Other Crops	2	yes	no	yes	NA	3	**Med**
Other Row Crops	1	yes	no	yes	no	3	**Low**
Vegetables and Ground Fruit	1	yes	no	yes	no	3	**Low**
Wheat	1	yes	no	yes	yes	3	**High**
Other Grains	1	yes	no	yes	no	3	**Low**
Nurseries	1	yes	no	yes	no	3	**Low**
Orchards and Vineyards	1	yes	no	yes	no	3	**Low**
Bin 3	3	yes	no	yes	NA	3	**Low**
Bin 4	3	yes	no	yes	NA	3	**Low**

Life Stage: Juvenile and Adult

Table 339. Direct mortality risk hypothesis; Atlantic sturgeon, Carolina DPS and malathion; Adults and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	6.9	High	**High**
Corn	3.8	High	**Medium**
Developed	3.3	High	**Medium**
Cotton	2.7	High	**Medium**
Other Crops	2.1	High	**Medium**
Other Row Crops	.7	High	**Low**
Vegetables and Ground Fruit	.1	High	**Low**
Wheat	.1	High	**High**
Other Grains	.1	High	**Low**
Nurseries	.02	High	**Low**
Orchards and Vineyards	.009	High	**Low**
Bin 3		Medium	**Low**
Bin 4		Medium	**Low**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult and juvenile abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 340. Prey risk hypothesis; Atlantic sturgeon, Carolina DPS and malathion; Adults and Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	6.9	High	**High**
Corn	3.8	High	**Medium**
Developed	3.3	High	**Medium**
Cotton	2.7	High	**Medium**
Other Crops	2.1	High	**Medium**
Other Row Crops	.7	High	**Low**
Vegetables and Ground Fruit	.1	High	**Low**
Wheat	.1	High	**High**
Other Grains	.1	High	**Low**
Nurseries	.02	High	**Low**
Orchards and Vineyards	.009	High	**Low**
Bin 3		High	**Low**
Bin 4		High	**Low**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult and juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 341. Behavior and sensory risk hypothesis; Atlantic sturgeon, Carolina DPS and malathion; Adults and Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	6.9	High	**High**
Corn	3.8	Medium	**Medium**
Developed	3.3	Medium	**Medium**
Cotton	2.7	High	**Medium**
Other Crops	2.1	Medium	**Medium**
Other Row Crops	.7	High	**Low**
Vegetables and Ground Fruit	.1	High	**Low**
Wheat	.1	Medium	**High**
Other Grains	.1	Medium	**Low**
Nurseries	.02	High	**Low**
Orchards and Vineyards	.009	High	**Low**
Bin 3		Low	**Low**
Bin 4		Low	**Low**

Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	6.9	High	**High**
Corn	3.8	Medium	**Medium**
Developed	3.3	Medium	**Medium**
Cotton	2.7	High	**Medium**
Other Crops	2.1	Medium	**Medium**
Other Row Crops	.7	High	**Low**
Vegetables and Ground Fruit	.1	High	**Low**
Wheat	.1	Medium	**High**
Other Grains	.1	Medium	**Low**
Nurseries	.02	High	**Low**
Orchards and Vineyards	.009	High	**Low**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 342. AChE risk hypothesis; Atlantic sturgeon, Carolina DPS and malathion; Adults and Juveniles

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	6.9	High	**High**
Corn	3.8	High	**Medium**
Developed	3.3	Medium	**Medium**
Cotton	2.7	High	**Medium**
Other Crops	2.1	High	**Medium**
Other Row Crops	.7	High	**Low**
Vegetables and Ground Fruit	.1	High	**Low**
Wheat	.1	High	**High**
Other Grains	.1	High	**Low**
Nurseries	.02	High	**Low**
Orchards and Vineyards	.009	High	**Low**
Bin 3		Medium	**Low**
Bin 4		Medium	**Low**
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		

High	**High**	

Table 343. Growth risk hypothesis; Atlantic sturgeon, Carolina DPS and malathion; Adults and Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	6.9	Medium	**High**
Corn	3.8	Medium	**Medium**
Developed	3.3	Low	**Medium**
Cotton	2.7	Medium	**Medium**
Other Crops	2.1	Medium	**Medium**
Other Row Crops	.7	Medium	**Low**
Vegetables and Ground Fruit	.1	Medium	**Low**
Wheat	.1	Medium	**High**
Other Grains	.1	Medium	**Low**
Nurseries	.02	Medium	**Low**
Orchards and Vineyards	.009	Medium	**Low**
Bin 3		Low	**Low**
Bin 4		Low	**Low**
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
High	**High**		

Table 344. Reproduction risk hypothesis; Atlantic sturgeon, Carolina DPS and malathion; Adults

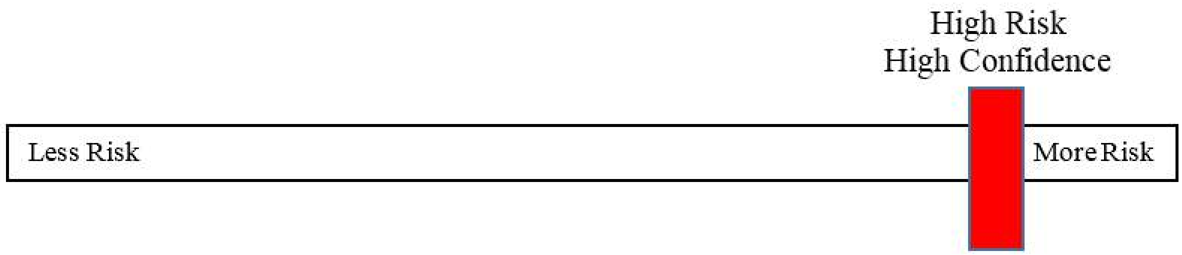
Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	**High**
Pasture	6.9	Medium	**High**
Corn	3.8	Low	**Medium**
Developed	3.3	Low	**Medium**
Cotton	2.7	High	**Medium**
Other Crops	2.1	Low	**Medium**
Other Row Crops	.7	Medium	**Low**
Vegetables and Ground Fruit	.1	High	**Low**
Wheat	.1	Low	**High**
Other Grains	.1	Low	**Low**
Nurseries	.02	Medium	**Low**
Orchards and Vineyards	.009	High	**Low**
Bin 3		Low	**Low**

Bin 4		Low	**Low**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 345. Effects analysis summary table: Atlantic sturgeon, Carolina DPS and malathion

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles and Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce adult and juvenile abundance via acute lethality.	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult and juvenile abundance via reduction in prey availability	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Atlantic sturgeon, Carolina DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where malathion achieves predicted levels. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, sturgeon will likely experience more toxicity. The overall risk to Atlantic sturgeon, Carolina DPS from the effects of the action is high and the confidence associated with that risk is high.



14.35 Atlantic Sturgeon, Chesapeake Bay DPS (Acipenser oxyrinchus oxyrinchus)

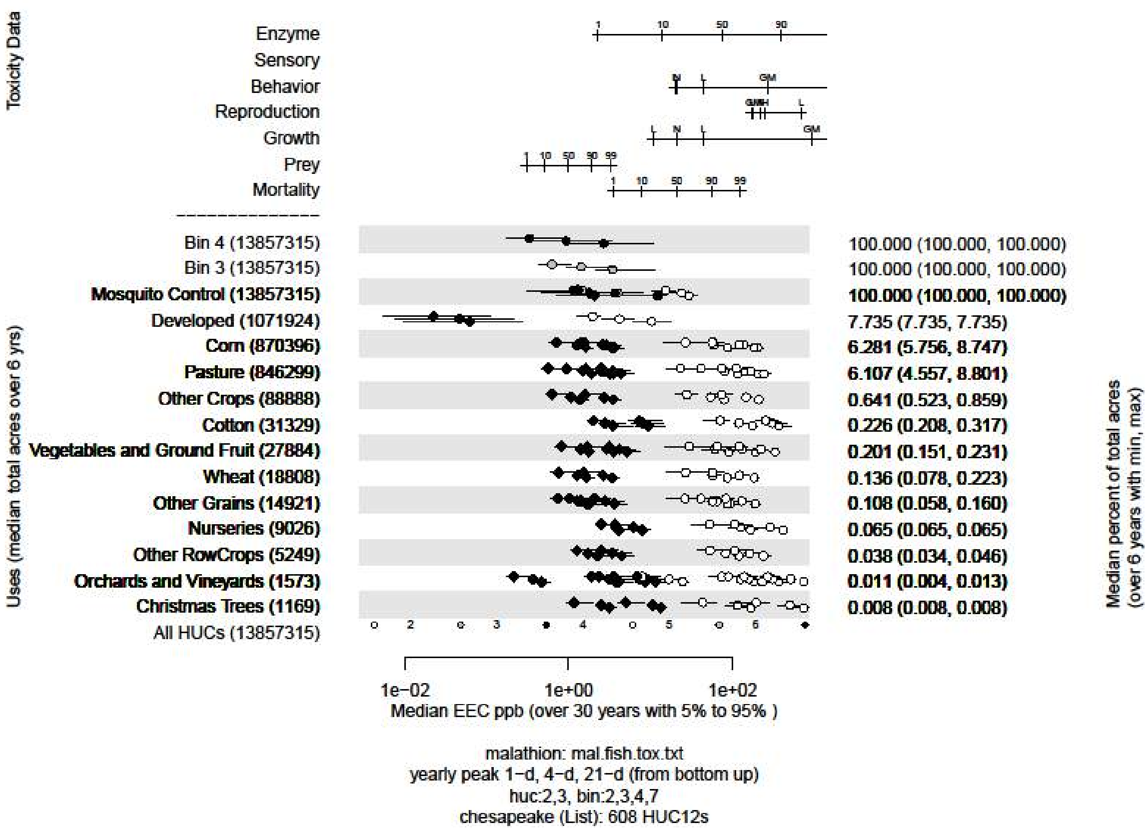


Figure 36. Effects analysis R-plot for Atlantic sturgeon, Chesapeake Bay DPS and malathion

Table 346. Likelihood of exposure determination for Atlantic sturgeon, Chesapeake Bay DPS and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Mosquito Control	3	yes	no	yes	NA	3	**High**
Developed	3	yes	no	yes	NA	3	**High**
Corn	3	yes	no	yes	NA	3	**High**
Pasture	3	yes	no	yes	NA	3	**High**
Other Crops	1	yes	no	yes	no	3	**Low**
Cotton	1	yes	no	yes	yes	3	**High**
Vegetables and Ground Fruit	1	yes	no	yes	no	3	**Low**
Wheat	1	yes	no	yes	yes	3	**High**
Other Grains	1	yes	no	yes	no	3	**Low**
Nurseries	1	yes	no	yes	no	3	**Low**
Other Row Crops	1	yes	no	yes	no	3	**Low**
Orchards and Vineyards	1	yes	no	yes	no	3	**Low**
Christmas Trees	1	yes	no	yes	no	3	**Low**
Bin 3	3	yes	no	yes	NA	3	**High**
Bin 4	3	yes	no	yes	NA	3	**High**

Life Stage: Juvenile and Adult

Table 347. Direct mortality risk hypothesis; Atlantic sturgeon, Chesapeake Bay DPS and malathion; Adults and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Developed	7.7	Medium	**High**
Corn	6.3	High	**High**
Pasture	6.1	High	**High**
Other Crops	.6	High	**Low**
Cotton	.2	High	**High**
Vegetables and Ground Fruit	.2	High	**Low**
Wheat	.1	High	**High**
Other Grains	.1	High	**Low**
Nurseries	.1	High	**Low**
Other Row Crops	.04	High	**Low**
Orchards and Vineyards	.01	High	**Low**
Christmas Trees	.01	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**

Risk Hypothesis: Exposure to malathion is sufficient to reduce adult and juvenile abundance via acute lethality.		
Risk	**Confidence**	
High	**High**	

Table 348. Prey risk hypothesis; Atlantic sturgeon, Chesapeake Bay DPS and malathion; Adults and Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Developed	7.7	High	**High**
Corn	6.3	High	**High**
Pasture	6.1	High	**High**
Other Crops	.6	High	**Low**
Cotton	.2	High	**High**
Vegetables and Ground Fruit	.2	High	**Low**
Wheat	.1	High	**High**
Other Grains	.1	High	**Low**
Nurseries	.1	High	**Low**
Other Row Crops	.04	High	**Low**
Orchards and Vineyards	.01	High	**Low**
Christmas Trees	.01	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult and juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 349. Behavior and sensory risk hypothesis; Atlantic sturgeon, Chesapeake Bay DPS and malathion; Adults and Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Developed	7.7	Low	**High**
Corn	6.3	High	**High**
Pasture	6.1	High	**High**
Other Crops	.6	High	**Low**
Cotton	.2	High	**High**
Vegetables and Ground Fruit	.2	High	**Low**
Wheat	.1	Medium	**High**
Other Grains	.1	Medium	**Low**

Nurseries	.1	High	**Low**
Other Row Crops	.04	High	**Low**
Orchards and Vineyards	.01	High	**Low**
Christmas Trees	.01	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Developed	7.7	Not Available	**High**
Corn	6.3	Not Available	**High**
Pasture	6.1	Not Available	**High**
Other Crops	.6	Not Available	**Low**
Cotton	.2	Not Available	**High**
Vegetables and Ground Fruit	.2	Not Available	**Low**
Wheat	.1	Not Available	**High**
Other Grains	.1	Not Available	**Low**
Nurseries	.1	Not Available	**Low**
Other Row Crops	.04	Not Available	**Low**
Orchards and Vineyards	.01	Not Available	**Low**
Christmas Trees	.01	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 350. AChE risk hypothesis; Atlantic sturgeon, Chesapeake Bay DPS and malathion; Adults and Juveniles

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Developed	7.7	Medium	**High**
Corn	6.3	High	**High**
Pasture	6.1	High	**High**
Other Crops	.6	High	**Low**
Cotton	.2	High	**High**
Vegetables and Ground Fruit	.2	High	**Low**
Wheat	.1	High	**High**
Other Grains	.1	High	**Low**

Nurseries	.1	High	**Low**
Other Row Crops	.04	High	**Low**
Orchards and Vineyards	.01	High	**Low**
Christmas Trees	.01	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Table 351. Growth risk hypothesis; Atlantic sturgeon, Chesapeake Bay DPS and malathion; Adults and Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Developed	7.7	Low	**High**
Corn	6.3	Medium	**High**
Pasture	6.1	Medium	**High**
Other Crops	.6	Medium	**Low**
Cotton	.2	Medium	**High**
Vegetables and Ground Fruit	.2	Medium	**Low**
Wheat	.1	Medium	**High**
Other Grains	.1	Medium	**Low**
Nurseries	.1	Medium	**Low**
Other Row Crops	.04	Medium	**Low**
Orchards and Vineyards	.01	Medium	**Low**
Christmas Trees	.01	Medium	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
High	**High**		

Table 352. Reproduction risk hypothesis; Atlantic sturgeon, Chesapeake Bay DPS and malathion; Adults and Juveniles

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	**High**
Developed	7.7	Low	**High**

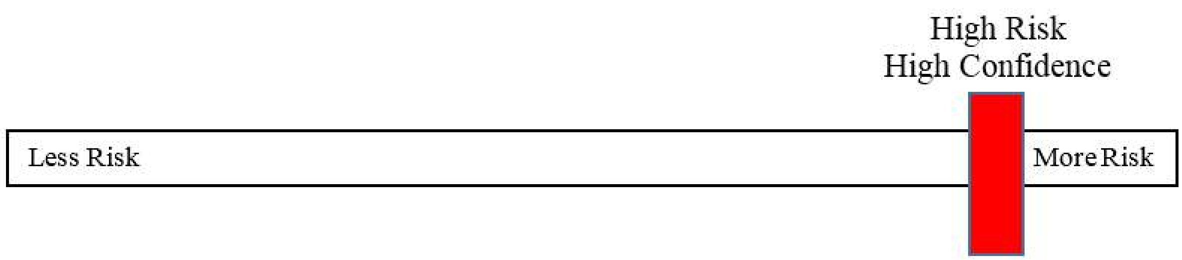
Corn	6.3	Low	**High**
Pasture	6.1	Low	**High**
Other Crops	.6	Low	**Low**
Cotton	.2	High	**High**
Vegetables and Ground Fruit	.2	Low	**Low**
Wheat	.1	Low	**High**
Other Grains	.1	Low	**Low**
Nurseries	.1	Medium	**Low**
Other Row Crops	.04	Low	**Low**
Orchards and Vineyards	.01	High	**Low**
Christmas Trees	.01	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Medium	**High**		

Table 353. Effects analysis summary table: Atlantic sturgeon, Chesapeake Bay DPS and malathion

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles and Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce adult and juvenile abundance via acute lethality.	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult and juvenile abundance via reduction in prey availability	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**

Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	Medium	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Atlantic sturgeon, Chesapeake Bay DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where malathion achieves predicted levels. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, sturgeon will likely experience more toxicity. The overall risk to Atlantic sturgeon, Chesapeake Bay DPS from the effects of the action is high and the confidence associated with that risk is high.



14.36 Atlantic Sturgeon, Gulf of Maine DPS (Acipenser oxyrinchus oxyrinchus)

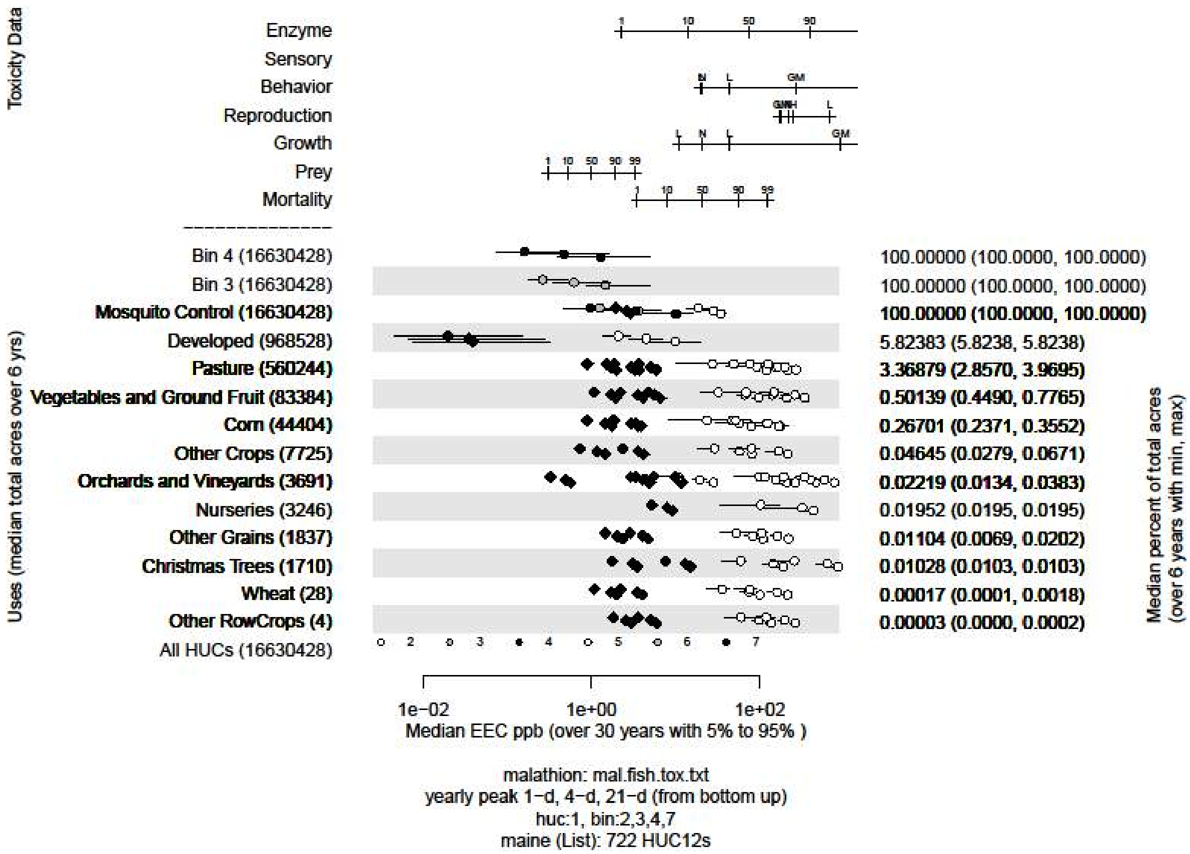


Figure 37. Effects analysis R-plot for Atlantic sturgeon, Gulf of Maine DPS and malathion

Table 354. Likelihood of exposure determination for Atlantic sturgeon, Gulf of Maine DPS and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Mosquito Control	3	yes	no	yes	NA	3	**High**
Developed	3	yes	no	yes	NA	3	**High**
Pasture	2	yes	no	yes	NA	3	**Med**
Vegetables and Ground Fruit	1	yes	no	yes	no	3	**Low**
Corn	1	yes	no	yes	no	3	**Low**
Other Crops	1	yes	no	yes	no	3	**Low**
Orchards and Vineyards	1	yes	no	yes	no	3	**Low**
Nurseries	1	yes	no	yes	no	3	**Low**
Other Grains	1	yes	no	yes	no	3	**Low**
Christmas Trees	1	yes	no	yes	no	3	**Low**
Bin 3	3	yes	no	yes	no	3	**High**
Bin 4	3	yes	no	yes	no	3	**High**

Life Stage: Juvenile and Adult

Table 355. Direct mortality risk hypothesis; Atlantic sturgeon, Gulf of Maine DPS and malathion; Adults and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Developed	5.8	Medium	**High**
Pasture	3.4	High	**Medium**
Vegetables and Ground Fruit	.5	High	**Low**
Corn	.3	High	**Low**
Other Crops	.05	High	**Low**
Orchards and Vineyards	.02	High	**Low**
Nurseries	.02	High	**Low**
Other Grains	.01	High	**Low**
Christmas Trees	.01	High	**Low**
Bin 3		Medium	High
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult and juvenile abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 356. Prey risk hypothesis; Atlantic sturgeon, Gulf of Maine DPS and malathion; Adults and Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Developed	5.8	High	**High**
Pasture	3.4	High	**Medium**
Vegetables and Ground Fruit	.5	High	**Low**
Corn	.3	High	**Low**
Other Crops	.05	High	**Low**
Orchards and Vineyards	.02	High	**Low**
Nurseries	.02	High	**Low**
Other Grains	.01	High	**Low**
Christmas Trees	.01	High	**Low**
Bin 3		High	High
Bin 4		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult and juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 357. Behavior and sensory risk hypothesis; Atlantic sturgeon, Gulf of Maine DPS and malathion; Adults and Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Developed	5.8	Low	**High**
Pasture	3.4	High	**Medium**
Vegetables and Ground Fruit	.5	High	**Low**
Corn	.3	Medium	**Low**
Other Crops	.05	Medium	**Low**
Orchards and Vineyards	.02	High	**Low**
Nurseries	.02	High	**Low**
Other Grains	.01	Medium	**Low**
Christmas Trees	.01	High	**Low**
Bin 3		Low	High
Bin 4		Low	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	NA	**High**
Developed	5.8		**High**

Pasture	3.4		**Medium**
Vegetables and Ground Fruit	.5		**Low**
Corn	.3		**Low**
Other Crops	.05		**Low**
Orchards and Vineyards	.02		**Low**
Nurseries	.02		**Low**
Other Grains	.01		**Low**
Christmas Trees	.01		**Low**
Bin 3			High
Bin 4			**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 358. AChE risk hypothesis; Atlantic sturgeon, Gulf of Maine DPS and malathion; Adults and Juveniles

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Developed	5.8	Medium	**High**
Pasture	3.4	High	**Medium**
Vegetables and Ground Fruit	.5	High	**Low**
Corn	.3	High	**Low**
Other Crops	.05	High	**Low**
Orchards and Vineyards	.02	High	**Low**
Nurseries	.02	High	**Low**
Other Grains	.01	High	**Low**
Christmas Trees	.01	High	**Low**
Bin 3		Medium	High
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Table 359. Growth risk hypothesis; Atlantic sturgeon, Gulf of Maine DPS and malathion; Adults and Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Mosquito Control	100	Medium	**High**
Developed	5.8	Low	**High**
Pasture	3.4	Medium	**Medium**
Vegetables and Ground Fruit	.5	Medium	**Low**
Corn	.3	Medium	**Low**
Other Crops	.05	Medium	**Low**
Orchards and Vineyards	.02	Medium	**Low**
Nurseries	.02	Medium	**Low**
Other Grains	.01	Medium	**Low**
Christmas Trees	.01	Medium	**Low**
Bin 3		Low	High
Bin 4		Low	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
High	**High**		

Table 360. Reproduction risk hypothesis; Atlantic sturgeon, Gulf of Maine DPS and malathion; Adults

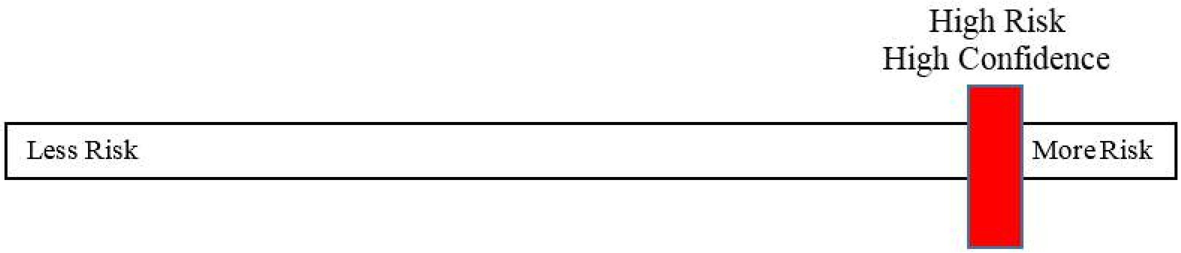
Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	**High**
Developed	5.8	Low	**High**
Pasture	3.4	Low	**Medium**
Vegetables and Ground Fruit	.5	High	**Low**
Corn	.3	Low	**Low**
Other Crops	.05	Low	**Low**
Orchards and Vineyards	.02	High	**Low**
Nurseries	.02	Medium	**Low**
Other Grains	.01	Low	**Low**
Christmas Trees	.01	High	**Low**
Bin 3		Low	High
Bin 4		Low	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**High**		

Table 361. Effects analysis summary table: Atlantic sturgeon, Gulf of Maine DPS and malathion

	R-plot Derived	**MagTool**	

Juveniles and Adults	Risk	Confidence	Range in median percent mortalities for aquatic bins	Risk Hypothesis Supported? Yes/No
Risk Hypothesis				
Exposure to malathion is sufficient to reduce adult and juvenile abundance via acute lethality.	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult and juvenile abundance via reduction in prey availability	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Atlantic sturgeon, Gulf of Maine DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where malathion achieves predicted levels. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, sturgeon will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed sturgeon. The overall risk to Atlantic sturgeon, Gulf of Maine DPS from the effects of the action is high and the confidence associated with that risk is high.



14.37 Atlantic Sturgeon, New York Bight DPS (Acipenser oxyrinchus oxyrinchus)

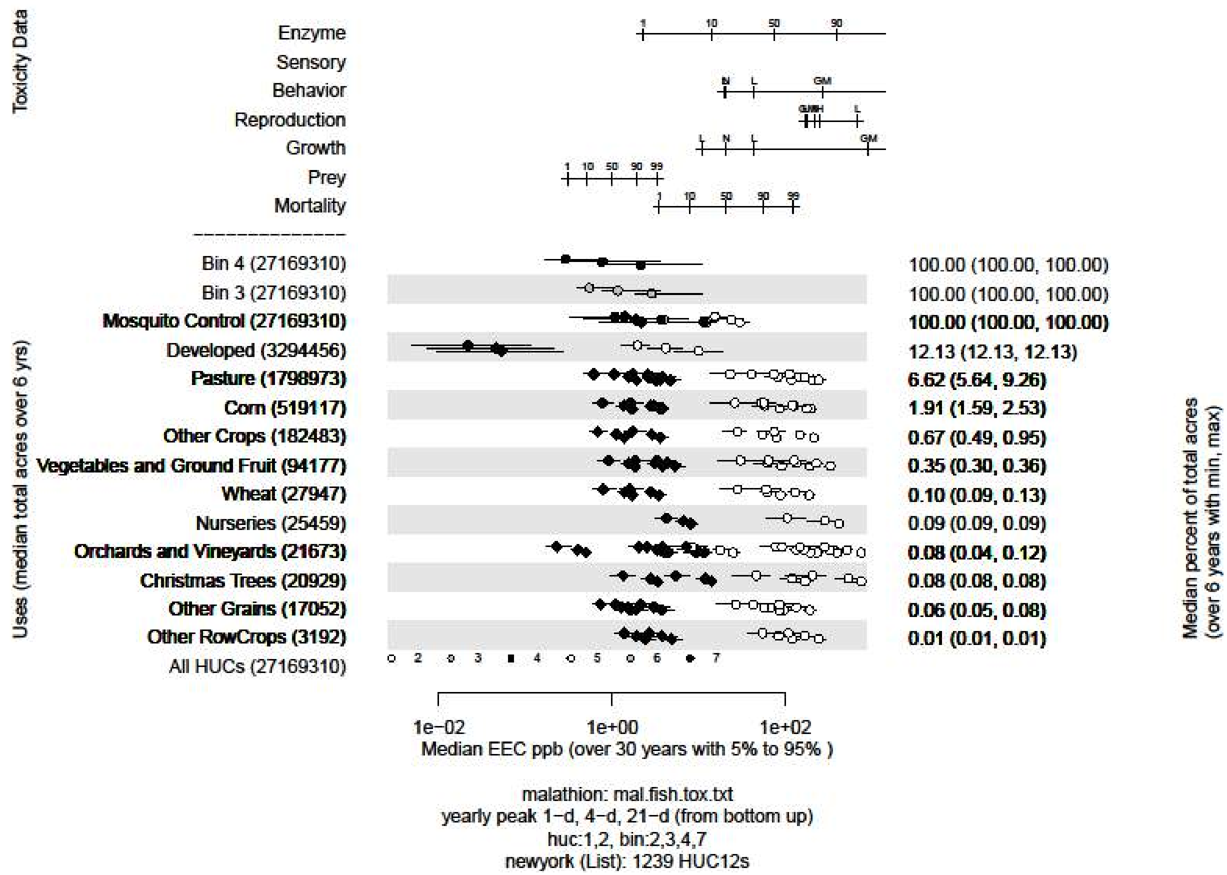


Figure 38. Effects analysis R-plot for Atlantic sturgeon, New York Bight DPS and malathion

Table 362. Likelihood of exposure determination for Atlantic sturgeon, New York Bight DPS and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Mosquito Control	3	yes	no	yes	NA	3	**High**
Developed	3	yes	no	yes	NA	3	**High**
Pasture	3	yes	no	yes	NA	3	**High**
Corn	2	yes	no	yes	NA	3	**Med**
Other Crops	1	yes	no	yes	yes	3	**High**
Vegetables and Ground fruit	1	yes	no	yes	yes	3	**High**
Wheat	1	yes	no	yes	yes	3	**High**
Nurseries	1	yes	no	yes	no	3	**Low**
Orchards and Vineyards	1	yes	no	yes	yes	3	**High**
Christmas Trees	1	yes	no	yes	no	3	**Low**
Other Grains	1	yes	no	yes	no	3	**Low**
Other Row Crops	1	yes	no	yes	no	3	**Low**
Bin 3	3	yes	no	yes	NA	3	**High**
Bin 4	3	yes	no	yes	NA	3	**High**

Life Stage: Juvenile and Adult

Table 363. Direct mortality risk hypothesis; Atlantic sturgeon, New York Bight DPS and malathion; Adults and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Developed	12.1	Medium	High
Pasture	6.7	High	High
Corn	1.9	High	Medium
Other Crops	.7	High	High
Vegetables and Ground fruit	.4	High	High
Wheat	.1	High	High
Nurseries	.1	High	Low
Orchards and Vineyards	.1	High	High
Christmas Trees	.1	High	Low
Other Grains	.1	High	Low
Other Row Crops	.01	High	Low
Bin 3		Medium	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult and juvenile abundance via acute lethality.			
Risk	**Confidence**		
High	**High**		

Table 364. Prey risk hypothesis; Atlantic sturgeon, New York Bight DPS and malathion; Adults and Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Developed	12.1	High	High
Pasture	6.7	High	High
Corn	1.9	High	Medium
Other Crops	.7	High	High
Vegetables and Ground fruit	.4	High	High
Wheat	.1	High	High
Nurseries	.1	High	Low
Orchards and Vineyards	.1	High	High
Christmas Trees	.1	High	Low
Other Grains	.1	High	Low
Other Row Crops	.01	High	Low
Bin 3		High	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult and juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 365. Behavior and sensory risk hypothesis; Atlantic sturgeon, New York Bight DPS and malathion; Adults and Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Developed	12.1	Low	High
Pasture	6.7	High	High
Corn	1.9	Medium	Medium
Other Crops	.7	Medium	High
Vegetables and Ground fruit	.4	High	High
Wheat	.1	Medium	High
Nurseries	.1	High	Low
Orchards and Vineyards	.1	High	High
Christmas Trees	.1	High	Low
Other Grains	.1	Medium	Low
Other Row Crops	.01	High	Low
Bin 3		Low	High

Bin 4		Low	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	High
Developed	12.1	Not Available	High
Pasture	6.7	Not Available	High
Corn	1.9	Not Available	Medium
Other Crops	.7	Not Available	High
Vegetables and Ground fruit	.4	Not Available	High
Wheat	.1	Not Available	High
Nurseries	.1	Not Available	Low
Orchards and Vineyards	.1	Not Available	High
Christmas Trees	.1	Not Available	Low
Other Grains	.1	Not Available	Low
Other Row Crops	.01	Not Available	Low
Bin 3		Not Available	High
Bin 4		Not Available	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 366. AChE risk hypothesis; Atlantic sturgeon, New York Bight DPS and malathion; Adults and Juveniles

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Developed	12.1	Medium	High
Pasture	6.7	High	High
Corn	1.9	High	Medium
Other Crops	.7	High	High
Vegetables and Ground fruit	.4	High	High
Wheat	.1	High	High
Nurseries	.1	High	Low
Orchards and Vineyards	.1	High	High
Christmas Trees	.1	High	Low
Other Grains	.1	High	Low
Other Row Crops	.01	High	Low
Bin 3		Medium	High
Bin 4		Medium	High

Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity		
Risk	**Confidence**	
High	**High**	

Table 367. Growth risk hypothesis; Atlantic sturgeon, New York Bight DPS and malathion; Adults and Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Developed	12.1	Low	High
Pasture	6.7	Medium	High
Corn	1.9	Medium	Medium
Other Crops	.7	Medium	High
Vegetables and Ground fruit	.4	Medium	High
Wheat	.1	Medium	High
Nurseries	.1	Medium	Low
Orchards and Vineyards	.1	Medium	High
Christmas Trees	.1	Medium	Low
Other Grains	.1	Medium	Low
Other Row Crops	.01	Medium	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
High	**High**		

Table 368. Reproduction risk hypothesis; Atlantic sturgeon, New York Bight DPS and malathion; Adults

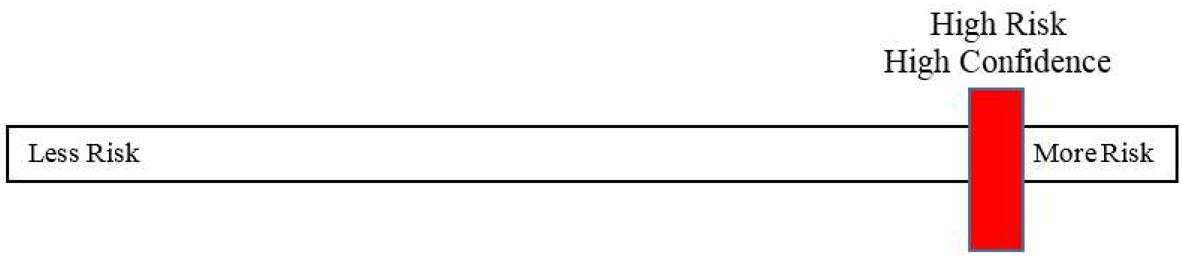
Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	High
Developed	12.1	Low	High
Pasture	6.7	Low	High
Corn	1.9	Low	Medium
Other Crops	.7	Low	High
Vegetables and Ground fruit	.4	Medium	High
Wheat	.1	Low	High
Nurseries	.1	High	Low
Orchards and Vineyards	.1	High	High

Christmas Trees	.1	High	Low
Other Grains	.1	Low	Low
Other Row Crops	.01	Low	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 369. Effects analysis summary table: Atlantic sturgeon, New York Bight DPS and malathion

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles and Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce adult and juvenile abundance via acute lethality.	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult and juvenile abundance via reduction in prey availability	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Atlantic sturgeon, New York Bight DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where malathion achieves predicted levels. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, sturgeon will likely experience more toxicity. Elevated water temperatures are anticipated to further enhance the toxicity of malathion and mixtures containing Malathion to exposed sturgeon. The overall risk to Atlantic sturgeon, New York Bight DPS from the effects of the action is high and the confidence associated with that risk is high.



14.38 Atlantic Sturgeon, South Atlantic DPS (Acipenser oxyrinchus oxyrinchus)

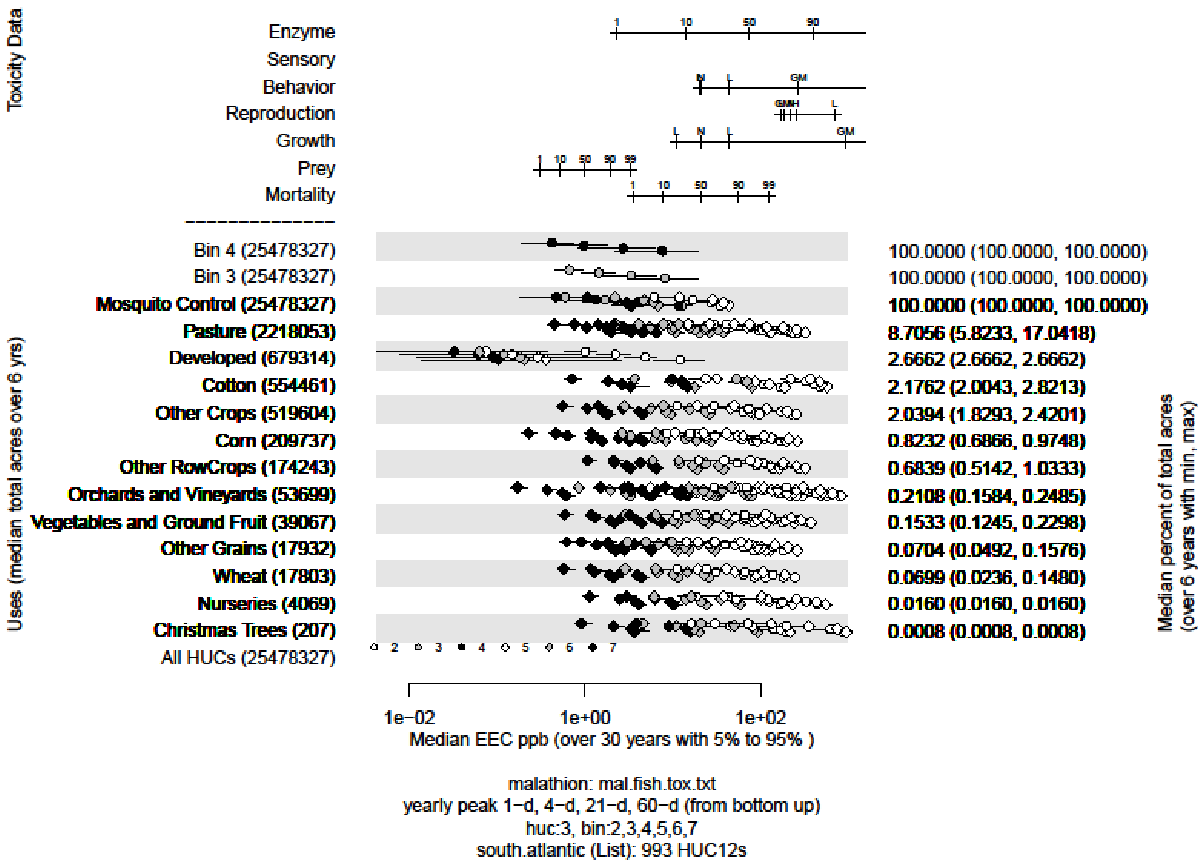


Figure 39. Effects analysis R-plot for Atlantic Sturgeon, South Atlantic DPS and malathion

Table 370. Likelihood of exposure determination for Atlantic Sturgeon, South Atlantic DPS and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Mosquito Control	3	yes	no	yes	NA	3	**High**
Pasture	3	yes	no	yes	NA	3	**High**
Developed	2	yes	no	yes	NA	3	**Med**
Cotton	2	yes	no	yes	NA	3	**Med**
Other Crops	2	yes	no	yes	NA	3	**Med**
Corn	1	yes	no	yes	yes	3	**High**
Other Row Crops	1	yes	no	yes	yes	3	**High**
Orchards and Vineyards	1	yes	no	yes	yes	3	**High**
Vegetables and Ground Fruit	1	yes	no	yes	no	3	**Low**
Other grains	1	yes	no	yes	no	3	**Low**
Wheat	1	yes	no	yes	yes	3	**High**
Nurseries	1	yes	no	yes	no	3	**Low**
Christmas Trees	1	yes	no	yes	no	3	**Low**
Bin 3	3	yes	no	yes	NA	3	**High**
Bin 4	3	yes	no	yes	NA	3	**High**

Life Stage: Juvenile and Adult

Table 371. Direct mortality risk hypothesis; Atlantic Sturgeon, South Atlantic DPS and malathion; Adults and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	8.7	High	**High**
Developed	2.7	High	**Medium**
Cotton	2.2	High	**Medium**
Other Crops	2.0	High	**Medium**
Corn	0.8	High	**High**
Other Row Crops	0.7	High	**High**
Orchards and Vineyards	0.2	High	**High**
Vegetables and Ground Fruit	0.2	High	**Low**
Other grains	0.07	High	**Low**
Wheat	0.07	High	**High**
Nurseries	0.02	High	**Low**
Christmas Trees	0.0008	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult and juvenile abundance via acute lethality.			

Risk	Confidence	
High	**High**	

Table 372. Prey risk hypothesis; Atlantic Sturgeon, South Atlantic DPS and malathion; Adults and Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Pasture	8.7	High	**High**
Developed	2.7	High	**Medium**
Cotton	2.2	High	**Medium**
Other Crops	2.0	High	**Medium**
Corn	0.8	High	**High**
Other Row Crops	0.7	High	**High**
Orchards and Vineyards	0.2	High	**High**
Vegetables and Ground Fruit	0.2	High	**Low**
Other grains	0.07	High	**Low**
Wheat	0.07	High	**High**
Nurseries	0.02	High	**Low**
Christmas Trees	0.0008	High	**Low**
Bin 3		High	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult and juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**High**		

Table 373. Behavior and sensory risk hypothesis; Atlantic Sturgeon, South Atlantic DPS and malathion; Adults and Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	**High**
Pasture	8.7	High	**High**
Developed	2.7	Low	**Medium**
Cotton	2.2	High	**Medium**
Other Crops	2.0	Medium	**Medium**
Corn	0.8	Medium	**High**
Other Row Crops	0.7	High	**High**
Orchards and Vineyards	0.2	High	**High**
Vegetables and Ground Fruit	0.2	High	**Low**
Other grains	0.07	Medium	**Low**
Wheat	0.07	Medium	**High**

Nurseries	0.02	High	**Low**
Christmas Trees	0.0008	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Pasture	8.7	Not Available	**High**
Developed	2.7	Not Available	**Medium**
Cotton	2.2	Not Available	**Medium**
Other Crops	2.0	Not Available	**Medium**
Corn	0.8	Not Available	**High**
Other Row Crops	0.7	Not Available	**High**
Orchards and Vineyards	0.2	Not Available	**High**
Vegetables and Ground Fruit	0.2	Not Available	**Low**
Other grains	0.07	Not Available	**Low**
Wheat	0.07	Not Available	**High**
Nurseries	0.02	Not Available	**Low**
Christmas Trees	0.0008	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**High**		

Table 374. AChE risk hypothesis; Atlantic Sturgeon, South Atlantic DPS and malathion; Adults and Juveniles

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	8.7	High	**High**
Developed	2.7	Medium	**Medium**
Cotton	2.2	High	**Medium**
Other Crops	2.0	High	**Medium**
Corn	0.8	High	**High**
Other Row Crops	0.7	High	**High**
Orchards and Vineyards	0.2	High	**High**
Vegetables and Ground Fruit	0.2	High	**Low**
Other grains	0.07	High	**Low**
Wheat	0.07	High	**High**

Nurseries	0.02	High	**Low**
Christmas Trees	0.0008	High	**Low**
Bin 3		Medium	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**High**		

Table 375. Growth risk hypothesis; Atlantic Sturgeon, South Atlantic DPS and malathion; Adults and Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Pasture	8.7	Medium	**High**
Developed	2.7	Low	**Medium**
Cotton	2.2	Medium	**Medium**
Other Crops	2.0	Medium	**Medium**
Corn	0.8	Medium	**High**
Other Row Crops	0.7	Medium	**High**
Orchards and Vineyards	0.2	Medium	**High**
Vegetables and Ground Fruit	0.2	Medium	**Low**
Other grains	0.07	Medium	**Low**
Wheat	0.07	Medium	**High**
Nurseries	0.02	Medium	**Low**
Christmas Trees	0.0008	Medium	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
High	**High**		

Table 376. Reproduction risk hypothesis; Atlantic Sturgeon, South Atlantic DPS and malathion; Adults

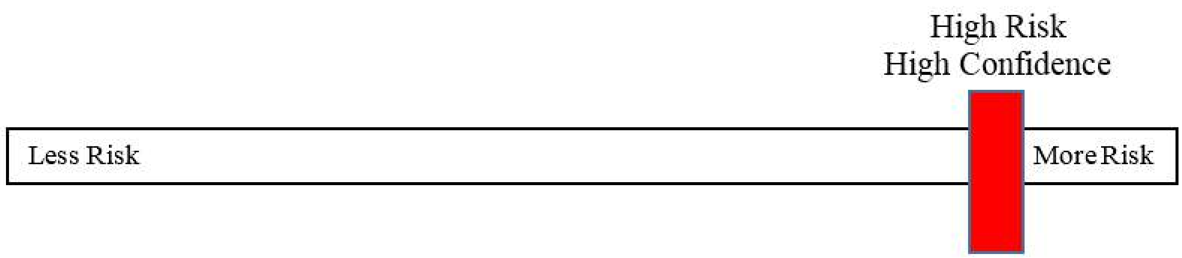
Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	**High**
Pasture	8.7	Medium	**High**
Developed	2.7	Low	**Medium**
Cotton	2.2	High	**Medium**
Other Crops	2.0	Low	**Medium**
Corn	0.8	Low	**High**

Other Row Crops	0.7	Medium	**High**
Orchards and Vineyards	0.2	High	**High**
Vegetables and Ground Fruit	0.2	High	**Low**
Other grains	0.07	Low	**Low**
Wheat	0.07	Low	**High**
Nurseries	0.02	High	**Low**
Christmas Trees	0.0008	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**High**		

Table 377. Effects analysis summary table: Atlantic Sturgeon, South Atlantic DPS and malathion

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Juveniles and Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce adult and juvenile abundance via acute lethality.	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult and juvenile abundance via reduction in prey availability	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Atlantic Sturgeon, South Atlantic DPS are anticipated to experience reduced abundance and productivity (spawning adults) from exposure to malathion. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where malathion achieves predicted levels. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, sturgeon will likely experience more toxicity. The overall risk to Atlantic Sturgeon, South Atlantic DPS from the effects of the action is high and the confidence associated with that risk is high.



14.39 Gulf Sturgeon (Acipenser oxyrinchus desotoi)

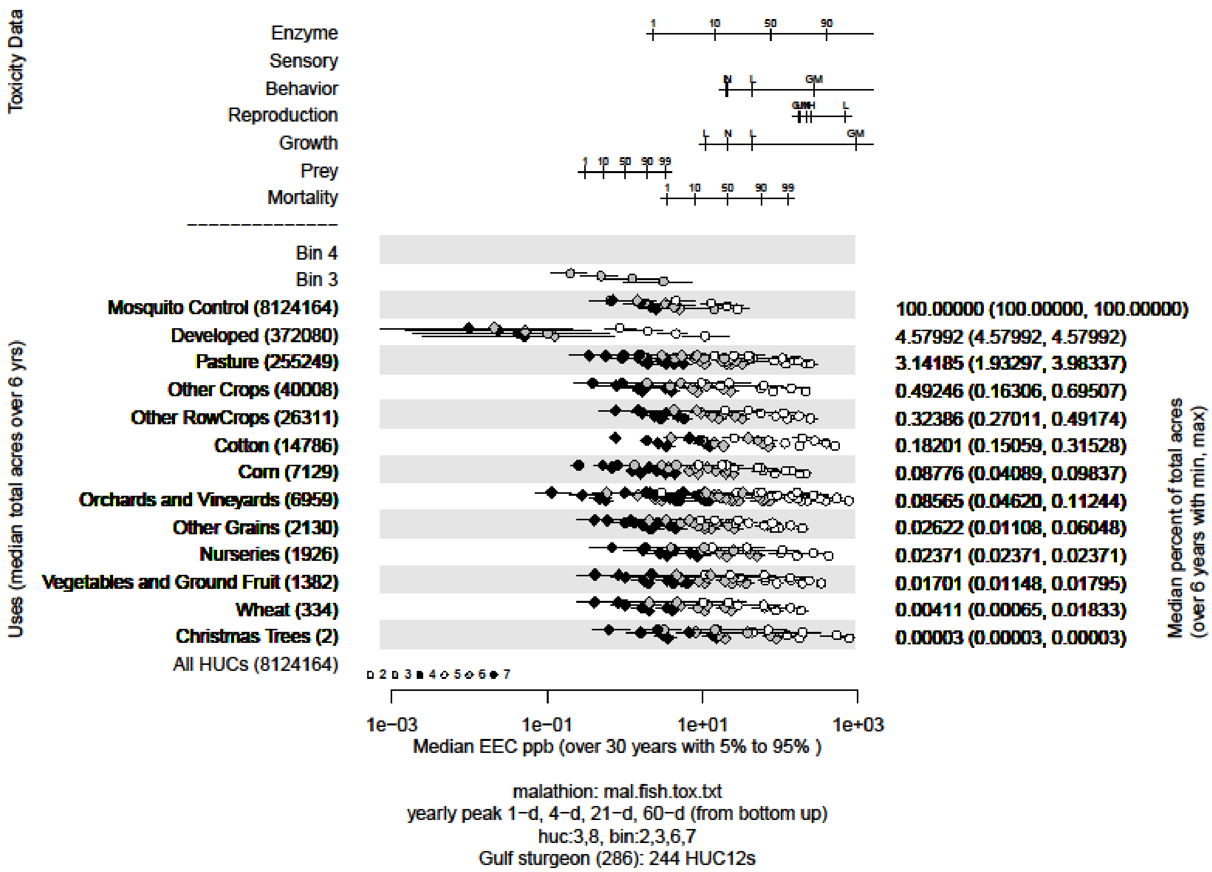


Figure 40. Effects analysis R-plot for Gulf Sturgeon and malathion

Table 378. Likelihood of exposure determination for Gulf Sturgeon and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Mosquito Control	3	yes	no	yes	NA	3	**High**
Developed	2	yes	no	yes	NA	3	**Med**
Pasture	2	yes	no	yes	NA	3	**Med**
Other Crops	1	yes	no	yes	NA	3	**Low**
Other Row Crops	1	yes	no	yes	NA	3	**Low**
Cotton	1	yes	no	yes	NA	3	**Low**
Corn	1	yes	no	yes	NA	3	**Low**
Orchards and Vineyards	1	yes	no	yes	NA	3	**Low**
Other Grains	1	yes	no	yes	NA	3	**Low**
Nurseries	1	yes	no	yes	NA	3	**Low**
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	**Low**
Wheat	1	yes	no	yes	NA	3	**Low**
Bin 3	1	yes	no	yes	NA	3	**High**

Life Stage: Juvenile and Adult (Marine Environment Only)

Table 379. Direct mortality risk hypothesis; Gulf Sturgeon and malathion; Adults and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Developed	4.6	High	Medium
Pasture	3.1	High	Medium
Other Crops	.5	High	Low
Other Row Crops	.3	High	Low
Cotton	.2	High	Low
Corn	.09	High	Low
Orchards and Vineyards	.09	High	Low
Other Grains	.03	High	Low
Nurseries	.02	High	Low
Vegetables and Ground Fruit	.02	High	Low
Wheat	.004	High	Low
Bin 3		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult and juvenile abundance via acute lethality.			
Risk	**Confidence**		
High	**Low**		

Table 380. Prey risk hypothesis; Gulf Sturgeon and malathion; Adults and Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Developed	4.6	High	Medium
Pasture	3.1	High	Medium
Other Crops	.5	High	Low
Other Row Crops	.3	High	Low
Cotton	.2	High	Low
Corn	.09	High	Low
Orchards and Vineyards	.09	High	Low
Other Grains	.03	High	Low
Nurseries	.02	High	Low
Vegetables and Ground Fruit	.02	High	Low
Wheat	.004	High	Low
Bin 3		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult and juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**Low**		

Table 381. Behavior and sensory risk hypothesis; Gulf Sturgeon and malathion; Adults and Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Developed	4.6	Medium	Medium
Pasture	3.1	High	Medium
Other Crops	.5	Medium	Low
Other Row Crops	.3	High	Low
Cotton	.2	High	Low
Corn	.09	Medium	Low
Orchards and Vineyards	.09	High	Low
Other Grains	.03	Medium	Low
Nurseries	.02	High	Low
Vegetables and Ground Fruit	.02	High	Low
Wheat	.004	Medium	Low
Bin 3		Low	High
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	High
Developed	4.6	Not Available	Medium

Pasture	3.1	Not Available	Medium
Other Crops	.5	Not Available	Low
Other Row Crops	.3	Not Available	Low
Cotton	.2	Not Available	Low
Corn	.09	Not Available	Low
Orchards and Vineyards	.09	Not Available	Low
Other Grains	.03	Not Available	Low
Nurseries	.02	Not Available	Low
Vegetables and Ground Fruit	.02	Not Available	Low
Wheat	.004	Not Available	Low
Bin 3		Not Available	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**Low**		

Table 382. AChE risk hypothesis; Gulf Sturgeon and malathion; Adults and Juveniles

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Developed	4.6	Medium	Medium
Pasture	3.1	High	Medium
Other Crops	.5	High	Low
Other Row Crops	.3	High	Low
Cotton	.2	High	Low
Corn	.09	High	Low
Orchards and Vineyards	.09	High	Low
Other Grains	.03	High	Low
Nurseries	.02	High	Low
Vegetables and Ground Fruit	.02	High	Low
Wheat	.004	High	Low
Bin 3		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Low**		

Table 383. Growth risk hypothesis; Gulf Sturgeon and malathion; Adults and Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

Mosquito Control	100	High	High
Developed	4.6	High	Medium
Pasture	3.1	High	Medium
Other Crops	.5	High	Low
Other Row Crops	.3	High	Low
Cotton	.2	High	Low
Corn	.09	High	Low
Orchards and Vineyards	.09	High	Low
Other Grains	.03	High	Low
Nurseries	.02	High	Low
Vegetables and Ground Fruit	.02	High	Low
Wheat	.004	High	Low
Bin 3		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
High	**Low**		

Table 384. Reproduction risk hypothesis; Gulf Sturgeon and malathion; Adults

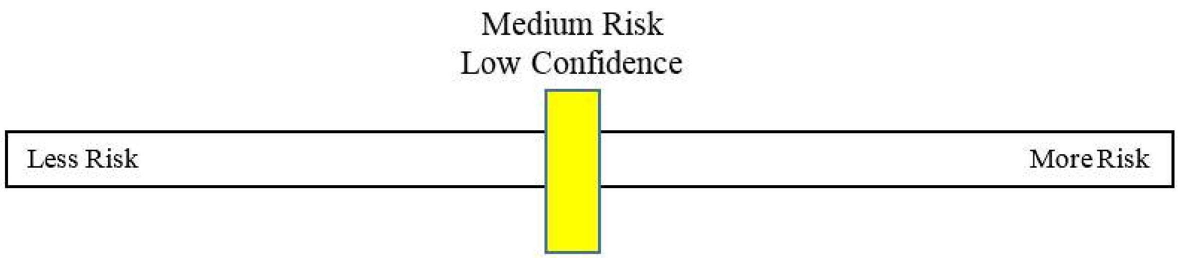
Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Developed	4.6	Low	Medium
Pasture	3.1	Medium	Medium
Other Crops	.5	Medium	Low
Other Row Crops	.3	Medium	Low
Cotton	.2	High	Low
Corn	.09	Medium	Low
Orchards and Vineyards	.09	High	Low
Other Grains	.03	Medium	Low
Nurseries	.02	High	Low
Vegetables and Ground Fruit	.02	High	Low
Wheat	.004	Medium	Low
Bin 3		Low	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	**Low**		

Table 385. Effects analysis summary table: Gulf Sturgeon and malathion

	R-plot Derived	**MagTool**	

Juveniles and Adults	Risk	Confidence	Range in median percent mortalities for aquatic bins	Risk Hypothesis Supported? Yes/No
Risk Hypothesis				
Exposure to malathion is sufficient to reduce adult and juvenile abundance via acute lethality.	High	Low	4-day:	**Yes**
Exposure to malathion is sufficient to reduce adult and juvenile abundance via reduction in prey availability	High	Low	4-day fish: 4-day invert:	**Yes**
Exposure to malathion is sufficient to reduce adult and juvenile abundance and adult productivity via impairments to ecologically significant behaviors.	High	Low	Not Available	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Low	Not Available	**Yes**
Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	Low	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	Low	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Gulf Sturgeon are not anticipated to experience significant reductions in abundance or productivity (spawning adults) from exposure to malathion in the marine environment. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, sturgeon may experience increased toxicity. If exposed to formulated products and tank mixtures containing malathion, Gulf sturgeon may experience increased toxicity. The MagTool results indicate that between 20-69 percent of individuals within a population will die. The overall risk to Gulf Sturgeon from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted malathion concentrations in coastal habitats.


Medium Risk
Low Confidence
Less Risk
More Risk

14.40 Yelloweye Rockfish (Sebastes ruberrimus)

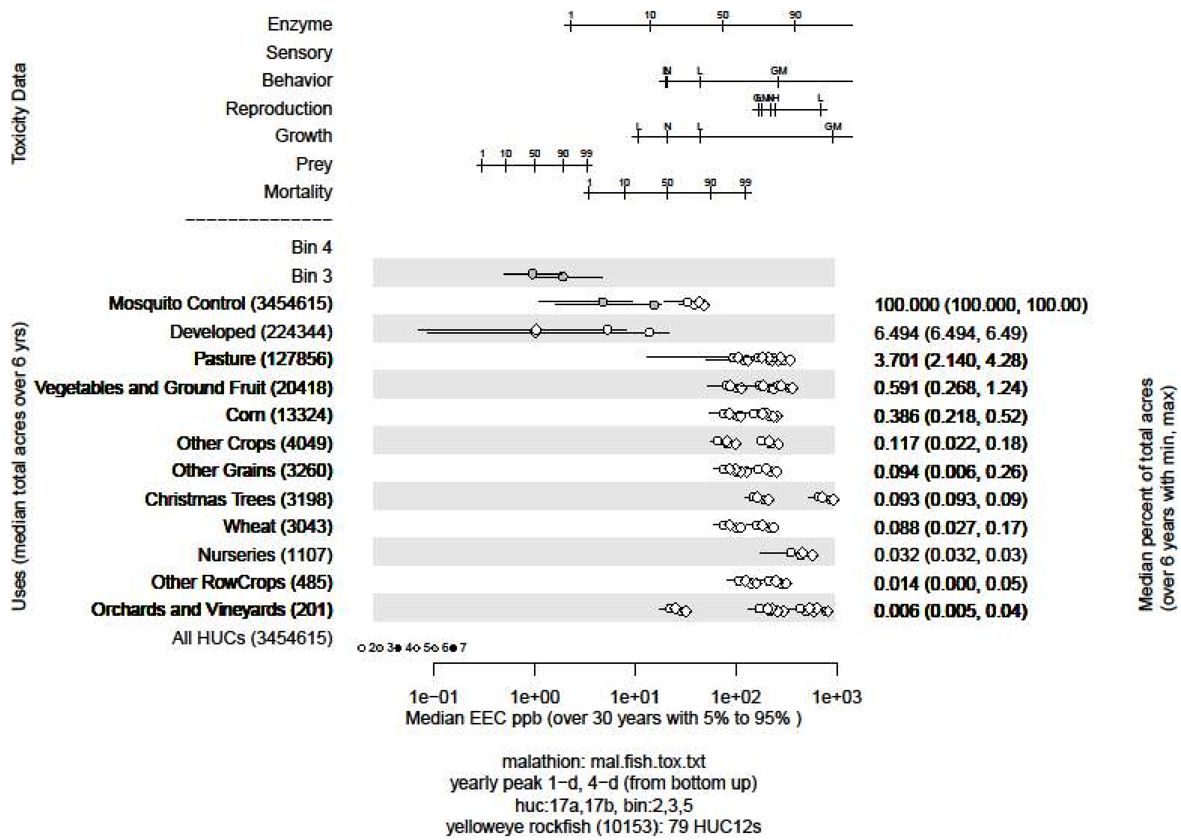


Figure 41. Effects analysis R-plot for Yelloweye Rockfish and malathion

Table 386. Likelihood of exposure determination for Yelloweye Rockfish and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Mosquito Control	3	yes	no	yes	NA	3	**High**
Developed	3	yes	no	yes	NA	3	**High**
Pasture	2	yes	no	yes	NA	3	**Med**
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	**Low**
Corn	1	yes	no	yes	NA	3	**Low**
Other Crops	1	yes	no	yes	NA	3	**Low**
Other Grains	1	yes	no	yes	NA	3	**Low**
Christmas Trees	1	yes	no	yes	NA	3	**Low**
Wheat	1	yes	no	yes	NA	3	**Low**
Nurseries	1	yes	no	yes	NA	3	**Low**
Other Row Crops	1	yes	no	yes	NA	3	**Low**
Orchards and Vineyards	1	yes	no	yes	NA	3	**Low**
Bin 3	3	yes	no	yes	NA	3	**High**
Bin 4	3	yes	no	yes	NA	3	**High**

Life Stage: Larvae and Juveniles

Table 387. Direct mortality risk hypothesis; Yelloweye Rockfish and malathion; Larvae and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Developed	6	High	High
Pasture	4	High	Medium
Vegetables and Ground Fruit	<1	High	Low
Corn	<1	High	Low
Other Crops	<1	High	Low
Other Grains	<1	High	Low
Christmas Trees	<1	High	Low
Wheat	<1	High	Low
Nurseries	<1	High	Low
Other Row Crops	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce larval and juvenile abundance via acute lethality.			
Risk	**Confidence**		
High	**Low**		

Table 388. Growth risk hypothesis; Yelloweye Rockfish and malathion; Larvae and Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Developed	6	Low	High
Pasture	4	Medium	Medium
Vegetables and Ground Fruit	<1	Medium	Low
Corn	<1	Medium	Low
Other Crops	<1	Medium	Low
Other Grains	<1	Medium	Low
Christmas Trees	<1	Medium	Low
Wheat	<1	Medium	Low
Nurseries	<1	Medium	Low
Other Row Crops	<1	Medium	Low
Orchards and Vineyards	<1	Medium	Low
Bin 3		Low	High
Bin 4		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce larval and juvenile abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
High	**Low**		

Table 389. Prey risk hypothesis; Yelloweye Rockfish and malathion; Larvae and Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Developed	6	High	High
Pasture	4	High	Medium
Vegetables and Ground Fruit	<1	High	Low
Corn	<1	High	Low
Other Crops	<1	High	Low
Other Grains	<1	High	Low
Christmas Trees	<1	High	Low
Wheat	<1	High	Low
Nurseries	<1	High	Low
Other Row Crops	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce larval and juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**Low**		

Table 390. AChE risk hypothesis; Yelloweye Rockfish and malathion; Larvae and Juveniles

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Developed	6	Medium	High
Pasture	4	High	Medium
Vegetables and Ground Fruit	<1	High	Low
Corn	<1	High	Low
Other Crops	<1	High	Low
Other Grains	<1	High	Low
Christmas Trees	<1	High	Low
Wheat	<1	High	Low
Nurseries	<1	High	Low
Other Row Crops	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		Medium	High
Bin 4		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Low**		

Table 391. Behavior and sensory risk hypothesis; Yelloweye Rockfish and malathion; Larvae and Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Developed	6	Medium	High
Pasture	4	High	Medium
Vegetables and Ground Fruit	<1	High	Low
Corn	<1	High	Low
Other Crops	<1	High	Low
Other Grains	<1	High	Low
Christmas Trees	<1	High	Low
Wheat	<1	High	Low
Nurseries	<1	High	Low
Other Row Crops	<1	High	Low
Orchards and Vineyards	<1	High	Low
Bin 3		Low	High
Endpoint: Sensory			

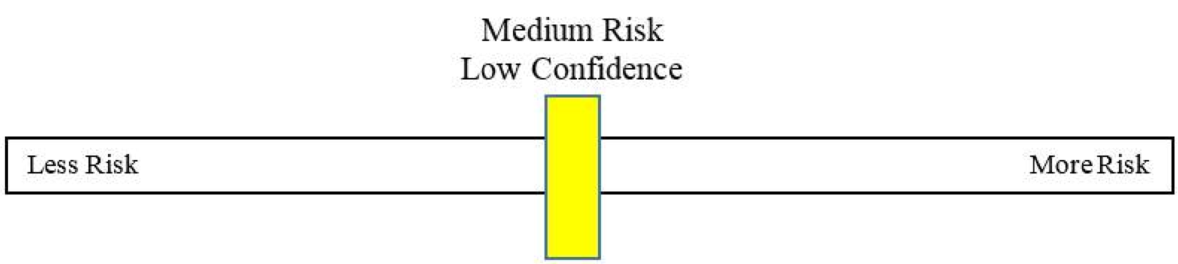
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Not Available	High
Developed	6	Not Available	High
Pasture	4	Not Available	Medium
Vegetables and Ground Fruit	<1	Not Available	Low
Corn	<1	Not Available	Low
Other Crops	<1	Not Available	Low
Other Grains	<1	Not Available	Low
Christmas Trees	<1	Not Available	Low
Wheat	<1	Not Available	Low
Nurseries	<1	Not Available	Low
Other Row Crops	<1	Not Available	Low
Orchards and Vineyards	<1	Not Available	Low
Bin 3		Not Available	High
Bin 4		Not Available	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce larval and juvenile abundance via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**Low**		

Table 392. Effects analysis summary table: Yelloweye Rockfish and malathion

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Larvae and Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce larval and juvenile abundance via acute lethality.	High	Low	Not Available	**Yes**
Exposure to malathion is sufficient to reduce larval and juvenile abundance via impacts to growth (direct toxicity)	High	Low	Not Available	**Yes**
Exposure to malathion is sufficient to reduce larval and juvenile abundance via reduction in prey availability	High	Low	Not Available	**Yes**
Exposure to malathion is sufficient to reduce ChE	High	Low	Not Available	**Yes**

activity; the identified mechanism of toxicity				
Exposure to malathion is sufficient to reduce larval and juvenile abundance via impairments to ecologically significant behaviors.	High	Low	Not Available	**Yes**

Effects analysis summary: Adult, juvenile and larval Yelloweye Rockfish are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to malathion in the marine environment. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, rockfish may experience increased toxicity. If exposed to formulated products and tank mixtures containing malathion, rockfish may experience increased toxicity. The overall risk to yelloweye rockfish from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted malathion concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty in the route of exposure to adult rockfish which are typically found in deep marine habitats.



14.41 Boccacio, Puget Sound/Georgia Basin DPS (Sebastes paucispinis)

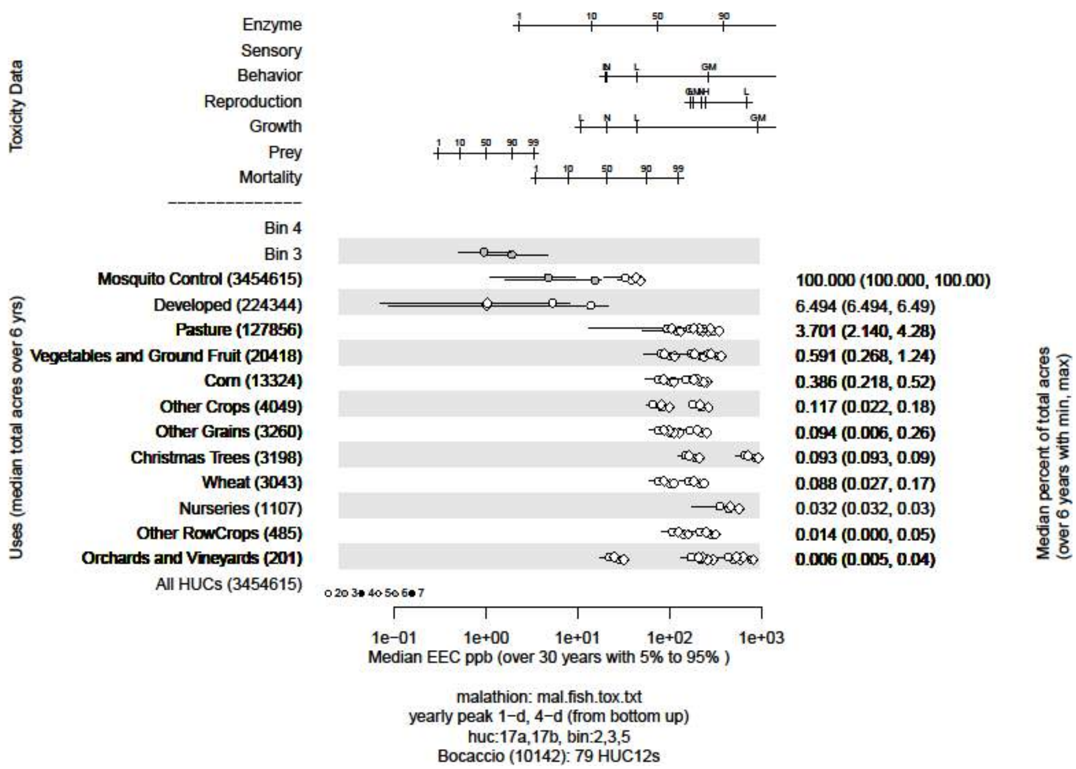


Figure 42. Effects analysis R-plot for Boccacio, Puget Sound/Georgia Basin DPS and malathion

Table 393. Likelihood of exposure determination for Boccacio, Puget Sound/Georgia Basin DPS and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Mosquito Control	3	yes	no	yes	NA	3	**High**
Developed	3	yes	no	yes	NA	3	**High**
Pasture	2	yes	no	yes	NA	3	**Med**
Vegetables and Ground Fruit	1	yes	no	yes	no	3	**Low**
Corn	1	yes	no	yes	no	3	**Low**
Other Crops	1	yes	no	yes	no	3	**Low**
Other Grains	1	yes	no	yes	no	3	**Low**
Christmas Trees	1	yes	no	yes	no	3	**Low**
Wheat	1	yes	no	yes	no	3	**Low**
Nurseries	1	yes	no	yes	no	3	**Low**
Other Row Crops	1	yes	no	yes	no	3	**Low**
Orchards and Vineyards	1	yes	no	yes	no	3	**Low**
Bin 3	3	yes	no	yes	no	3	**High**
Bin 4	3	yes	no	yes	no	3	**High**

Life Stage: Larvae and Juveniles

Table 394. Direct mortality risk hypothesis; Boccacio, Puget Sound/Georgia Basin DPS and malathion; Larvae and Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Developed	6	High	**High**
Pasture	4	High	**Medium**
Vegetables and Ground Fruit	1	High	**Low**
Corn	<1	High	**Low**
Other Crops	<1	High	**Low**
Other Grains	<1	High	**Low**
Christmas Trees	<1	High	**Low**
Wheat	<1	High	**Low**
Nurseries	<1	High	**Low**
Other Row Crops	<1	High	**Low**
Orchards and Vineyards	<1	High	**Low**
Bin 3		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce larval and juvenile abundance via acute lethality.			
Risk	**Confidence**		
High	**Low**		

Table 395. Growth risk hypothesis; Boccacio, Puget Sound/Georgia Basin DPS and malathion; Larvae and Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Developed	6	Low	**High**
Pasture	4	Medium	**Medium**
Vegetables and Ground Fruit	1	Medium	**Low**
Corn	<1	Medium	**Low**
Other Crops	<1	Medium	**Low**
Other Grains	<1	Medium	**Low**
Christmas Trees	<1	Medium	**Low**
Wheat	<1	Medium	**Low**
Nurseries	<1	Medium	**Low**
Other Row Crops	<1	Medium	**Low**
Orchards and Vineyards	<1	Medium	**Low**
Bin 3		Low	**High**
Bin 4		Medium	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce larval and juvenile abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
High	**Low**		

Table 396. Prey risk hypothesis; Boccacio, Puget Sound/Georgia Basin DPS and malathion; Larvae and Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Developed	6	High	**High**
Pasture	4	High	**Medium**
Vegetables and Ground Fruit	1	High	**Low**
Corn	<1	High	**Low**
Other Crops	<1	High	**Low**
Other Grains	<1	High	**Low**
Christmas Trees	<1	High	**Low**
Wheat	<1	High	**Low**
Nurseries	<1	High	**Low**
Other Row Crops	<1	High	**Low**
Orchards and Vineyards	<1	High	**Low**
Bin 3		High	**High**

Bin 4		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce larval and juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**Low**		

Table 397. AChE risk hypothesis; Boccacio, Puget Sound/Georgia Basin DPS and malathion; Larvae and Juveniles

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Developed	6	Medium	**High**
Pasture	4	High	**Medium**
Vegetables and Ground Fruit	1	High	**Low**
Corn	<1	High	**Low**
Other Crops	<1	High	**Low**
Other Grains	<1	High	**Low**
Christmas Trees	<1	High	**Low**
Wheat	<1	High	**Low**
Nurseries	<1	High	**Low**
Other Row Crops	<1	High	**Low**
Orchards and Vineyards	<1	High	**Low**
Bin 3		Medium	**High**
Bin 4		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Low**		

Table 398. Behavior and sensory risk hypothesis; Boccacio, Puget Sound/Georgia Basin DPS and malathion; Larvae and Juveniles

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Developed	6	Medium	**High**
Pasture	4	High	**Medium**
Vegetables and Ground Fruit	1	High	**Low**
Corn	<1	High	**Low**
Other Crops	<1	High	**Low**
Other Grains	<1	High	**Low**
Christmas Trees	<1	High	**Low**

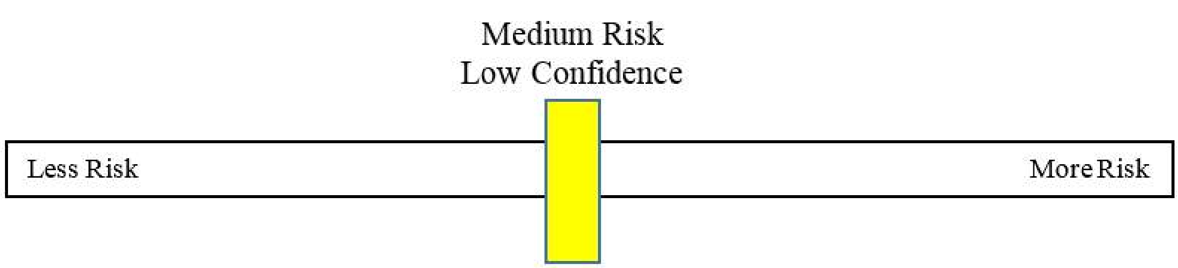
Wheat	<1	High	**Low**
Nurseries	<1	High	**Low**
Other Row Crops	<1	High	**Low**
Orchards and Vineyards	<1	High	**Low**
Bin 3		Low	**High**
Bin 4		Low	**High**
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Developed	6	Not Available	**High**
Pasture	4	Not Available	**Medium**
Vegetables and Ground Fruit	1	Not Available	**Low**
Corn	<1	Not Available	**Low**
Other Crops	<1	Not Available	**Low**
Other Grains	<1	Not Available	**Low**
Christmas Trees	<1	Not Available	**Low**
Wheat	<1	Not Available	**Low**
Nurseries	<1	Not Available	**Low**
Other Row Crops	<1	Not Available	**Low**
Orchards and Vineyards	<1	Not Available	**Low**
Bin 3		Not Available	**High**
Bin 4		Not Available	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce larval and juvenile abundance via impairments to ecologically significant behaviors.			
Risk	**Confidence**		
High	**Low**		

Table 399. Effects analysis summary table: Boccacio, Puget Sound/Georgia Basin DPS and malathion

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Larvae and Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce larval and juvenile abundance via acute lethality.	High	Low	Not Available	**Yes**
Exposure to malathion is sufficient to reduce larval and juvenile abundance via impacts to growth (direct toxicity)	High	Low	Not Available	**Yes**

Exposure to malathion is sufficient to reduce larval and juvenile abundance via reduction in prey availability	High	Low	Not Available	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Low	Not Available	**Yes**
Exposure to malathion is sufficient to reduce larval and juvenile abundance via impairments to ecologically significant behaviors.	High	Low	Not Available	**Yes**

Effects analysis summary: Adult, juvenile and larval boccacio are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to malathion in the marine environment. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, boccacio may experience increased toxicity. If exposed to formulated products and tank mixtures containing malathion, boccacio may experience increased toxicity. The overall risk to boccacio from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted malathion concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty in the route of exposure to adult boccacio which are typically found in deep marine habitats.



14.42 Gulf Grouper (Mycteroperca jordani)

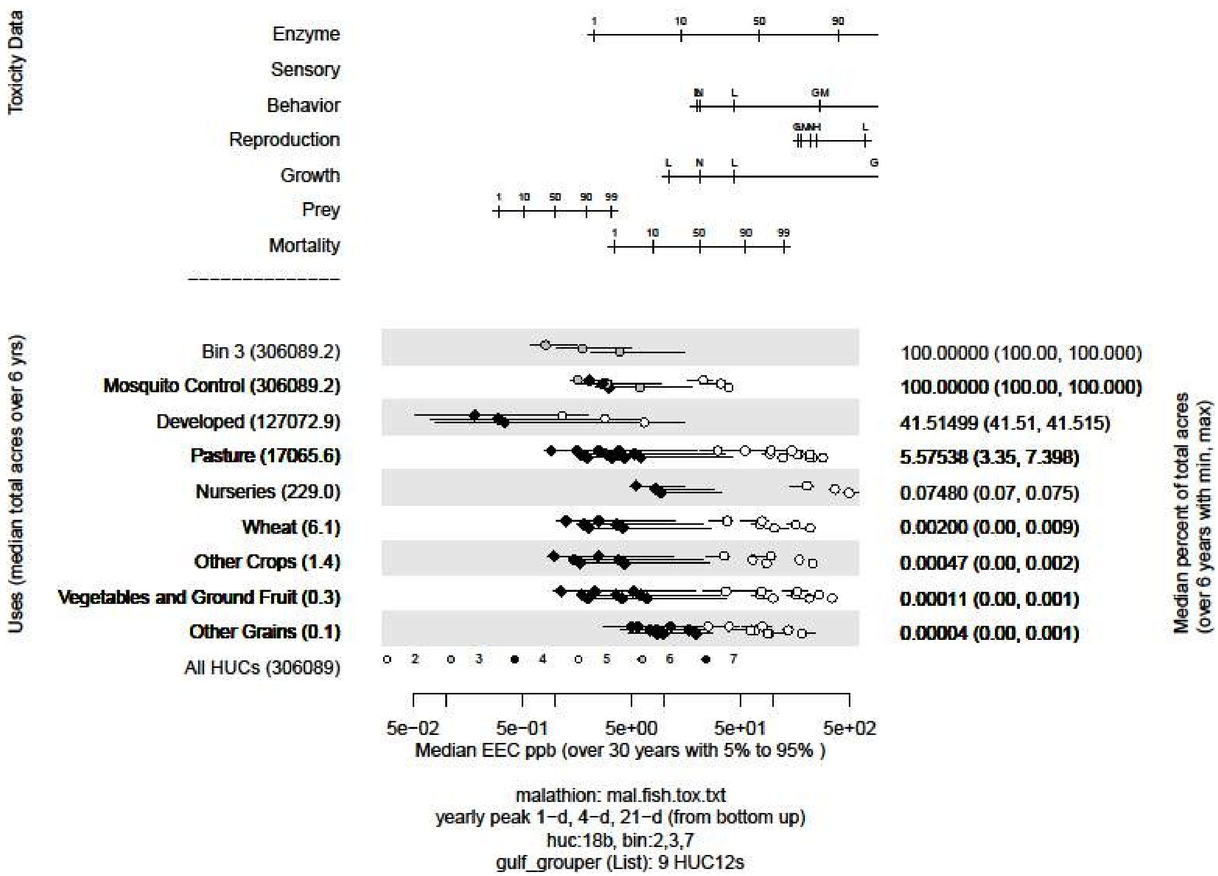


Figure 43. Effects analysis R-plot for Gulf grouper and malathion

Table 400. Likelihood of exposure determination for Gulf grouper and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range in US Territories	Likelihood of Exposure
Mosquito Control	3	yes	yes	yes	NA	3	small	**Low**
Developed	3	yes	yes	yes	NA	3	small	**Low**
Pasture	3	yes	yes	yes	NA	3	small	**Low**
Nurseries	1	yes	yes	yes	NA	3	small	**Low**
Wheat	1	yes	yes	yes	no	3	small	**Low**
Bin 3	1	yes	yes	yes	no	3	small	**Low**

Life Stage: Adult

Exposure pathway not anticipated for adult life history of this species, therefore risk hypotheses for adult life stages not evaluated.

Life Stage: Juvenile

Table 401. Direct mortality risk hypothesis; Gulf grouper and malathion; Juveniles

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	Low
Developed	41.6	Medium	Low
Pasture	5.6	High	Low
Nurseries	<1	High	Low
Wheat	<1	High	Low
Bin 3		Medium	
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.			
Risk	**Confidence**		
Low	**High**		

Table 402. Prey risk hypothesis; Gulf grouper and malathion; Juveniles

Endpoint: Prey			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	Low
Developed	41.6	High	Low
Pasture	5.6	High	Low
Nurseries	<1	High	Low
Wheat	<1	High	Low
Bin 3		High	
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	**High**		

Table 403. Growth risk hypothesis; Gulf grouper and malathion; Juveniles

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	Low
Developed	41.6	Medium	Low
Pasture	5.6	Medium	Low

Nurseries	<1	Medium	Low
Wheat	<1	Medium	Low
Bin 3		Low	
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
Low	**High**		

Table 404. AChE risk hypothesis; Gulf grouper and malathion; Juveniles

Endpoint: Enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	Low
Developed	41.6	Medium	Low
Pasture	5.6	High	Low
Nurseries	<1	High	Low
Wheat	<1	High	Low
Bin 3		Medium	
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**High**		

Table 405. Behavior and sensory risk hypothesis; Gulf grouper and malathion; Juveniles

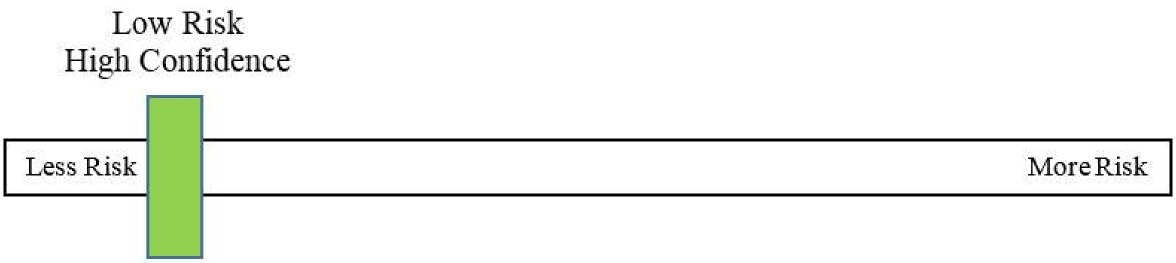
Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	Low
Developed	41.6	Low	Low
Pasture	5.6	High	Low
Nurseries	<1	High	Low
Wheat	<1	Medium	Low
Bin 3		Low	
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	Low
Developed	41.6	Not Available	Low
Pasture	5.6	Not Available	Low
Nurseries	<1	Not Available	Low
Wheat	<1	Not Available	Low
Bin 3		Not Available	
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors			
Risk	**Confidence**		

Low	**High**	

Table 406. Effects analysis summary table: Gulf grouper and malathion

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.	Low	**High**	Not Available	**No**
Exposure to malathion is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)	Low	**High**	Not Available	**No**
Exposure to malathion is sufficient to reduce juvenile abundance via reduction in prey availability	Low	**High**	Not Available	**No**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	**High**	Not Available	**No**
Exposure to malathion is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	Low	**High**	Not Available	**No**

Effects analysis summary: Adult and juvenile Gulf grouper are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to malathion in the marine environment. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, groupers may experience increased toxicity. The overall risk to Gulf grouper from the effects of the action is low and the confidence associated with that risk is high. The low risk to groupers is due primarily to the small portion of the species' range within US territories. Low risk is also attributed to uncertainty in the route of exposure to adult groupers which are typically found in deep marine habitats



14.43 Nassau Grouper (Epinephelus striatus)

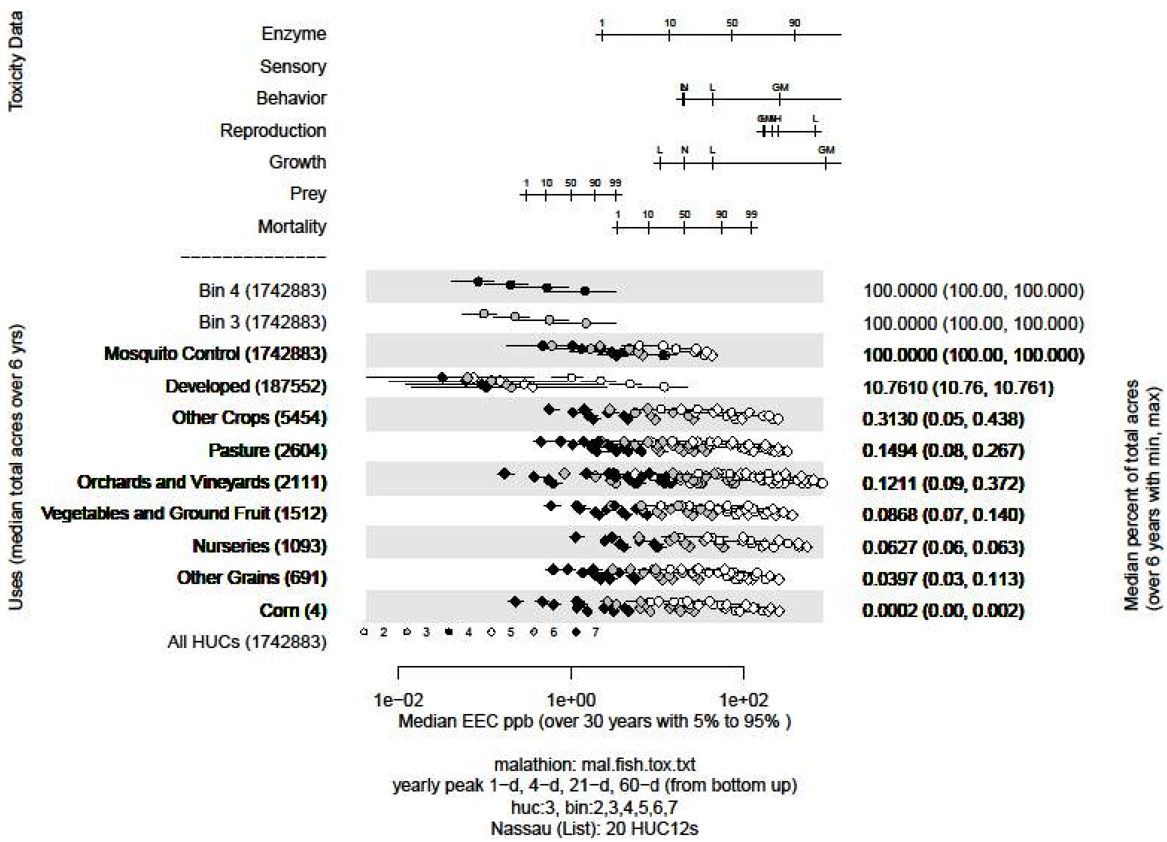


Figure 44. Effects analysis R-plot for Nassau Grouper and malathion

Table 407. Likelihood of exposure determination for Nassau Grouper and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range within US Territories	Likelihood of Exposure
Adults and Juveniles (Florida)								
Mosquito Control	3	yes	no	yes	NA	3	small	Low
Developed	3	yes	no	yes	NA	3	small	Low
Other Crops	1	yes	no	yes	NA	3	small	Low
Pasture	1	yes	no	yes	NA	3	small	Low
Orchards and Vineyards	1	yes	no	yes	NA	3	small	Low
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	small	Low
Nurseries	1	yes	no	yes	NA	3	small	Low
Other Grains	1	yes	no	yes	NA	3	small	Low
Corn	1	yes	no	yes	NA	3	small	Low
Bin 3	3	yes	no	yes	NA	3	small	Low
Adults and Juveniles (US Territories in Caribbean)								
Crops	NA	yes	no	yes	NA	3	small	Low
Developed	NA	yes	no	yes	NA	3	small	Low
Mosquito Control	NA	yes	no	yes	NA	3	small	Low
Other	NA	yes	yes	yes	NA	3	small	Low

Life Stage: Adult

Table 408. Direct mortality risk hypothesis; Nassau Grouper and malathion; Adults (Florida Coast)

Endpoint: Mortality (Florida Coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	Low
Developed	10.8	High	Low
Other Crops	<1	High	Low
Pasture	<1	High	Low
Orchards and Vineyards	<1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Nurseries	<1	High	Low
Other Grains	<1	High	Low
Corn	<1	High	Low
Bin 3	<1	Med	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**High**		

Table 409. Direct mortality risk hypothesis; Nassau Grouper and malathion; Adults (US Territories in the Caribbean)

Endpoint: Mortality (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	100	High	Low
Other	Not Available	High	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**High**		

Table 410. Reproduction risk hypothesis; Nassau Grouper and malathion; Adults (Florida Coast)

Endpoint: Reproduction (Florida coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	Low
Developed	10.8	Low	Low
Other Crops	<1	Low	Low
Pasture	<1	Low	Low
Orchards and Vineyards	<1	High	Low
Vegetables and Ground Fruit	<1	Low	Low
Nurseries	<1	Low	Low
Other Grains	<1	Low	Low
Corn	<1	Low	Low
Bin 3	<1	Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**High**		

Table 411. Reproduction risk hypothesis; Nassau Grouper and malathion; Adults (US Territories in the Caribbean)

Endpoint: Reproduction (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	Low	Low
Mosquito Control	100	Low	Low
Other	Not Available	High	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**High**		

Table 412. AChE risk hypothesis; Nassau Grouper and malathion; Adults (Florida Coast)

Endpoint: enzyme (Florida coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Med	Low
Developed	10.8	High	Low
Other Crops	<1	High	Low
Pasture	<1	High	Low
Orchards and Vineyards	<1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Nurseries	<1	High	Low
Other Grains	<1	High	Low
Corn	<1	High	Low
Bin 3	<1	Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**High**		

Table 413. AChE risk hypothesis; Nassau Grouper and malathion; Adults (US Territories in the Caribbean)

Endpoint: Enzyme (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	Med	Low
Mosquito Control	100	Med	Low
Other	Not Available	High	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**High**		

Table 414. Behavior and sensory risk hypothesis; Nassau Grouper and malathion; Adults (Florida Coast)

Endpoint: Behavior (Florida coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Med	Low
Developed	10.8	Med	Low
Other Crops	<1	Med	Low
Pasture	<1	High	Low

Orchards and Vineyards	<1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Nurseries	<1	High	Low
Other Grains	<1	Med	Low
Corn	<1	Med	Low
Bin 3	<1	Low	Low
Endpoint: Sensory (Florida coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	Low
Developed	10.8	Not Available	Low
Other Crops	<1	Not Available	Low
Pasture	<1	Not Available	Low
Orchards and Vineyards	<1	Not Available	Low
Vegetables and Ground Fruit	<1	Not Available	Low
Nurseries	<1	Not Available	Low
Other Grains	<1	Not Available	Low
Corn	<1	Not Available	Low
Bin 3	<1	Not Available	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors			
Risk	**Confidence**		
Low	**High**		

Table 415. Behavior and sensory risk hypothesis; Nassau Grouper and malathion; Adults (US Territories in the Caribbean)

Endpoint: Behavior (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	Med	Low
Mosquito Control	100	Med	Low
Other	Not Available	High	Low
Endpoint: Sensory (HUC03 – Puerto Rico)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	Med	Low
Mosquito Control	100	Med	Low
Other	Not Available	High	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors			
Risk	**Confidence**		

Low	**High**	

Life Stage: Juvenile

Table 416. Direct mortality risk hypothesis; Nassau Grouper and malathion; Juveniles (Florida Coast)

Endpoint: Mortality (Florida coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	Low
Developed	10.8	High	Low
Other Crops	<1	High	Low
Pasture	<1	High	Low
Orchards and Vineyards	<1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Nurseries	<1	High	Low
Other Grains	<1	High	Low
Corn	<1	High	Low
Bin 3	<1	Med	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.			
Risk	**Confidence**		
Low	**High**		

Table 417. Direct mortality risk hypothesis; Nassau Grouper and malathion; Juveniles (US Territories in the Caribbean)

Endpoint: Mortality (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	100	High	Low
Other	Not Available	High	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.			
Risk	**Confidence**		
Low	**High**		

Table 418. Prey risk hypothesis; Nassau Grouper and malathion; Juveniles (Florida Coast)

Endpoint: Prey (Florida coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	Low
Developed	10.8	High	Low

Other Crops	<1	High	Low
Pasture	<1	High	Low
Orchards and Vineyards	<1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Nurseries	<1	High	Low
Other Grains	<1	High	Low
Corn	<1	High	Low
Bin 3	<1	High	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	**High**		

Table 419. Prey risk hypothesis; Nassau Grouper and malathion; Juveniles (US Territories in the Caribbean)

Endpoint: Prey (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	100	High	Low
Other	Other	High	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	**High**		

Table 420. Growth risk hypothesis; Nassau Grouper and malathion; Juveniles (Florida Coast)

Endpoint: Growth (Florida coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Med	Low
Developed	10.8	Low	Low
Other Crops	<1	Med	Low
Pasture	<1	Med	Low
Orchards and Vineyards	<1	Med	Low
Vegetables and Ground Fruit	<1	Med	Low
Nurseries	<1	Med	Low
Other Grains	<1	Med	Low
Corn	<1	Med	Low
Bin 3	<1	Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		

Low	**High**	

Table 421. Growth risk hypothesis; Nassau Grouper and malathion; Juveniles (US Territories in the Caribbean)

Endpoint: Growth (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Med	Low
Developed	Not Available	Low	Low
Mosquito Control	Not Available	Med	Low
Other		Med	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce juvenile abundance via impacts to growth (direct toxicity)			
Risk	**Confidence**		
Low	**High**		

Table 422. AChE risk hypothesis; Nassau Grouper and malathion; Juveniles (Florida Coast)

Endpoint: Enzyme (Florida coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Med	Low
Developed	10.8	High	Low
Other Crops	<1	High	Low
Pasture	<1	High	Low
Orchards and Vineyards	<1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Nurseries	<1	High	Low
Other Grains	<1	High	Low
Corn	<1	High	Low
Bin 3	<1	Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**High**		

Table 423. AChE risk hypothesis; Nassau Grouper and malathion; Juveniles (US Territories in the Caribbean)

Endpoint: Enzyme (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	Med	Low
Mosquito Control	100	Med	Low

Other	Not Available	High	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**High**		

Table 424. Behavior and sensory risk hypothesis; Nassau Grouper and malathion; Juveniles (Florida Coast)

Endpoint: Behavior (Florida coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Med	Low
Developed	10.8	Med	Low
Other Crops	<1	Med	Low
Pasture	<1	High	Low
Orchards and Vineyards	<1	High	Low
Vegetables and Ground Fruit	<1	High	Low
Nurseries	<1	High	Low
Other Grains	<1	Med	Low
Corn	<1	Med	Low
Bin 3	<1	Low	Low
Endpoint: Sensory (Florida coast)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	Low
Developed	10.8	Not Available	Low
Other Crops	<1	Not Available	Low
Pasture	<1	Not Available	Low
Orchards and Vineyards	<1	Not Available	Low
Vegetables and Ground Fruit	<1	Not Available	Low
Nurseries	<1	Not Available	Low
Other Grains	<1	Not Available	Low
Corn	<1	Not Available	Low
Bin 3	<1	Not Available	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors			
Risk	**Confidence**		
Low	**High**		

Table 425. Behavior and sensory risk hypothesis; Nassau Grouper and malathion; Juveniles (US Territories in the Caribbean)

Endpoint: behavior (HUC03 – Puerto Rico, Virgin Islands)

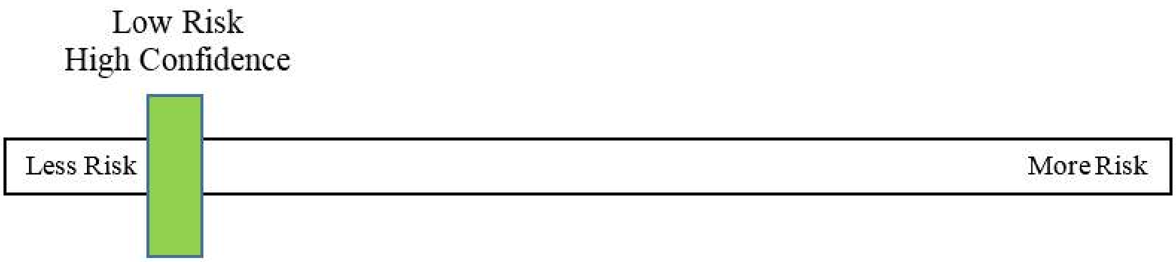
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Crops	Not Available	High	Low
Developed	Not Available	Med	Low
Mosquito Control	100	Med	Low
Other	Not Available	High	Low
Endpoint: sensory (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	Med	Low
Mosquito Control	100	Med	Low
Other	Not Available	High	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce productivity of populations via effects on larvae (settling, metamorphosis, mortality, etc.)			
Risk	**Confidence**		
Low	**High**		

Table 426. Effects analysis summary table: Nassau Grouper and malathion

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Juveniles and Adults (Florida Coast)	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	**Low**	**High**	Not Available	**No**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction (Adult)	**Low**	**High**	Not Available	**No**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	**Low**	**High**	Not Available	**No**
Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	**Low**	**High**	Not Available	**No**

Exposure to malathion is sufficient to reduce juvenile abundance via reduction in prey availability	**Low**	**High**	Not Available	**No**
Juveniles and Adults (HUC03 – Puerto Rico, Virgin Islands)				
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	**Low**	**High**	Not Available	**No**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction (Adults)	**Low**	**High**	Not Available	**No**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	**Low**	**High**	Not Available	**No**
Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	**Low**	**High**	Not Available	**No**
Exposure to malathion is sufficient to reduce juvenile abundance via reduction in prey availability	**Low**	**High**	Not Available	**No**

Effects analysis summary: Adult and juvenile Nassau Grouper are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to malathion in the marine environment. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, groupers may experience increased toxicity. The overall risk to Nassau Grouper from the effects of the action is low and the confidence associated with that risk is high. The low risk to Nassau Grouper is due primarily to the small portion of the species' range within US territories. Low risk is also attributed to uncertainty in the route of exposure to adult groupers which are typically found in deep marine habitats.



14.44 Smalltooth Sawfish (Pristis pectinate)

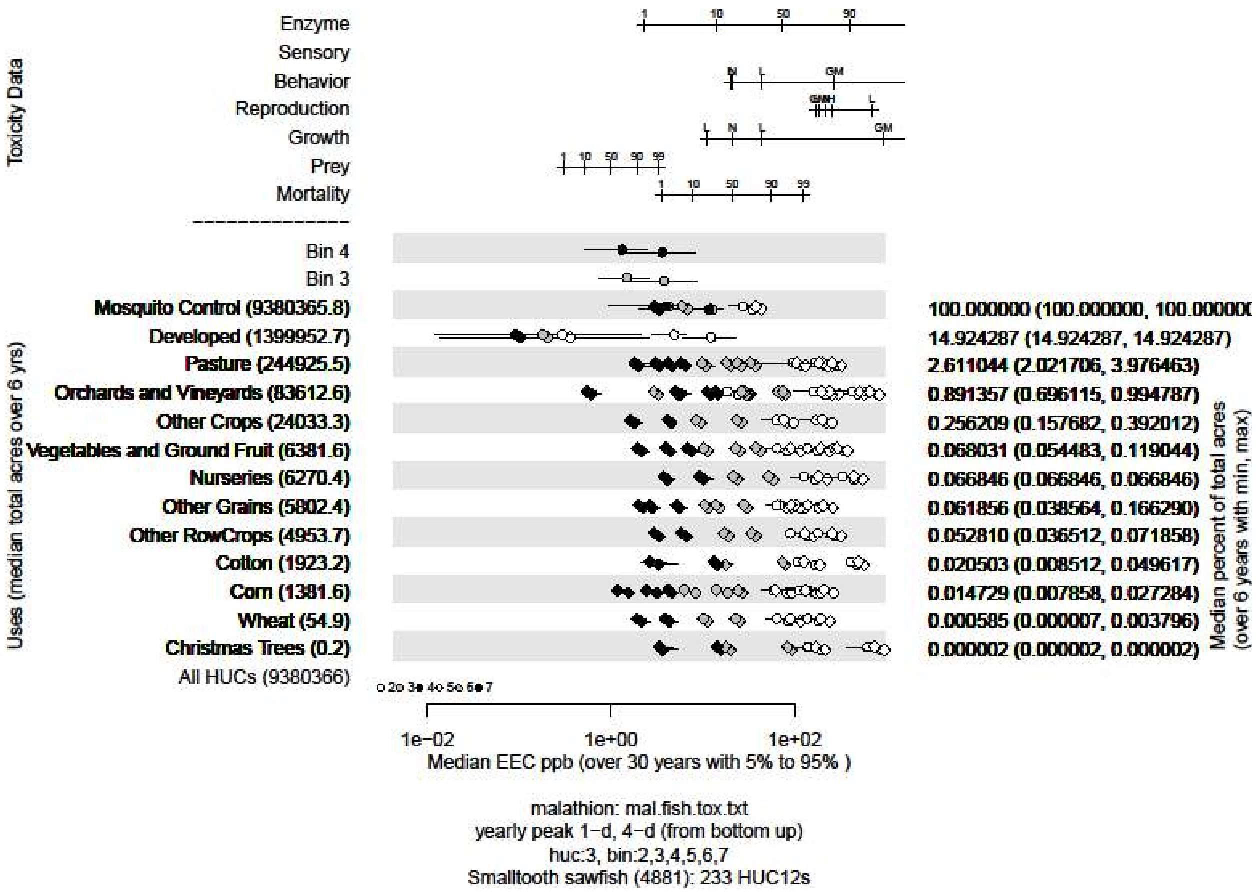


Figure 45. Effects analysis R-plot for Smalltooth sawfish and malathion; Full Range

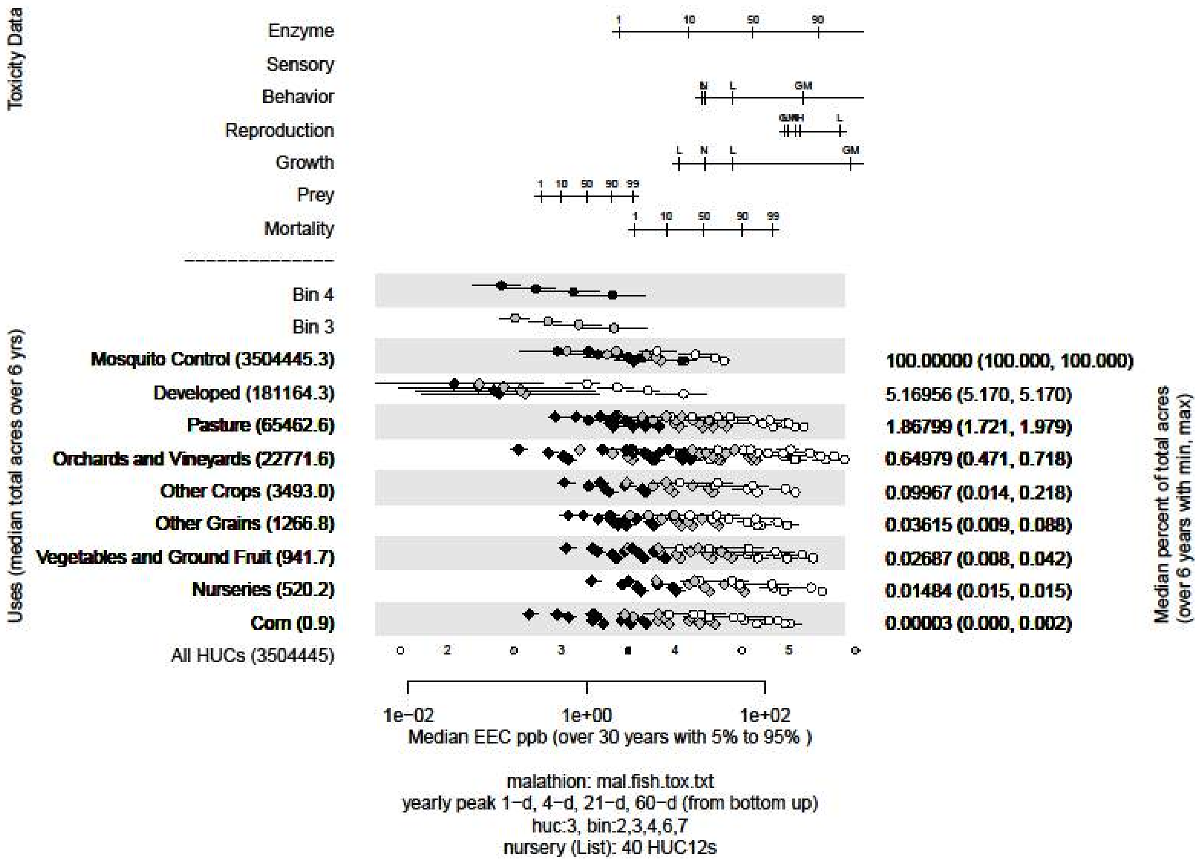


Figure 46. Effects analysis R-plot for Smalltooth sawfish and malathion; Charlotte Harbor, Ten Thousand Islands, Everglades Nursery Areas

Table 427. Likelihood of exposure determination for Smalltooth sawfish and malathion

	Percent Overlap	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Full Range							
Mosquito Control	3	yes	no	yes	NA	3	High
Developed	3	yes	no	yes	NA	3	High
Pasture	2	yes	no	yes	NA	3	Med
Bin 3	3	yes	no	yes	NA	3	High
Nursery Only							
Mosquito Control	3	yes	no	yes	NA	3	High
Developed	3	yes	no	yes	NA	3	High
Pasture	2	yes	no	yes	NA	3	Med
Orchards and Vineyards	1	yes	no	yes	yes	3	High
Other Crops	1	yes	no	yes	no	3	Low
Other Grains	1	yes	no	yes	no	3	Low
Vegetables and Ground Fruit	1	yes	no	yes	no	3	Low
Nurseries	1	yes	no	yes	no	3	Low
Bin3	3	yes	no	yes	no	3	High
Bin 4	3	yes	no	yes	no	3	High

Adult Life Stage (Coastal Habitats - Full Species Range)

Table 428. Direct mortality risk hypothesis; Smalltooth sawfish and malathion; Adults

Mortality (% overlap)	Effect of Exposure	Likelihood of Exposure
Mosquito Control (100%)	High	High
Developed (15%)	High	High
Pasture (3%)	High	Med
Bin 3	Med	High
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.		
	Risk	**Confidence**
	High	Low

Table 429. Prey risk hypothesis; Smalltooth sawfish and malathion; Adults

Prey (% overlap)	Effect of Exposure	Likelihood of Exposure
Mosquito Control (100%)	High	High
Developed (15%)	High	High
Pasture	High	Med

(3%)		
Bin 3	High	High
Exposure to malathion is sufficient to reduce adult abundance via reduction in prey availability		
	Risk	**Confidence**
	High	**Low**

Table 430. AChE risk hypothesis; Smalltooth sawfish and malathion; Adults

Enzyme - AChE (% overlap)	Effect of Exposure	Likelihood of Exposure
Mosquito Control (100%)	Med	High
Developed (15%)	Med	High
Pasture (3%)	High	Med
Bin 3	Med	High
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity		
	Risk	**Confidence**
	High	**Low**

Table 431. Behavior and sensory risk hypothesis; Smalltooth sawfish and malathion; Adults

Sensory (% overlap)	Effect of Exposure	Likelihood of Exposure
Mosquito Control (100%)	NA	NA
Developed (15%)	NA	NA
Pasture (3%)	NA	NA
Bin 3	NA	NA
Behavior (% overlap)	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control (100%)	Med	High
Developed (15%)	Med	High
Pasture (3%)	High	Med
Bin 3	Low	High
Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.		
	Risk	**Confidence**
	High	**Low**

Table 432. Reproduction risk hypothesis; Smalltooth sawfish and malathion; Adults

Reproduction (% overlap)	Effect of Exposure	Likelihood of Exposure
Mosquito Control (100%)	Low	High
Developed (15%)	Low	High
Pasture (3%)	Med	Med
Bin 3	Low	High
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction		
	Risk	**Confidence**
	Med	**Low**

Juvenile and Adult Female Life Stages (Nursery Habitats)

Table 433. Direct mortality risk hypothesis; Smalltooth sawfish and malathion; Adults and Juveniles

Juvenile Mortality (% overlap)	Effect of Exposure	Likelihood of Exposure
Mosquito Control (100%)	High	High
Developed (5%)	High	High
Pasture (2%)	High	Med
Orchards and Vineyards (<1%)	High	High
Other crop (<1%)	High	Low
Other grains (<1%)	High	Low
Veggie (<1%)	High	Low
Nursery (<1%)	High	Low
Bin 3	Med	High
Bin 4	Med	High
Exposure to malathion is sufficient to reduce juvenile abundance via acute lethality.		
	Risk	**Confidence**
	High	**High**

Table 434. Prey risk hypothesis; Smalltooth sawfish and malathion; Adults and Juveniles

Juvenile Prey (% overlap)	Effect of Exposure	Likelihood of Exposure
Mosquito Control (100%)	High	High

Developed (5%)	High	High
Pasture (2%)	High	Med
Orchards and Vineyards (<1%)	High	High
Other crop (<1%)	High	Low
Other grains (<1%)	High	Low
Veggie (<1%)	High	Low
Nursery (<1%)	High	Low
Bin 3	High	High
Bin 4	High	High
Exposure to malathion is sufficient to reduce juvenile abundance via reduction in prey availability		
	Risk	**Confidence**
	High	**High**

Table 435. AChE risk hypothesis; Smalltooth sawfish and malathion; Adults and Juveniles

Juvenile AChE (% overlap)	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control (100%)	Med	High
Developed (5%)	Med	High
Pasture (2%)	High	Med
Orchards and Vineyards (<1%)	High	High
Other uses (<1%)	High	Low
Other grains (<1%)	High	Low
Veggie (<1%)	High	Low
Nursery (<1%)	High	Low
Bin 3	Med	High
Bin 4	Med	High
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity		
	Risk	**Confidence**
	High	**High**

Table 436. Behavior and sensory risk hypothesis; Smalltooth sawfish and malathion; Adults and Juveniles

Juvenile Sensory (% overlap)	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control (100%)	NA	NA
Developed (5%)	NA	NA
Pasture (2%)	NA	NA
Orchards and Vineyards (<1%)	NA	NA
Other crop (<1%)	NA	NA
Other grains (<1%)	NA	NA
Veggie (<1%)	NA	NA
Other crop (<1%)	NA	NA
Bin 3	NA	NA
Bin 4	NA	NA
Juvenile Behavior (% overlap)	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control (100%)	Med	High
Developed (5%)	Med	High
Pasture (2%)	High	Med
Orchards and Vineyards (<1%)	High	High
Other crop (<1%)	Med	Low
Other grains (<1%)	Med	Low
Veggie (<1%)	High	Low
Nursery (<1%)	High	Low
Bin 3	Low	High
Bin 4	Low	High
Exposure to malathion is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.		
	Risk	**Confidence**
	High	**High**

Table 437. Reproduction risk hypothesis; Smalltooth sawfish and malathion; Adults

Adult Female Reproduction	**Effect of Exposure**	**Likelihood of Exposure**

Mosquito Control (100%)	Low	High
Developed (5%)	Low	High
Pasture (2%)	Low	Med
Orchards and Vineyards (<1%)	Med	High
Other crop (<1%)	Low	Low
Other grains (<1%)	Low	Low
Veggie (<1%)	Med	Low
Nursery (<1%)	Med	Low
Bin 3	Low	High
Bin 4	Low	High
Exposure to malathion is sufficient to reduce female productivity via impairments to reproduction		
	Risk	**Confidence**
	Med	**Med**

Table 438. Growth risk hypothesis; Smalltooth sawfish and malathion; Juveniles

Juvenile Growth (% overlap)	Effect of Exposure	Likelihood of Exposure
Mosquito Control (100%)	Med	High
Developed (5%)	Low	High
Pasture (2%)	Med	Med
Orchards and Vineyards (<1%)	Med	High
Other crop (<1%)	Med	Low
Other grains (<1%)	Med	Low
Veggie (<1%)	Med	Low
Nursery (<1%)	Med	Low
Bin 3	Low	High
Bin 4	Low	High
Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)		
	Risk	**Confidence**

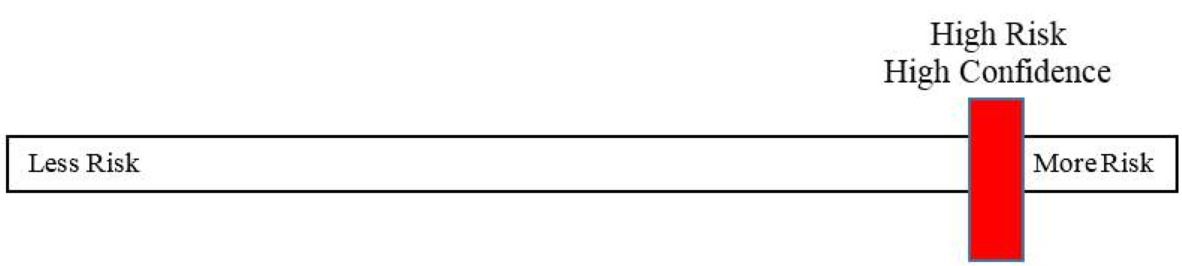
	High	**High**

Table 439. Effects analysis summary table: Smalltooth sawfish and malathion

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Adults (Full Range)	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	High	Low	4-day: 0-4	**Yes**
Exposure to malathion is sufficient to reduce adult abundance via reduction in prey availability	High	Low	4-day fish: 0-4 4-day invert: 4-30	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; mechanism of toxicity	High	Low	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult abundance and productivity via impairments to ecologically significant behaviors.	High	Low	Not Available	**Yes**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	High	Low	Not Available	**Yes**
Adult Females in Nursery Areas				
Exposure to malathion is sufficient to reduce female productivity via impairments to reproduction	High	Medium	Not Available	**Yes**
Juveniles in Nursery Areas				
Exposure to malathion is sufficient to reduce	High	High	4-day: 0-3	**Yes**

juvenile abundance via acute lethality.				
Exposure to malathion is sufficient to reduce juvenile abundance via reduction in prey availability	High	High	4-day fish: 0-3 4-day invert: 3-14	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce juvenile abundance via impairments to ecologically significant behaviors.	High	High	Not Available	**Yes**
Exposure to malathion is sufficient to reduce abundance via impacts to growth (direct toxicity)	High	High	Not Available	**Yes**

Effects analysis summary: Adult and juvenile Smalltooth sawfish are anticipated to experience reduced abundance and productivity (adults) from exposure to malathion. Reduced cholinesterase activity, reduced productivity, reduced prey abundance, and impaired behaviors including ability to swim are anticipated to occur in areas where malathion achieves predicted levels. The MagTool results indicate that between 0-4 percent of individuals within a population will die. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, sawfish will likely experience more toxicity. The overall risk to Smalltooth sawfish from the effects of the action is high and the confidence associated with that risk is high.



14.45 Black Abalone (Haliotis cracherodii)

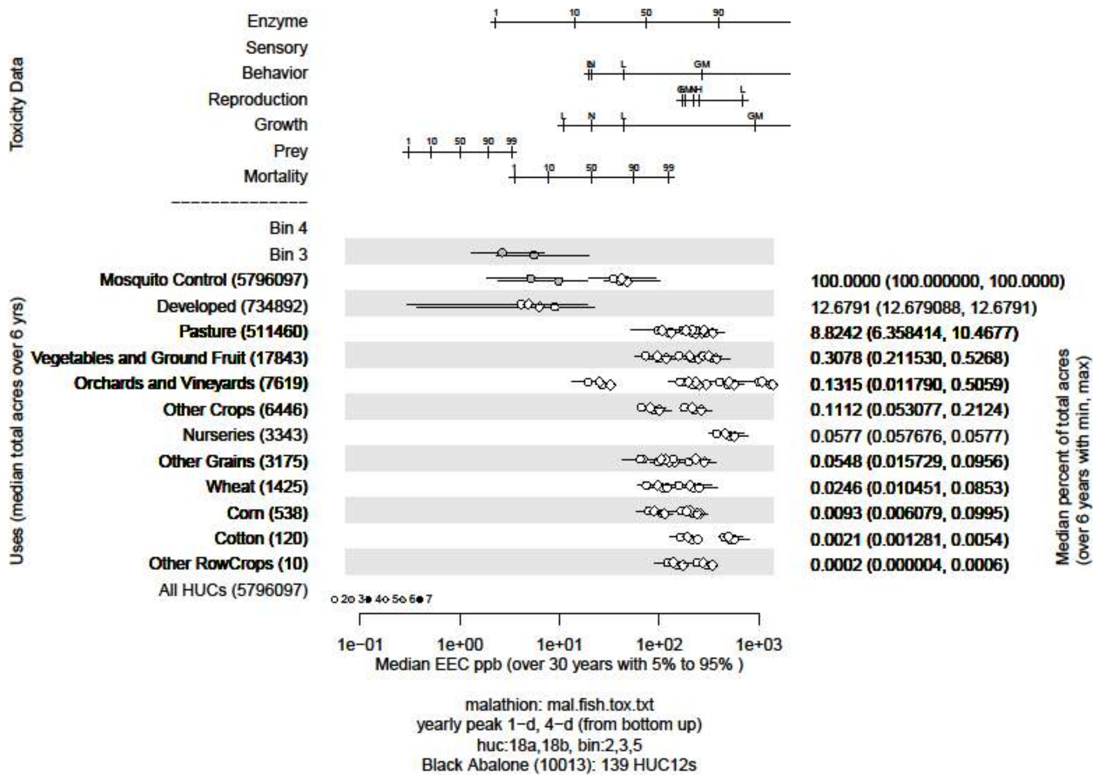


Figure 47. Effects analysis R-plot for Black abalone and malathion

Table 440. Likelihood of exposure determination for Black abalone and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Mosquito Control	3	yes	no	yes	NA	3	**High**
Developed	3	yes	no	yes	NA	3	**High**
Pasture	3	yes	no	yes	NA	3	**High**
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	**Low**
Orchards and Vineyard	1	yes	no	yes	NA	3	**Low**
Other Crops	1	yes	no	yes	NA	3	**Low**
Nurseries	1	yes	no	yes	NA	3	**Low**
Other Grains	1	yes	no	yes	NA	3	**Low**
Wheat	1	yes	no	yes	NA	3	**Low**
Corn	1	yes	no	yes	NA	3	**Low**
Cotton	1	yes	no	yes	NA	3	**Low**
Other Row Crops	1	yes	no	yes	NA	3	**Low**
Bin 3	1	yes	no	yes	NA	3	**Low**

Life Stage: Larvae/Juvenile and Adult (full-range)

Table 441. Direct mortality risk hypothesis; Black abalone and malathion; Larvae/Juvenile and Adult

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Developed	12.7	High	**High**
Pasture	8.8	High	**High**
Vegetables and Ground Fruit	<1	High	**Low**
Orchards and Vineyard	<1	High	**Low**
Other Crops	<1	High	**Low**
Nurseries	<1	High	**Low**
Other Grains	<1	High	**Low**
Wheat	<1	High	**Low**
Corn	<1	High	**Low**
Cotton	<1	High	**Low**
Other Row Crops	<1	High	**Low**
Bin 3		High	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce the abundance of larval/juvenile and adults via direct toxicity			
Risk	**Confidence**		
High	**Low**		

Table 442. Prey risk hypothesis; Black abalone and malathion; Juvenile and Adult

Endpoint: Prey

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	Low	**High**
Developed	12.7	Low	**High**
Pasture	8.8	Low	**High**
Vegetables and Ground Fruit	<1	Low	**Low**
Orchards and Vineyard	<1	Low	**Low**
Other Crops	<1	Low	**Low**
Nurseries	<1	Low	**Low**
Other Grains	<1	Low	**Low**
Wheat	<1	Low	**Low**
Corn	<1	Low	**Low**
Cotton	<1	Low	**Low**
Other Row Crops	<1	Low	**Low**
Bin 3		Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce the abundance of juvenile and adults via reduction in prey availability			
Risk	**Confidence**		
High	**Low**		

Table 443. Behavior and sensory risk hypothesis; Black abalone and malathion; Larvae/Juvenile and Adult

Endpoint: Behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	**High**
Developed	12.7	Medium	**High**
Pasture	8.8	High	**High**
Vegetables and Ground Fruit	<1	High	**Low**
Orchards and Vineyard	<1	High	**Low**
Other Crops	<1	High	**Low**
Nurseries	<1	High	**Low**
Other Grains	<1	High	**Low**
Wheat	<1	High	**Low**
Corn	<1	Low	**Low**
Cotton	<1	High	**Low**
Other Row Crops	<1	High	**Low**
Bin 3		High	Low
Endpoint: Sensory			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Not Available	**High**
Developed	12.7	Not Available	**High**
Pasture	8.8	Not Available	**High**
Vegetables and Ground Fruit	<1	Not Available	**Low**

Orchards and Vineyard	<1	Not Available	**Low**
Other Crops	<1	Not Available	**Low**
Nurseries	<1	Not Available	**Low**
Other Grains	<1	Not Available	**Low**
Wheat	<1	Not Available	**Low**
Corn	<1	Not Available	**Low**
Cotton	<1	Not Available	**Low**
Other Row Crops	<1	Not Available	**Low**
Bin 3		Not Available	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce the abundance and productivity of larval/juvenile and adults via impairments to ecologically significant behaviors (e.g. prey capture, settling, metamorphosis).			
Risk	**Confidence**		
High	**Low**		

Table 444. AChE risk hypothesis; Black abalone and malathion; Larvae/Juvenile and Adult

Endpoint: enzyme			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Developed	12.7	High	**High**
Pasture	8.8	High	**High**
Vegetables and Ground Fruit	<1	High	**Low**
Orchards and Vineyard	<1	High	**Low**
Other Crops	<1	High	**Low**
Nurseries	<1	High	**Low**
Other Grains	<1	High	**Low**
Wheat	<1	High	**Low**
Corn	<1	High	**Low**
Cotton	<1	High	**Low**
Other Row Crops	<1	High	**Low**
Bin 3		High	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Low**		

Table 445. Growth risk hypothesis; Black abalone and malathion; Larvae/Juvenile and Adult

Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Developed	12.7	Medium	**High**
Pasture	8.8	High	**High**

Vegetables and Ground Fruit	<1	High	**Low**
Orchards and Vineyard	<1	High	**Low**
Other Crops	<1	High	**Low**
Nurseries	<1	High	**Low**
Other Grains	<1	High	**Low**
Wheat	<1	High	**Low**
Corn	<1	High	**Low**
Cotton	<1	High	**Low**
Other Row Crops	<1	High	**Low**
Bin 3		Medium	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce the abundance and productivity of larval/juvenile and adults via reductions in growth (direct toxicity)			
Risk	**Confidence**		
High	**Low**		

Table 446. Reproduction risk hypothesis; Black abalone and malathion; Adult

Endpoint: Reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Developed	12.7	High	**High**
Pasture	8.8	High	**High**
Vegetables and Ground Fruit	<1	High	**Low**
Orchards and Vineyard	<1	High	**Low**
Other Crops	<1	High	**Low**
Nurseries	<1	High	**Low**
Other Grains	<1	High	**Low**
Wheat	<1	High	**Low**
Corn	<1	High	**Low**
Cotton	<1	High	**Low**
Other Row Crops	<1	High	**Low**
Bin 3		Medium	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce the productivity of adults via impairments to reproduction.			
Risk	**Confidence**		
High	**Low**		

Table 447. Effects analysis summary table: Black abalone and malathion

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Larvae/Juveniles and Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				

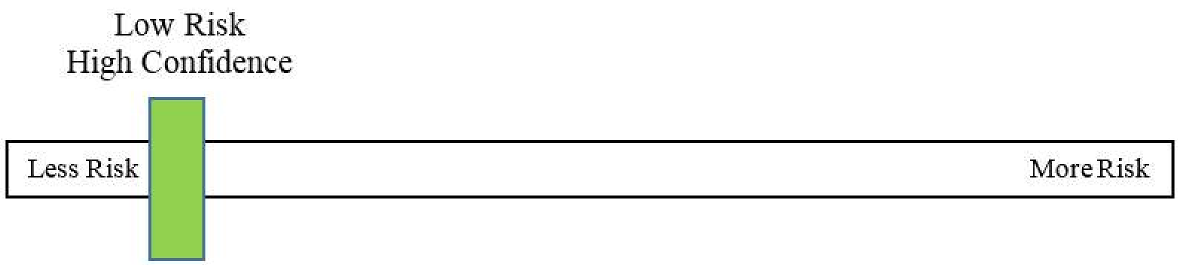
Exposure to malathion is sufficient to reduce the abundance of larval/juvenile and adults via direct toxicity	High	Low	Not Available	**Yes**
Exposure to malathion is sufficient to reduce the abundance of juvenile and adults via reduction in prey availability	High	Low	Not Available	**Yes**
Exposure to malathion is sufficient to reduce the abundance and productivity of larval/juvenile and adults via impairments to ecologically significant behaviors (e.g. prey capture, settling, metamorphosis).	High	Low	Not Available	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	High	Low	Not Available	**Yes**
Exposure to malathion is sufficient to reduce the abundance and productivity of larval/juvenile and adults via reductions in growth (direct toxicity)	High	Low	Not Available	**Yes**
Exposure to malathion is sufficient to reduce the productivity of adults via impairments to reproduction.	High	Low	Not Available	Yes

Effects analysis summary: Adult, juvenile and larval black abalone are not anticipated to experience significant reductions in abundance and productivity (adults) from exposure to malathion. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, abalone may experience increased toxicity. The overall risk to black abalone from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted malathion concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the portion of the population which occupy tide-pools.


Medium Risk
Low Confidence
Less Risk
More Risk

14.46 White Abalone (Haliotis sorenseni)

Effects analysis summary: Adult and juvenile white abalone are not anticipated to experience significant reductions in abundance and productivity (adults) from exposure to malathion. The overall risk to white abalone from the effects of the action is low and the confidence associated with that risk is high. The low risk is due primarily to the proximity of white abalone habitat (marine off-shore; depths of 80-100 feet) relative to malathion use sites.



14.47 Caribbean Corals (7 species): Orbicella franksi; Orbicella annularis; Orbicella faveolata; Mycetophyllia ferox; Acropora cervicornis; Acropora palmate; Dendrogyra cylindrus

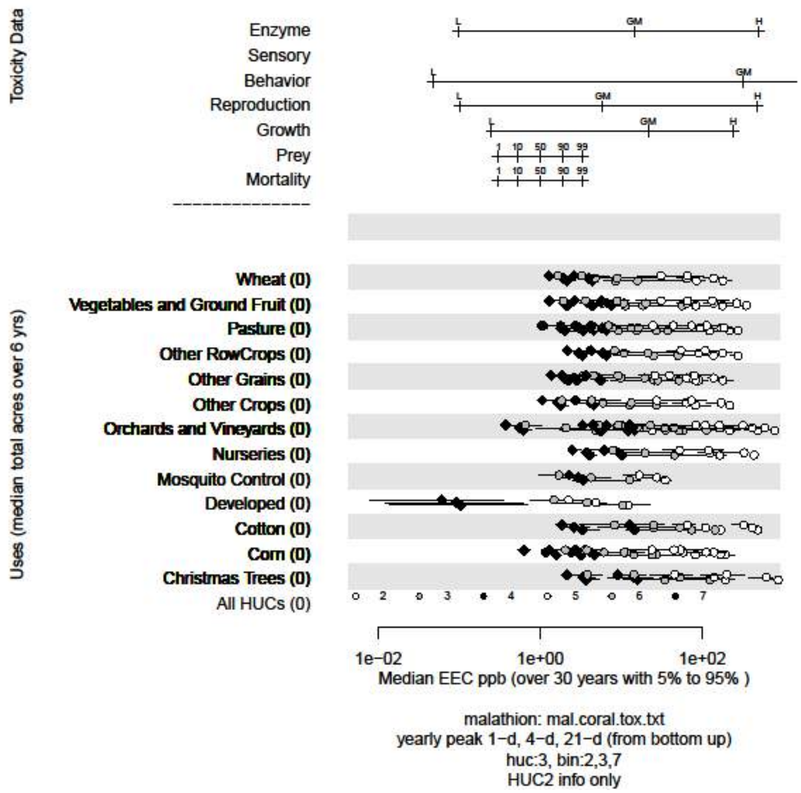


Figure 48. Effects Analysis R-plot for Caribbean Corals (7 Species) and Malathion

Table 448. Likelihood of exposure determination for Caribbean corals (7 species) and malathion

	Percent Overlap	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range within US Territories	Likelihood of Exposure
Florida Coast								
Mosquito Control	3	yes	no	yes	NA	3	8%	**High**
Developed	2	yes	no	yes	NA	3	8%	**Med**
Pasture	1	yes	no	yes	NA	3	8%	**Low**
Other Crops	1	yes	no	yes	NA	3	8%	**Low**
Orchards and Vineyards	1	yes	no	yes	NA	3	8%	**Low**
Nurseries	1	yes	no	yes	NA	3	8%	**Low**
Other Grains	1	yes	no	yes	NA	3	8%	**Low**
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	8%	**Low**
Bin 3	3	yes	no	yes	NA	3	8%	**High**
US Territories in Caribbean								
Crops	NA	yes	yes	yes	NA	3	8%	**Med**
Developed	NA	yes	yes	yes	NA	3	8%	**Med**
Mosquito Control	100	yes	yes	yes	NA	3	8%	**High**
Managed Forest/Other	NA	yes	yes	yes	NA	3	8%	**Med**

Table 449. Direct mortality risk hypothesis; Caribbean corals (7 species) and malathion; Florida Coast

Endpoint: Mortality (Southeast Florida Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Developed	16.1	High	Medium
Pasture	.3	High	Low
Other Crops	.07	High	Low
Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low
Other Grains	.03	High	Low
Vegetables and Ground Fruit	.01	High	Low
Bin 3		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce the abundance of populations via direct toxicity			
Risk	**Confidence**		
High	**Low**		

Table 450. Direct mortality risk hypothesis; Caribbean corals (7 species) and malathion; US Territories in the Caribbean

Endpoint: Mortality (HUC03; US territories in the Caribbean)

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Crops	Not Available	High	Medium
Developed	Not Available	High	Medium
Mosquito Control	Not Available	High	High
Other	Not Available	High	Medium
Risk Hypothesis: Exposure to malathion is sufficient to reduce the abundance of populations via direct toxicity			
Risk	**Confidence**		
High	**Low**		

Table 451. Prey risk hypothesis; Caribbean corals (7 species) and malathion; Florida Coast

Endpoint: Prey (Southeast Florida Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Developed	16.1	High	Medium
Pasture	.3	High	Low
Other Crops	.07	High	Low
Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low
Other Grains	.03	High	Low
Vegetables and Ground Fruit	.01	High	Low
Bin 3		High	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce the abundance of populations via reduction in prey availability			
Risk	**Confidence**		
High	**Low**		

Table 452. Prey risk hypothesis; Caribbean corals (7 species) and malathion; US Territories in the Caribbean

Endpoint: Prey (HUC03; US territories in the Caribbean)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Medium
Developed	Not Available	High	Medium
Mosquito Control	Not Available	High	High
Other	Not Available	High	Medium
Risk Hypothesis: Exposure to malathion is sufficient to reduce the abundance of populations via reduction in prey availability			
Risk	**Confidence**		
High	**Low**		

Table 453. AChE risk hypothesis; Caribbean corals (7 species) and malathion; Florida Coast

Endpoint: Enzyme (Southeast Florida Coastal HUC-12s)

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Mosquito Control	100	High	High
Developed	16.1	High	Medium
Pasture	.3	High	Low
Other Crops	.07	High	Low
Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low
Other Grains	.03	High	Low
Vegetables and Ground Fruit	.01	High	Low
Bin 3		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Low**		

Table 454. AChE risk hypothesis; Caribbean corals (7 species) and malathion; US Territories in the Caribbean

Endpoint: Enzyme (HUC03; US territories in the Caribbean)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Medium
Developed	Not Available	High	Medium
Mosquito Control	Not Available	High	High
Other	Not Available	High	Medium
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
High	**Low**		

Table 455. Behavior and sensory risk hypothesis; Caribbean corals (7 species) and malathion; Florida Coast

Endpoint: Behavior (Southeast Florida Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Developed	16.1	Medium	Medium
Pasture	.3	Medium	Low
Other Crops	.07	Medium	Low
Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low
Other Grains	.03	Medium	Low
Vegetables and Ground Fruit	.01	High	Low
Bin 3		Medium	High

Risk Hypothesis: Exposure to malathion is sufficient to reduce the abundance and productivity of populations via impairments to ecologically significant behaviors (e.g. prey capture).		
Risk	**Confidence**	
High	**Low**	

Table 456. Behavior and sensory risk hypothesis; Caribbean corals (7 species) and malathion; US Territories in the Caribbean

Endpoint: Behavior (HUC03; US territories in the Caribbean)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Medium to High	Medium
Developed	Not Available	Medium	Medium
Mosquito Control	Not Available	Medium	High
Other	Not Available	Medium to High	Medium
Risk Hypothesis: Exposure to malathion is sufficient to reduce the abundance and productivity of populations via impairments to ecologically significant behaviors (e.g. prey capture).			
Risk	**Confidence**		
High	**Low**		

Table 457. Reproduction risk hypothesis; Caribbean corals (7 species) and malathion; Florida Coast

Endpoint: Reproduction (Southeast Florida Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Developed	16.1	Medium	Medium
Pasture	.3	High	Low
Other Crops	.07	High	Low
Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low
Other Grains	.03	High	Low
Vegetables and Ground Fruit	.01	High	Low
Bin 3		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce the productivity of populations via impairments to reproduction (e.g. spawning cues).			
Risk	**Confidence**		
High	**Low**		

Table 458. Reproduction risk hypothesis; Caribbean corals (7 species) and malathion; US Territories in the Caribbean

Endpoint: Reproduction (HUC03; US territories in the Caribbean)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Medium
Developed	Not Available	Medium	Medium

Mosquito Control	Not Available	High	High
Other	Not Available	High	Medium
Risk Hypothesis: Exposure to malathion is sufficient to reduce the productivity of populations via impairments to reproduction (e.g. spawning cues).			
Risk	**Confidence**		
High	**Low**		

Table 459. Direct mortality, behavior, reproduction risk hypothesis; Caribbean corals (7 species) and malathion; Florida Coast; Larvae

Endpoint: mortality (Southeast Florida Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Developed	16.1	High	Medium
Pasture	.3	High	Low
Other Crops	.07	High	Low
Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low
Other Grains	.03	High	Low
Vegetables and Ground Fruit	.01	High	Low
Bin 3		High	High
Endpoint: behavior (Southeast Florida Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	High
Developed	16.1	Medium	Medium
Pasture	.3	Medium	Low
Other Crops	.07	Medium	Low
Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low
Other Grains	.03	Medium	Low
Vegetables and Ground Fruit	.01	High	Low
Bin 3		Medium	High
Endpoint: reproduction (Southeast Florida Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	High
Developed	16.1	Medium	Medium
Pasture	.3	High	Low
Other Crops	.07	High	Low
Orchards and Vineyards	.05	High	Low
Nurseries	.04	High	Low

Other Grains	.03	High	Low
Vegetables and Ground Fruit	.01	High	Low
Bin 3		Medium	High
Risk Hypothesis: Exposure to malathion is sufficient to reduce productivity of populations via effects on larvae (settling, metamorphosis, mortality, etc.)			
Risk	**Confidence**		
High	**Low**		

Table 460. Direct mortality, behavior, reproduction risk hypothesis; Caribbean corals (7 species) and malathion; US Territories in the Caribbean; Larvae

Endpoint: mortality (HUC03; US territories in the Caribbean)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Medium
Developed	Not Available	High	Medium
Mosquito Control	Not Available	High	High
Managed Forest	Not Available	High	Medium
Endpoint: behavior (HUC03; US territories in the Caribbean)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Medium to High	Medium
Developed	Not Available	Medium	Medium
Mosquito Control	Not Available	Medium	High
Managed Forest	Not Available	Medium to High	Medium
Endpoint: reproduction (HUC03; US territories in the Caribbean)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Medium
Developed	Not Available	Medium	Medium
Mosquito Control	Not Available	High	High
Managed Forest	Not Available	High	Medium
Risk Hypothesis: Exposure to malathion is sufficient to reduce productivity of populations via effects on larvae (settling, metamorphosis, mortality, etc.)			
Risk	**Confidence**		
High	**Low**		

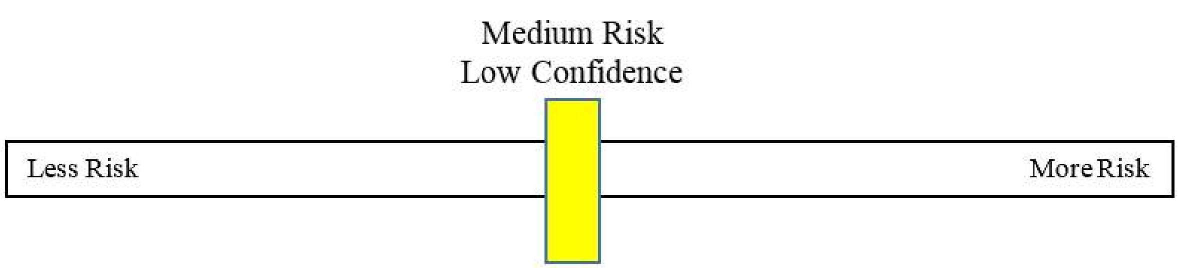
Table 461. Effects analysis summary table: Caribbean corals (7 species) and malathion

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
(Southeast Florida Coastal HUC-12s)	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce the	**High**	**Low**	Not Available	**Yes**

abundance of populations via direct toxicity				
Exposure to malathion is sufficient to reduce the abundance of populations via reduction in prey availability	**High**	**Low**	Not Available	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	**High**	**Low**	Not Available	**Yes**
Exposure to malathion is sufficient to reduce the abundance and productivity of populations via impairments to ecologically significant behaviors (e.g. prey capture).	**High**	**Low**	Not Available	**Yes**
Exposure to malathion is sufficient to reduce the productivity of populations via impairments to reproduction (e.g. spawning cues).	**High**	**Low**	Not Available	**Yes**
Exposure to malathion is sufficient to reduce productivity of populations via effects on larvae (settling, metamorphosis, mortality, etc.)	**High**	**Low**	Not Available	**Yes**
(HUC03; US territories in the Caribbean)				
Exposure to malathion is sufficient to reduce the abundance of populations via direct toxicity	**High**	**Low**	Not Available	**Yes**
Exposure to malathion is sufficient to reduce the abundance of populations via reduction in prey availability	**High**	**Low**	Not Available	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	**High**	**Low**	Not Available	**Yes**
Exposure to malathion is sufficient to reduce the abundance and productivity of populations via impairments to ecologically	**High**	**Low**	Not Available	**Yes**

significant behaviors (e.g. prey capture).				
Exposure to malathion is sufficient to reduce the productivity of populations via impairments to reproduction (e.g. spawning cues).	**High**	**Low**	Not Available	**Yes**
Exposure to malathion is sufficient to reduce productivity of populations via effects on larvae (settling, metamorphosis, mortality, etc.)	**High**	**Low**	Not Available	**Yes**

Effects analysis summary: Caribbean coral populations (7 species: Orbicella franksi; Orbicella annularis; Orbicella faveolata; Mycetophyllia ferox; Acropora cervicornis; Acropora palmate; Dendrogyra cylindrus) are not anticipated to experience significant reductions in abundance or productivity from exposure to malathion. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, coral may experience increased toxicity. The overall risk to Caribbean corals (7 species) from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted malathion concentrations in coastal habitats. Low confidence of risk is also attributed to the low portion of the species range within US territories.



14.48 Indo-Pacific Corals (7 species): Acropora retusa; Acropora globiceps; Seriatopora aculeate; Euphyllia paradivisa; Isopora crateriformis; Acropora jacquelineae; Acropora speciose

Table 462. Effects analysis R-plot for Indo-Pacific corals (7 species) and malathion

	Percent Overlap	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range within US Territories	Likelihood of Exposure
Crops	NA	yes	no	yes	NA	3	0.2 - 1.4%	**Low**
Developed	NA	yes	no	yes	NA	3	0.2 - 1.4%	**Low**
Mosquito	NA	yes	no	yes	NA	3	0.2 - 1.4%	**Low**

Table 463. Direct mortality risk hypothesis; Indo-Pacific corals (7 species) and malathion; Hawaii/US Territories in the Pacific

Endpoint: Mortality (HUC2: 20a/20b Hawaii and US territories in the Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	Not Available	High	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce the abundance of populations via direct toxicity			
Risk	**Confidence**		
Low	**Medium**		

Table 464. Prey risk hypothesis; Indo-Pacific corals (7 species) and malathion; Hawaii/US Territories in the Pacific

Endpoint: Prey (HUC2: 20a/20b Hawaii and US territories in the Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	Not Available	High	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce the abundance of populations via reduction in prey availability			

Risk	Confidence	
Low	**Medium**	

Table 465. AChE risk hypothesis; Indo-Pacific corals (7 species) and malathion; Hawaii/US Territories in the Pacific

Endpoint: Enzyme (HUC2: 20a/20b Hawaii and US territories in the Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	Not Available	High	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**Medium**		

Table 466. Behavior and sensory risk hypothesis; Indo-Pacific corals (7 species) and malathion; Hawaii/US Territories in the Pacific

Endpoint: Behavior (HUC2: 20a/20b Hawaii and US territories in the Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	Medium	Low
Mosquito Control	Not Available	Medium	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce the abundance and productivity of populations via impairments to ecologically significant behaviors (e.g. prey capture).			
Risk	**Confidence**		
Low	**Medium**		

Table 467. Reproduction risk hypothesis; Indo-Pacific corals (7 species) and malathion; Hawaii/US Territories in the Pacific

Endpoint: Reproduction (HUC2: 20a/20b Hawaii and US territories in the Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	Not Available	High	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce the productivity of populations via impairments to reproduction (e.g. spawning cues).			
Risk	**Confidence**		
Low	**Medium**		

Table 468. Direct mortality, behavior, reproduction risk hypothesis; Indo-Pacific corals (7 species) and malathion; Hawaii/US Territories in the Pacific; larvae

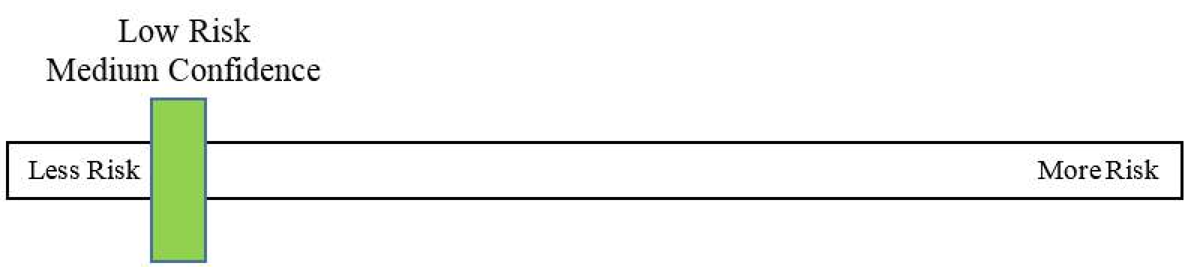
Endpoint: mortality (HUC2: 20a/20b Hawaii and US territories in the Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	100	High	Low
Endpoint: behavior			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	Medium	Low
Mosquito Control	100	Medium	Low
Endpoint: reproduction			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	100	High	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce productivity of populations via effects on larvae (settling, metamorphosis, mortality, etc.)			
Risk	**Confidence**		
Low	**Medium**		

Table 469. Effects analysis summary table: Indo-Pacific corals (7 species) and malathion

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Hawaii and US territories in the Pacific	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce the abundance of populations via direct toxicity	**Low**	**Medium**	Not Available	**No**
Exposure to malathion is sufficient to reduce the abundance of populations via reduction in prey availability	**Low**	**Medium**	Not Available	**No**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	**Low**	**Medium**	Not Available	**No**
Exposure to malathion is sufficient to reduce the abundance and productivity	**Low**	**Medium**	Not Available	**No**

of populations via impairments to ecologically significant behaviors (e.g. prey capture).				
Exposure to malathion is sufficient to reduce the productivity of populations via impairments to reproduction (e.g. spawning cues).	**Low**	**Medium**	Not Available	**No**
Exposure to malathion is sufficient to reduce productivity of populations via effects on larvae (settling, metamorphosis, mortality, etc.)	**Low**	**Medium**	Not Available	**No**

Effects analysis summary: Indo-Pacific coral populations (7 species: Acropora retusa; Acropora globiceps; Seriatopora aculeate; Euphyllia paradivisa; Isopora crateriformis; Acropora jacquelineae; Acropora speciose) are not anticipated to experience significant reductions in abundance or productivity from exposure to malathion. Where formulated products and tank mixtures containing malathion occur in aquatic habitats, coral may experience increased toxicity. The overall risk to Indo-Pacific corals (7 species) from the effects of the action is low and the confidence associated with that risk is med. The lack in confidence is due primarily to the uncertainty in predicted malathion concentrations in coastal habitats. Low risk is attributed primarily to the low portion of the species range within US territories.



14.49 Green Sea Turtle, Central North Pacific DPS (Chelonia mydas)

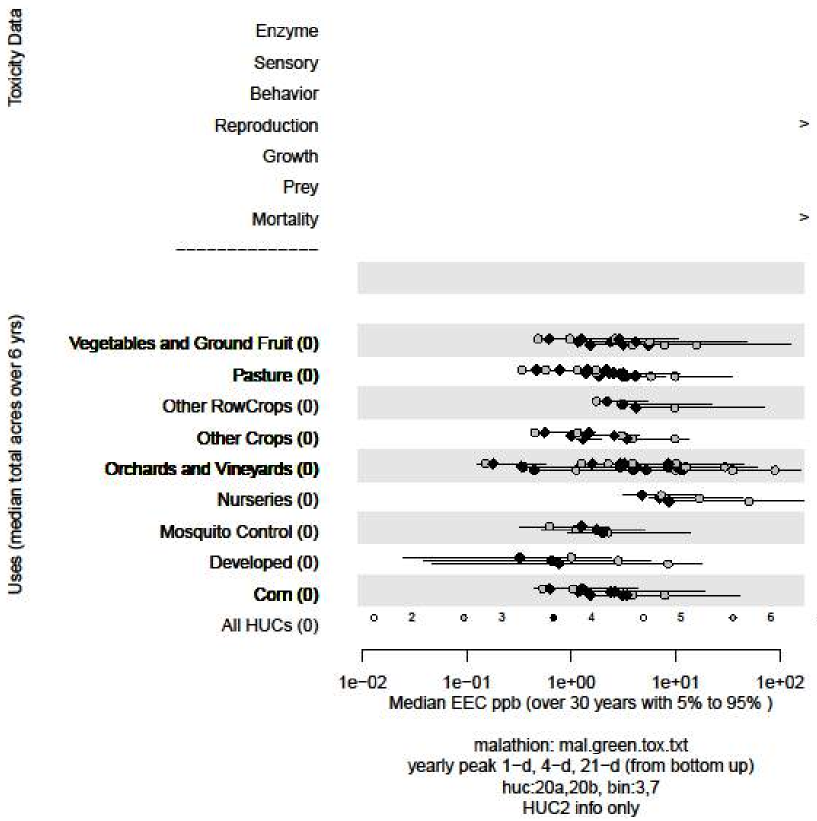


Figure 49. Effects analysis R-plot for Green sea turtle, central north pacific DPS and malathion

Table 470. Likelihood of exposure determination for Green sea turtle, central north pacific DPS and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Vegetables and Ground Fruit	NA	yes	no	yes	NA	3	**Med**
Pasture	NA	yes	no	yes	NA	3	**Med**
Other Row Crop	NA	yes	no	yes	NA	3	**Med**
Other Crop	NA	yes	no	yes	NA	3	**Med**
Orchards and Vineyards	NA	yes	no	yes	NA	3	**Med**
Nurseries	NA	yes	no	yes	NA	3	**Med**
Mosquito Control	3	yes	no	yes	NA	3	**High**
Developed	NA	yes	no	yes	NA	3	**Med**
Corn	NA	yes	no	yes	NA	3	**Med**
Bin 3	NA	yes	no	yes	NA	3	**Med**

Life Stage: Juveniles

Based on the life history of green turtles, hatchlings crawl to the water and swim to offshore areas where they reside for several years. Therefore juveniles are not expected to experience substantial exposure to malathion.

Life Stage: Adults

Table 471. Direct mortality risk hypothesis; Green sea turtle, central north pacific DPS and malathion; Adults

Endpoint: Mortality (HUC2: 20 Hawaii)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	NA	Low	**Medium**
Pasture	NA	Low	**Medium**
Other Row Crop	NA	Low	**Medium**
Other Crop	NA	Low	**Medium**
Orchards and Vineyards	NA	Low	**Medium**
Nurseries	NA	Low	**Medium**
Mosquito Control	NA	Low	**High**
Developed	NA	Low	**Medium**
Corn	NA	Low	**Medium**
Bin 3	NA	Low	**Medium**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**Low**		

Table 472. Reproduction risk hypothesis; Green sea turtle, central north pacific DPS and malathion; Adults

Endpoint: Reproduction (HUC2: 20 Hawaii)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	NA	Low	**Medium**
Pasture	NA	Low	**Medium**
Other Row Crop	NA	Low	**Medium**
Other Crop	NA	Low	**Medium**
Orchards and Vineyards	NA	Low	**Medium**
Nurseries	NA	Low	**Medium**
Mosquito Control	NA	Low	**High**
Developed	NA	Low	**Medium**
Corn	NA	Low	**Medium**
Bin 3	NA	Low	**Medium**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**Low**		

Table 473. AChE risk hypothesis; Green sea turtle, central north pacific DPS and malathion; Adults

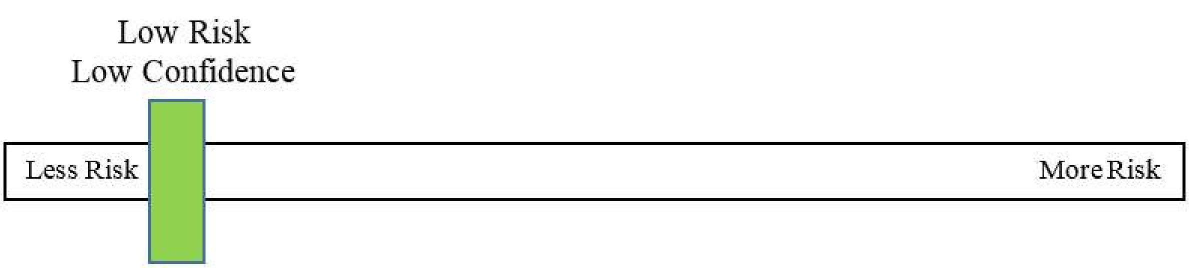
Endpoint: enzyme (HUC2: 20 Hawaii)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	NA	Low	**Medium**
Pasture	NA	Low	**Medium**
Other Row Crop	NA	Low	**Medium**
Other Crop	NA	Low	**Medium**
Orchards and Vineyards	NA	Low	**Medium**
Nurseries	NA	Low	**Medium**
Mosquito Control	NA	Low	**High**
Developed	NA	Low	**Medium**
Corn	NA	Low	**Medium**
Bin 3	NA	Low	**Medium**
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**Low**		

Table 474. Effects analysis summary table: Green sea turtle, central north pacific DPS and malathion

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	

Risk Hypothesis				
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	Low	Not Available	**No**

Effects analysis summary: Adult and juvenile Green sea turtle, central north pacific DPS are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to malathion in the marine environment. If exposed to formulated products and tank mixtures containing malathion, sea turtles may experience increased toxicity. The overall risk to Green sea turtle, central north pacific DPS from the effects of the action is low and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted malathion concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites within the species range.



14.50 Green Sea Turtle, Central South Pacific DPS (Chelonia mydas)

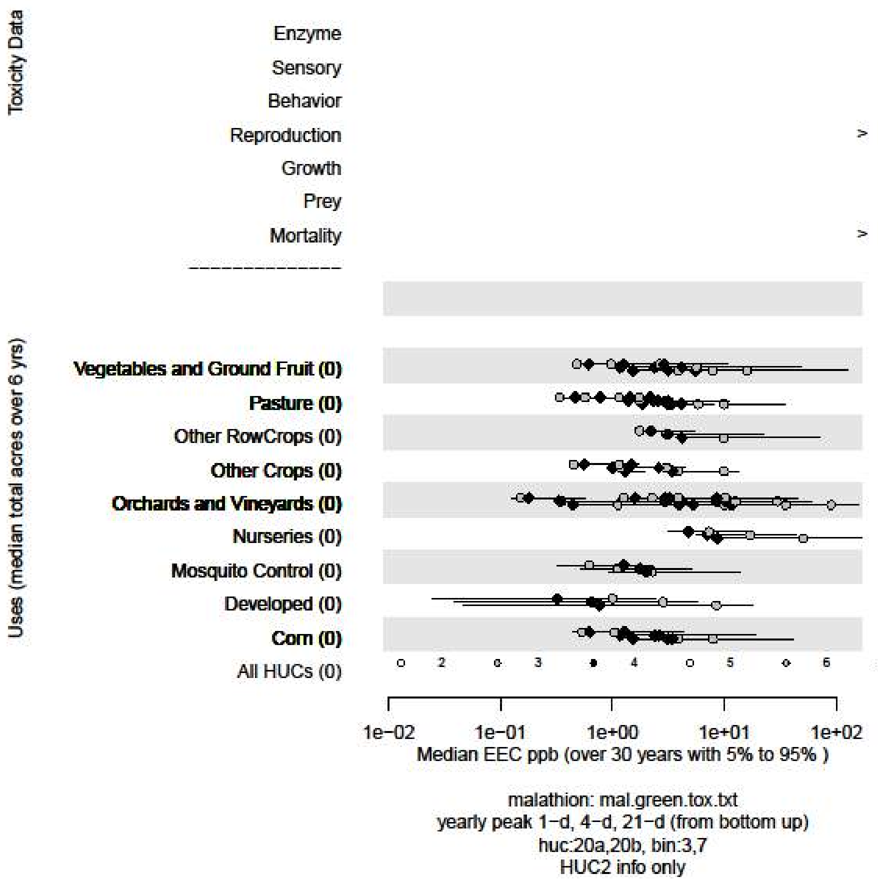


Figure 50. Effects analysis R-plot for Green sea turtle, central south pacific DPS and malathion

Table 475. Likelihood of exposure determination for Green sea turtle, central south pacific DPS and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Vegetables and Ground Fruit	NA	yes	no	yes	NA	3	**Med**
Pasture	NA	yes	no	yes	NA	3	**Med**
Other Row Crop	NA	yes	no	yes	NA	3	**Med**
Other Crop	NA	yes	no	yes	NA	3	**Med**
Orchards and Vineyards	NA	yes	no	yes	NA	3	**Med**
Nurseries	NA	yes	no	yes	NA	3	**Med**
Mosquito Control	3	yes	no	yes	NA	3	**High**
Developed	NA	yes	no	yes	NA	3	**Med**
Corn	NA	yes	no	yes	NA	3	**Med**
Bin 3	NA	yes	no	yes	NA	3	**Med**

Life Stage: Juveniles

Based on the life history of green turtles, hatchlings crawl to the water and swim to offshore areas where they reside for several years. Therefore juveniles are not expected to experience substantial exposure to malathion.

Life Stage: Adults

Table 476. Direct mortality risk hypothesis; Green sea turtle, central south pacific DPS and malathion; Adults

Endpoint: Mortality (HUC2: 20 Hawaii)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	NA	Low	**Medium**
Pasture	NA	Low	**Medium**
Other Row Crop	NA	Low	**Medium**
Other Crop	NA	Low	**Medium**
Orchards and Vineyards	NA	Low	**Medium**
Nurseries	NA	Low	**Medium**
Mosquito Control	NA	Low	**High**
Developed	NA	Low	**Medium**
Corn	NA	Low	**Medium**
Bin 3	NA	Low	**Medium**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**Low**		

Table 477. Reproduction risk hypothesis; Green sea turtle, central south pacific DPS and malathion; Adults

Endpoint: Reproduction (HUC2: 20 Hawaii)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	NA	Low	**Medium**
Pasture	NA	Low	**Medium**
Other Row Crop	NA	Low	**Medium**
Other Crop	NA	Low	**Medium**
Orchards and Vineyards	NA	Low	**Medium**
Nurseries	NA	Low	**Medium**
Mosquito Control	NA	Low	**High**
Developed	NA	Low	**Medium**
Corn	NA	Low	**Medium**
Bin 3	NA	Low	**Medium**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**Low**		

Table 478. AChE risk hypothesis; Green sea turtle, central south pacific DPS and malathion; Adults

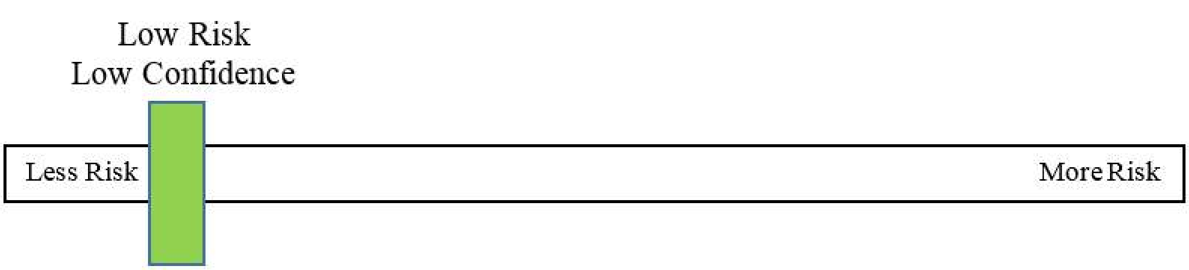
Endpoint: enzyme (HUC2: 20 Hawaii)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	NA	Low	**Medium**
Pasture	NA	Low	**Medium**
Other Row Crop	NA	Low	**Medium**
Other Crop	NA	Low	**Medium**
Orchards and Vineyards	NA	Low	**Medium**
Nurseries	NA	Low	**Medium**
Mosquito Control	NA	Low	**High**
Developed	NA	Low	**Medium**
Corn	NA	Low	**Medium**
Bin 3	NA	Low	**Medium**
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**Low**		

Table 479. Effects analysis summary table: Green sea turtle, central south pacific DPS and malathion

	R-plot Derived	**MagTool**	

Adults	Risk	Confidence	Range in median percent mortalities for aquatic bins	Risk Hypothesis Supported? Yes/No
Risk Hypothesis				
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	Low	Not Available	**No**

Effects analysis summary: Adult and juvenile Green sea turtle, central south pacific DPS are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to malathion in the marine environment. If exposed to formulated products and tank mixtures containing malathion, sea turtles may experience increased toxicity. The overall risk to Green sea turtle, central south pacific DPS from the effects of the action is low and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted malathion concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites with the species range.



14.51 Green Sea Turtle, Central West Pacific DPS (Chelonia mydas)

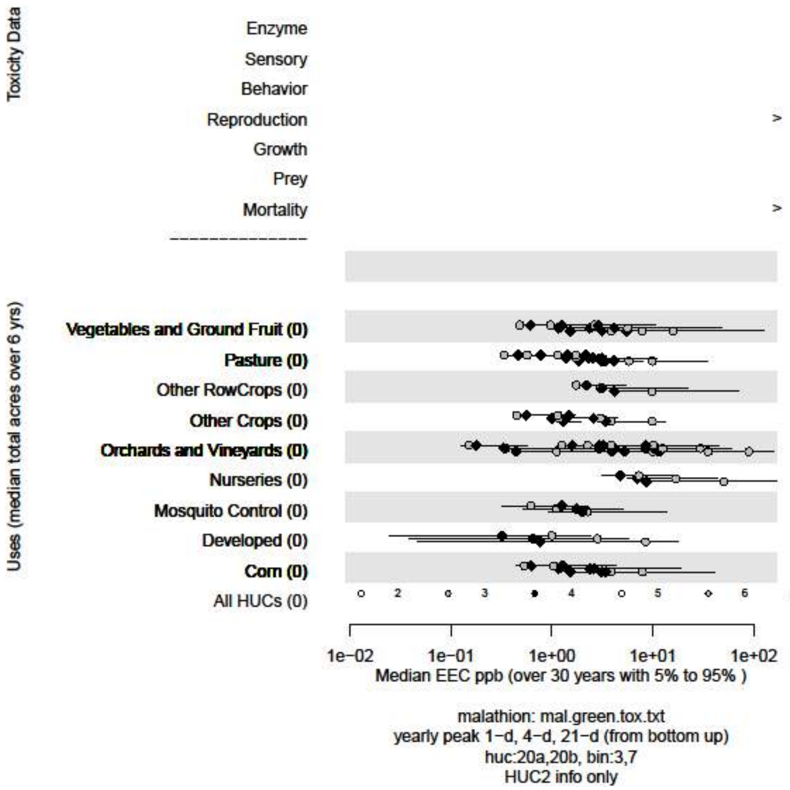


Figure 51. Effects analysis R-plot for Green sea turtle, central west pacific DPS and malathion

Table 480. Likelihood of exposure determination for Green sea turtle, central west pacific DPS and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range within US Territories	Likelihood of Exposure
Vegetables and Ground Fruit	NA	yes	no	yes	NA	3	small	Low
Pasture	NA	yes	no	yes	NA	3	small	Low
Other Row Crop	NA	yes	no	yes	NA	3	small	Low
Other Crop	NA	yes	no	yes	NA	3	small	Low
Orchards and Vineyards	NA	yes	no	yes	NA	3	small	Low
Nurseries	NA	yes	no	yes	NA	3	small	Low
Mosquito Control	3	yes	no	yes	NA	3	small	Low
Developed	NA	yes	no	yes	NA	3	small	Low
Corn	NA	yes	no	yes	NA	3	small	Low
Bin 3	NA	yes	no	yes	NA	3	small	Low

Life Stage: Juveniles

Based on the life history of green turtles, hatchlings crawl to the water and swim to offshore areas where they reside for several years. Therefore juveniles are not expected to experience substantial exposure to malathion.

Life Stage: Adults

Table 481. Direct mortality risk hypothesis; Green sea turtle, central west pacific DPS and malathion; Adults

Endpoint: Mortality (HUC20; Guam and Mariana)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	NA	Low	Low
Pasture	NA	Low	Low
Other Row Crop	NA	Low	Low
Other Crop	NA	Low	Low
Orchards and Vineyards	NA	Low	Low
Nurseries	NA	Low	Low
Mosquito Control	NA	Low	Low
Developed	NA	Low	Low
Corn	NA	Low	Low
Bin 3	NA	Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**Low**		

Table 482. Reproduction risk hypothesis; Green sea turtle, central west pacific DPS and malathion; Adults

Endpoint: Reproduction (HUC20; Guam and Mariana)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	NA	Low	Low
Pasture	NA	Low	Low
Other Row Crop	NA	Low	Low
Other Crop	NA	Low	Low
Orchards and Vineyards	NA	Low	Low
Nurseries	NA	Low	Low
Mosquito Control	NA	Low	Low
Developed	NA	Low	Low
Corn	NA	Low	Low
Bin 3	NA	Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**Low**		

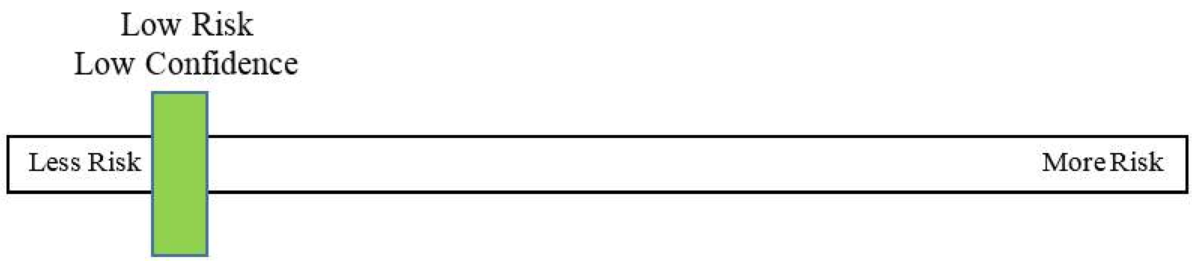
Table 483. AChE risk hypothesis; Green sea turtle, central west pacific DPS and malathion; Adults

Endpoint: enzyme (HUC20; Guam and Mariana)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	NA	Low	Low
Pasture	NA	Low	Low
Other Row Crop	NA	Low	Low
Other Crop	NA	Low	Low
Orchards and Vineyards	NA	Low	Low
Nurseries	NA	Low	Low
Mosquito Control	NA	Low	Low
Developed	NA	Low	Low
Corn	NA	Low	Low
Bin 3	NA	Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**Low**		

Table 484. Effects analysis summary table: Green sea turtle, central west pacific DPS and malathion

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	Low	Not Available	**No**

Effects analysis summary: Adult and juvenile Green sea turtle, central west pacific DPS are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to malathion in the marine environment. If exposed to formulated products and tank mixtures containing malathion, sea turtles may experience increased toxicity. The overall risk to Green sea turtle, central south pacific DPS from the effects of the action is low and the confidence associated with that risk is low. The low risk is due primarily to the small portion of the species range within US territories. The lack in confidence is due primarily to the uncertainty in predicted malathion concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites with the species range.



14.52 Green Sea Turtle, East Pacific DPS (Chelonia mydas)

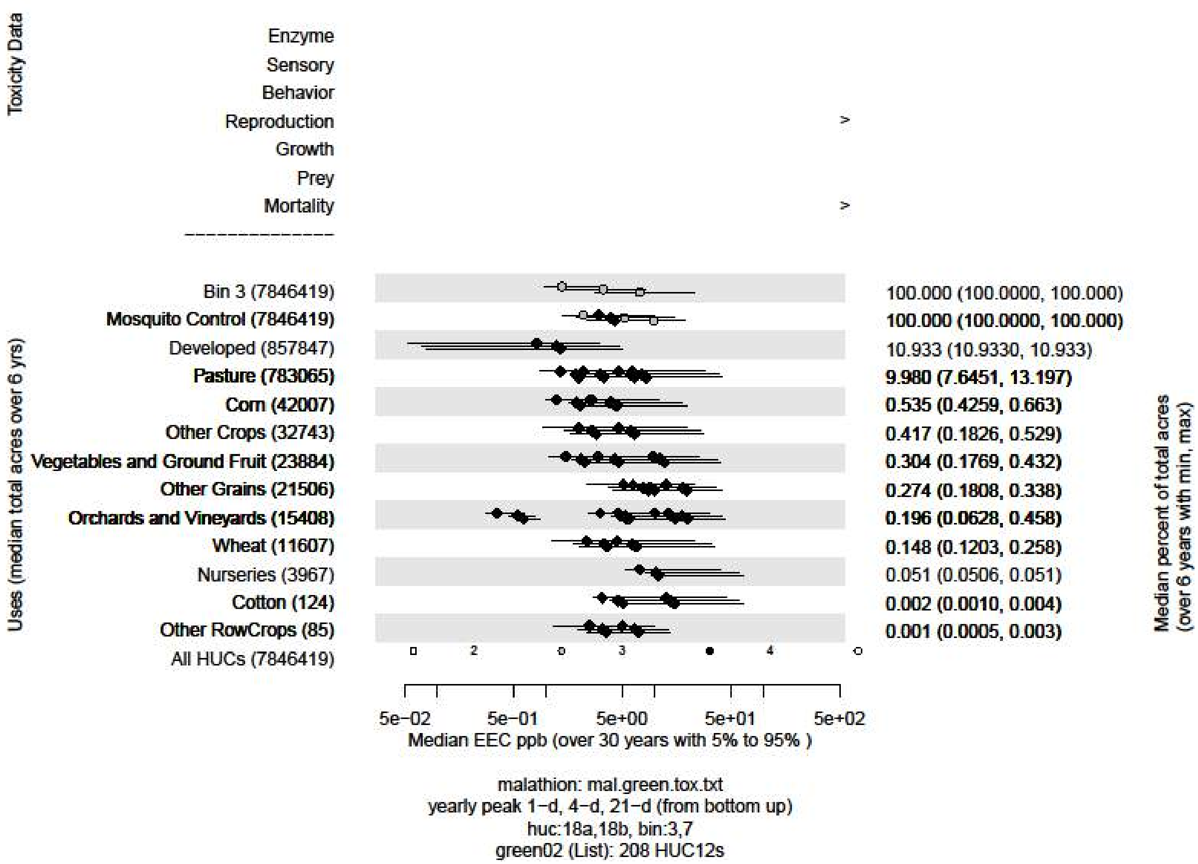


Figure 52. Effects analysis R-plot for Green sea turtle, east pacific DPS and malathion

Table 485. Likelihood of exposure determination for Green sea turtle, east pacific DPS and malathion

Adults	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of the Species Name in US Territories	Likelihood of Exposure
Mosquito Control	3	yes	no	yes	NA	3	8%	High
Developed	1	yes	no	yes	NA	3	8%	Low
Pasture	1	yes	no	yes	NA	3	8%	Low
Corn	1	yes	no	yes	NA	3	8%	Low
Other Crops	1	yes	no	yes	NA	3	8%	Low
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	8%	Low
Other Grains	1	yes	no	yes	NA	3	8%	Low
Orchards and Vineyards	1	yes	no	yes	NA	3	8%	Low
Wheat	1	yes	no	yes	NA	3	8%	Low
Nurseries	1	yes	no	yes	NA	3	8%	Low
Cotton	1	yes	no	yes	NA	3	8%	Low
Other Row Crops	1	yes	no	yes	NA	3	8%	Low
Bin 3	3	yes	no	yes	NA	3	8%	High

Life Stage: Juveniles

Based on the life history of green turtles, hatchlings crawl to the water and swim to offshore areas where they reside for several years. Therefore juveniles are not expected to experience substantial exposure to malathion.

Life Stage: Adults

Table 486. Direct mortality risk hypothesis; Green sea turtle, east pacific DPS and malathion; Adults

Endpoint: Mortality (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	**High**
Developed	10.9	Low	**Low**
Pasture	10	Low	**Low**
Corn	.5	Low	**Low**
Other Crops	.4	Low	**Low**
Vegetables and Ground Fruit	.3	Low	**Low**
Other Grains	.3	Low	**Low**
Orchards and Vineyards	.2	Low	**Low**
Wheat	.1	Low	**Low**
Nurseries	.05	Low	**Low**
Cotton	.002	Low	**Low**
Other Row Crops	.001	Low	**Low**
Bin 3	100	Low	**High**

Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.		
Risk	Confidence	
Low	Low	

Table 487. Reproduction risk hypothesis; Green sea turtle, east pacific DPS and malathion; Adults

Endpoint: Reproduction (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	**High**
Developed	10.9	Low	**Low**
Pasture	10	Low	**Low**
Corn	.5	Low	**Low**
Other Crops	.4	Low	**Low**
Vegetables and Ground Fruit	.3	Low	**Low**
Other Grains	.3	Low	**Low**
Orchards and Vineyards	.2	Low	**Low**
Wheat	.1	Low	**Low**
Nurseries	.05	Low	**Low**
Cotton	.002	Low	**Low**
Other Row Crops	.001	Low	**Low**
Bin 3	100	Low	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**Low**		

Table 488. AChE risk hypothesis; Green sea turtle, east pacific DPS and malathion; Adults

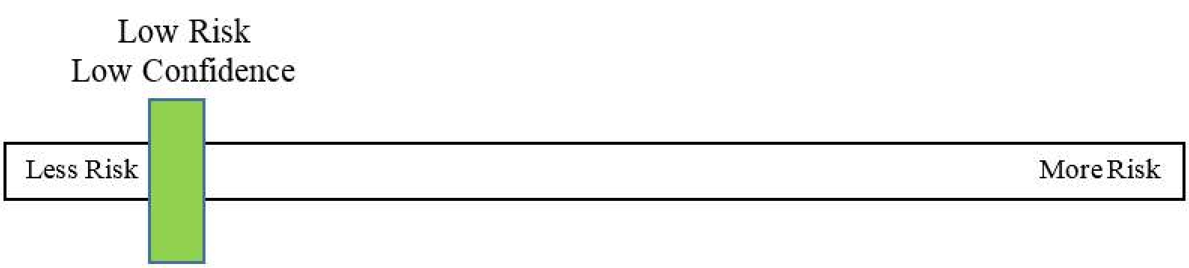
Endpoint: enzyme (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All uses	NA	Not Available	
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
NA	**Na**		

Table 489. Effects analysis summary table: Green sea turtle, east pacific DPS and malathion

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				

Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	NA	NA	Not Available	**No**

Effects analysis summary: Adult and juvenile Green sea turtle, east pacific DPS are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to malathion in the marine environment. If exposed to formulated products and tank mixtures containing malathion, sea turtles may experience increased toxicity. The overall risk to Green sea turtle, east pacific DPS from the effects of the action is low and the confidence associated with that risk is low. The medium risk is due primarily to the small portion of the species range within US territories. The lack in confidence is due primarily to the uncertainty in predicted malathion concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites with the species range.



14.53 Green Sea Turtle, North Atlantic DPS (Chelonia mydas)

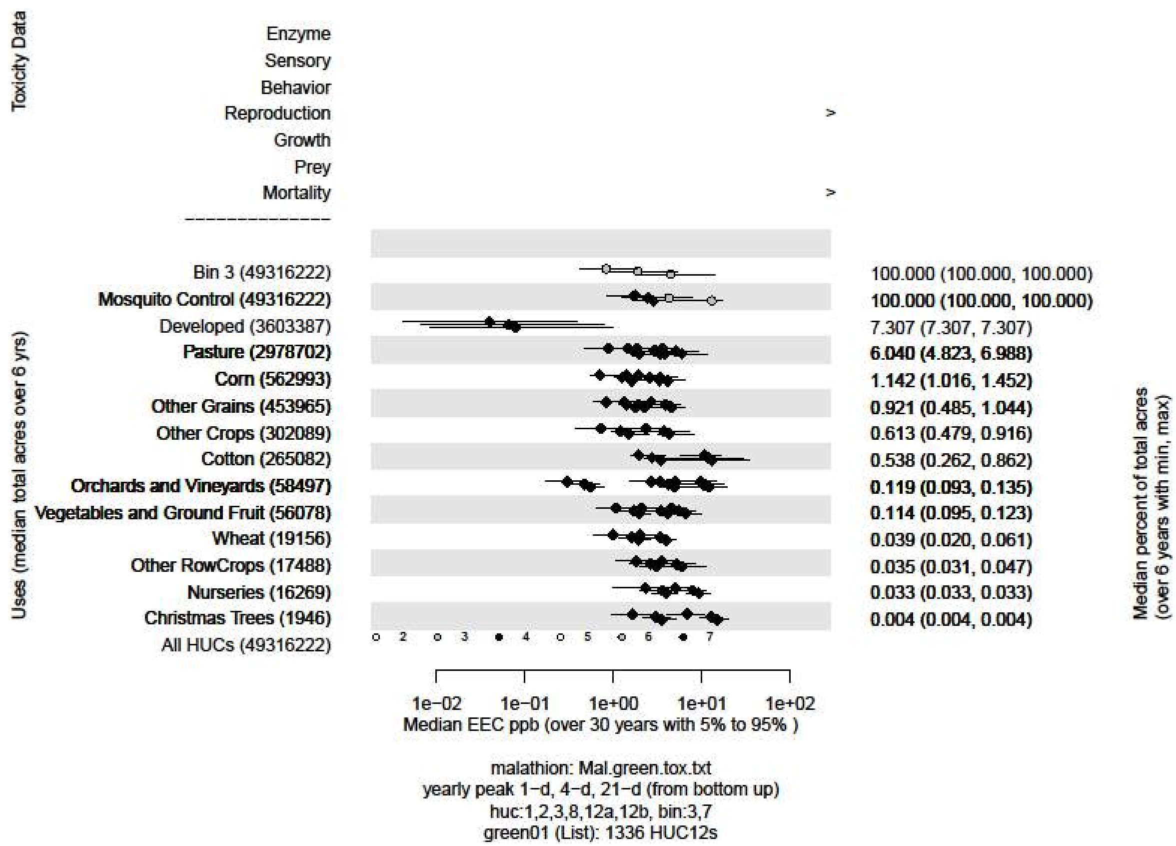


Figure 53. Effects analysis R-plot for Green sea turtle, north Atlantic DPS and malathion

Table 490. Likelihood of exposure determination for Green sea turtle, north Atlantic DPS and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range in US Territories	Likelihood of Exposure
Adults - Atlantic Coast								
Mosquito Control	3	yes	yes	yes	NA	3	Med	Med
Developed	3	yes	yes	yes	NA	3	Med	Med
Pasture	3	yes	yes	yes	NA	3	Med	Med
Corn	2	yes	yes	yes	NA	3	Med	Med
Other Grain	1	yes	yes	yes	NA	3	Med	Low
Other Crops	1	yes	yes	yes	NA	3	Med	Low
Cotton	1	yes	yes	yes	NA	3	Med	Low
Orchard and Vineyards	1	yes	yes	yes	NA	3	Med	Low
Vegetables anf Ground Fruit	1	yes	yes	yes	NA	3	Med	Low
Wheat	1	yes	yes	yes	NA	3	Med	Low
Other Row Crops	1	yes	yes	yes	NA	3	Med	Low
Nurseries	1	yes	yes	yes	NA	3	Med	Low
Christmas Trees	1	yes	yes	yes	NA	3	Med	Low
Bin 3	1	yes	yes	yes	NA	3	Med	Low
Adults - US Territories in Atlantic/Caribbean								
Crops	NA	yes	yes	yes	NA	3	Med	Low
Developed	NA	yes	yes	yes	NA	3	Med	Low
Mosquito Control	NA	yes	yes	yes	NA	3	Med	Low
Other	NA	yes	yes	yes	NA	3	Med	Low

Life Stage: Juveniles

Based on the life history of green turtles, hatchlings crawl to the water and swim to offshore areas where they reside for several years. Therefore juveniles are not expected to experience substantial exposure to malathion.

Life Stage: Adults

Table 491. Direct mortality risk hypothesis; Green sea turtle, north Atlantic DPS and malathion; Adults; Atlantic Coast

Endpoint: Mortality (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	Medium
Developed	7.3	Low	Medium
Pasture	6.0	Low	Medium
Corn	1.1	Low	Medium
Other Grains	.9	Low	Low
Other Crops	.6	Low	Low
Cotton	.5	Low	Low
Orchards and Vineyards	.1	Low	Low
Vegetables and Ground Fruit	.1	Low	Low
Wheat	.04	Low	Low

Other Row crops	.04	Low	Low
Nurseries	.03	Low	Low
Christmas Trees	.004	Low	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**Low**		

Table 492. Direct mortality risk hypothesis; Green sea turtle, north Atlantic DPS and malathion; Adults; US Territories in Atlantic

Endpoint: Mortality (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Low	Low
Developed	Not Available	Low	Low
Mosquito Control	100	Low	Low
Other	Not Available	Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**Low**		

Table 493. Reproduction risk hypothesis; Green sea turtle, north Atlantic DPS and malathion; Adults; Atlantic Coast

Endpoint: Reproduction (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	Medium
Developed	7.3	Low	Medium
Pasture	6.0	Low	Medium
Corn	1.1	Low	Medium
Other Grains	.9	Low	Low
Other Crops	.6	Low	Low
Cotton	.5	Low	Low
Orchards and Vineyards	.1	Low	Low
Vegetables and Ground Fruit	.1	Low	Low
Wheat	.04	Low	Low
Other Row crops	.04	Low	Low
Nurseries	.03	Low	Low
Christmas Trees	.004	Low	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		

Low	**Low**	

Table 494. Reproduction risk hypothesis; Green sea turtle, north Atlantic DPS and malathion; Adults; US Territories in Atlantic

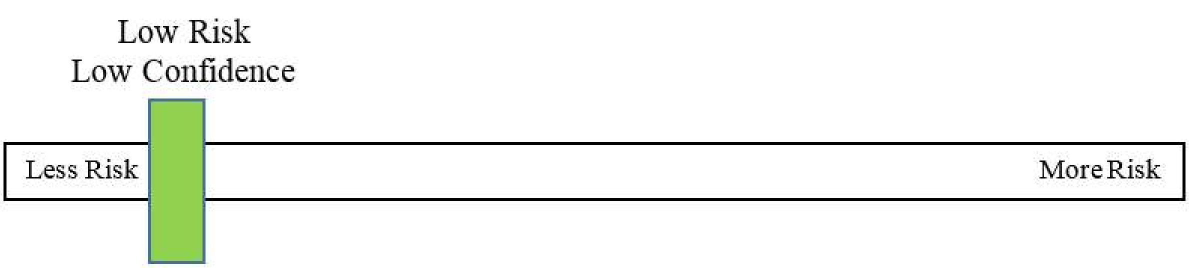
Endpoint: Reproduction (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Low	Low
Developed	Not Available	Low	Low
Mosquito Control	100	Low	Low
Other	Not Available	Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**Low**		

Table 495. Effects analysis summary table: Green sea turtle, north Atlantic DPS and malathion

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults (Lower 48 – Coastal HUC-12s)	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	NA	NA	Not Available	**No**
Adults (HUC03 – Territories in Atlantic)				
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce adult productivity via	Low	Low	Not Available	**No**

impairments to reproduction				
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	Low	Not Available	**No**

Effects analysis summary: Adult and juvenile Green sea turtle, north Atlantic DPS are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to malathion in the marine environment. If exposed to formulated products and tank mixtures containing malathion, sea turtles may experience increased toxicity. The overall risk to Green sea turtle, north Atlantic DPS from the effects of the action is low and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted malathion concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites with the species range.



14.54 Green Sea Turtle, South Atlantic DPS (Chelonia mydas)

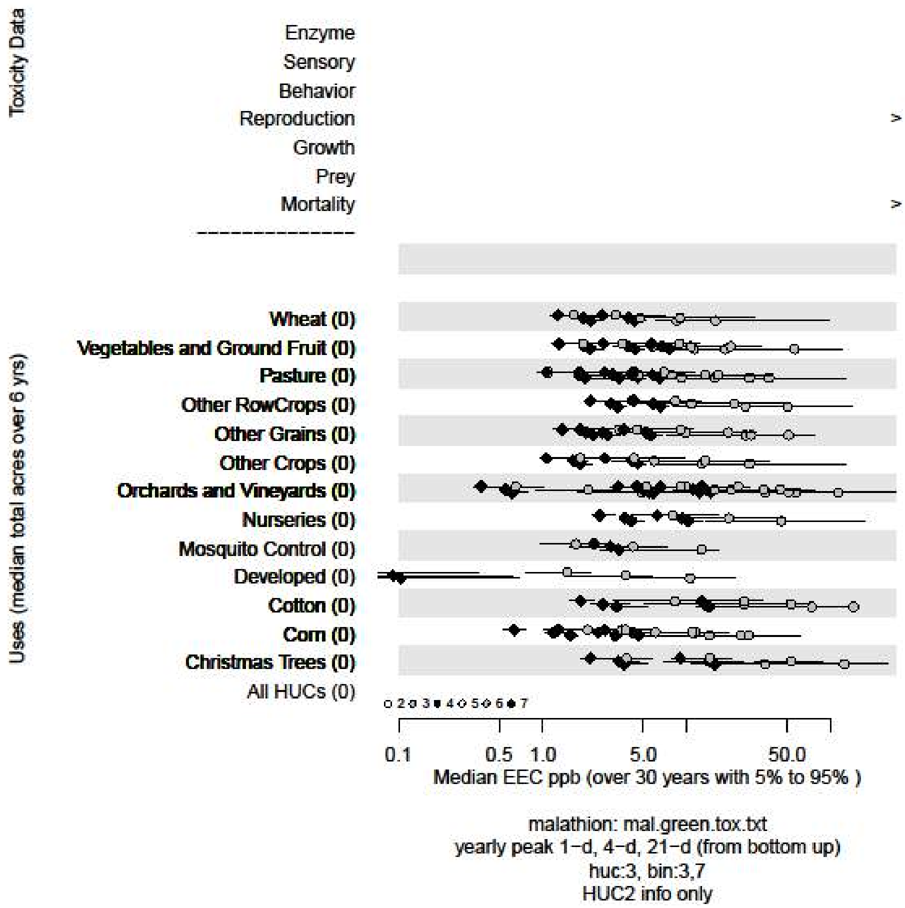


Figure 54. Effects analysis R-plot for Green sea turtle, south Atlantic DPS and malathion

Table 496. Likelihood of exposure determination for Green sea turtle, south Atlantic DPS and malathion

Adults	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range within US Territories	Likelihood of Exposure
Wheat	NA	yes	no	yes	NA	3	small	Low
Vegetables and Ground Fruit	NA	yes	no	yes	NA	3	small	Low
Pasture	NA	yes	no	yes	NA	3	small	Low
Other Row Crops	NA	yes	no	yes	NA	3	small	Low
Other Grains	NA	yes	no	yes	NA	3	small	Low
Other Crops	NA	yes	no	yes	NA	3	small	Low
Orchards and Vineyards	3	yes	no	yes	NA	3	small	Low
Nurseries	NA	yes	no	yes	NA	3	small	Low
Mosquito Control	NA	yes	no	yes	NA	3	small	Low
Developed	NA	yes	no	yes	NA	3	small	Low

Life Stage: Juveniles

Based on the life history of green turtles, hatchlings crawl to the water and swim to offshore areas where they reside for several years. Therefore juveniles are not expected to experience substantial exposure to malathion.

Life Stage: Adults

Table 497. Direct mortality risk hypothesis; Green sea turtle, south Atlantic DPS and malathion; Adults

Endpoint: Mortality (HUC2: 03)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wheat	NA	Low	Low
Vegetables and Ground Fruit	NA	Low	Low
Pasture	NA	Low	Low
Other Row Crops	NA	Low	Low
Other Grains	NA	Low	Low
Other Crops	NA	Low	Low
Orchards and Vineyards	NA	Low	Low
Nurseries	NA	Low	Low
Mosquito Control	NA	Low	Low
Developed	NA	Low	Low
Corn	NA	Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**Low**		

Table 498. Reproduction risk hypothesis; Green sea turtle, south Atlantic DPS and malathion; Adults

Endpoint: Reproduction (HUC2: 03)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wheat	NA	Low	Low
Vegetables and Ground Fruit	NA	Low	Low
Pasture	NA	Low	Low
Other Row Crops	NA	Low	Low
Other Grains	NA	Low	Low
Other Crops	NA	Low	Low
Orchards and Vineyards	NA	Low	Low
Nurseries	NA	Low	Low
Mosquito Control	NA	Low	Low
Developed	NA	Low	Low
Corn	NA	Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**Low**		

Table 499. AChE risk hypothesis; Green sea turtle, south Atlantic DPS and malathion; Adults

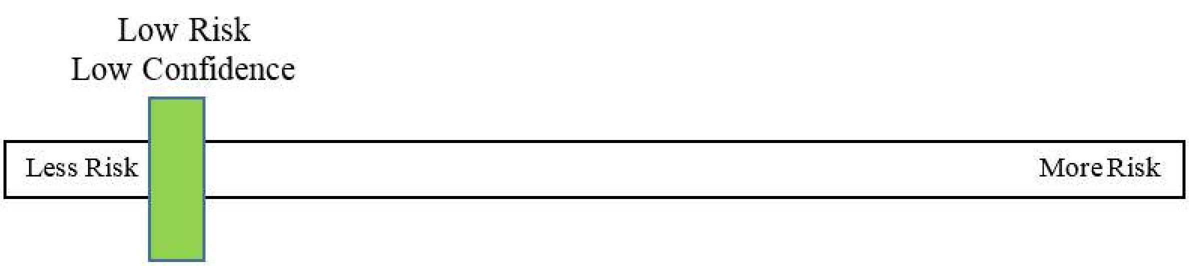
Endpoint: enzyme (HUC2: 03)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wheat	NA	Low	Low
Vegetables and Ground Fruit	NA	Low	Low
Pasture	NA	Low	Low
Other Row Crops	NA	Low	Low
Other Grains	NA	Low	Low
Other Crops	NA	Low	Low
Orchards and Vineyards	NA	Low	Low
Nurseries	NA	Low	Low
Mosquito Control	NA	Low	Low
Developed	NA	Low	Low
Corn	NA	Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**Low**		

Table 500. Effects analysis summary table: Green sea turtle, south Atlantic DPS and malathion

	R-plot Derived	**MagTool**	

Adults	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	**Risk Hypothesis Supported? Yes/No**
Risk Hypothesis				
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	Low	Not Available	**No**

Effects analysis summary: Adult and juvenile Green sea turtle, south Atlantic DPS are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to malathion in the marine environment. If exposed to formulated products and tank mixtures containing malathion, sea turtles may experience increased toxicity. The overall risk to Green sea turtle, south Atlantic DPS from the effects of the action is low and the confidence associated with that risk is low. The low risk is due primarily to the small portion of the species range within US territories. The lack in confidence is due primarily to the uncertainty in predicted malathion concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites with the species range.



14.55 Hawksbill Sea Turtle (Eretmochelys imbricate)

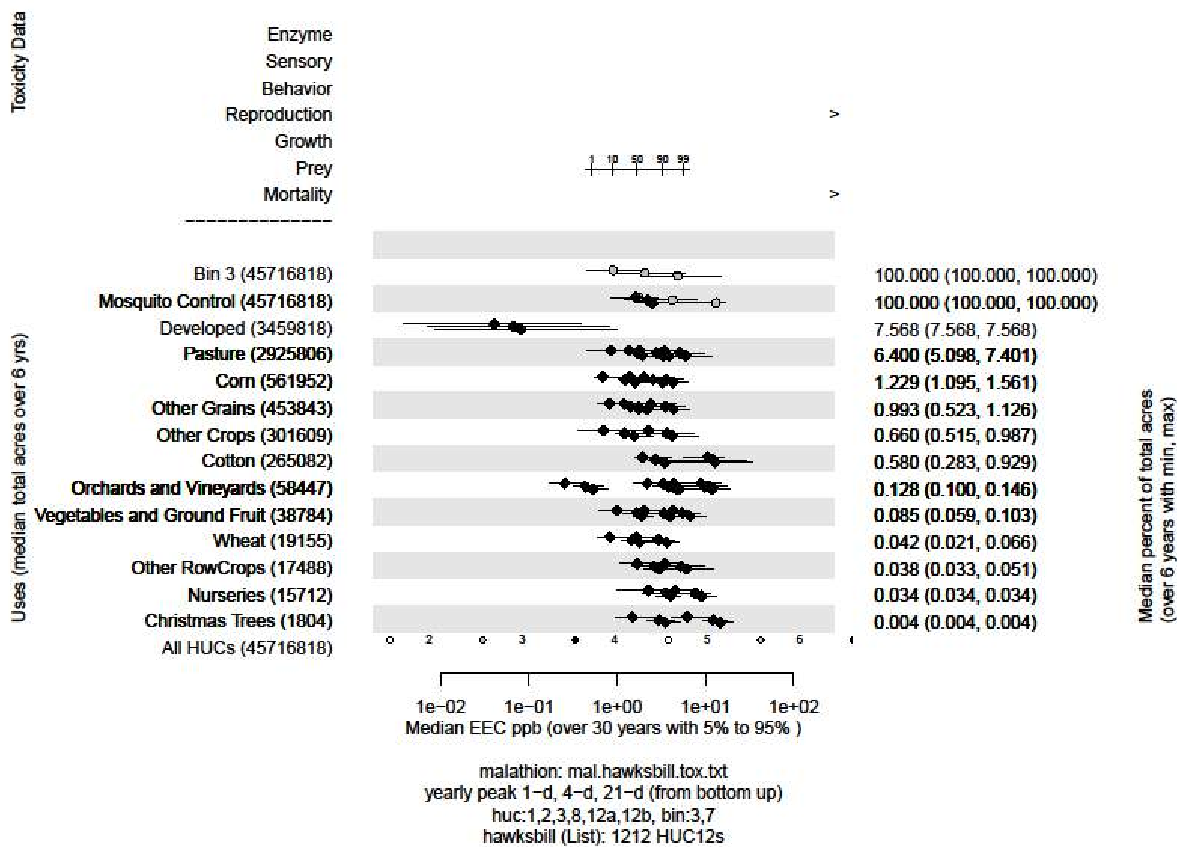


Figure 55. Effects analysis R-plot for Hawskbill sea turtle and malathion

Table 501. Likelihood of exposure determination for Hawskbill sea turtle and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range in US Territories	Likelihood of Exposure
Lower-48 Coastal Habitats								
Mosquito Control	3	yes	no	yes	NA	3	small	Low
Developed	3	yes	no	yes	NA	3	small	Low
Pasture	3	yes	no	yes	NA	3	small	Low
Corn	2	yes	no	yes	NA	3	small	Low
Other Grains	2	yes	no	yes	NA	3	small	Low
Other Crops	1	yes	no	yes	NA	3	small	Low
Cotton	1	yes	no	yes	NA	3	small	Low
Orchards and vineyards	1	yes	no	yes	NA	3	small	Low
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	small	Low
Wheat	1	yes	no	yes	NA	3	small	Low
Other Row Crops	1	yes	no	yes	NA	3	small	Low
Nurseries	1	yes	no	yes	NA	3	small	Low
Christmas Trees	1	yes	no	yes	NA	3	small	Low
Bin 3	1	yes	no	yes	NA	3	small	Low
US Territories in Pacific								
Crops	NA	yes	yes	yes	NA	low	small	Low
Developed	NA	yes	yes	yes	NA	low	small	Low
Mosquito Control	NA	yes	yes	yes	NA	low	small	Low
Other	NA	yes	yes	yes	NA	low	small	Low
US Territories in Atlantic								
Crops	NA	yes	yes	yes	NA	low	small	Low
Developed	NA	yes	yes	yes	NA	low	small	Low
Mosquito Control	NA	yes	yes	yes	NA	low	small	Low
Other	NA	yes	yes	yes	NA	low	small	Low

Life Stage: Adults and Juveniles

Table 502. Direct mortality risk hypothesis; Hawskbill sea turtle and malathion; Adults and Juveniles; Lower-48

Endpoint: Mortality (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	Low
Developed	7.6	Low	Low
Pasture	6.4	Low	Low
Corn	1.2	Low	Low
Other Grains	1	Low	Low
Other Crops	.7	Low	Low
Cotton	.6	Low	Low
Orchards and vineyards	.1	Low	Low
Vegetables and Ground Fruit	.09	Low	Low
Wheat	.04	Low	Low
Other Row Crops	.04	Low	Low
Nurseries	.03	Low	Low

Christmas Trees	.004	Low	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juveniles abundance via acute lethality.			
Risk	**Confidence**		
Low	**Low**		

Table 503. Direct mortality risk hypothesis; Hawskbill sea turtle and malathion; Adults and Juveniles; US Territories in Pacific

Endpoint: Mortality (HUC20 – Hawaii; US territories in Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Low	Low
Developed	Not Available	Low	Low
Mosquito Control	100	Low	Low
Other	Not Available	Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce juveniles abundance via acute lethality.			
Risk	**Confidence**		
Low	**Low**		

Table 504. Direct mortality risk hypothesis; Hawskbill sea turtle and malathion; Adults and Juveniles; US Territories in Atlantic

Endpoint: Mortality (HUC03 – US territories in Caribbean/Atlantic)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Low	Low
Developed	Not Available	Low	Low
Mosquito Control	100	Low	Low
Other	Not Available	Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce juveniles abundance via acute lethality.			
Risk	**Confidence**		
Low	Low		

Table 505. Prey risk hypothesis; Hawskbill sea turtle and malathion; Adults and Juveniles; Lower-48

Endpoint: Prey (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	Low
Developed	7.6	Med	Low
Pasture	6.4	High	Low
Corn	1.2	High	Low
Other Grains	1	High	Low

Other Crops	.7	High	Low
Cotton	.6	High	Low
Orchards and vineyards	.1	High	Low
Vegetables and Ground Fruit	.09	High	Low
Wheat	.04	High	Low
Other Row Crops	.04	High	Low
Nurseries	.03	High	Low
Christmas Trees	.004	High	Low
Bin 3		High	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	**Low**		

Table 506. Prey risk hypothesis; Hawskbill sea turtle and malathion; Adults and Juveniles; US Territories in Atlantic

Endpoint: Prey (HUC03 – US territories in Caribbean/Atlantic)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	100	High	Low
Other	Not Available	High	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	**Low**		

Table 507. Prey risk hypothesis; Hawskbill sea turtle and malathion; Adults and Juveniles; US Territories in Pacific

Endpoint: Prey (HUC20 – Hawaii; US territories in Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Low
Developed	Not Available	High	Low
Mosquito Control	100	High	Low
Other	Not Available	High	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
Low	Low		

Table 508. AChE risk hypothesis; Hawskbill sea turtle and malathion; Adults and Juveniles; Lower-48

Endpoint: enzyme (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All Uses	NA	Not Available	NA
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
NA	NA		

Table 509. AChE risk hypothesis; Hawskbill sea turtle and malathion; Adults and Juveniles; US Territories in Atlantic

Endpoint: Enzyme (HUC20 – Hawaii; US territories in Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All Uses	NA	Not Available	NA
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
NA	NA		

Table 510. AChE risk hypothesis; Hawskbill sea turtle and malathion; Adults and Juveniles; US Territories in Pacific

Endpoint: Enzyme (HUC03 – US territories in Caribbean/Atlantic)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
All Uses	NA	Not Available	NA
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity			
Risk	**Confidence**		
NA	NA		

Table 511. Reproduction risk hypothesis; Hawskbill sea turtle and malathion; Adults and Juveniles; Lower-48

Endpoint: Reproduction (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	Low
Developed	7.6	Low	Low
Pasture	6.4	Low	Low
Corn	1.2	Low	Low
Other Grains	1	Low	Low
Other Crops	.7	Low	Low
Cotton	.6	Low	Low

Orchards and vineyards	.1	Low	Low
Vegetables and Ground Fruit	.09	Low	Low
Wheat	.04	Low	Low
Other Row Crops	.04	Low	Low
Nurseries	.03	Low	Low
Christmas Trees	.004	Low	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**Low**		

Table 512. Reproduction risk hypothesis; Hawskbill sea turtle and malathion; Adults and Juveniles; US Territories in Pacific

Endpoint: Reproduction (HUC20 – Hawaii; US territories in Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Low	Low
Developed	Not Available	Low	Low
Mosquito Control	100	Low	Low
Other	Not Available	Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**Low**		

Table 513. Reproduction risk hypothesis; Hawskbill sea turtle and malathion; Adults and Juveniles; US Territories in Atlantic

Endpoint: Reproduction (HUC03 – US territories in Caribbean/Atlantic)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Low	Low
Developed	Not Available	Low	Low
Mosquito Control	100	Low	Low
Other	Not Available	Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	Low		

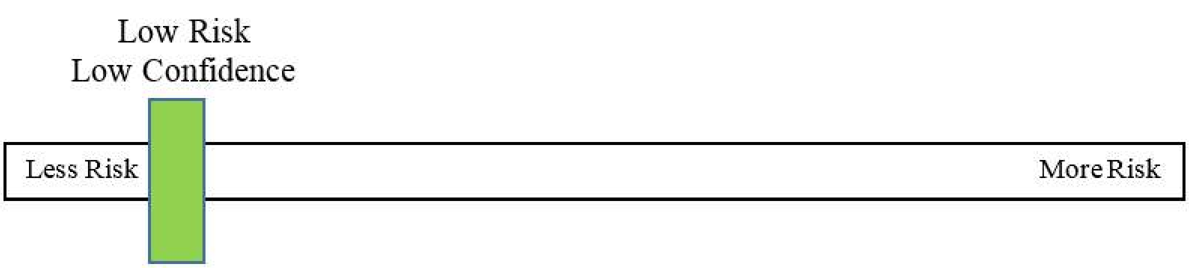
Table 514. Effects analysis summary table: Hawskbill sea turtle and malathion

	R-plot Derived	**MagTool**	

(Lower 48 – Coastal HUC-12s)	Risk	Confidence	Range in median percent mortalities for aquatic bins	Risk Hypothesis Supported? Yes/No
Risk Hypothesis				
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	NA	NA	Not Available	**No**
(HUC20 – Hawaii; US territories in Pacific)				
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	NA	NA	Not Available	**No**
(HUC03 – US territories in Caribbean/Atlantic)				

Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	NA	NA	Not Available	**No**

Effects analysis summary: Adult and juvenile hawksbill sea turtles are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to malathion in the marine environment. If exposed to formulated products and tank mixtures containing malathion, sea turtles may experience increased toxicity. The overall risk to hawksbill sea turtles from the effects of the action is low and the confidence associated with that risk is low. The low risk is due primarily to the small portion of the species range within US territories. The lack in confidence is due primarily to the uncertainty in predicted malathion concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites with the species range.



14.56 Kemp's Ridley Sea Turtle (Lepidochelys kempii)

Table 515. Likelihood of exposure determination for Kemp's ridley sea turtle and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
US Lower-48							
Mosquito Control	3	yes	no	yes	NA	3	**High**
Developed	3	yes	no	yes	NA	3	**High**
Pasture	3	yes	no	yes	NA	3	**High**
Corn	2	yes	no	yes	NA	3	**Med**
Other Grains	1	yes	no	yes	NA	3	**Low**
Other Crops	1	yes	no	yes	NA	3	**Low**
Cotton	1	yes	no	yes	NA	3	**Low**
Orchards and Vineyards	1	yes	no	yes	NA	3	**Low**
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	**Low**
Wheat	1	yes	no	yes	NA	3	**Low**
Other Row Crops	1	yes	no	yes	NA	3	**Low**
Nurseries	1	yes	no	yes	NA	3	**Low**
Christmas Trees	1	yes	no	yes	NA	3	**Low**
Bin 3	3	yes	no	yes	NA	3	**High**
US Territories in Atlantic							
Crops	NA	yes	no	yes	NA	3	**Med**
Developed	NA	yes	no	yes	NA	3	**Med**
Mosquito Control	NA	yes	no	yes	NA	3	**Med**
Other	NA	yes	no	yes	NA	3	**Med**

Life Stage: Adults and Juveniles

Table 516. Direct mortality risk hypothesis; Kemp's ridley sea turtle and malathion; Adults and Juveniles; US Lower-48

Endpoint: Mortality (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	**High**
Developed	7.3	Low	**High**
Pasture	6.0	Low	**High**
Corn	1.1	Low	**Medium**
Other Grains	.9	Low	**Low**
Other Crops	.6	Low	**Low**
Cotton	.5	Low	**Low**
Orchards and Vineyards	.1	Low	**Low**
Vegetables and Ground Fruit	.1	Low	**Low**

Wheat	.04	Low	**Low**
Other Row Crops	.04	Low	**Low**
Nurseries	.03	Low	**Low**
Christmas Trees	.004	Low	**Low**
Bin 3		Low	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**Low**		

Table 517. Direct mortality risk hypothesis; Kemp's ridley sea turtle and malathion; Adults; US Territories in Atlantic

Endpoint: Mortality (HUC03 – US territories in Caribbean/Atlantic)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Low	Medium
Developed	Not Available	Low	Medium
Mosquito Control	100	Low	Medium
Other	Not Available	Low	Medium
Risk Hypothesis: Exposure to malathion is sufficient to reduce juveniles abundance via acute lethality.			
Risk	**Confidence**		
Low	Low		

Table 518. Prey risk hypothesis; Kemp's ridley sea turtle and malathion; Adults and Juveniles; US Lower-48

Endpoint: Prey (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Developed	7.3	Medium	**High**
Pasture	6.0	High	**High**
Corn	1.1	High	**Medium**
Other Grains	.9	High	**Low**
Other Crops	.6	High	**Low**
Cotton	.5	High	**Low**
Orchards and Vineyards	.1	High	**Low**
Vegetables and Ground Fruit	.1	High	**Low**
Wheat	.04	High	**Low**
Other Row Crops	.04	High	**Low**
Nurseries	.03	High	**Low**
Christmas Trees	.004	High	**Low**
Bin 3		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		

High	**Low**	

Table 519. Prey risk hypothesis; Kemp's ridley sea turtle and malathion; Adults; US Territories in Atlantic

Endpoint: Prey (HUC03 – US territories in Caribbean/Atlantic)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Medium
Developed	Not Available	High	Medium
Mosquito Control	100	High	Medium
Other	Not Available	High	Medium
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**Low**		

Table 520. Reproduction risk hypothesis; Kemp's ridley sea turtle and malathion; Adults; US Territories in Atlantic

Endpoint: Reproduction (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	**High**
Developed	7.3	Low	**High**
Pasture	6.0	Low	**High**
Corn	1.1	Low	**Medium**
Other Grains	.9	Low	**Low**
Other Crops	.6	Low	**Low**
Cotton	.5	Low	**Low**
Orchards and Vineyards	.1	Low	**Low**
Vegetables and Ground Fruit	.1	Low	**Low**
Wheat	.04	Low	**Low**
Other Row Crops	.04	Low	**Low**
Nurseries	.03	Low	**Low**
Christmas Trees	.004	Low	**Low**
Bin 3		Low	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**Low**		

Table 521. Reproduction risk hypothesis; Kemp's ridley sea turtle and malathion; Adults; US Territories in Atlantic

Endpoint: Reproduction (HUC03 – US territories in Caribbean/Atlantic)

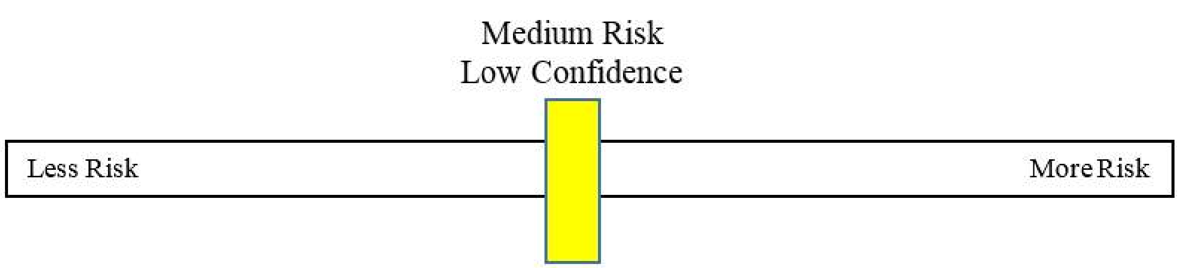
Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Crops	Not Available	Low	Medium
Developed	Not Available	Low	Medium
Mosquito Control	100	Low	Medium
Other	Not Available	Low	Medium
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
High	Low		

Table 522. Effects analysis summary table: Kemp's ridley sea turtle and malathion

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
(Lower 48 – Coastal HUC-12s)	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability	High	Low	Not Available	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	NA	NA	Not Available	**NA**
(HUC03 – US territories in Caribbean/Atlantic)				
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce adult productivity via	Low	Low	Not Available	**No**

impairments to reproduction				
Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability	High	Low	Not Available	**Yes**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	NA	NA	Not Available	**NA**

Effects analysis summary: Adult and juvenile Kemp's ridley sea turtles are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to malathion in the marine environment. If exposed to formulated products and tank mixtures containing malathion, sea turtles may experience increased toxicity. The overall risk to Kemp's ridley sea turtles from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted malathion concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites with the species range.



14.57 Leatherback Sea Turtle (Dermochelys coriacea)

Table 523. Likelihood of exposure determination for Leatherback sea turtle and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range in US Territories	Likelihood of Exposure
US Lower-48								
Mosquito Control	3	yes	no	yes	NA	3	Med	**Med**
Developed	3	yes	no	yes	NA	3	Med	**Med**
Pasture	3	yes	no	yes	NA	3	Med	**Med**
Corn	1	yes	no	yes	NA	3	Med	Low
Other Grains	1	yes	no	yes	NA	3	Med	Low
Other Crops	1	yes	no	yes	NA	3	Med	Low
Cotton	1	yes	no	yes	NA	3	Med	Low
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	Med	Low
Orchards and Vineyards	1	yes	no	yes	NA	3	Med	Low
Wheat	1	yes	no	yes	NA	3	Med	Low
Nurseries	1	yes	no	yes	NA	3	Med	Low
Other Row Crops	1	yes	no	yes	NA	3	Med	Low
Christmas Trees	1	yes	no	yes	NA	3	Med	Low
Bin 3	1	yes	no	yes	NA	3	Med	Low
US Territories in Pacific								
Crops	NA	yes	no	yes	NA	3	Med	Low
Developed	NA	yes	no	yes	NA	3	Med	Low
Mosquito Control	NA	yes	no	yes	NA	3	Med	Low
Other	NA	yes	no	yes	NA	3	Med	Low
US Territories in Atlantic								
Crops	NA	yes	no	yes	NA	3	Med	Low
Developed	NA	yes	no	yes	NA	3	Med	Low
Mosquito Control	NA	yes	no	yes	NA	3	Med	Low
Other	NA	yes	no	yes	NA	3	Med	Low

Life Stage: Juveniles

Based on the life history of leatherback turtles, hatchlings crawl to the water and swim to offshore areas where they reside for several years. Therefore juveniles are not expected to experience substantial exposure to malathion.

Life Stage: Adults

Table 524. Direct mortality risk hypothesis; Leatherback sea turtle and malathion; Adults; US Lower-48

Endpoint: Mortality (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	**Med**
Developed	7.4	Low	**Med**
Pasture	6.2	Low	**Med**
Corn	.9	Low	**Low**
Other Grains	.7	Low	**Low**
Other Crops	.5	Low	**Low**

Cotton	.4	Low	**Low**
Vegetables and Ground Fruit	.1	Low	**Low**
Orchards and Vineyards	.1	Low	**Low**
Wheat	.05	Low	**Low**
Nurseries	.03	Low	**Low**
Other Row Crops	.03	Low	**Low**
Christmas Trees	.01	Low	**Low**
Bin 3		Low	**Low**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**Low**		

Table 525. Direct mortality risk hypothesis; Leatherback sea turtle and malathion; Adults; US Territories in Pacific

Endpoint: Mortality (HUC20 – Hawaii; US territories in Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Low	Low
Developed	Not Available	Low	Low
Mosquito Control	100	Low	Low
Other	Not Available	Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**Low**		

Table 526. Direct mortality risk hypothesis; Leatherback sea turtle and malathion; Adults; US Territories in Atlantic

Endpoint: Mortality (HUC03 – US territories in Caribbean/Atlantic)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Low	Low
Developed	Not Available	Low	Low
Mosquito Control	100	Low	Low
Other	Not Available	Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	Low		

Table 527. Reproduction risk hypothesis; Leatherback sea turtle and malathion; Adults; US Lower-48

Endpoint: Reproduction (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	**Med**
Developed	7.4	Low	**Med**
Pasture	6.2	Low	**Med**
Corn	.9	Low	**Low**
Other Grains	.7	Low	**Low**
Other Crops	.5	Low	**Low**
Cotton	.4	Low	**Low**
Vegetables and Ground Fruit	.1	Low	**Low**
Orchards and Vineyards	.1	Low	**Low**
Wheat	.05	Low	**Low**
Nurseries	.03	Low	**Low**
Other Row Crops	.03	Low	**Low**
Christmas Trees	.01	Low	**Low**
Bin 3		Low	**Low**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**Low**		

Table 528. Reproduction risk hypothesis; Leatherback sea turtle and malathion; Adults; US Territories in Pacific

Endpoint: Reproduction (HUC20 – Hawaii; US territories in Pacific)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Low	Low
Developed	Not Available	Low	Low
Mosquito Control	100	Low	Low
Other	Not Available	Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	Low		

Table 529. Reproduction risk hypothesis; Leatherback sea turtle and malathion; Adults; US Territories in Atlantic

Endpoint: Reproduction (HUC03 – US territories in Caribbean/Atlantic)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Low	Low
Developed	Not Available	Low	Low

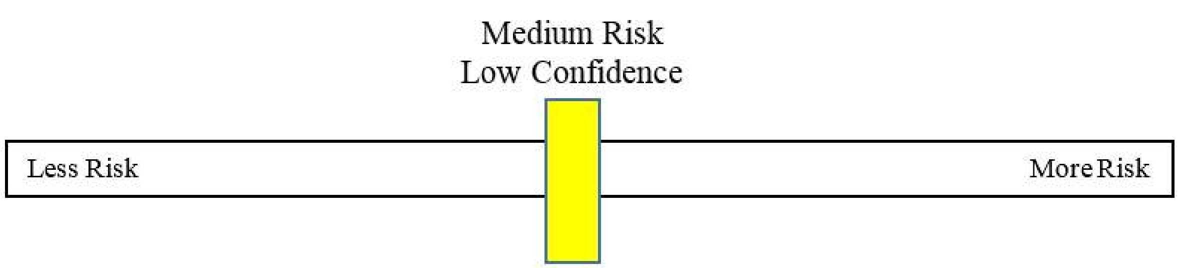
Mosquito Control	100	Low	Low
Other	Not Available	Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	Low		

Table 530. Effects analysis summary table: Leatherback sea turtle and malathion

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
(Lower 48 – Coastal HUC-12s)	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	No
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	No
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	Low	Not Available	No
(HUC03 – US territories in Caribbean/Atlantic)				
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	Low	Not Available	**No**
(HUC20 – Hawaii; US territories in Pacific)				
Exposure to malathion is sufficient to reduce adult	Low	Low	Not Available	**No**

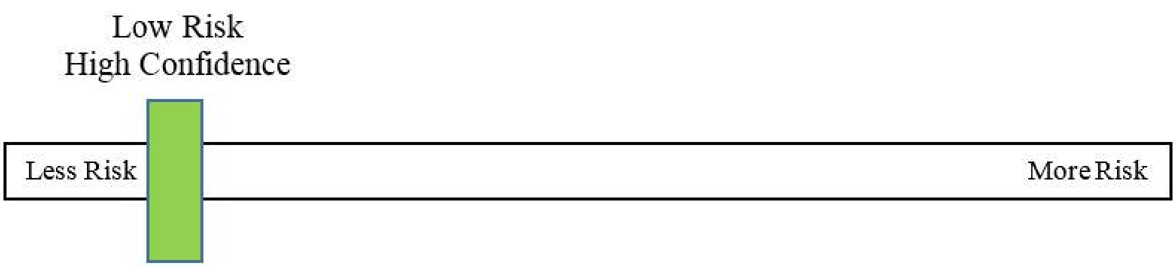
abundance via acute lethality.				
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce ChE activity; the identified mechanism of toxicity	Low	Low	Not Available	**No**

Effects analysis summary: Adult and juvenile leatherback sea turtles are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to malathion in the marine environment. If exposed to formulated products and tank mixtures containing malathion, sea turtles may experience increased toxicity. The overall risk to leatherback sea turtles from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted malathion concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites with the species range.



14.58 Loggerhead Sea Turtle, North Pacific Ocean DPS (Caretta caretta)

Effects analysis summary: Adult and juvenile loggerhead sea turtle, North Pacific Ocean DPS are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to malathion in the marine environment. If exposed to formulated products and tank mixtures containing malathion, sea turtles may experience increased toxicity. The overall risk to loggerhead sea turtle, North Pacific DPS from the effects of the action is low and the confidence associated with that risk is high. Low risk is due primarily to the small portion of the species range within US territories and the species utilization of off-shore habitats.



14.59 Loggerhead Sea Turtle, Northwest Atlantic Ocean DPS (Caretta caretta)

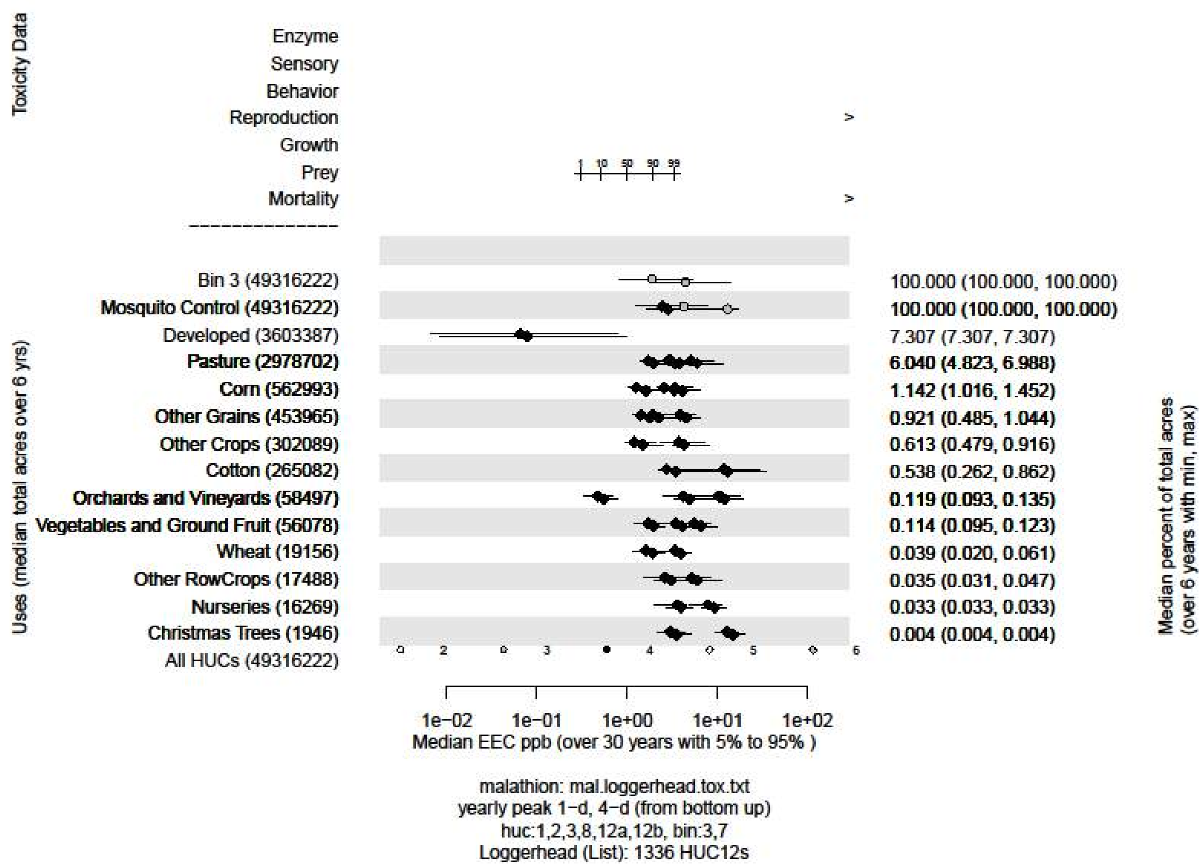


Figure 56. Effects analysis R-plot for Loggerhead sea turtle, northwest Atlantic Ocean DPS and malathion

Table 531. Likelihood of exposure determination for Loggerhead sea turtle, northwest Atlantic Ocean DPS and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
US Lower-48							
Mosquito Control	3	yes	no	yes	NA	3	**High**
Developed	3	yes	no	yes	NA	3	**High**
Pasture	3	yes	no	yes	NA	3	**High**
Corn	2	yes	no	yes	NA	3	**Med**
Other Grains	1	yes	no	yes	NA	3	**Low**
Other Crops	1	yes	no	yes	NA	3	**Low**
Cotton	1	yes	no	yes	NA	3	**Low**
Orchards and Vineyards	1	yes	no	yes	NA	3	**Low**
Vegetables and Ground Fruit	1	yes	no	yes	NA	3	**Low**
Wheat	1	yes	no	yes	NA	3	**Low**
Other Row Crops	1	yes	no	yes	NA	3	**Low**
Nurseries	1	yes	no	yes	NA	3	**Low**
Christmas Trees	1	yes	no	yes	NA	3	**Low**
Bin 3	3	yes	no	yes	NA	3	**High**
US Territories in Atlanitc							
Crops	NA	yes	no	yes	NA	3	**Med**
Developed	NA	yes	no	yes	NA	3	**Med**
Mosquito Control	NA	yes	no	yes	NA	3	**Med**
Other	NA	yes	no	yes	NA	3	**Med**

Life Stage: Adults and Juveniles

Table 532. Direct mortality risk hypothesis; Loggerhead sea turtle, northwest Atlantic Ocean DPS and malathion; Adults and Juveniles; US Lower-48

Endpoint: Mortality (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	**High**
Developed	7.3	Low	**High**
Pasture	6.0	Low	**High**
Corn	1.1	Low	**Medium**
Other Grains	.9	Low	**Low**
Other Crops	.6	Low	**Low**
Cotton	.5	Low	**Low**
Orchards and Vineyards	.1	Low	**Low**
Vegetables and Ground Fruit	.1	Low	**Low**
Wheat	.04	Low	**Low**
Other Row Crops	.04	Low	**Low**
Nurseries	.03	Low	**Low**
Christmas Trees	.004	Low	**Low**
Bin 3		Low	**High**

Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.		
Risk	**Confidence**	
Low	**Low**	

Table 533. Direct mortality risk hypothesis; Loggerhead sea turtle, northwest Atlantic Ocean DPS and malathion; Adults and Juveniles; US Territories in Atlantic

Endpoint: Mortality (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	Low	Medium
Developed	Not Available	Low	Medium
Mosquito Control	100	Low	Medium
Other	Not Available	Low	Medium
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult abundance via acute lethality.			
Risk	**Confidence**		
Low	**Low**		

Table 534. Prey risk hypothesis; Loggerhead sea turtle, northwest Atlantic Ocean DPS and malathion; Adults and Juveniles; US Lower-48

Endpoint: Prey (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	**High**
Developed	7.3	Medium	**High**
Pasture	6.0	High	**High**
Corn	1.1	High	**Medium**
Other Grains	.9	High	**Low**
Other Crops	.6	High	**Low**
Cotton	.5	High	**Low**
Orchards and Vineyards	.1	High	**Low**
Vegetables and Ground Fruit	.1	High	**Low**
Wheat	.04	High	**Low**
Other Row Crops	.04	High	**Low**
Nurseries	.03	High	**Low**
Christmas Trees	.004	High	**Low**
Bin 3		High	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**Low**		

Table 535. Prey risk hypothesis; Loggerhead sea turtle, northwest Atlantic Ocean DPS and malathion; Adults and Juveniles; US Territories in Atlantic

Endpoint: Prey (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Crops	Not Available	High	Medium
Developed	Not Available	High	Medium
Mosquito Control	100	High	Medium
Other	Not Available	High	Medium
Risk Hypothesis: Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability			
Risk	**Confidence**		
High	**Low**		

Table 536. Reproduction risk hypothesis; Loggerhead sea turtle, northwest Atlantic Ocean DPS and malathion; Adults; US Lower-48

Endpoint: Reproduction (Lower 48 – Coastal HUC-12s)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	**High**
Developed	7.3	Low	**High**
Pasture	6.0	Low	**High**
Corn	1.1	Low	**Medium**
Other Grains	.9	Low	**Low**
Other Crops	.6	Low	**Low**
Cotton	.5	Low	**Low**
Orchards and Vineyards	.1	Low	**Low**
Vegetables and Ground Fruit	.1	Low	**Low**
Wheat	.04	Low	**Low**
Other Row Crops	.04	Low	**Low**
Nurseries	.03	Low	**Low**
Christmas Trees	.004	Low	**Low**
Bin 3		Low	**High**
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**Low**		

Table 537. Reproduction risk hypothesis; Loggerhead sea turtle, northwest Atlantic Ocean DPS and malathion; Adults; US Territories in Atlantic

Endpoint: Reproduction (HUC03 – Puerto Rico, Virgin Islands)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**

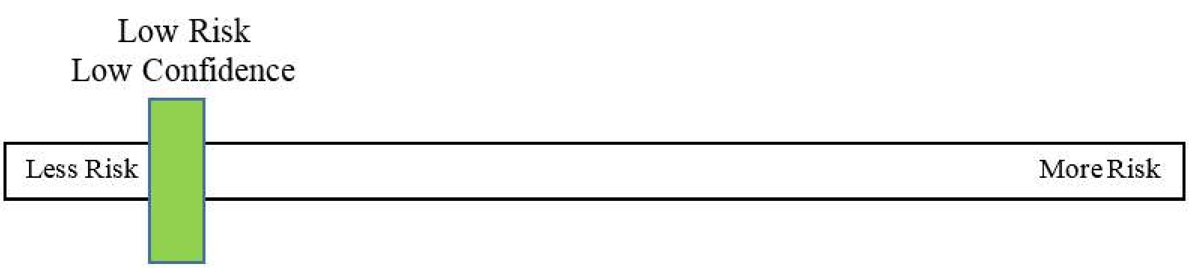
Crops	Not Available	Low	Medium
Developed	Not Available	Low	Medium
Mosquito Control	100	Low	Medium
Other	Not Available	Low	Medium
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction			
Risk	**Confidence**		
Low	**Low**		

Table 538. Effects analysis summary table: Loggerhead sea turtle, northwest Atlantic Ocean DPS and malathion

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
(Lower 48 – Coastal HUC-12s)	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce Juvenile abundance via reduction in prey availability	Low	Low	Not Available	**No**
(HUC03 – US territories in Caribbean/Atlantic)				
Exposure to malathion is sufficient to reduce adult abundance via acute lethality.	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction	Low	Low	Not Available	**No**
Exposure to malathion is sufficient to reduce	Low	Low	Not Available	**No**

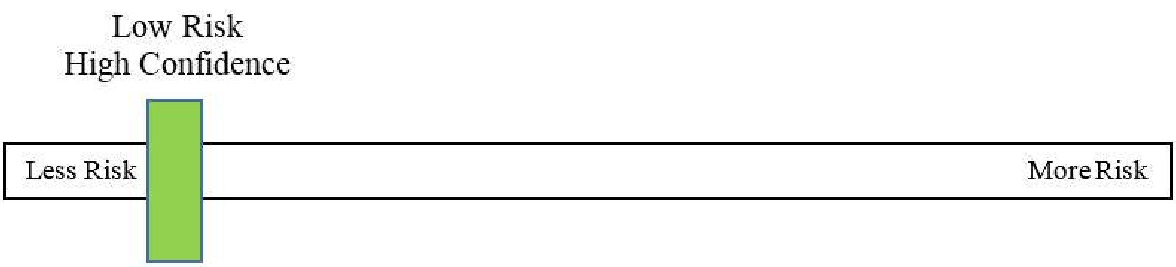
Juvenile abundance via reduction in prey availability				

Effects analysis summary: Adult and juvenile loggerhead sea turtles, northwest Atlantic Ocean DPS are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to malathion in the marine environment. If exposed to formulated products and tank mixtures containing malathion, sea turtles may experience increased toxicity. The overall risk to loggerhead sea turtles from the effects of the action is low and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted malathion concentrations in coastal habitats. Low confidence of risk is also attributed to uncertainty regarding the location of pesticide use sites with the species range.



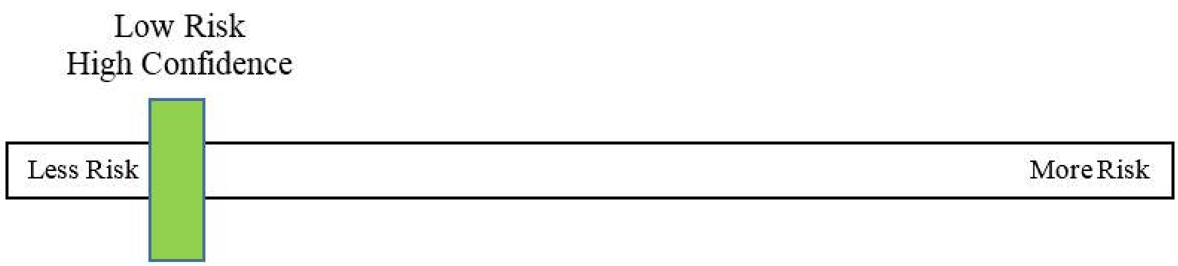
Olive Ridley Sea Turtle, Mexico's Pacific Coast Breeding Colonies (Lepidochelys olivacea)

Effects analysis summary: Adult and juvenile Olive ridley sea turtles within Mexico's Pacific breeding colonies are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to malathion in the marine environment. If exposed to formulated products and tank mixtures containing malathion, sea turtles may experience increased toxicity. The overall risk to Mexico's Pacific coast breeding colonies of Olive ridley sea turtles is low and the confidence associated with that risk is high. Low risk is due primarily to the small portion of the species range within US territories and the species' utilization of off-shore habitats.



14.60 Olive Ridley Sea Turtle, All Other Areas (Lepidochelys olivacea)

Effects analysis summary: Adult and juvenile Olive ridley sea turtles (all areas outside of Mexico's Pacific breeding colonies) are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to malathion in the marine environment. If exposed to formulated products and tank mixtures containing malathion, sea turtles may experience increased toxicity. The overall risk to Olive ridley sea turtles (all areas outside of Mexico's Pacific coast breeding colonies) is low and the confidence associated with that risk is high. Low risk is due primarily to the small portion of the species range within US territories and the species' utilization of off-shore habitats.



14.61 Killer Whale, Southern Resident DPS (Orcinus orca)

Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via reduction in prey availability (primarily salmonids and other fish)

Table 539. Prey Risk Hypothesis; Killer Whale, Southern Resident DPS; Adults and Juveniles

Endpoint: Prey			
Prey Species	**DPS**	**Biological Opinion Conclusion (Jeopardy/No jeopardy)**	
Chum Salmon (Oncorhynchus keta)			
Chum	Hood Canal summer-run	Jeopardy	
Chum	Lower Columbia R.	Jeopardy	
Chinook Salmon (Oncorhynchus tshawytscha)			
Chinook	California coastal	Jeopardy	
Chinook	Central Valley spring-run	Jeopardy	
Chinook	Lower Columbia River	Jeopardy	
Chinook	Puget Sound	Jeopardy	
Chinook	Sacramento R winter-run	Jeopardy	
Chinook	Snake River fall-run	Jeopardy	
Chinook	Snake River spring/summer	Jeopardy	
Chinook	Upper Col. R. spring-run	Jeopardy	
Chinook	Upper Willamette River	Jeopardy	
Population Model: Chinook, ocean-type		***Population Model: Chinook, stream-type***	
Portion of juveniles exposed to malathion EECs; 0.75-100 µg/l	*Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles*	*Portion of juveniles exposed to malathion EECs; 0.75-100 µg/l*	*Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles*
25%	*1-12% (13-23)*	*25%*	*1-11% (5-18)*
50%	*1-23% (13-26)*	*50%*	*1-21% (5-22)*
75%	*2-35% (13-24)*	*75%*	*2-31% (4-21)*
100%	*3-97% (13-0)*	*100%*	*2-97% (4-0)*
Coho Salmon (Oncorhynchus kisutch)			
Coho	Central California coast	Jeopardy	
Coho	Lower Columbia River	Jeopardy	
Coho	Oregon coast	Jeopardy	
Coho	SONC	Jeopardy	
Population Model: Coho Salmon			
Portion of juveniles exposed to malathion EECs; 0.75-100 µg/l		*Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles*	
25%		1-14% (8-23)	
50%		1-27% (8-28)	
75%		2-40% (7-27)	
100%		3-99% (7-0)	
Sockeye Salmon (Oncorhynchus nerka)			
Sockeye	Ozette Lake	Jeopardy	
Sockeye	Snake R	Jeopardy	

Population Model: Sockeye Salmon		
Portion of juveniles exposed to malathion EECs; 0.75-100 µg/l		*Mean percent reduction (STD) in a population's intrinsic growth, lambda, from death of juveniles*
25%		*1-11% (8-19)*
50%		*1-20% (8-22)*
75%		*2-29% (8-20)*
100%		*2-97% (8-0)*
Steelhead	California C. Valley	Jeopardy
Steelhead	CCC	Jeopardy
Steelhead	LC River	Jeopardy
Steelhead	MC River	Jeopardy
Steelhead	Northern California	Jeopardy
Steelhead	Puget Sound	Jeopardy
Steelhead	Snake River Basin	Jeopardy
Steelhead	South-Central California coast	Jeopardy
Steelhead	Southern California	Jeopardy
Steelhead	Upper Columbia River	Jeopardy
Steelhead	Upper Willamette River	Jeopardy
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via reduction in prey availability (primarily salmonids and other fish)		
Risk	**Confidence**	
High	**High**	

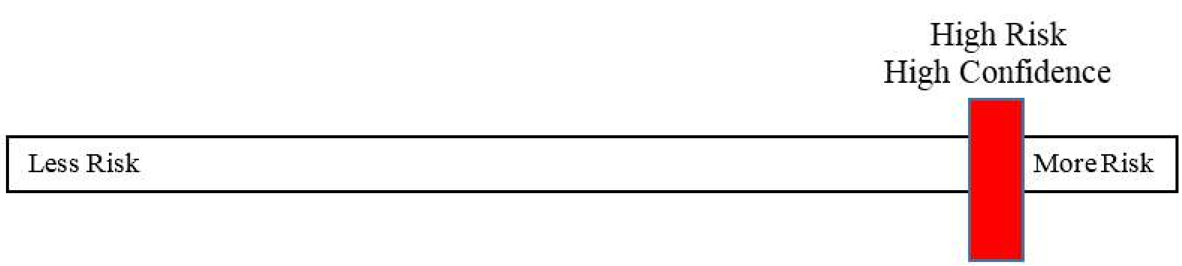
Effects analysis summary: Adult and juvenile Killer whales (southern resident DPS) are anticipated to experience reduced abundance via reductions in prey from exposure to malathion. The primary dietary item of the southern resident killer whale is salmon (predominantly Chinook). Chinook salmon populations have declined due to degradation of habitat, hydrology issues, harvest, and hatchery introgression; such reductions may require an increase in foraging effort. In addition, these prey contain environmental pollutants. These contaminants become concentrated at higher trophic levels and may lead to immune suppression or reproductive impairment. The overall risk to Killer whale, southern resident DPS from the effects of the action is high and the confidence associated with that risk is high.

National Marine Fisheries Service (NMFS) qualitatively evaluated long-term effects on the Southern Residents from the anticipated appreciable reduction in the likelihood of survival and recovery of all 28 Pacific salmon Evolutionarily Significant Units (ESUs)/ Distinct Population Segment (DPSs), and in particular, the nine Chinook salmon ESUs. We assessed the likelihood for localized depletions, and long-term implications for Southern Residents' survival and recovery, resulting from the increased risk of extinction of all listed Chinook salmon ESUs. In this way, NMFS can determine whether the increased likelihood of extinction of prey species is also likely to appreciably reduce the likelihood of survival and recovery of Southern Residents.

A reduction in prey would occur over time as abundance declined for the nine ESUs of Chinook salmon, along with the decline of lesser preferred prey ESUs/DPSs of other listed salmon. The continued depletion of these ESUs would also preclude the potential for their future recovery to healthy, more substantial numbers. Fewer populations contributing to Southern Residents' prey base will reduce the representation of diversity in life histories, resiliency in withstanding stochastic events, and redundancy to ensure there is a margin of safety for the salmon and Southern Residents to withstand catastrophic events.

The long-term reduction of the nine ESUs of Chinook salmon and other listed salmon and steelhead can lead to nutritional stress in the whales. Nutritional stress can lead to reduced body size and condition of individuals and can also lower reproductive and survival rates. Prey sharing would distribute more evenly the effects of prey limitation across individuals of the population that would otherwise be the case. Therefore, poor nutrition from the reduction of prey could contribute to additional mortality in this population. Food scarcity could also cause whales to draw on fat stores, mobilizing contaminants stored in their fat and affecting reproduction and immune function.

Differences in adult salmon life histories and locations of their natal streams likely affect the distribution of salmon across the Southern Residents' coastal range. The continued decline and potential extinction of the nine ESUs of Chinook salmon and other listed salmonids, and consequent interruption in the geographic continuity of salmon-bearing watersheds in the Southern Residents' coastal range, is likely to alter the distribution of migrating salmon and increase the likelihood of localized depletions in prey. This would have adverse effects on the Southern Residents' ability to meet their energy needs. A fundamental change in the prey base originating from the whales' geographic range is likely to result in Southern Residents abandoning areas in search of more abundant prey or expending substantial effort to find depleted prey resources. This potential increase in energy demands should have the same effect on an animal's energy budget as reductions in available energy, such as one would expect from reductions in prey.



14.62 Steller Sea Lion, Western DPS (Eumetopias jubatus)

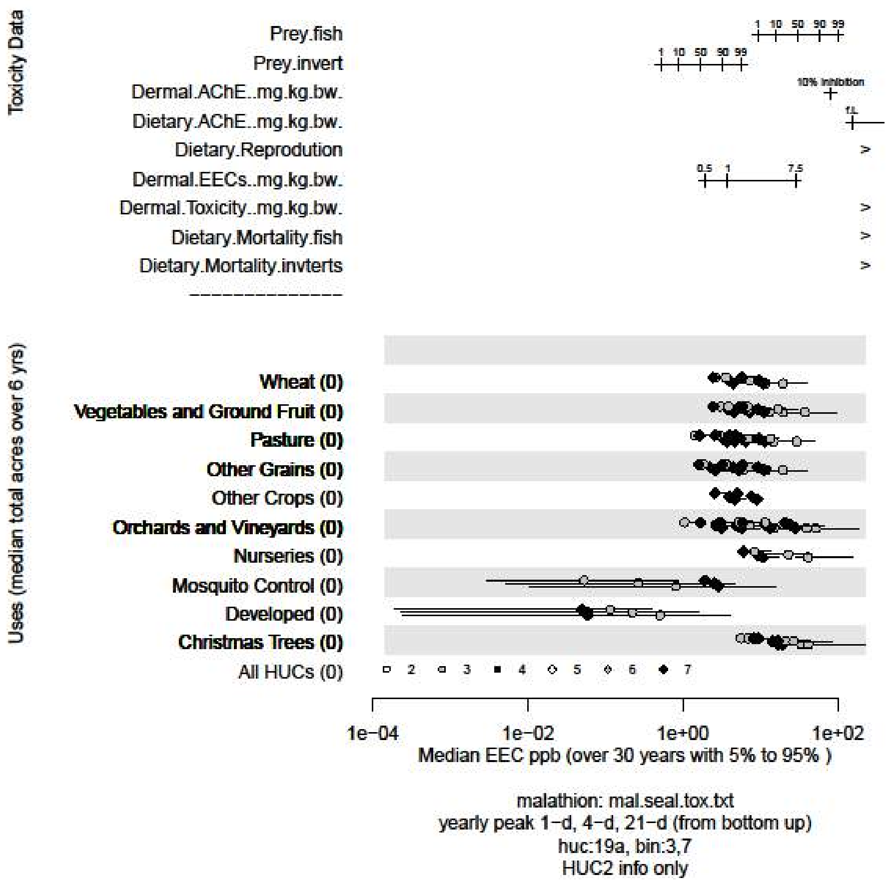


Figure 57. Effects analysis R-plot for Steller sea lion (western DPS) and malathion

Table 540. Likelihood of exposure determination for Steller sea lion (western DPS) and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Wheat	NA	yes	no	yes	NA	3	**Low**
Vegetables and Ground Fruit	NA	yes	no	yes	NA	3	**Low**
Pasture	NA	yes	no	yes	NA	3	**Low**
Other Grains	NA	yes	no	yes	NA	3	**Low**
Other Crops	NA	yes	no	yes	NA	3	**Low**
Vineyards	NA	yes	no	yes	NA	3	**Low**
Nursery	NA	yes	no	yes	NA	3	**Low**
Mosquito Control	NA	yes	no	yes	NA	3	**High**
Developed	NA	yes	no	yes	NA	3	**Low**
Christmas Tree	NA	yes	no	yes	NA	3	**Low**

Life Stage: Juvenile and Adult (full-range)

Table 541. Direct mortality (dietary: fish) risk hypothesis; Steller sea lion (western DPS) and malathion; Adults and Juveniles

Endpoint: Mortality (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wheat	Unknown	Low	Low
Vegetables and Ground Fruit	Unknown	Low	Low
Pasture	Unknown	Low	Low
Other Grains	Unknown	Low	Low
Other Crops	Unknown	Low	Low
Vineyards	Unknown	Low	Low
Nursery	Unknown	Low	Low
Mosquito Control	100	Low	High
Developed	Unknown	Low	Low
Christmas Tree	Unknown	Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via dietary aquatic exposure (fish)			
Risk	**Confidence**		
Low	**Medium**		

Table 542. Direct mortality (dermal) risk hypothesis; Steller sea lion (western DPS) and malathion; Adults and Juveniles

Endpoint: Mortality (dermal)			
Application Rate	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
0.5 – 7.5 lbs a.i./kg-bw	Unknown	Low	Medium

Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via dermal exposure		
Risk	**Confidence**	
Low	**Medium**	

Table 543. Prey (inverts) risk hypothesis; Steller sea lion (western DPS) and malathion; Adults and Juveniles

Endpoint: Prey (inverts)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wheat	Unknown	High	Low
Vegetables and Ground Fruit	Unknown	High	Low
Pasture	Unknown	High	Low
Other Grains	Unknown	High	Low
Other Crops	Unknown	High	Low
Vineyards	Unknown	High	Low
Nursery	Unknown	High	Low
Mosquito Control	100	High	High
Developed	Unknown	High	Low
Christmas Tree	Unknown	High	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via reduction in prey availability (aquatic inverts)			
Risk	**Confidence**		
High	**Low**		

Table 544. Prey (fish) risk hypothesis; Steller sea lion (western DPS) and malathion; Adults and Juveniles

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wheat	Unknown	High	Low
Vegetables and Ground Fruit	Unknown	High	Low
Pasture	Unknown	High	Low
Other Grains	Unknown	High	Low
Other Crops	Unknown	Medium	Low
Vineyards	Unknown	High	Low
Nursery	Unknown	High	Low
Mosquito Control	100	Medium	High
Developed	Unknown	Low	Low
Christmas Tree	Unknown	High	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via reduction in prey availability (fish)			
Risk	**Confidence**		
High	**Low**		

Table 545. AChE (dietary) risk hypothesis; Steller sea lion (western DPS) and malathion; Adults and Juveniles

Endpoint: AChE (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wheat	Unknown	Low	Low
Vegetables and Ground Fruit	Unknown	Medium	Low
Pasture	Unknown	Low	Low
Other Grains	Unknown	Low	Low
Other Crops	Unknown	Low	Low
Vineyards	Unknown	High	Low
Nursery	Unknown	High	Low
Mosquito Control	100	Low	High
Developed	Unknown	Low	Low
Christmas Tree	Unknown	Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity via dietary exposure (inverts and fish); the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**Medium**		

Table 546. AChE (dermal) risk hypothesis; Steller sea lion (western DPS) and malathion; Adults and Juveniles

Endpoint: AChE (dermal)			
Application Rate	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
0.5 -7.5 lbs a.i. /acre	Unknown	Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity via dermal exposure; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**Medium**		

Table 547. Reproduction (dietary) risk hypothesis; Steller sea lion (western DPS) and malathion; Adults

Endpoint: Reproduction (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	Unknown	Low	Low
Pasture	Unknown	Low	Low
Other Row Crops	Unknown	Low	Low
Other Crops	Unknown	Low	Low
Orchards and Vineyards	Unknown	Low	Low
Nurseries	Unknown	Low	Low
Mosquito Control	Unknown	Low	Low
Developed	100	Low	High

Corn	Unknown	Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction via dietary exposure (fish)			
Risk	**Confidence**		
Low	**Medium**		

Table 548. Effects analysis summary table: Steller sea lion (western DPS) and malathion

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults and Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce abundance via dietary aquatic exposure (fish)	**Low**	**Medium**	Not Available	**No**
Exposure to malathion is sufficient to reduce abundance via dermal exposure	**Low**	**Medium**	Not Available	**No**
Exposure to malathion is sufficient to reduce abundance via reduction in prey availability (aquatic inverts)	High	Low	Not Available	**Yes**
Exposure to malathion is sufficient to reduce abundance via reduction in prey availability (fish)	High	Low	Not Available	**Yes**
Exposure to malathion is sufficient to reduce ChE activity via dietary exposure (inverts and fish); the identified mechanism of toxicity	Low	Medium	Not Available	**No**
Exposure to malathion is sufficient to reduce ChE activity via dermal exposure; the identified mechanism of toxicity	Low	Medium	Not Available	**No**
Exposure to malathion is sufficient to reduce adult productivity via	Low	Medium	Not Available	**No**

impairments to reproduction via dietary exposure (fish)				

Effects analysis summary: Adult and juvenile Steller sea lion (western DPS) are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to malathion in the marine environment. If exposed to formulated products and tank mixtures containing malathion, sea lions may experience increased toxicity. The overall risk to Steller sea lion (western DPS) from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted malathion concentrations in coastal habitats.

14.63 Guadalupe Fur Seal (Arctocephalus townsendi)

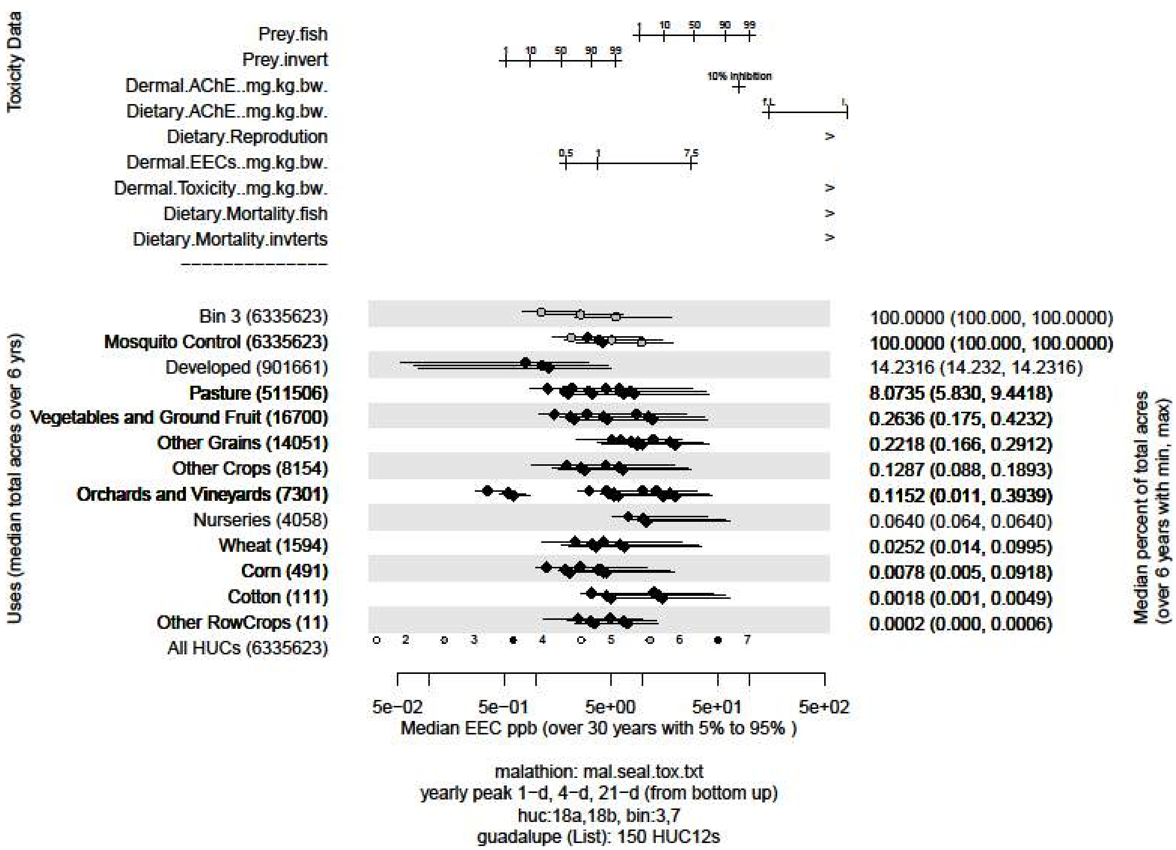


Figure 58. Effects analysis R-plot for Guadalupe fur seal and malathion

Table 549. Likelihood of exposure determination for Guadalupe fur seal and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Portion of Species Range within US Territories	Likelihood of Exposure
Mosquito Control	3	yes	no	yes	NA	unknown	small	Low
Developed	3	yes	no	yes	NA	unknown	small	Low
Pasture	3	yes	no	yes	NA	unknown	small	Low
Vegetables and Ground Fruit	1	yes	no	yes	NA	unknown	small	Low
Other Grains	1	yes	no	yes	NA	unknown	small	Low
Other Crops	1	yes	no	yes	NA	unknown	small	Low
Orchards and Vineyards	1	yes	no	yes	no	unknown	small	Low
Nurseries	1	yes	no	yes	no	unknown	small	Low
Wheat	1	yes	no	yes	no	unknown	small	Low
Corn	1	yes	no	yes	no	unknown	small	Low
Cotton	1	yes	no	yes	no	unknown	small	Low
Bin 3	1	yes	no	yes	no	unknown	small	Low

Life Stage: Juvenile and Adult (full-range)

Table 550. Direct mortality (dietary – inverts) risk hypothesis; Guadalupe fur seal and malathion; Adults and Juveniles

Endpoint: Mortality (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	Low
Developed	14.2	Low	Low
Pasture	8.1	Low	Low
Vegetables and Ground Fruit	.1	Low	Low
Other Grains	.3	Low	Low
Other Crops	.2	Low	Low
Orchards and Vineyards	.1	Low	Low
Nurseries	.06	Low	Low
Wheat	.03	Low	Low
Corn	.008	Low	Low
Cotton	.002	Low	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via dietary aquatic exposure (inverts)			
Risk	**Confidence**		
Low	**Medium**		

Table 551. Direct mortality (dietary – fish) risk hypothesis; Guadalupe fur seal and malathion; Adults and Juveniles

Endpoint: Mortality (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	Low
Developed	14.2	Low	Low
Pasture	8.1	Low	Low
Vegetables and Ground Fruit	.1	Low	Low
Other Grains	.3	Low	Low
Other Crops	.2	Low	Low
Orchards and Vineyards	.1	Low	Low
Nurseries	.06	Low	Low
Wheat	.03	Low	Low
Corn	.008	Low	Low
Cotton	.002	Low	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via dietary aquatic exposure (fish)			
Risk	**Confidence**		
Low	**Medium**		

Table 552. Direct mortality (dermal) risk hypothesis; Guadalupe fur seal and malathion; Adults and Juveniles

Endpoint: Mortality (dermal)			
Application Rate	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
0.01 – 6.0 lbs a.i./acre	Not Applicable	Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via dermal exposure			
Risk	**Confidence**		
Low	**Medium**		

Table 553. Prey (inverts) risk hypothesis; Guadalupe fur seal and malathion; Adults and Juveniles

Endpoint: Prey (inverts)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	High	Low
Developed	14.2	High	Low
Pasture	8.1	High	Low
Vegetables and Ground Fruit	.1	High	Low
Other Grains	.3	High	Low
Other Crops	.2	High	Low
Orchards and Vineyards	.1	High	Low

Nurseries	.06	High	Low
Wheat	.03	High	Low
Corn	.008	High	Low
Cotton	.002	High	Low
Bin 3		High	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via reduction in prey availability (aquatic inverts)			
Risk	**Confidence**		
Low	**Medium**		

Table 554. Prey (fish) risk hypothesis; Guadalupe fur seal and malathion; Adults and Juveniles

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Medium	Low
Developed	14.2	Low	Low
Pasture	8.1	High	Low
Vegetables and Ground Fruit	.1	High	Low
Other Grains	.3	High	Low
Other Crops	.2	Medium	Low
Orchards and Vineyards	.1	High	Low
Nurseries	.06	High	Low
Wheat	.03	High	Low
Corn	.008	Medium	Low
Cotton	.002	High	Low
Bin 3		Medium	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via reduction in prey availability (fish)			
Risk	**Confidence**		
Low	**Medium**		

Table 555. AChE (dietary) risk hypothesis; Guadalupe fur seal and malathion; Adults and Juveniles

Endpoint: AChE (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	Low
Developed	14.2	Low	Low
Pasture	8.1	Low	Low
Vegetables and Ground Fruit	.1	Low	Low
Other Grains	.3	Low	Low
Other Crops	.2	Low	Low
Orchards and Vineyards	.1	Low	Low
Nurseries	.06	Low	Low
Wheat	.03	Low	Low

Corn	.008	Low	Low
Cotton	.002	Low	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity via dietary exposure (inverts and fish); the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**Medium**		

Table 556. AChE (dermal) risk hypothesis; Guadalupe fur seal and malathion; Adults and Juveniles

Endpoint: AChE (dermal)			
Application Rate	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
< 1 lbs a.i. /acre	Not Applicable	Low	Low
> 1.0 lbs a.i. /acre	Not Applicable	Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity via dermal exposure; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**Medium**		

Table 557. Reproduction (dietary) risk hypothesis; Guadalupe fur seal and malathion; Adults

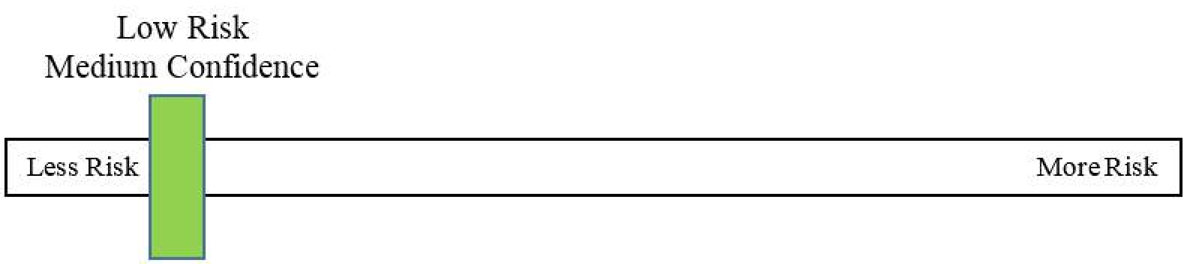
Endpoint: Reproduction (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	Low
Developed	14.2	Low	Low
Pasture	8.1	Low	Low
Vegetables and Ground Fruit	.1	Low	Low
Other Grains	.3	Low	Low
Other Crops	.2	Low	Low
Orchards and Vineyards	.1	Low	Low
Nurseries	.06	Low	Low
Wheat	.03	Low	Low
Corn	.008	Low	Low
Cotton	.002	Low	Low
Bin 3		Low	Low
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction via dietary exposure (fish)			
Risk	**Confidence**		
Low	**Medium**		

Table 558. Effects analysis summary table: Guadalupe fur seal and malathion

	R-plot Derived	**MagTool**	

Adults and Juveniles	Risk	Confidence	Range in median percent mortalities for aquatic bins	Risk Hypothesis Supported? Yes/No
Risk Hypothesis				
Exposure to malathion is sufficient to reduce abundance via dietary aquatic exposure (inverts)	**Low**	**Medium**	Not Available	**No**
Exposure to malathion is sufficient to reduce abundance via dietary aquatic exposure (fish)	**Low**	**Medium**	Not Available	**No**
Exposure to malathion is sufficient to reduce abundance via dermal exposure	**Low**	**Medium**	Not Available	**No**
Exposure to malathion is sufficient to reduce abundance via reduction in prey availability (aquatic inverts)	**Low**	**Medium**	Not Available	**No**
Exposure to malathion is sufficient to reduce abundance via reduction in prey availability (fish)	**Low**	**Medium**	Not Available	**No**
Exposure to malathion is sufficient to reduce ChE activity via dietary exposure (inverts and fish); the identified mechanism of toxicity	**Low**	**Medium**	Not Available	**No**
Exposure to malathion is sufficient to reduce ChE activity via dermal exposure; the identified mechanism of toxicity	**Low**	**Medium**	Not Available	**No**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction via dietary exposure (fish)	**Low**	**Medium**	Not Available	**No**

Effects analysis summary: Adult and juvenile Guadalupe fur seals are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to malathion in the marine environment. If exposed to formulated products and tank mixtures containing malathion, fur seals may experience increased toxicity. The overall risk to Guadalupe fur seals from the effects of the action is low and the confidence associated with that risk is medium. The Low risk is due primarily to the small portion of the species' range within US territories. The lack in confidence is due primarily to the uncertainty in predicted malathion concentrations in coastal habitats.



14.64 Hawaiian Monk Seal (Monachus schauinslandi)

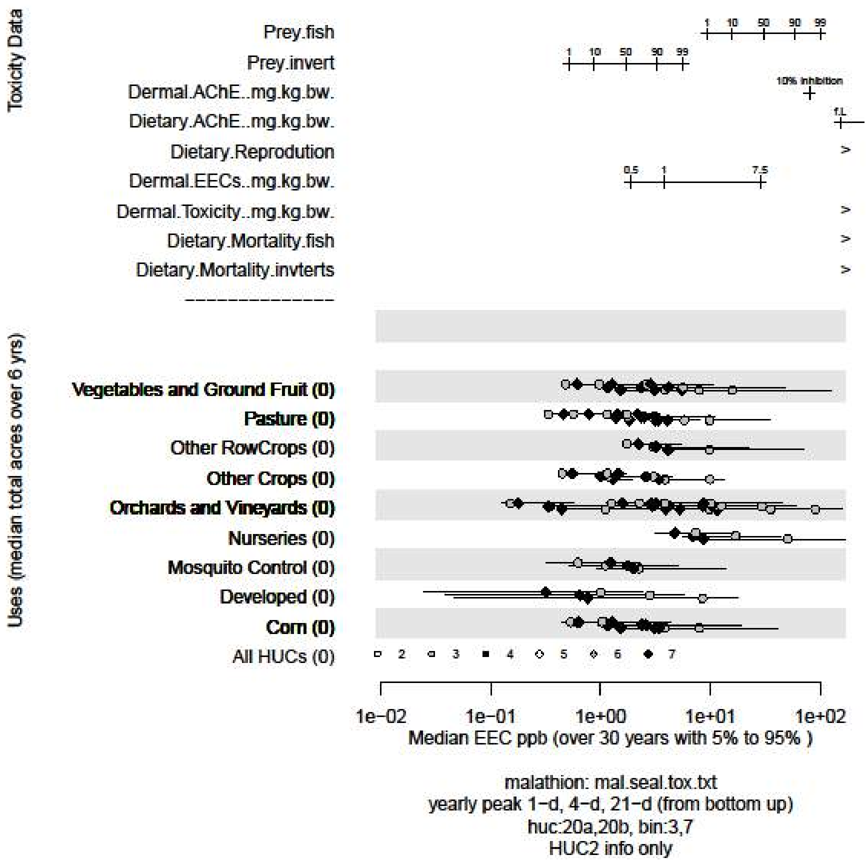


Figure 59. Effects analysis R-plot for Hawaiian monk seal and malathion

Table 559. Likelihood of exposure determination for Hawaiian monk seal and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Vegetables and Ground Fruit	NA	yes	no	yes	NA	3	**Med**
Pasture	NA	yes	no	yes	NA	3	**Med**
Other Row Crops	NA	yes	no	yes	NA	3	**Med**
Other Crops	NA	yes	no	yes	NA	3	**Med**
Orchards and Vineyards	NA	yes	no	yes	NA	3	**Med**
Nurseries	NA	yes	no	yes	NA	3	**Med**
Mosquito Control	NA	yes	no	yes	NA	3	**Med**
Developed	NA	yes	no	yes	NA	3	**Med**
Corn	NA	yes	no	yes	NA	3	**Med**

Life Stage: Juvenile and Adult (full-range)

Table 560. Direct mortality (dietary – fish) risk hypothesis; Hawaiian monk seal and malathion; Adults and Juveniles

Endpoint: Mortality (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	Unknown	Low	Medium
Pasture	Unknown	Low	Medium
Other Row Crops	Unknown	Low	Medium
Other Crops	Unknown	Low	Medium
Orchards and Vineyards	Unknown	Low	Medium
Nurseries	Unknown	Low	Medium
Mosquito Control	100	Low	Medium
Developed	Unknown	Low	Medium
Corn	Unknown	Low	Medium
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via dietary aquatic exposure (fish)			
Risk	**Confidence**		
Low	**Medium**		

Table 561. Direct mortality (dermal) risk hypothesis; Hawaiian monk seal and malathion; Adults and Juveniles

Endpoint: Mortality (dermal)			
Application Rate	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
0.5 – 7.5 lbs a.i./kg-bw	Unknown	Low	Medium

Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via dermal exposure		
Risk	Confidence	
Low	Medium	

Table 562. Prey (inverts) risk hypothesis; Hawaiian monk seal and malathion; Adults and Juveniles

Endpoint: Prey (inverts)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	Unknown	High	Medium
Pasture	Unknown	High	Medium
Other Row Crops	Unknown	High	Medium
Other Crops	Unknown	High	Medium
Orchards and Vineyards	Unknown	High	Medium
Nurseries	Unknown	High	Medium
Mosquito Control	100	High	Medium
Developed	Unknown	High	Medium
Corn	Unknown	High	Medium
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via reduction in prey availability (aquatic inverts)			
Risk	**Confidence**		
High	**Low**		

Table 563. Prey (fish) risk hypothesis; Hawaiian monk seal and malathion; Adults and Juveniles

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	Unknown	High	Medium
Pasture	Unknown	High	Medium
Other Row Crops	Unknown	High	Medium
Other Crops	Unknown	Medium	Medium
Orchards and Vineyards	Unknown	High	Medium
Nurseries	Unknown	High	Medium
Mosquito Control	100	Medium	Medium
Developed	Unknown	Medium	Medium
Corn	Unknown	High	Medium
Risk Hypothesis: Exposure to malathion is sufficient to reduce abundance via reduction in prey availability (fish)			
Risk	**Confidence**		
High	**Low**		

Table 564. AChE (dietary) risk hypothesis; Hawaiian monk seal and malathion; Adults and Juveniles

Endpoint: AChE (dietary)

Use Category	% Overlap	Effect of Exposure	Likelihood of Exposure
Vegetables and Ground Fruit	Unknown	Low	Medium
Pasture	Unknown	Low	Medium
Other Row Crops	Unknown	Low	Medium
Other Crops	Unknown	Low	Medium
Orchards and Vineyards	Unknown	Low	Medium
Nurseries	Unknown	Low	Medium
Mosquito Control	100	Low	Medium
Developed	Unknown	Low	Medium
Corn	Unknown	Low	Medium
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity via dietary exposure (inverts and fish); the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**Medium**		

Table 565. AChE (dermal) risk hypothesis; Hawaiian monk seal and malathion; Adults and Juveniles

Endpoint: AChE (dermal)			
Application Rate	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
0.5 -7.5 lbs a.i. /acre	Unknown	Low	Medium
Risk Hypothesis: Exposure to malathion is sufficient to reduce ChE activity via dermal exposure; the identified mechanism of toxicity			
Risk	**Confidence**		
Low	**Medium**		

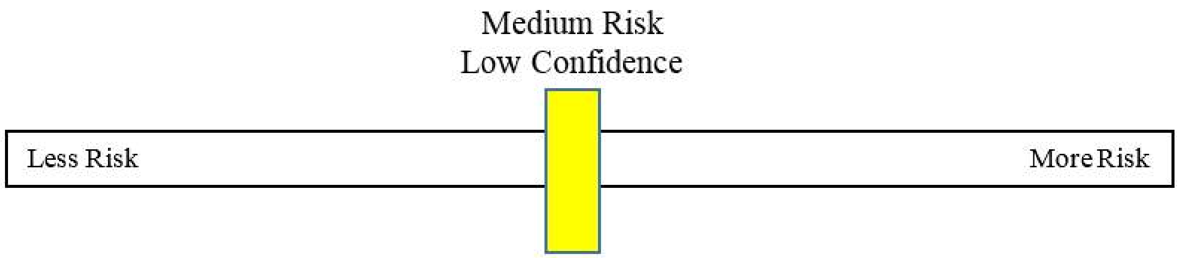
Table 566. Reproduction (dietary) risk hypothesis; Hawaiian monk seal and malathion; Adults

Endpoint: Reproduction (dietary)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	Unknown	Low	Medium
Pasture	Unknown	Low	Medium
Other Row Crops	Unknown	Low	Medium
Other Crops	Unknown	Low	Medium
Orchards and Vineyards	Unknown	Low	Medium
Nurseries	Unknown	Low	Medium
Mosquito Control	100	Low	Medium
Developed	Unknown	Low	Medium
Corn	Unknown	Low	Medium
Risk Hypothesis: Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction via dietary exposure (fish)			
Risk	**Confidence**		
Low	**Medium**		

Table 567. Effects analysis summary table: Hawaiian monk seal and malathion

	R-plot Derived		MagTool	Risk Hypothesis Supported? Yes/No
Adults and Juveniles	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to malathion is sufficient to reduce abundance via dietary aquatic exposure (fish)	Low	Medium	Not Available	**No**
Exposure to malathion is sufficient to reduce abundance via dermal exposure	Low	Medium	Not Available	**No**
Exposure to malathion is sufficient to reduce abundance via reduction in prey availability (aquatic inverts)	High	Low	Not Available	**Yes**
Exposure to malathion is sufficient to reduce abundance via reduction in prey availability (fish)	High	Low	Not Available	**Yes**
Exposure to malathion is sufficient to reduce ChE activity via dietary exposure (inverts and fish); the identified mechanism of toxicity	Low	Medium	Not Available	**No**
Exposure to malathion is sufficient to reduce ChE activity via dermal exposure; the identified mechanism of toxicity	Low	Medium	Not Available	**No**
Exposure to malathion is sufficient to reduce adult productivity via impairments to reproduction via dietary exposure (fish)	Low	Medium	Not Available	**No**

Effects analysis summary: Adult and juvenile Hawaiian monk seals are not anticipated to experience significant reductions in abundance or productivity (adults) from exposure to malathion in the marine environment. If exposed to formulated products and tank mixtures containing malathion, fur seals may experience increased toxicity. The overall risk to Hawaiian monk seals from the effects of the action is medium and the confidence associated with that risk is low. The lack in confidence is due primarily to the uncertainty in predicted malathion concentrations in coastal habitats.



14.65 Johnson's Seagrass (Halophila johnsonii)

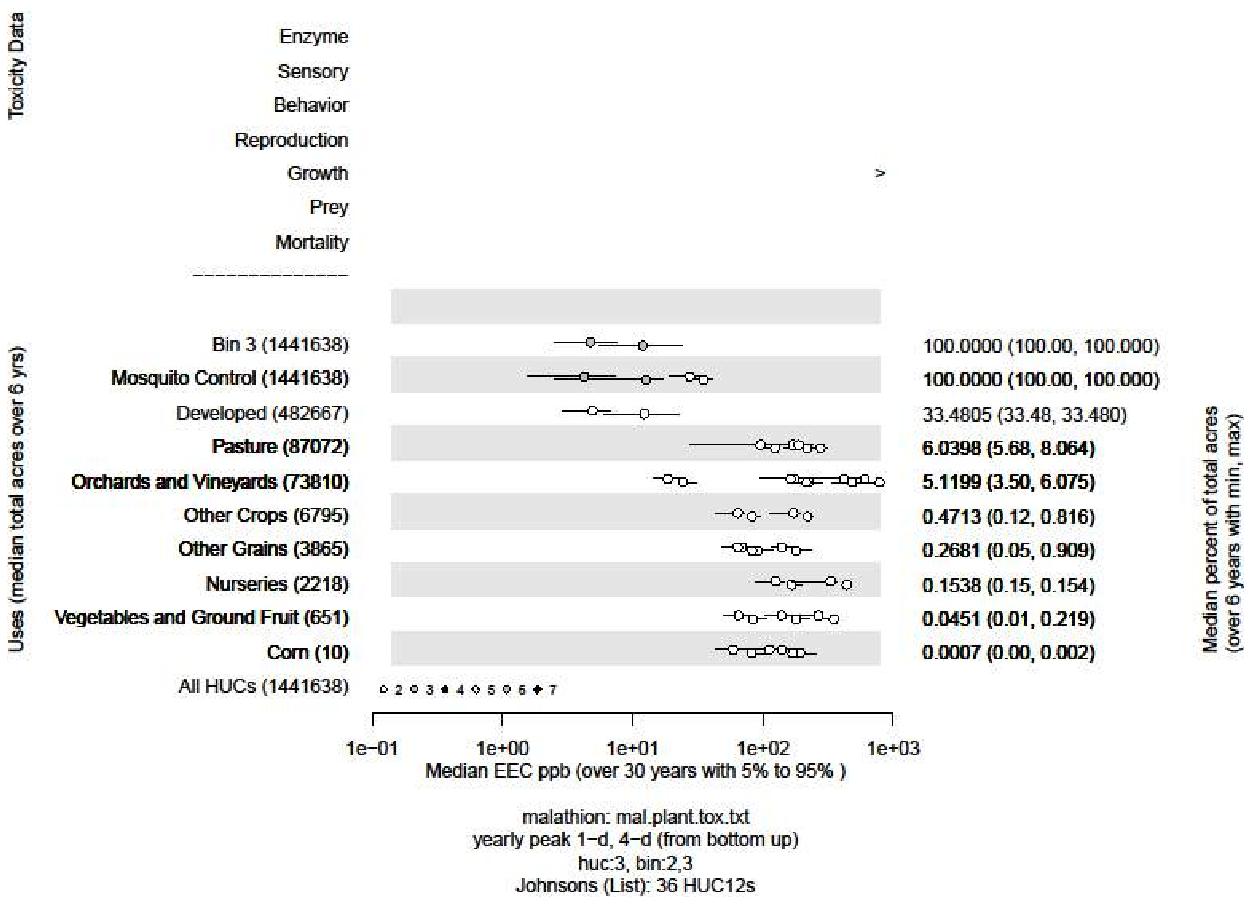


Figure 60. Effects analysis R-plot for Johnson's seagrass and malathion

	Percent Overlap Category	Seasonal Analysis	Persistence	Multiple Applications	Proximity to sensitive area	Duration of migration/residency	Likelihood of Exposure
Mosquito Control	3	yes	yes	yes	NA	3	**High**
Developed	3	yes	yes	yes	NA	3	**High**
Pasture	3	yes	yes	yes	NA	3	**High**
Orchards and Vineyards	3	yes	yes	yes	NA	3	**High**
Other Crops	1	yes	yes	yes	no	3	**Low**
Other Grains	1	yes	yes	yes	no	3	**Low**
Nurseries	1	yes	yes	yes	no	3	**Low**
Vegetables and Ground Fruit	1	yes	yes	yes	no	3	**Low**
Bin 3	3	yes	yes	yes	NA	3	**High**
Bin 4	3	yes	yes	yes	NA	3	**High**

Figure 61. Likelihood of exposure determination for Johnson's seagrass and malathion

Table 568. Direct mortality risk hypothesis; Johnson's seagrass and malathion

Endpoint: Mortality			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	NA	High
Developed	33	NA	High
Pasture	6	NA	High
Orchards and Vineyards	5	NA	High
Other Crops	<1	NA	Low
Other Grains	<1	NA	Low
Nurseries	<1	NA	Low
Vegetables and Ground Fruit	<1	NA	Low
Bin 3		NA	High
Bin 4		NA	High
Risk Hypothesis: Exposure to the pesticide is sufficient to reduce abundance via direct mortality.			
Risk	**Confidence**		

NA	**NA**	

Table 569. Growth risk hypothesis; Johnson's seagrass and malathion

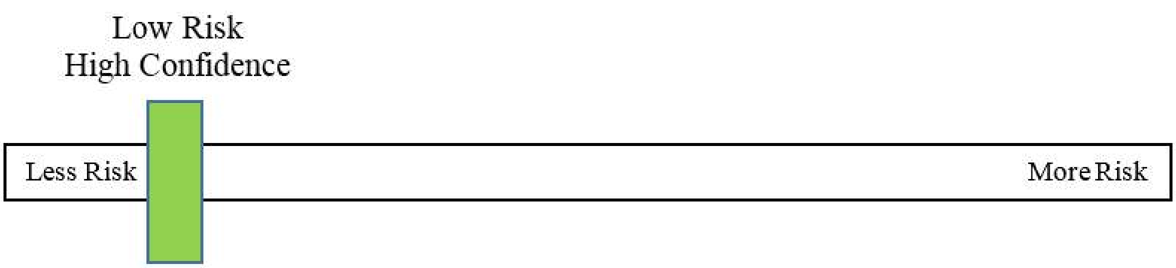
Endpoint: Growth			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100	Low	High
Developed	33	Low	High
Pasture	6	Low	High
Orchards and Vineyards	5	Low	High
Other Crops	<1	Low	Low
Other Grains	<1	Low	Low
Nurseries	<1	Low	Low
Vegetables and Ground Fruit	<1	Low	Low
Bin 3		Low	High
Bin 4		Low	High
Risk Hypothesis: Exposure to the pesticides is sufficient to reduce abundance via impacts to growth.			
Risk	**Confidence**		
Low	**High**		

Table 570. Effects analysis summary table: Johnson's seagrass and malathion

	R-plot Derived		**MagTool**	**Risk Hypothesis Supported? Yes/No**
Adults (Lower 48 – Coastal HUC-12s)	**Risk**	**Confidence**	**Range in median percent mortalities for aquatic bins**	
Risk Hypothesis				
Exposure to the pesticide is sufficient to reduce	NA	NA	Not Available	No

abundance via direct mortality.				
Exposure to the pesticides is sufficient to reduce abundance via impacts to growth.	Low	High	Not Available	No

Effects analysis summary: Johnson's seagrass is not anticipated to experience significant reductions in abundance or productivity from exposure to malathion in the marine environment. The overall risk to Johnson's seagrass from the effects of the action is low and the confidence associated with that risk is high.



CHAPTER 15

DESIGNATED CRITICAL HABITAT EFFECTS ANALYSIS

CHLORPYRIFOS

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15.1 Introduction

The National Marine Fisheries Service's (NMFS') critical habitat analysis determines whether the proposed action is likely to destroy or adversely modify critical habitat for ESA-listed species by examining potential reductions in the conservation value of the essential features of designated critical habitat. "Destruction or adverse modification" means a direct or indirect alteration that appreciably diminishes the value of designated critical habitat for the conservation of an ESA-listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features (PBFs) essential to the conservation of a species or that preclude or significantly delay development of such features (50 C.F.R. §402.02).

In this section, NMFS evaluates the potential consequences to designated critical habitat from exposure to the stressors of the proposed action. A diagram of our analysis framework is shown in ***Figure 1***. It is similar in structure to the jeopardy analysis, but focuses on whether the proposed action is likely to destroy or adversely modify designated critical habitat for listed species. NMFS reviews the status of designated and proposed critical habitat affected by the proposed action separate from species effects by examining the condition and trends of the designated essential physical or biological features (PBFs) of critical habitat throughout the action area. We first determine whether critical habitat is likely to be exposed to the stressors of the proposed action (exposure profile). To conduct this analysis, we relied on R-plots showing expected pesticide concentrations in the species' designated critical habitat. If we find that critical habitat is likely to be exposed, we determined the relevant PBFs for each species' designated critical habitat that would be at risk from this proposed action and assess the consequences of that exposure on the quality, quantity, or availability of those PBFs (response profile) (Appendix C). We relied heavily on Crop Land Data Layers of crop uses provided by Environmental Protection Agency (EPA) and conducted an overlap of critical habitat analysis to determine exposure potential to designated critical habitat.

In all of the critical habitat designations that are exposed to the stressors of this action, water quality and forage (prey availability) are key attributes that are either designated as PBFs of the critical habitat, or are relevant to the PBFs. Water quality encompasses a range of typically measured parameters, including dissolved oxygen, temperature, turbidity, and presence of contaminants. Here, we use the presence of chemical contaminants as an indicator of degraded water quality. The proposed action would degrade water quality by introducing chlorpyrifos, diazinon, malathion, and other associated chemicals into designated critical habitats. Therefore, we use the pesticide concentrations likely to adversely affect listed species or prey (e.g. invertebrates and juvenile fish) as measures of degraded water quality. We also note that the PBF's for most of the critical habitats at issue include availability and quality of prey. The three a.i.s are expected to affect prey at concentrations within the range predicted to occur in most freshwater and estuarine habitats by exposure models. This analysis is conducted by comparing toxicity information (e.g., aquatic invertebrate LC_{50} values) provided in EPA's "Effects Characterization" in their BE, with expected pesticide concentrations derived from R-plots using data from EPA's MagTool.

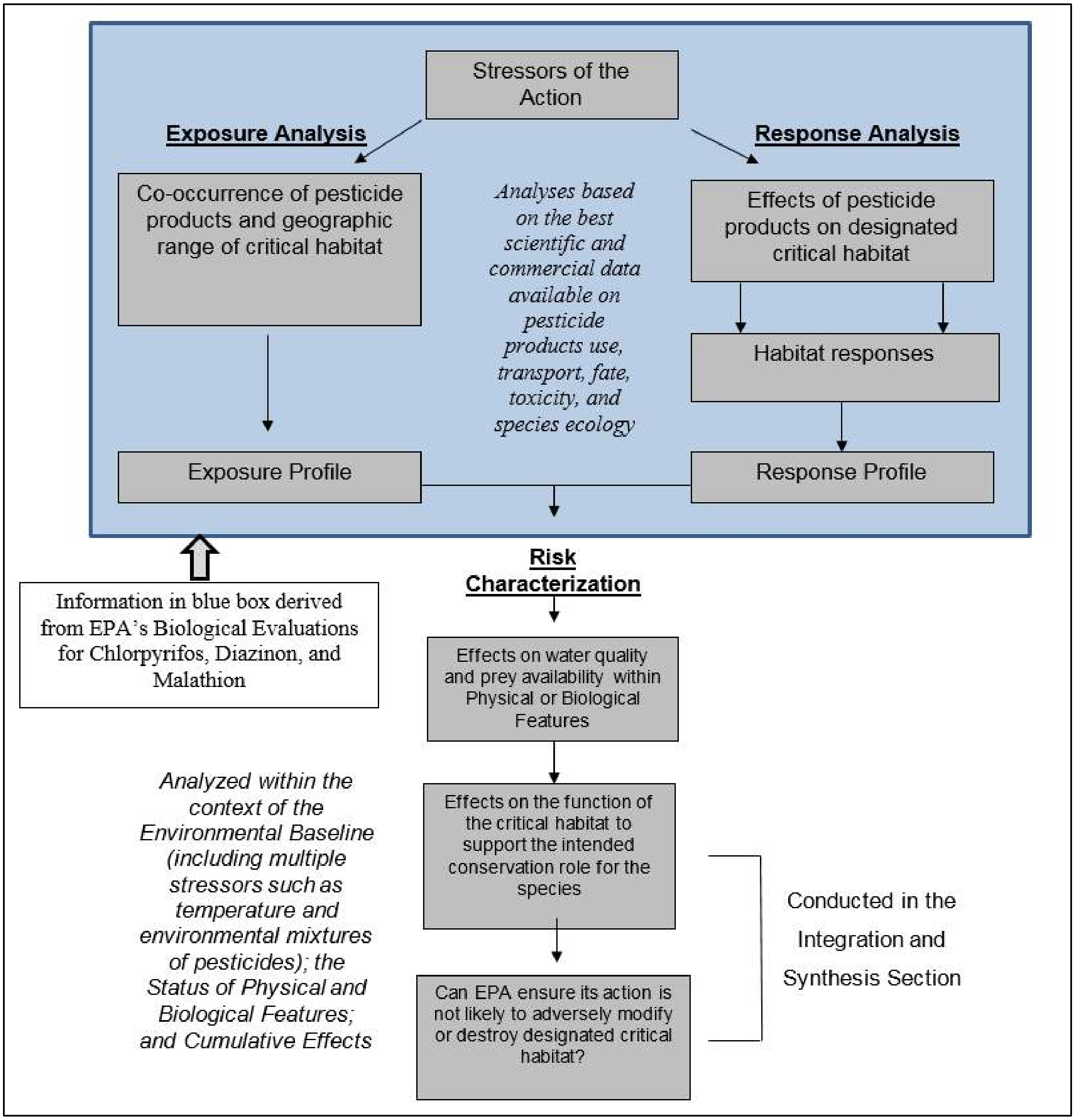


Figure 1. Assessment Framework for Designated Critical Habitat

We translated each PBF into a risk hypothesis to assess potential impacts on designated critical habitat. The analysis of risk hypotheses is based on: 1) the likely concentrations of the three pesticides that would be observed in critical habitat; and 2) the response of PBFs to those anticipated concentrations.

The action area for this Opinion encompasses all designated critical habitat for listed species within the continental U.S., Hawaii, Alaska, and U.S. Protectorates. These species include Pacific salmonids in Washington, Oregon, California and Idaho. As the species of salmonids addressed in this Opinion have similar life history characteristics, they share many of the same

PBFs. These PBFs include sites that support one or more life stages and contain physical or biological features essential to the conservation of the evolutionarily significant unit (ESU) or distinct population segment (DPS). PBFs include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, estuarine areas, nearshore marine areas, and offshore marine areas. Other species include two Puget Sound rockfish species, eulachon, two sturgeon species, two species of corals, black abalone, several species of sea turtles, Southern Resident Killer Whale, two pinniped species, Johnson's seagrass, and Smalltooth sawfish. For each of these species we determined the relevant PBFs that would be affected by the proposed action. Descriptions of species' designated critical habitats and associated PBFs are provided in Appendix C.

Water quality and prey availability in freshwater and estuarine areas may be susceptible to pesticide effects where critical habitat overlaps with or is adjacent to use sites. Effects to water quality and prey availability will be evaluated to determine the likelihood of reducing the quality of freshwater, estuarine, and nearshore marine areas. Given the use and environmental fate profile of the pesticide formulations containing these active ingredients, we do not expect offshore marine areas to be directly affected. Therefore, a risk hypothesis was not developed for this area and further evaluation of this PBF is not warranted.

Sufficient water quality is a necessary attribute of many aquatic PBFs to support the conservation role of designated critical habitat, and water quality unimpaired by toxins is necessary to the PBFs of the critical habitats affected by the stressors of this action. For example, all species of juvenile salmon need clean cold water. Clean and cold water is essential support for producing abundant prey for salmonid growth and development. This is also true for green sturgeon. Eggs and larvae develop in freshwater. Development of early life stages is affectd by water flow and temperature. Juvenile sturgeon rear and feed in fresh and estuarine waters from one to 4 years prior to dispersing into marine waters as subadults. During this time, their growth and development relies on adequate water quality to support abundant prey production. Water quality is clearly degraded when pesticides and other stressors of the action reach levels in habitat that are sufficient to adversely affect aquatic organisms and reduce individual fitness of exposed Endangered Species Act (ESA)-listed species. Impacts to species fitness were evaluated earlier in the document and these impacts are used as indicators of degraded water quality. We evaluate exposure and effect concentrations presented in EPA's BEs to determine whether PBFs are impacted.

We also evaluate effects on prey because forage is an essential attribute of many PBFs. Freshwater juvenile rearing and migratory habitats as well as estuarine and nearshore marine areas must provide sufficient forage to support growth and development of the listed species. Reductions in the abundance of prey items can decrease the quality of rearing, migration, and estuarine PBFs, as less available food will support fewer individuals. Reductions in prey can reduce a PBF's potential to support species (juvenile development, growth, maturation, survival), thereby reducing the carrying capacity of critical habitat. We evaluated the toxicity assessment endpoints including prey and fish survival (EC_{50}/LC_{50}) to determine whether expected concentrations of the stressors of the action are sufficient to affect PBFs of species critical habitats.

Designated critical habitat is located within the action area. Many freshwater areas overlap with the allowable uses of the three a.i.'s. The stressors of the action contaminate these habitats via drift and runoff (including from irrigation returns), and to a lesser extent from atmospheric deposition. Once in species habitats, the three active ingredients persist for varying periods of time, depending in part on the chemical, biological, and physical environment of the contaminated aquatic habitats. The most persistent of the three, chlorpyrifos (soil half-life 171 days),[1] may accumulate in soils and contribute to aquatic loading via runoff months later affecting organisms beyond those exposed initially from application events. Expected concentrations of other/inert ingredients and adjuvants added to formulations prior to application remain unknown, and are an identified data gap.

We use the toxicity information provided in the BEs and presented earlier in the Effects Analysis (Chapters 12, 13, and 14) to evaluate the scientific lines of evidence that support or refute risk hypotheses developed for designated and proposed critical habitats. Freshwater spawning and rearing sites, migration corridors, estuarine areas, and nearshore marine areas within designated critical habitats are likely to be exposed to the stressors of the action over the 15-year registration duration. We estimate expected concentrations and durations of exposure for these habitats based on pesticide use information, surface water monitoring data, EPA modeling estimates, and NMFS modeling estimates.

For each risk hypothesis in ***Table 1*** (also refer to Appendix E for specific risk hypotheses for each species PBFs relevant to this analysis) we qualitatively weigh the evidence to determine whether the PBF attributes of water quality and prey availability are affected for each species designated critical habitat. Water quality is degraded when pesticides and other stressors of the action reach levels in habitat that are sufficient to adversely affect aquatic organisms and reduce individual fitness of exposed ESA-listed species (this was evaluated earlier in the document). We ultimately determine whether the degradation of water quality and reduction in prey availability within freshwater spawning and rearing sites, migration corridors, estuarine areas, and nearshore marine areas will rise to the level expected to reduce the intended conservation role of designated critical habitats. This analysis is conducted by evaluating toxicity information (e.g., aquatic invertebrate LC50 values), as well as by characterizing the likelihood of exposure within the designated critical habitat. Likelihood of exposure for critical habitat considers three factors: 1) percent overlap; 2) chemical persistence, and; 3) number of repeated applications allowed. See Chapter 3 for a description of how these factors are considered to determine the overall likelihood of exposure.

See Chapters 22 – 24 (Integration and Synthesis for Designated Critical Habitat*)* for the final conclusion of whether EPA's proposed action with end-use products containing chlorpyrifos, diazinon, or malathion are likely to adversely modify or destroy a species' designated or proposed critical habitat.

Table 1. Generalized risk hypotheses for relevant PBF's.

Risk hypothesis for relevant physical or biological features
1. Exposure to the stressors of the action is sufficient to degrade water quality and/or reduce prey resources in freshwater spawning sites.
2. Exposure to the stressors of the action is sufficient to degrade water quality and/or reduce prey resources in freshwater rearing sites.

[1] Diazinon soil half-life is 34 days, malathion soil half-life is 1 day.

3. Exposure to the stressors of the action is sufficient to degrade water quality, and/or reduce prey resources in freshwater migratory corridors.
4. Exposure to the stressors of the action is sufficient to degrade water quality and/or reduce prey resources in estuarine areas.
5. Exposure to the stressors of the action is sufficient to degrade water quality and/or reduce prey resources in nearshore marine areas.

The following sections provide the chemical-specific assessments of risk hypotheses for each designated critical habitats involved in this consultation (defined by the action area).

15.2 Columbia River Chum Salmon (O. keta) Designated Critical Habitat

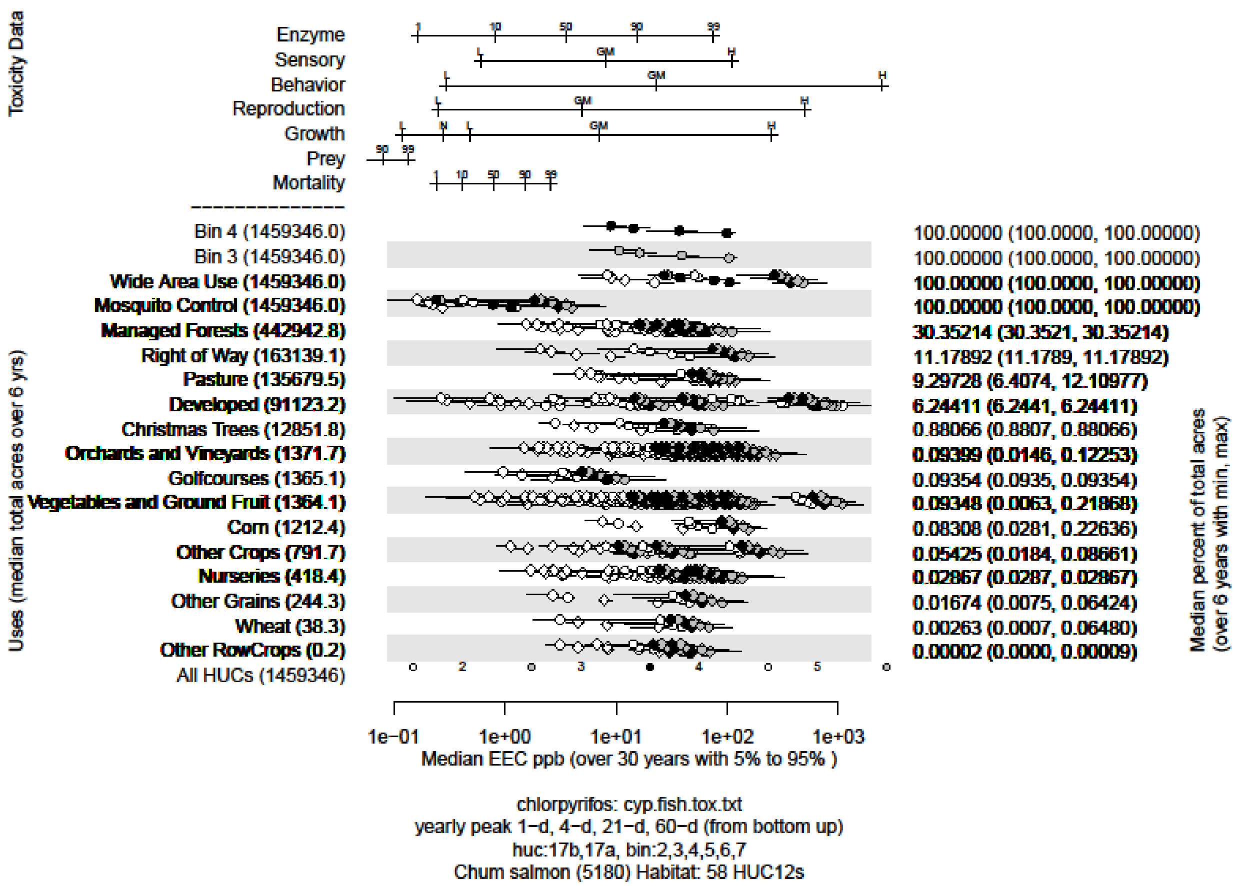


Figure 2. Effects analysis R-plot; chum salmon, Columbia River ESU designated critical habitat.

Table 2. Prey risk hypothesis; chum salmon, Columbia River ESU designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	30.35	High	High
Right of Way	11.18	High	High
Pasture	9.30	High	High
Developed	6.24	High	High
Christmas Trees	0.88	High	Low
Orchards and Vineyards	0.09	High	Low
Golfcourses	0.09	High	Low

Vegetables and Ground Fruit	0.09	High	Low
Corn	0.08	High	Low
Other Crops	0.05	High	Low
Nurseries	0.03	High	Low
Other Grains	0.02	High	Low
Wheat	<0.01	High	Low
Other RowCrops	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 3. Water quality risk hypothesis; chum salmon, Columbia River ESU designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within Chum salmon, Columbia River ESU designated critical habitat. Fourteen use site categories, totaling more than 852,477 acres (over 58% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

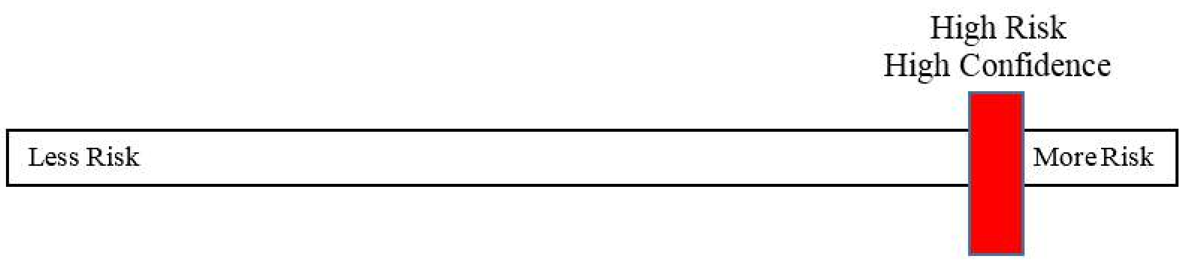
Table 4. Effects analysis summary table; chum salmon, Columbia River ESU designated critical habitat.

Designated Critical Habitat; Risk Hypotheses	**R-plot Derived**		**Risk Hypothesis Supported?**
	Risk	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Columbia River Chum Salmon. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We have greater confidence in the risk determinations associated with the freshwater habitats than we do in the estuarine and nearshore habitats. Overall the risk is high and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.



15.3 Hood Canal Summer-run Chum (O. keta) Designated Critical Habitat

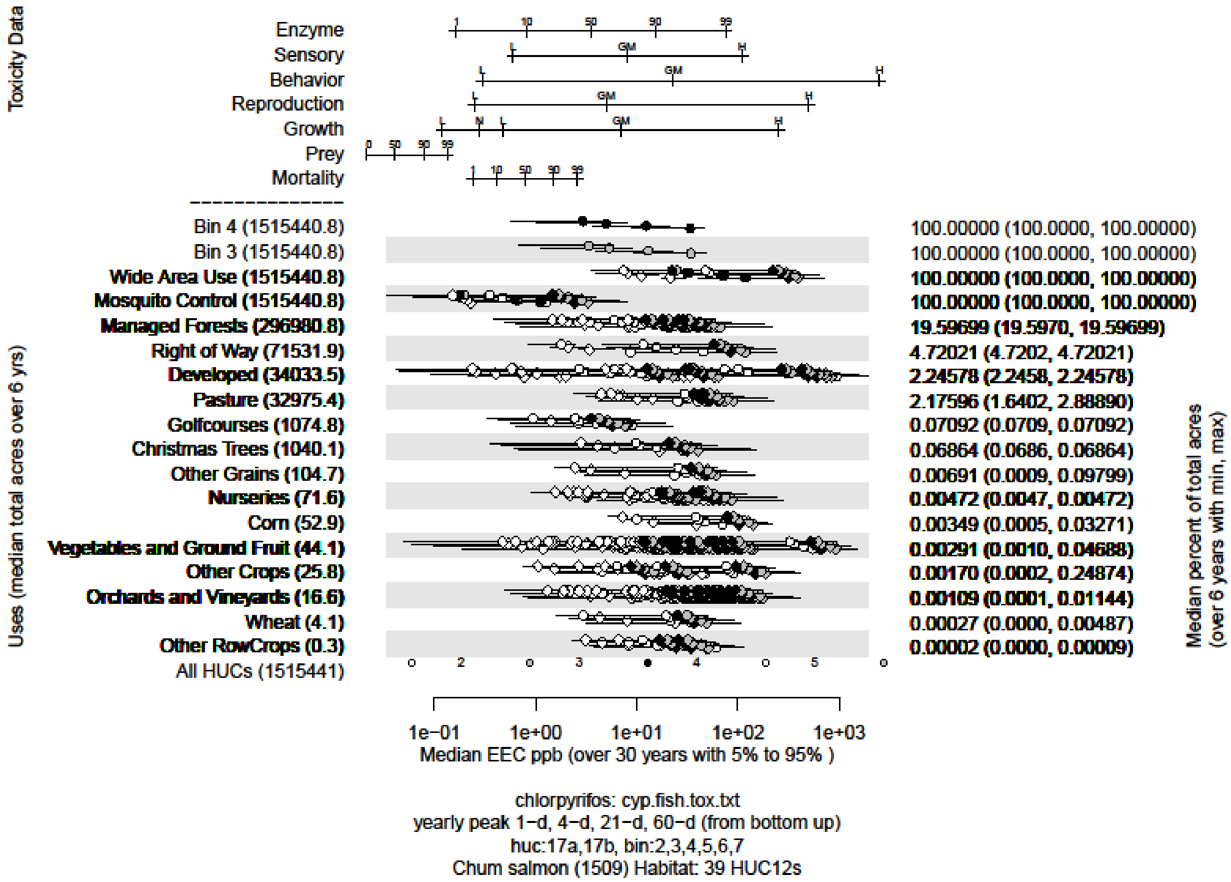


Figure 3. Effects analysis R-plot; chum salmon, Hood Canal summer-run River ESU designated critical habitat.

Table 5. Prey Risk Hypothesis; Chum salmon, Hood Canal summer-run ESU designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	19.60	High	High
Right of Way	4.72	High	High
Developed	2.25	High	High
Pasture	2.18	High	High
Golfcourses	0.07	High	Low
Christmas Trees	0.07	High	Low

Other Grains	0.01	High	Low
Nurseries	<0.01	High	Low
Corn	<0.01	High	Low
Vegetables and Ground Fruit	<0.01	High	Low
Other Crops	<0.01	High	Low
Orchards and Vineyards	<0.01	High	Low
Wheat	<0.01	High	Low
Other RowCrops	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 6. Water quality risk hypothesis; Chum salmon, Hood Canal summer-run ESU; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Chum salmon, Hood Canal summer-run ESU. Sixteen use site categories, totaling more than 437951 acres (over 31% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

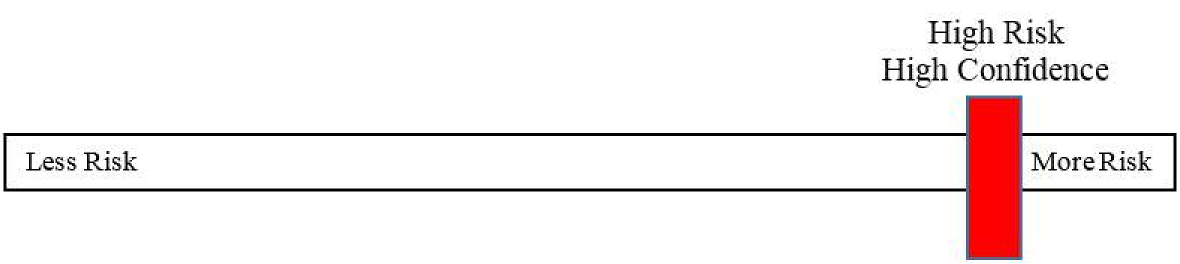
Table 7. Effects analysis summary table; chum salmon, Hood Canal ESU; designated critical habitat.

	R-plot Derived	

Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Risk Hypothesis Supported?** **Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Hood Canal summer-run Chum. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



15.4 California Coastal Chinook (O. tshawytscha) Designated Critical Habitat

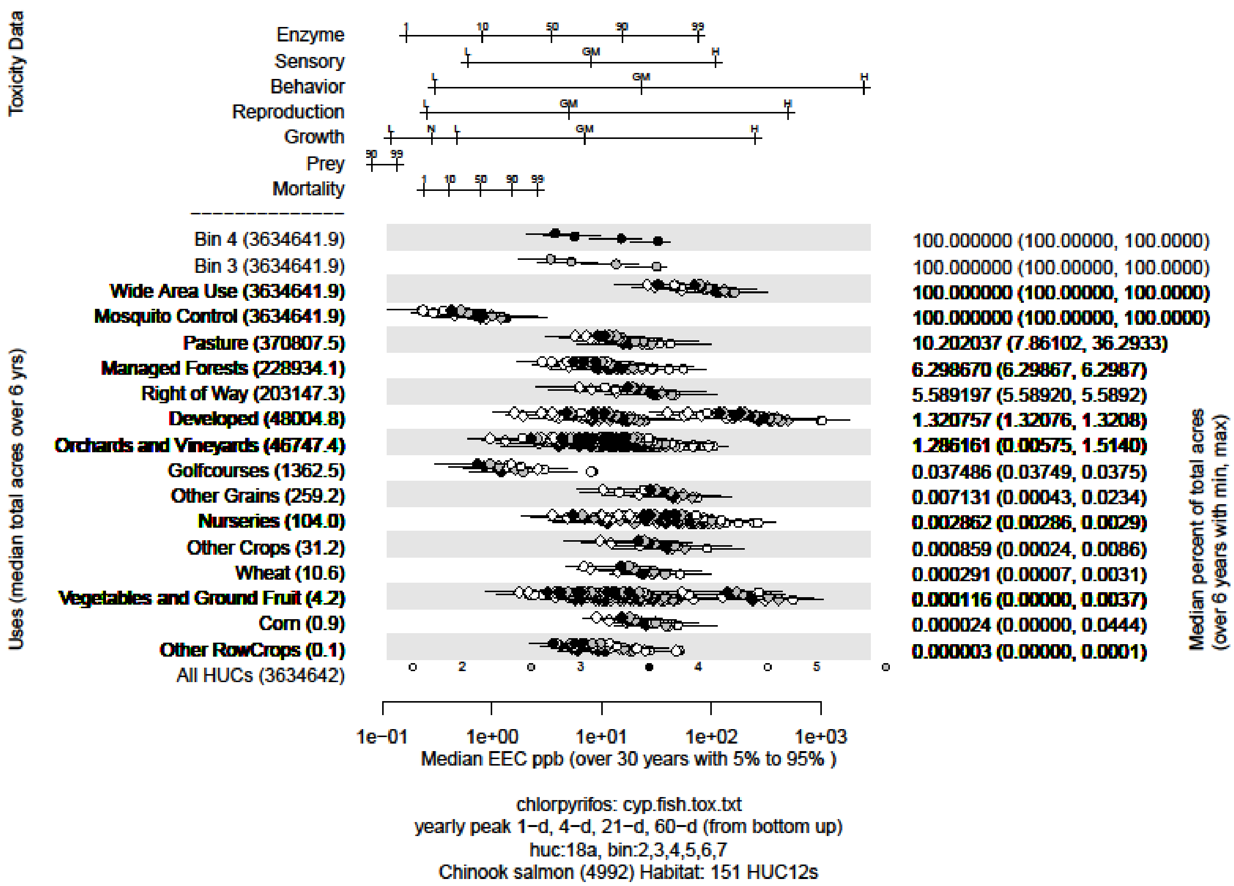


Figure 4. Effects analysis R-plot; Chinook salmon, California Coastal ESU designated critical habitat.

Table 8. Prey Risk Hypothesis; Chinook salmon, California Coastal ESU designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	10.20	High	High
Managed Forests	6.30	High	High
Right of Way	5.59	High	High
Developed	1.32	High	High
Orchards and Vineyards	1.29	High	High
Golfcourses	0.04	High	Low

Other Grains	0.01	High	Low
Nurseries	<0.01	High	Low
Other Crops	<0.01	High	Low
Wheat	<0.01	High	Low
Vegetables and Ground Fruit	<0.01	High	Low
Corn	<0.01	High	Low
Other RowCrops	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 9. Water quality risk hypothesis; Chinook, California coastal ESU; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Chinook, California coastal ESU. Fifteen use site categories, totaling more than 899410 acres (over 16% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

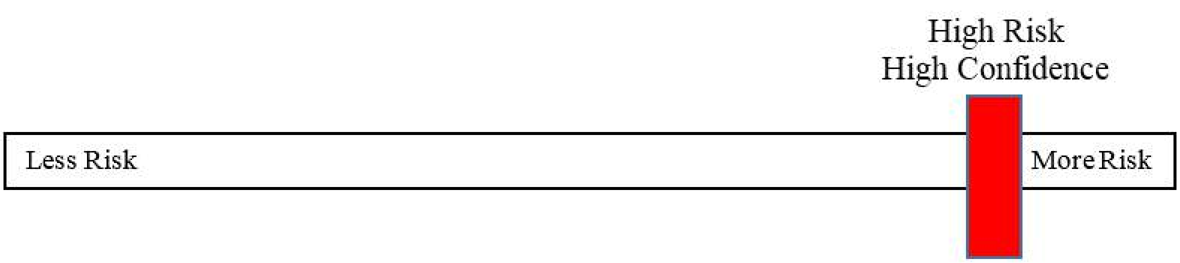
Table 10. Effects analysis summary table; Chinook, California coastal ESU; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of California Coastal Chinook. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



15.5 Central Valley Spring-run Chinook Designated Critical Habitat

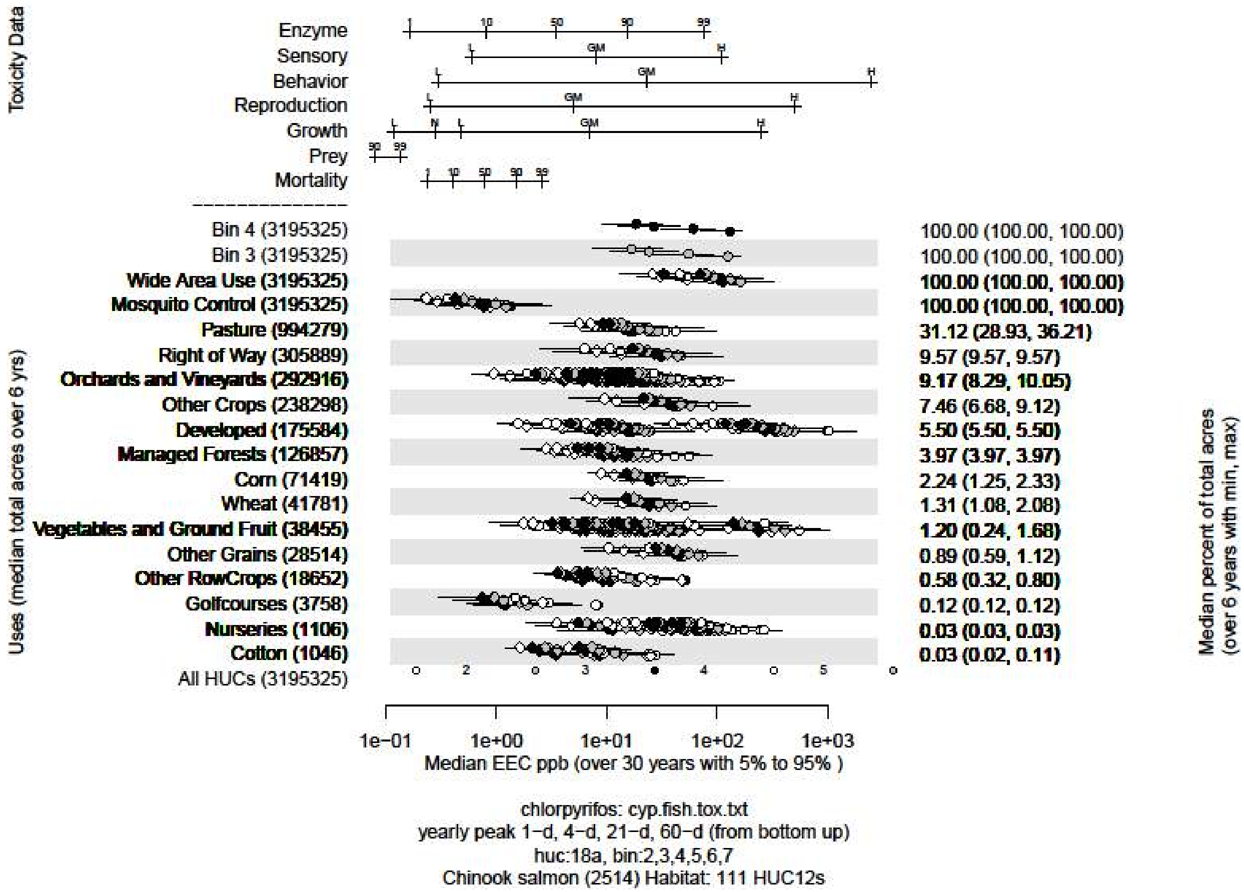


Figure 5. Effects analysis R-plot; Chinook salmon, Central Valley spring-run ESU designated critical habitat.

Table 11. Prey risk hypothesis; Chinook, Central Valley spring-run ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	31.12	High	High
Right of Way	9.57	High	High

Orchards and Vineyards	9.17	High	High
Other Crops	7.46	High	High
Developed	5.50	High	High
Managed Forests	3.97	High	High
Corn	2.24	High	High
Wheat	1.31	High	High
Vegetables and Ground Fruit	1.20	High	High
Other Grains	0.89	High	Low
Other RowCrops	0.58	High	Low
Golfcourses	0.12	High	Low
Nurseries	0.03	High	Low
Cotton	0.03	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 12. Water quality risk hypothesis; Chinook, Central Valley spring-run ESU; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Chinook, Central Valley spring-run ESU. Sixteen use site categories, totaling more than 2,211,697 acres (over 65% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur,

chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.

Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

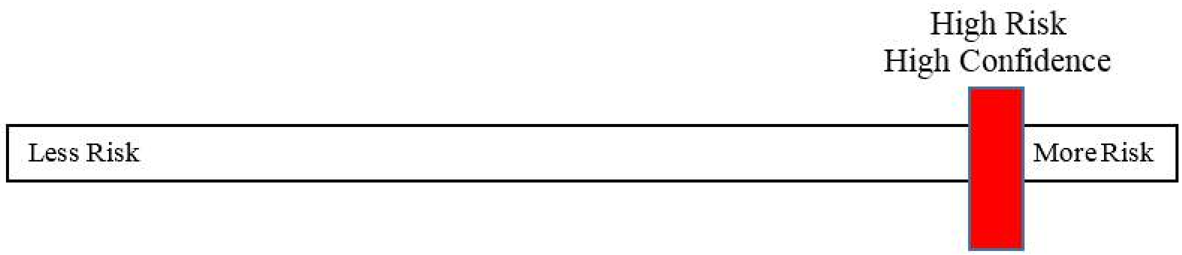
Table 13. Effects analysis summary table; Chinook, Central Valley spring-run ESU; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Central Valley Spring-run Chinook. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical

habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



15.6 Lower Columbia River Chinook Designated Critical Habitat

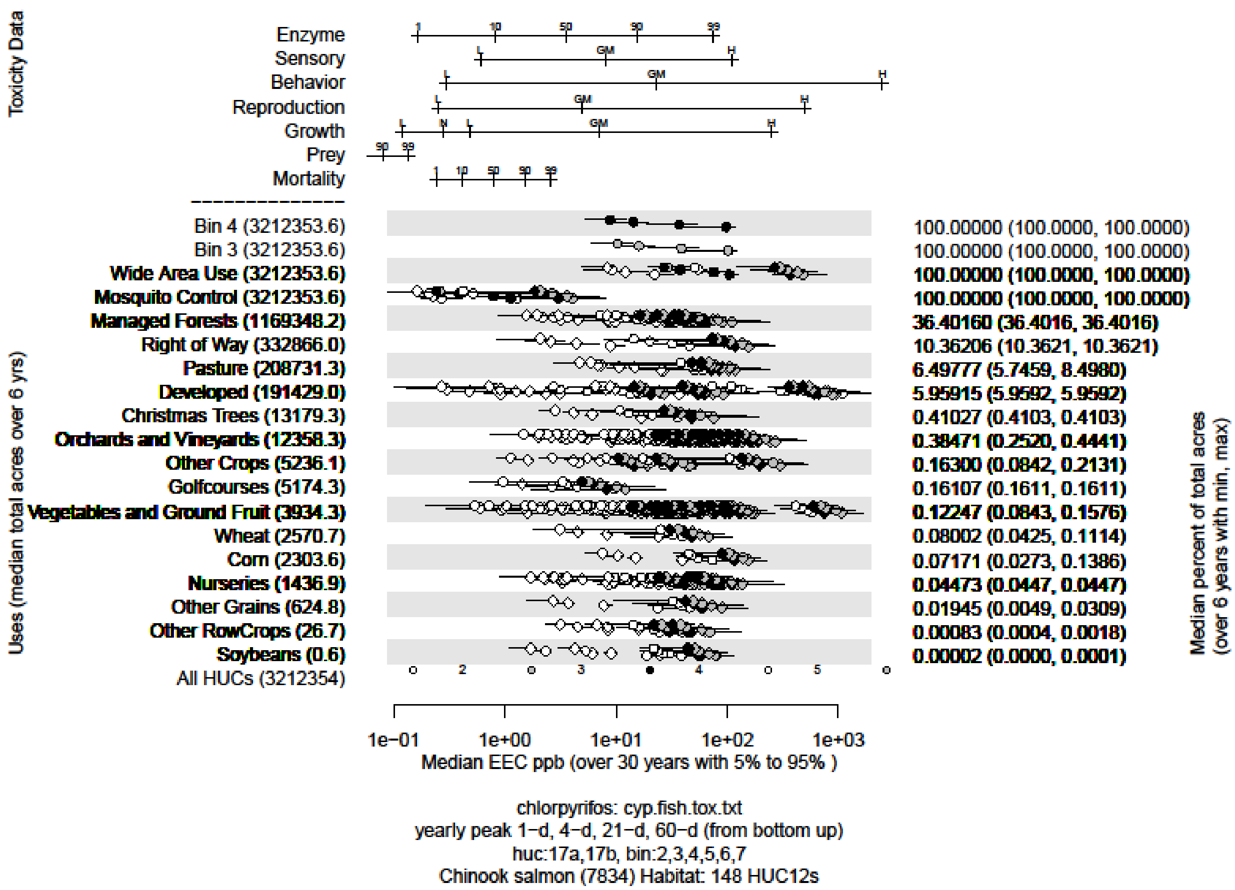


Figure 6. Effects analysis R-plot; Chinook salmon, Lower Columbia River ESU designated critical habitat.

Table 14. Prey risk hypothesis; Chinook, Lower Columbia River ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	36.40	High	High
Right of Way	10.36	High	High

Pasture	6.50	High	High
Developed	5.96	High	High
Christmas Trees	0.41	High	Low
Orchards and Vineyards	0.38	High	Low
Other Crops	0.16	High	Low
Golfcourses	0.16	High	Low
Vegetables and Ground Fruit	0.12	High	Low
Wheat	0.08	High	Low
Corn	0.07	High	Low
Nurseries	0.04	High	Low
Other Grains	0.02	High	Low
Other RowCrops	<0.01	High	Low
Soybeans	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 15. Water quality risk hypothesis; Chinook, Lower Columbia River ESU; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Chinook, Lower Columbia River ESU. Seventeen use site categories, totaling more than 1,949,214 acres (over 62% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur,

chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

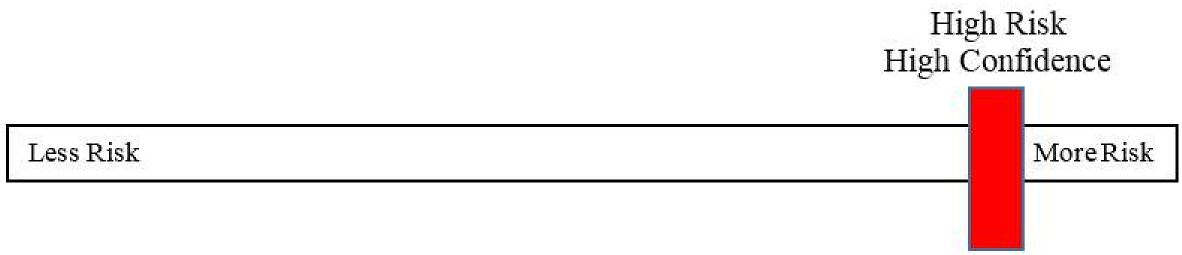
Table 16. Effects analysis summary table; Chinook, Lower Columbia River ESU; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Lower Columbia River Chinook. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical

habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



15.7 Puget Sound Chinook Designated Critical Habitat

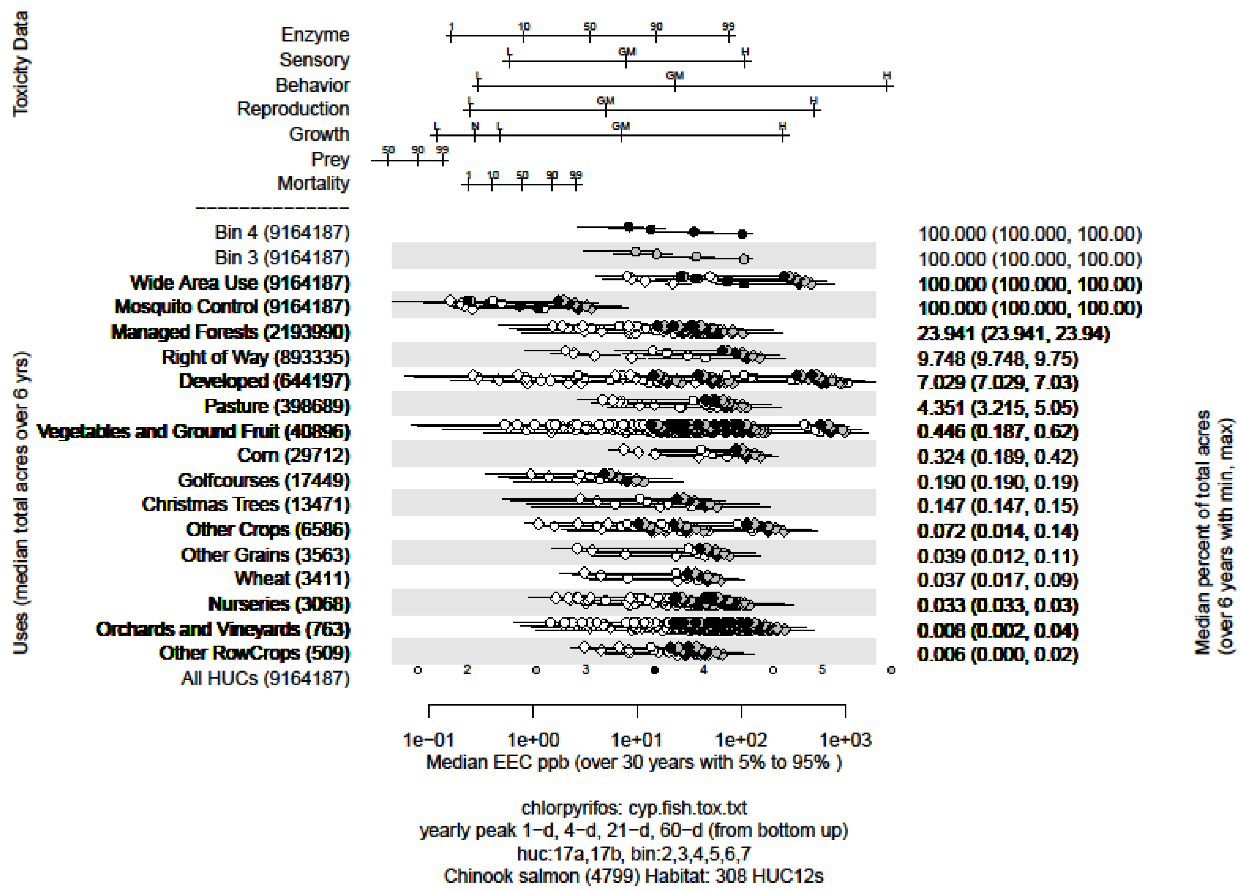


Figure 7. Effects naalysis R-plot; Chinook salmon, Puget Sound ESU designated critical habitat.

Table 17. Prey risk hypothesis; Chinook, Puget Sound ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	23.94	High	High
Right of Way	9.75	High	High

Developed	7.03	High	High
Pasture	4.35	High	High
Vegetables and Ground Fruit	0.45	High	Low
Corn	0.32	High	Low
Golfcourses	0.19	High	Low
Christmas Trees	0.15	High	Low
Other Crops	0.07	High	Low
Other Grains	0.04	High	Low
Wheat	0.04	High	Low
Nurseries	0.03	High	Low
Orchards and Vineyards	0.01	High	Low
Other RowCrops	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 18. Water quality risk hypothesis; Chinook, Puget Sound ESU; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Chinook, Puget Sound ESU. Sixteen use site categories, totaling more than 4,249,639 acres (over 45% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.

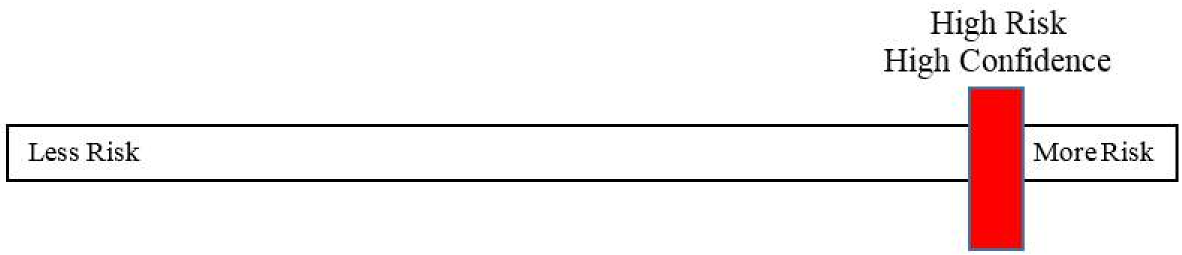
Risk	Confidence	
High	**High**	

Table 19. Effects analysis summary table; Chinook, Puget Sound ESU; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported? Yes/No
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Puget Sound Chinook. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.


High Risk
High Confidence
Less Risk
More Risk

15.8 Sacramento River Winter-run Chinook Salmon Designated Critical Habitat

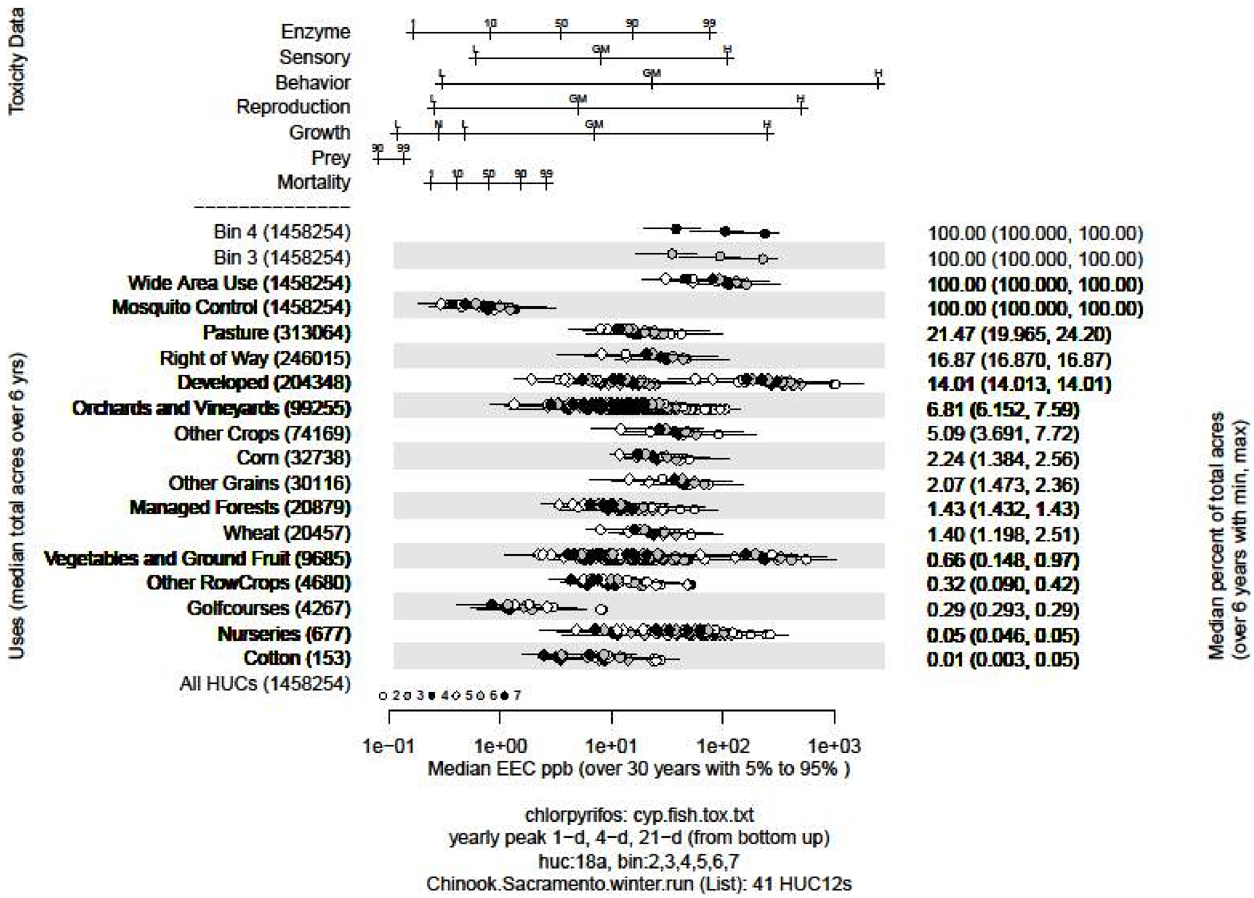


Figure 8. Effects naalysis R-plot; Chinook salmon, Sacramento River winter-run ESU designated critical habitat.

Table 20. Prey risk hypothesis; Chinook, Sacramento River winter-run ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	21.47	High	High

Right of Way	16.87	High	High
Developed	14.01	High	High
Orchards and Vineyards	6.81	High	High
Other Crops	5.09	High	High
Corn	2.24	High	High
Other Grains	2.07	High	High
Managed Forests	1.43	High	High
Wheat	1.40	High	High
Vegetables and Ground Fruit	0.66	High	Low
Other RowCrops	0.32	High	Low
Golfcourses	0.29	High	Low
Nurseries	0.05	High	Low
Cotton	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 21. Water quality risk hypothesis; Chinook, Sacramento River winter-run ESU; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Sacramento River Winter-run Chinook. Sixteen use site categories, totaling more than 1,060,503 acres (over 71% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur,

chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

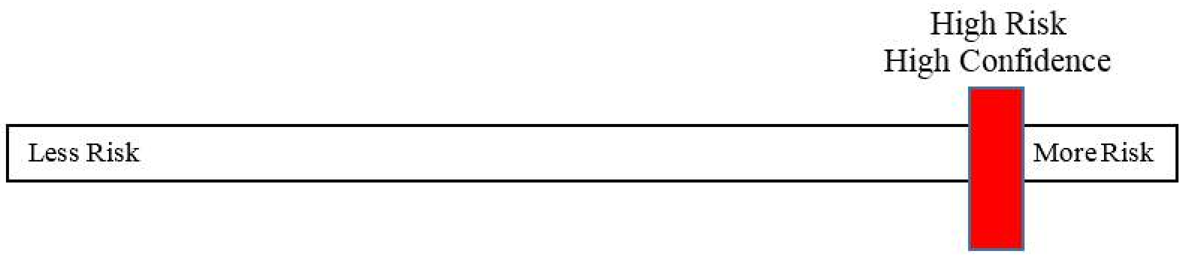
Table 22. Effects analysis summary table; Chinook, Sacramento River winter-run ESU; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Sacramento River Winter-run Chinook. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical

habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



15.9 Snake River Fall-run Chinook Salmon Designated Critical Habitat

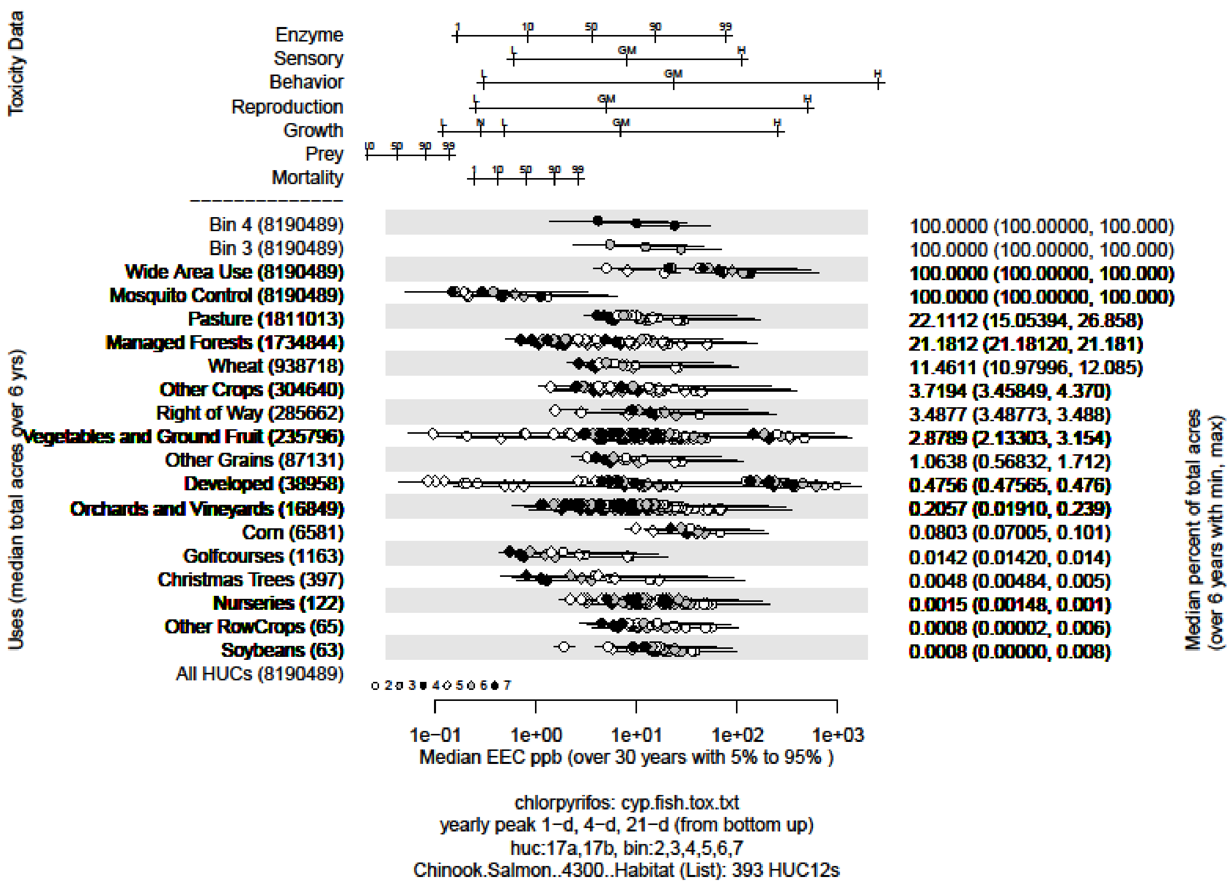


Figure 9. Effects naalysis R-plot; Chinook salmon, Snake River fall-run ESU designated critical habitat.

Table 23. Prey risk hypothesis; Chinook, Snake River fall-run ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	22.11	High	High

Managed Forests	21.18	High	High
Wheat	11.46	High	High
Other Crops	3.72	High	High
Right of Way	3.49	High	High
Vegetables and Ground Fruit	2.88	High	High
Other Grains	1.06	High	High
Developed	0.48	High	Low
Orchards and Vineyards	0.21	High	Low
Corn	0.08	High	Low
Golfcourses	0.01	High	Low
Christmas Trees	<0.01	High	Low
Nurseries	<0.01	High	Low
Other RowCrops	<0.01	High	Low
Soybeans	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 24. Water quality risk hypothesis; Chinook, Snake River fall-run ESU; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Snake River Fall-run Chinook. Seventeen use site categories, totaling more than 5,462,029 acres (over 66% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur,

chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.

Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

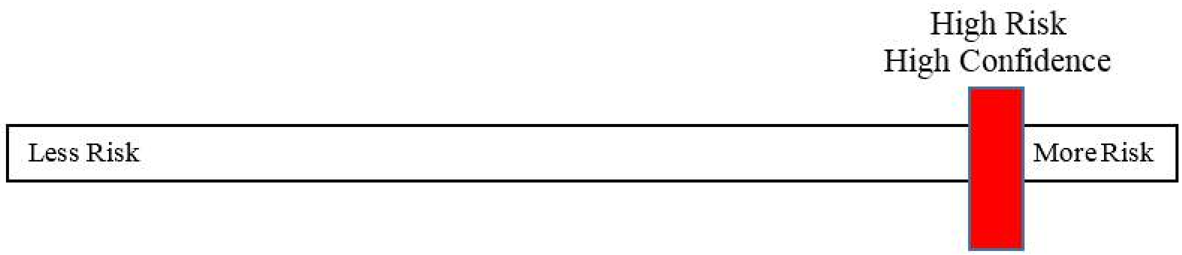
Table 25. Effects analysis summary table; Chinook, Snake River fall-run ESU; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Snake River Fall-run Chinook. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical

habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



15.10 Snake River Spring/Summer-run Chinook Salmon Designated Critical Habitat

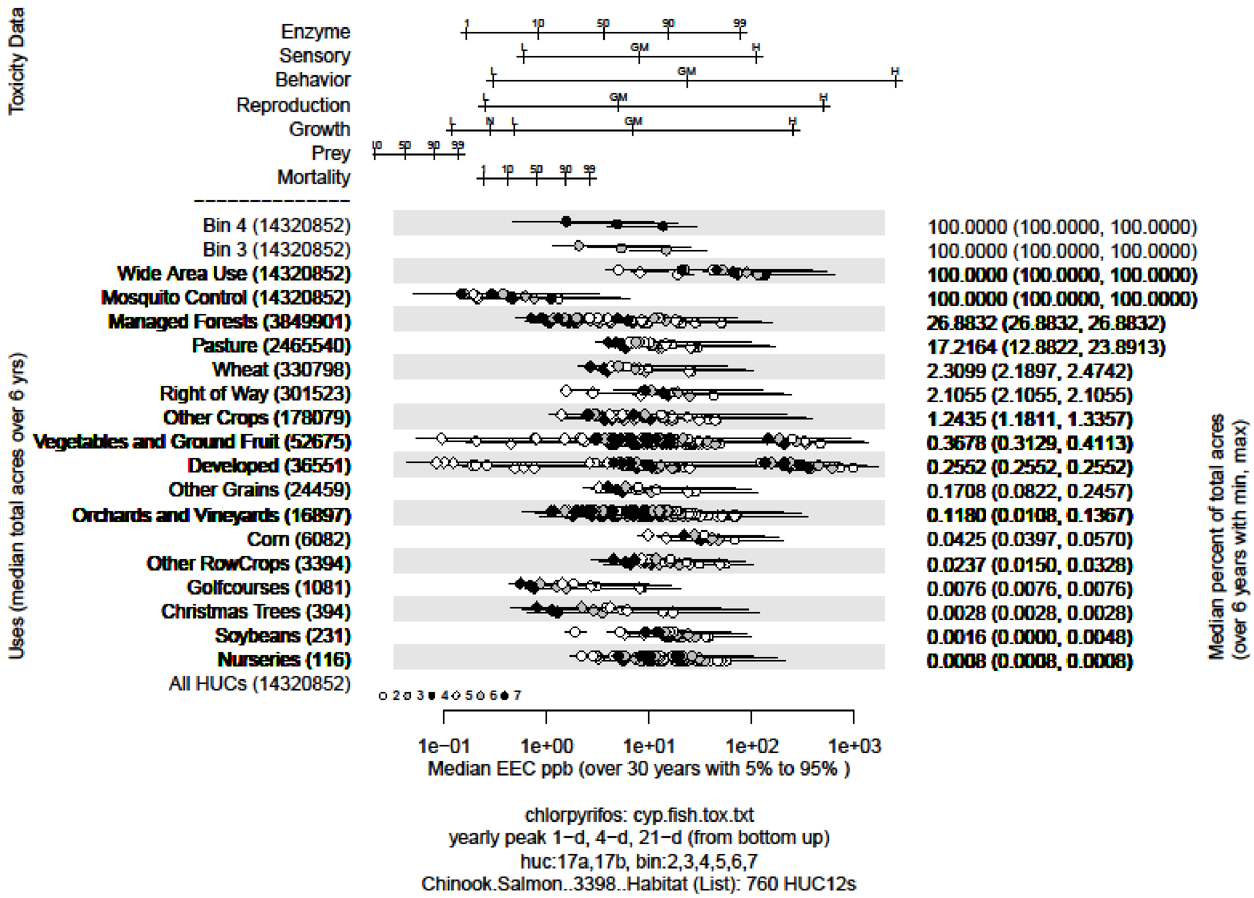


Figure 10. Effects naalysis R-plot; Chinook salmon, Snake River spring/summer-run ESU designated critical habitat.

Table 26. Prey risk hypothesis; Chinook, Snake River spring/summer-run ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	26.88	High	High

Pasture	17.22	High	High
Wheat	2.31	High	High
Right of Way	2.11	High	High
Other Crops	1.24	High	High
Vegetables and Ground Fruit	0.37	High	Low
Developed	0.26	High	Low
Other Grains	0.17	High	Low
Orchards and Vineyards	0.12	High	Low
Corn	0.04	High	Low
Other RowCrops	0.02	High	Low
Golfcourses	0.01	High	Low
Christmas Trees	<0.01	High	Low
Soybeans	<0.01	High	Low
Nurseries	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 27. Water quality risk hypothesis; Chinook, Snake River spring/summer-run ESU; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Snake River Spring/Summer-run Chinook. Seventeen use site categories, totaling more than 7,267,721 acres (over 50% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes

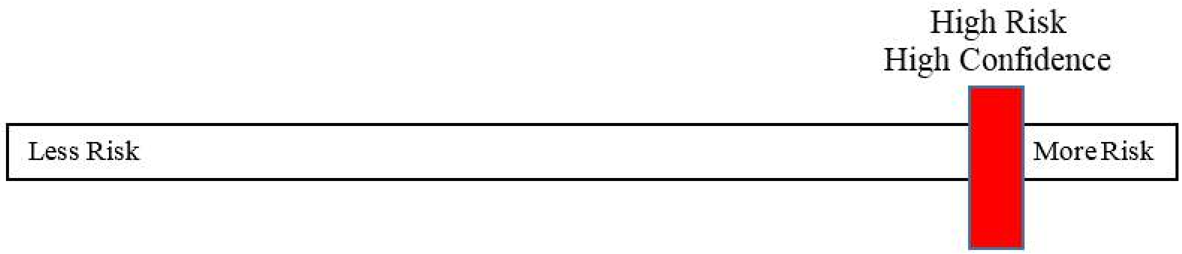
increases the extent of water quality degradation. Additionally, where elevated temperatures occur, chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

Table 28. Effects analysis summary table; Chinook, Snake River spring/summer-run ESU; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Snake River Spring/Summer-run Chinook. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



15.11 Upper Columbia River Spring-run Chinook Salmon Designated Critical Habitat

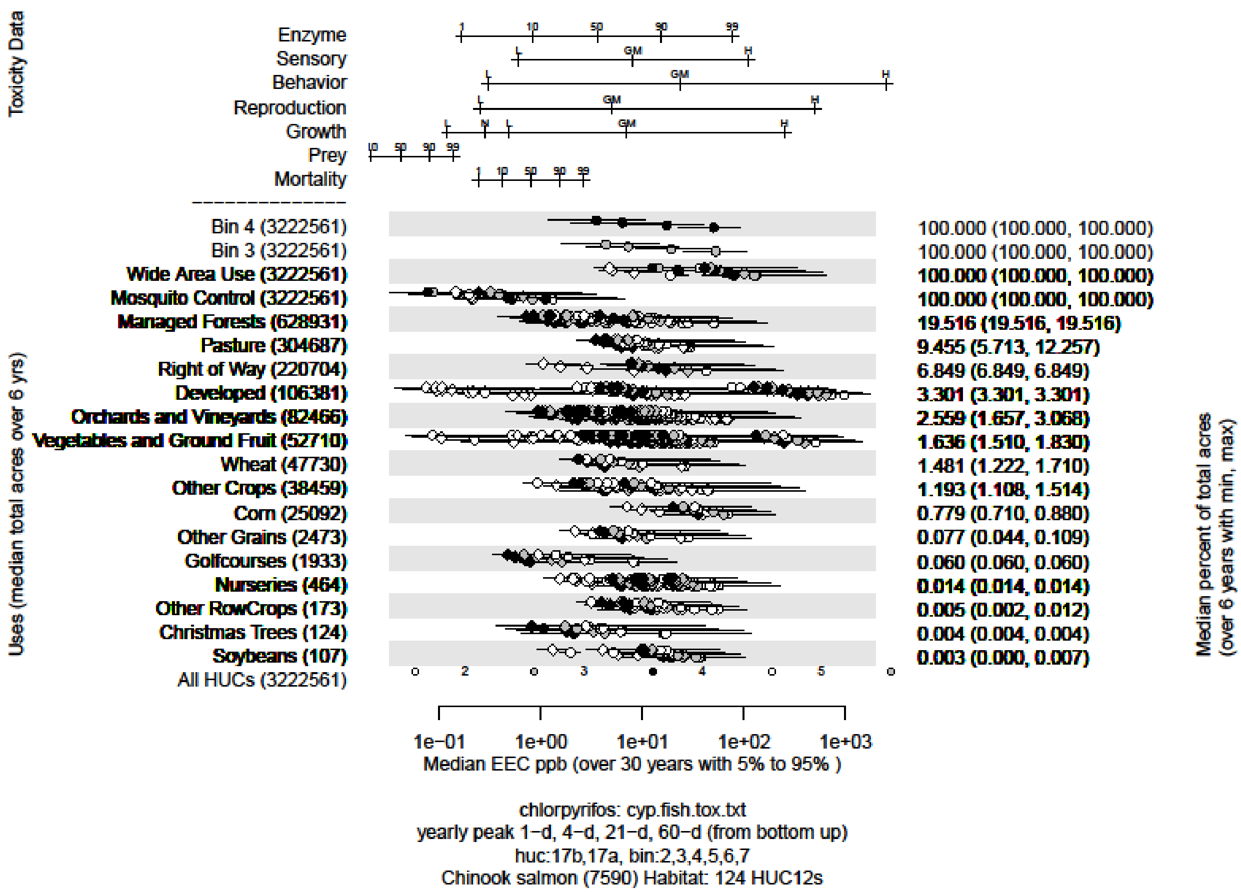


Figure 11. Effects Analysis R-plot; Chinook salmon, Upper Columbia River Spring-run ESU designated critical habitat.

Table 29. Prey risk hypothesis; Chinook salmon, upper Columbia River spring-run ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	19.52	High	High

Pasture	9.45	High	High
Right of Way	6.85	High	High
Developed	3.30	High	High
Orchards and Vineyards	2.56	High	High
Vegetables and Ground Fruit	1.64	High	High
Wheat	1.48	High	High
Other Crops	1.19	High	High
Corn	0.78	High	Low
Other Grains	0.08	High	Low
Golfcourses	0.06	High	Low
Nurseries	0.01	High	Low
Other RowCrops	0.01	High	Low
Christmas Trees	<0.01	High	Low
Soybeans	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 30. Water quality risk hypothesis; Chinook salmon, upper Columbia River spring-run ESU; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Chinook salmon, upper Columbia River spring-run ESU. Seventeen use site categories, totaling more than 1,512,434 acres (over 48% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations

or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.

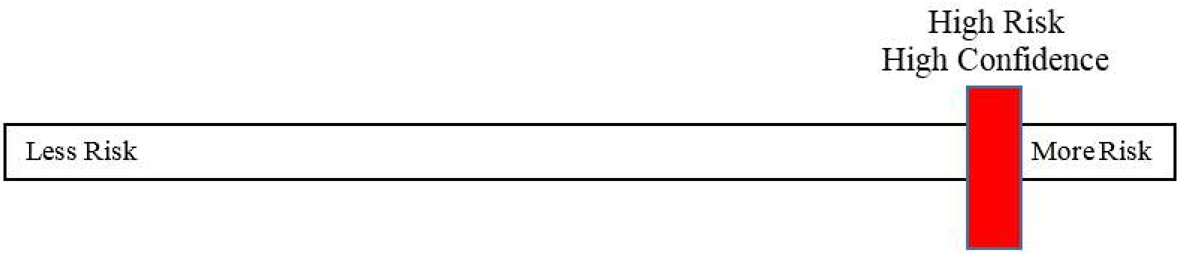
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

Table 31. Effects analysis summary table; Chinook salmon, upper Columbia River spring-run ESU; designated critical habitat

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Upper Columbia River Spring-run Chinook. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



15.12 Upper Willamette River Chinook Salmon Designated Critical Habitat

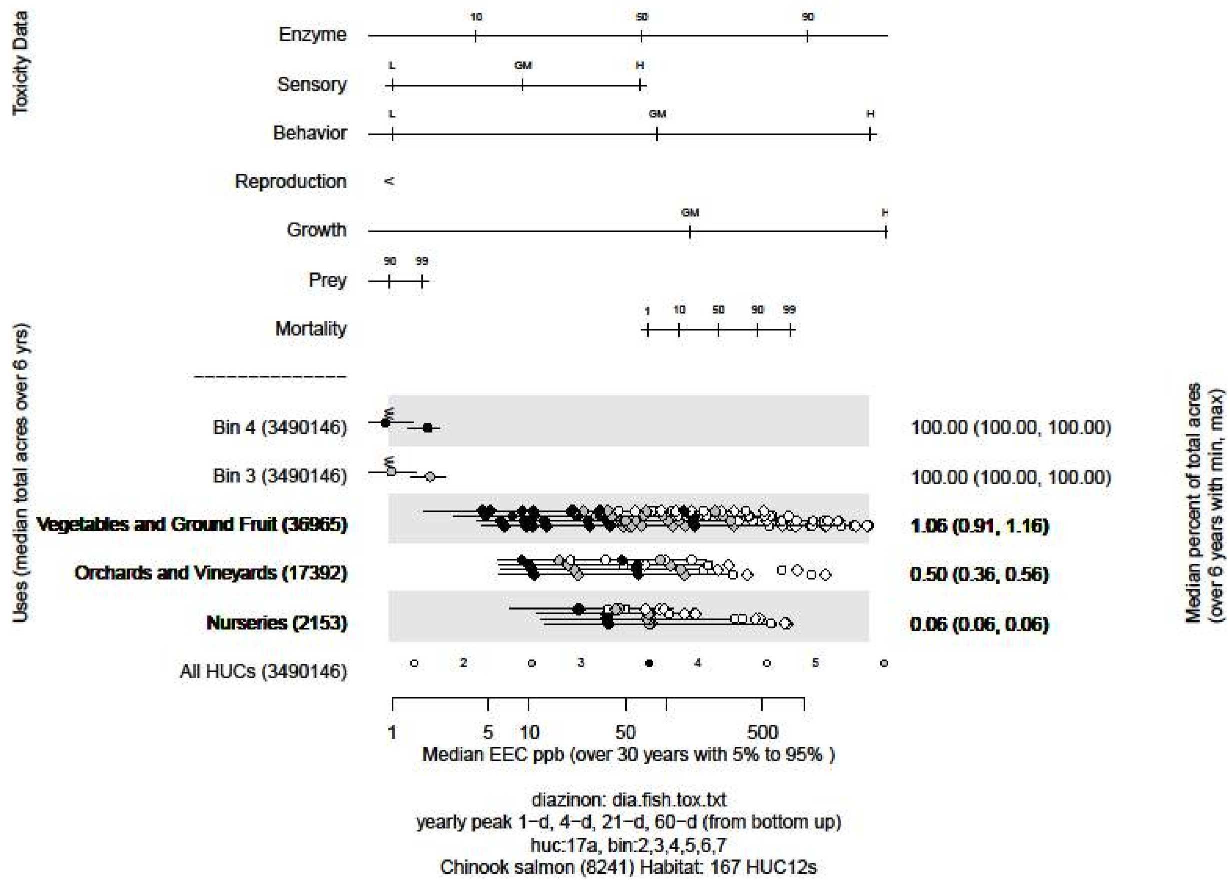


Figure 12. Effects analysis R-plot; Chinook salmon, Upper Willamette River ESU designated critical habitat.

Table 32. Prey risk hypothesis; Chinook, upper Willamette River ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	36.99	High	High

Pasture	12.71	High	High
Right of Way	9.53	High	High
Other Crops	5.56	High	High
Developed	4.92	High	High
Vegetables and Ground Fruit	1.06	High	High
Wheat	0.81	High	Low
Christmas Trees	0.76	High	Low
Orchards and Vineyards	0.50	High	Low
Corn	0.28	High	Low
Golfcourses	0.14	High	Low
Other Grains	0.08	High	Low
Other RowCrops	0.07	High	Low
Nurseries	0.06	High	Low
Soybeans	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 33. Water quality risk hypothesis; Chinook, upper Willamette River ESU; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Chinook, upper Willamette River ESU. Seventeen use site categories, totaling more than 2,564,130 acres (over 74% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur,

chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.

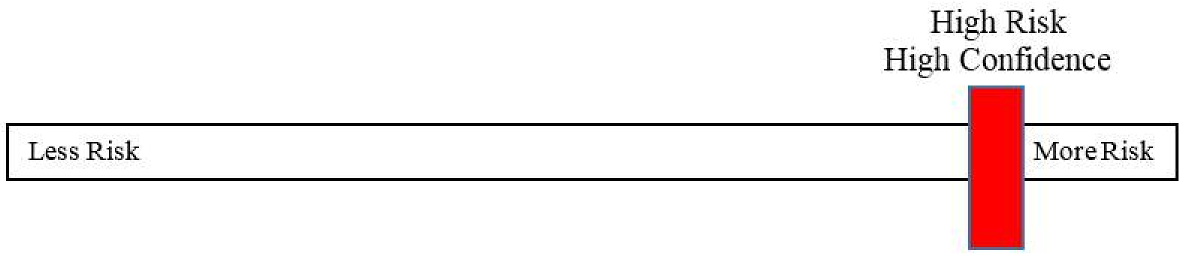
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

Table 34. Effects analysis summary table; Chinook, upper Willamette River ESU; designated critical habitat.

Designated Critical Habitat; Risk Hypotheses	R-plot Derived		Risk Hypothesis Supported? Yes/No
	Risk	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Upper Willamette River Chinook. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



15.13 Central California Coast Coho Salmon Designated Critical Habitat

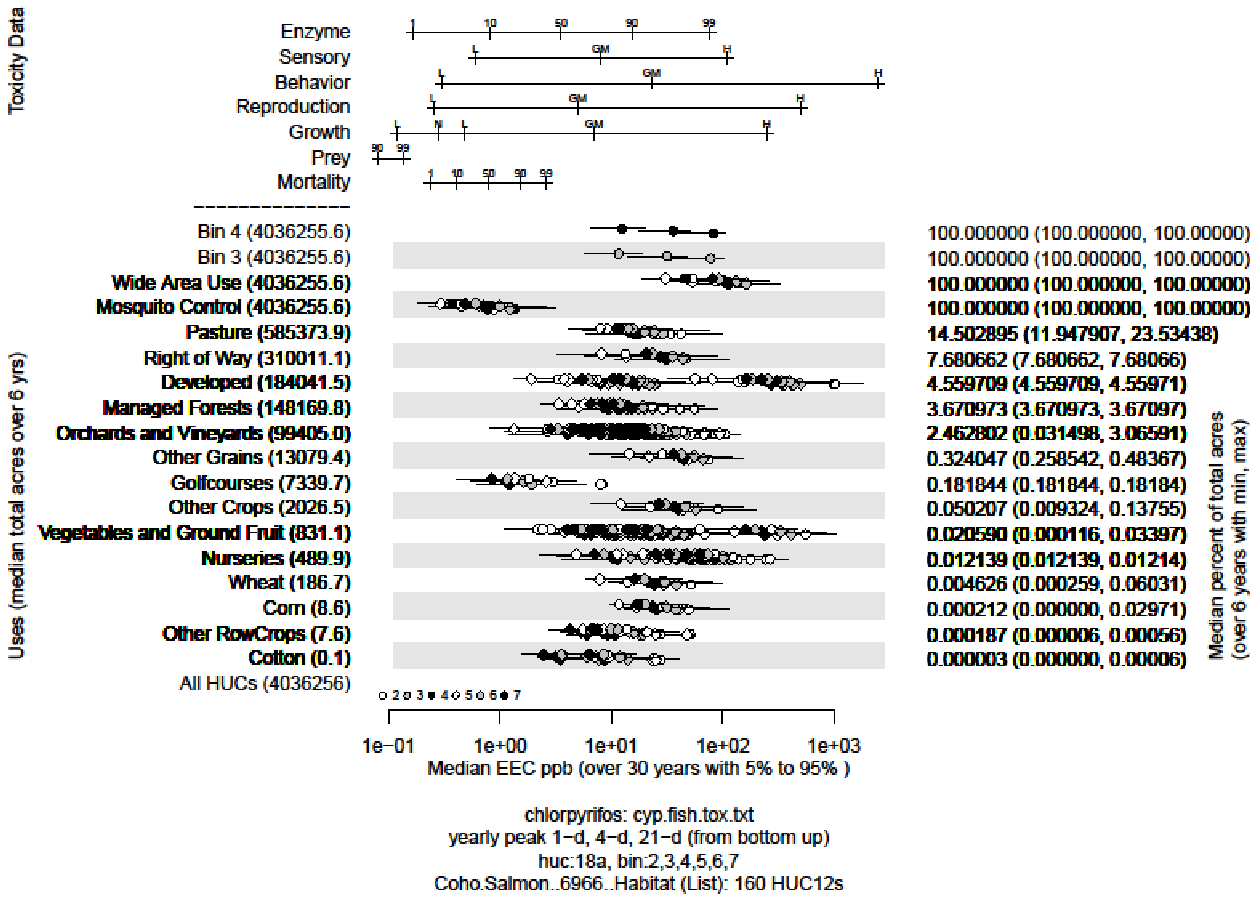


Figure 13. Effects analysis R-plot; Coho, Central California Coast ESU designated critical habitat.

Table 35. Prey risk hypothesis; Coho, Central California Coast ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	14.50	High	High
Right of Way	7.68	High	High

Developed	4.56	High	High
Managed Forests	3.67	High	High
Orchards and Vineyards	2.46	High	High
Other Grains	0.32	High	Low
Golfcourses	0.18	High	Low
Other Crops	0.05	High	Low
Vegetables and Ground Fruit	0.02	High	Low
Nurseries	0.01	High	Low
Wheat	<0.01	High	Low
Corn	<0.01	High	Low
Other RowCrops	<0.01	High	Low
Cotton	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 36. Water quality risk hypothesis; Coho, Central California Coast ESU; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Central California Coast Coho. Sixteen use site categories, totaling more than 1,351,070 acres (over 35% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.

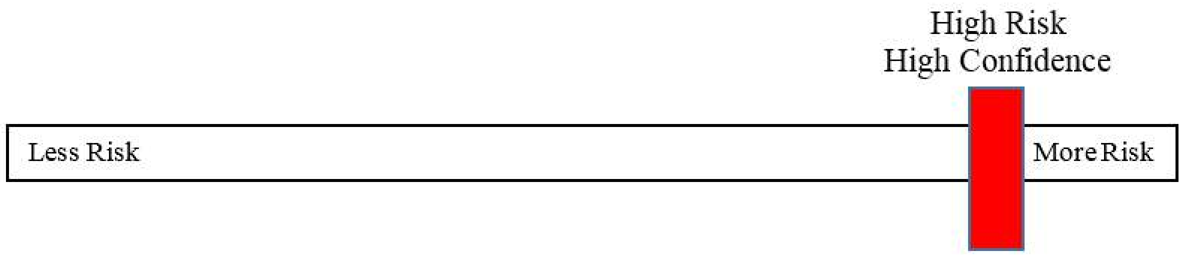
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

Table 37. Effects analysis summary table; Coho, Central California Coast ESU; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported?
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Central California Coast Coho. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.


High Risk
High Confidence
Less Risk
More Risk

15.14 Lower Columbia River Coho Salmon Designated Critical Habitat

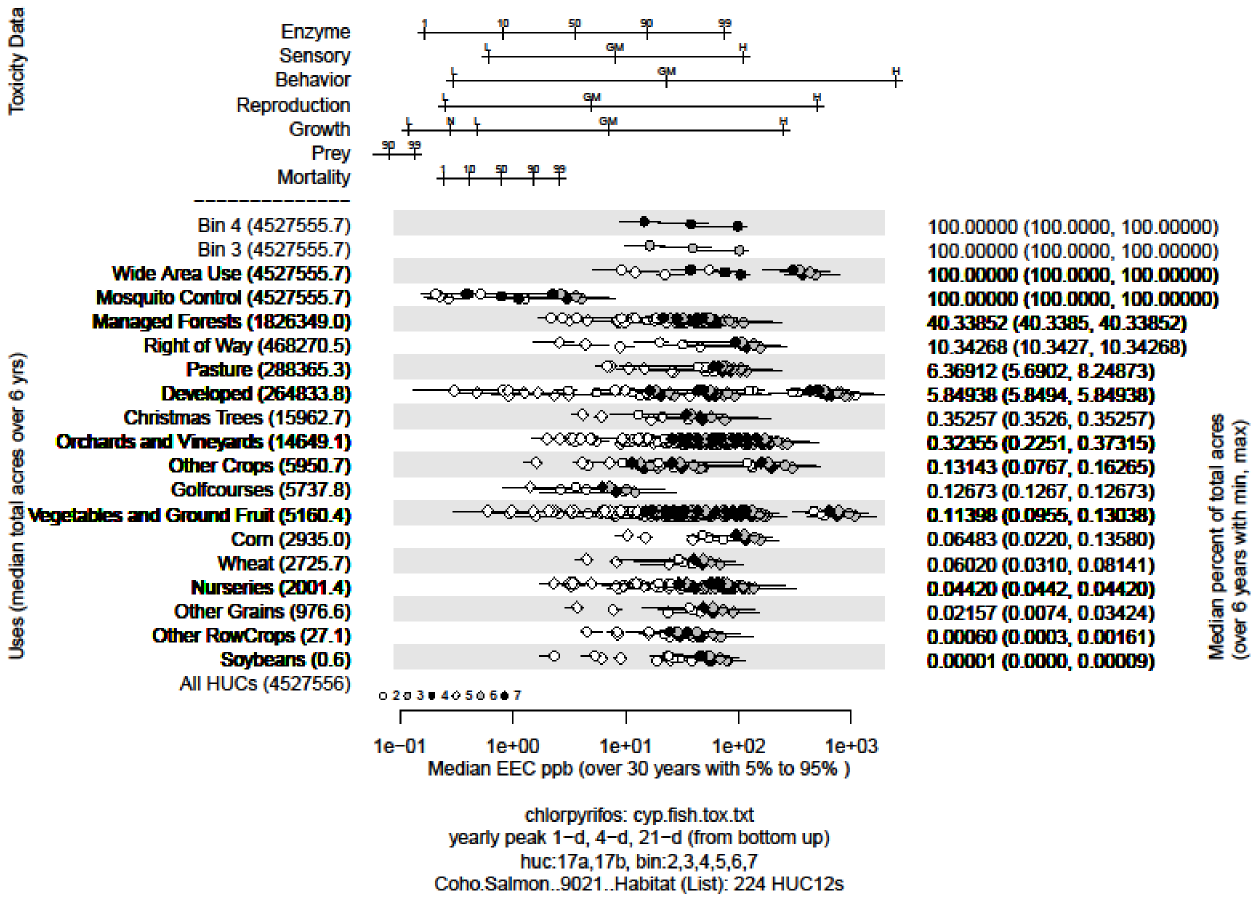


Figure 14. Effects analysis R-plot; Coho, Lower Columbia River ESU designated critical habitat.

Table 38. Prey risk hypothesis; Coho, Lower Columbia River ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	40.34	High	High
Right of Way	10.34	High	High

Pasture	6.37	High	High
Developed	5.85	High	High
Christmas Trees	0.35	High	Low
Orchards and Vineyards	0.32	High	Low
Other Crops	0.13	High	Low
Golfcourses	0.13	High	Low
Vegetables and Ground Fruit	0.11	High	Low
Corn	0.06	High	Low
Wheat	0.06	High	Low
Nurseries	0.04	High	Low
Other Grains	0.02	High	Low
Other RowCrops	<0.01	High	Low
Soybeans	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 39. Water quality risk hypothesis; Coho, Lower Columbia River ESU; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Lower Columbia River Coho. Seventeen use site categories, totaling more than 2,903,477 acres (over 62% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur,

chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.

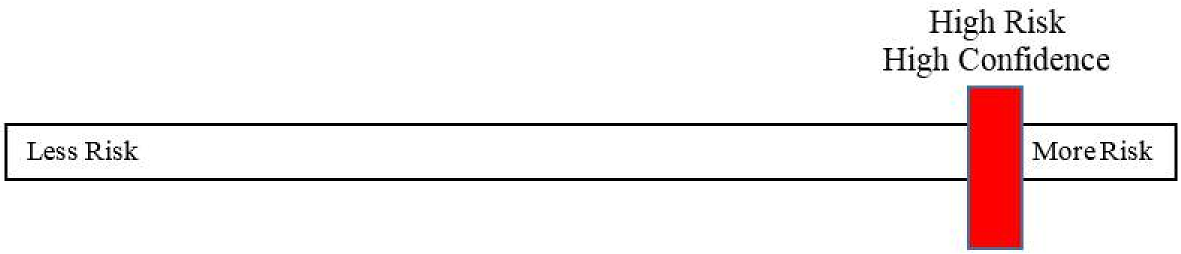
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

Table 40. Effects analysis summary table; Coho, Lower Columbia River ESU; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Lower Columbia River Coho. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



15.15 Oregon Coast Coho Salmon Designated Critical Habitat

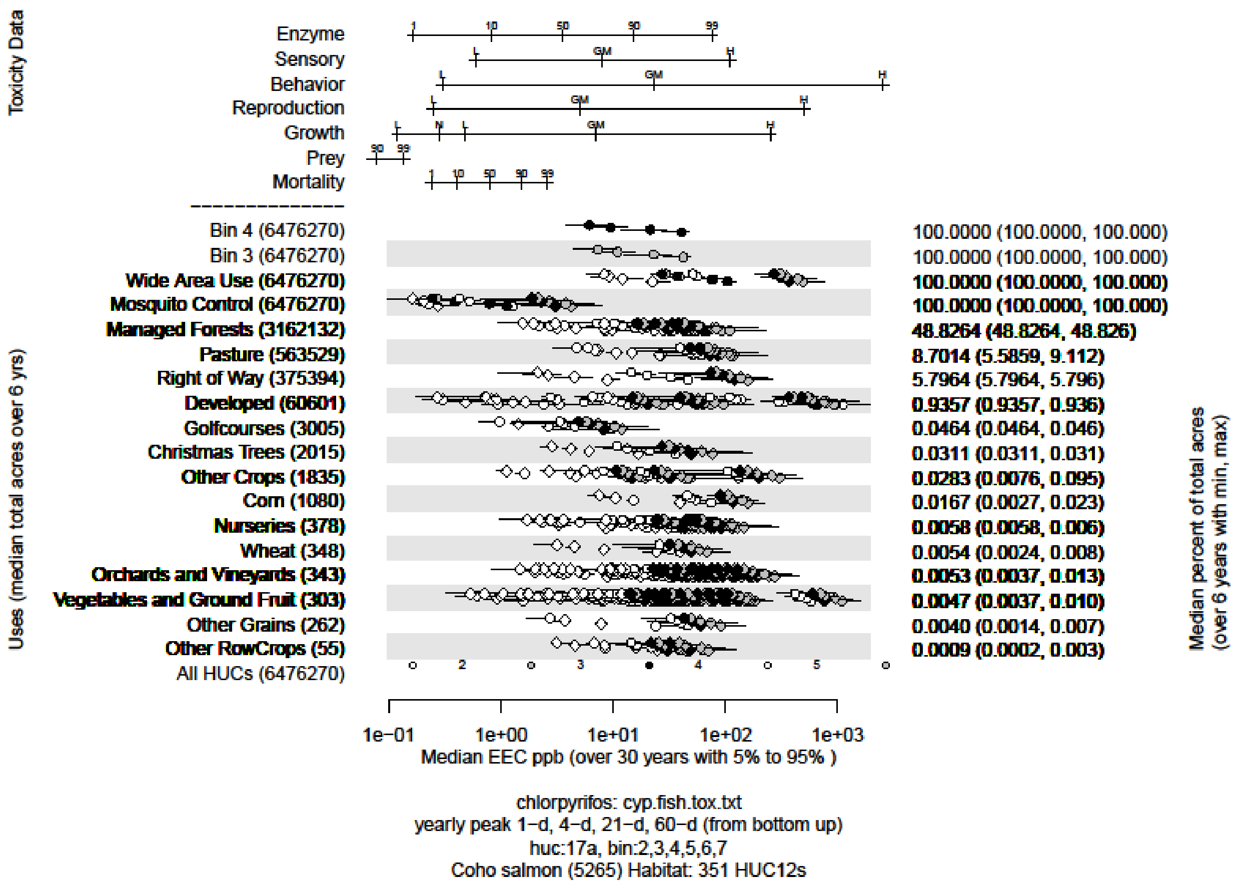


Figure 15. Effects analysis R-plot; Coho salmon, Oregon Coast ESU designated critical habitat.

Table 41. Prey risk hypothesis; Coho, Oregon coast ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	48.83	High	High
Pasture	8.70	High	High

Right of Way	5.80	High	High
Developed	0.94	High	Low
Golfcourses	0.05	High	Low
Christmas Trees	0.03	High	Low
Other Crops	0.03	High	Low
Corn	0.02	High	Low
Nurseries	0.01	High	Low
Wheat	0.01	High	Low
Orchards and Vineyards	0.01	High	Low
Vegetables and Ground Fruit	<0.01	High	Low
Other Grains	<0.01	High	Low
Other RowCrops	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 42. Water quality risk hypothesis; Coho, Oregon coast ESU; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Coho, Oregon coast ESU. Sixteen use site categories, totaling more than 4,171,280 acres (over 66% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.

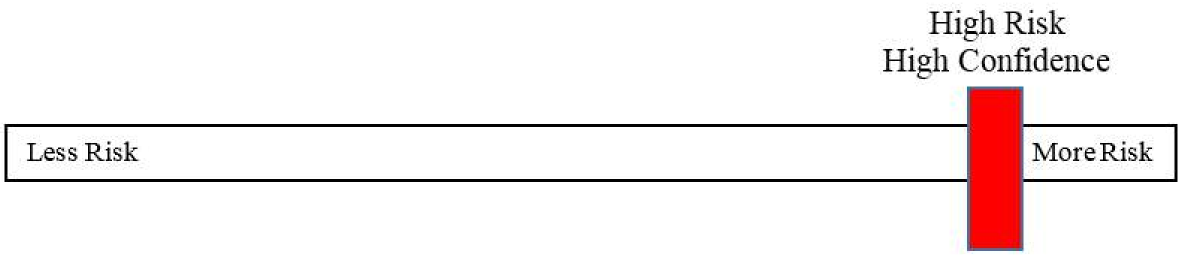
Risk	Confidence	
High	**High**	

Table 43. Effects analysis summary table; Coho, Oregon coast ESU; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported? Yes/No
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Oregon Coast Coho. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.


High Risk
High Confidence
Less Risk
More Risk

15.16 Southern Oregon Northern California (SONC) Coho Salmon Designated Critical Habitat

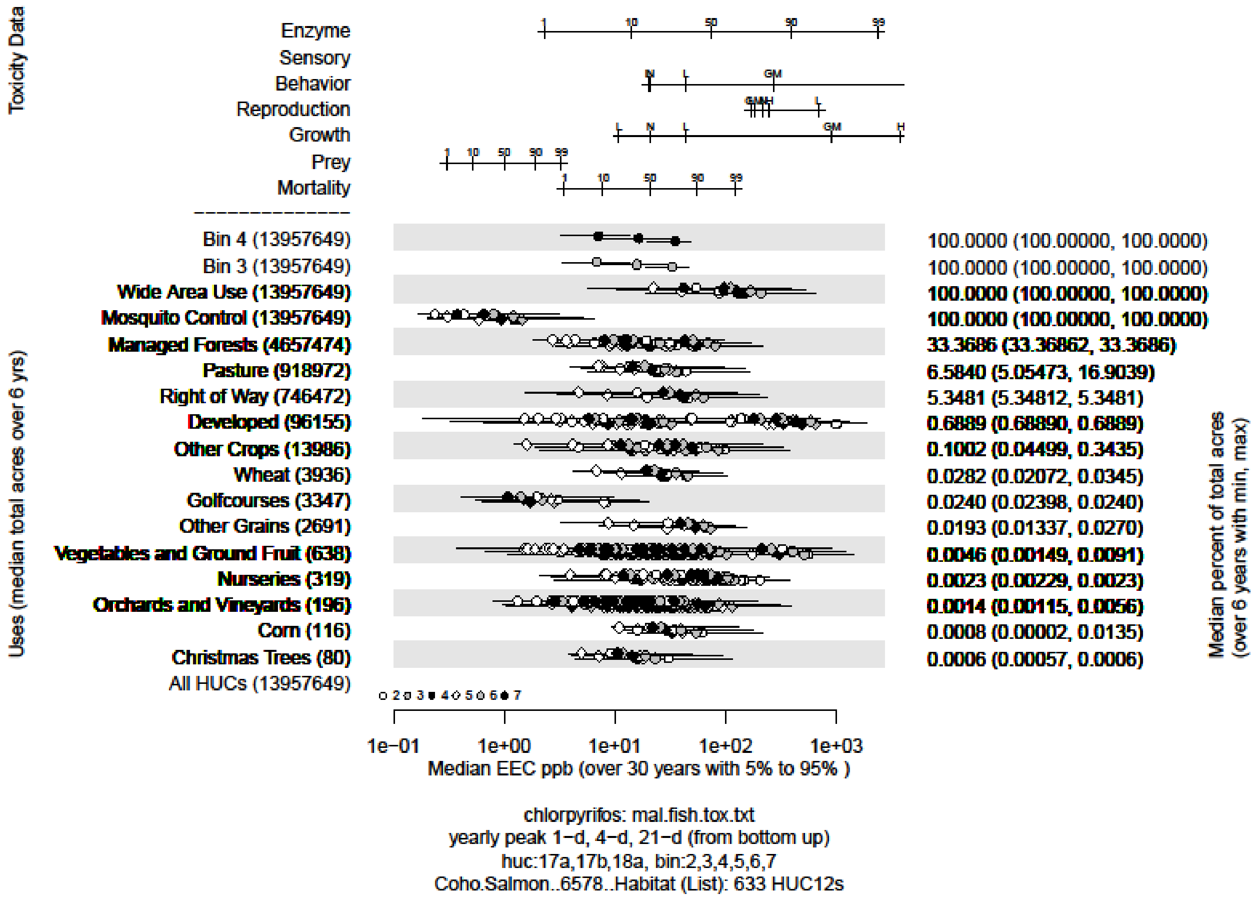


Figure 16. Effects analysis R-plot; Coho salmon, SONC ESU designated critical habitat.

Table 44. Prey risk hypothesis; Coho, SONC ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	33.37	High	High

Pasture	6.58	High	High
Right of Way	5.35	High	High
Developed	0.69	High	Low
Other Crops	0.10	High	Low
Wheat	0.03	High	Low
Golfcourses	0.02	High	Low
Other Grains	0.02	High	Low
Vegetables and Ground Fruit	<0.01	High	Low
Nurseries	<0.01	High	Low
Orchards and Vineyards	<0.01	High	Low
Corn	<0.01	High	Low
Christmas Trees	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 45. Water quality risk hypothesis; Coho, SONC ESU; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Southern Oregon Northern California (SONC) Coho. Fifteen use site categories, totaling more than 6,444,382 acres (over 46% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.

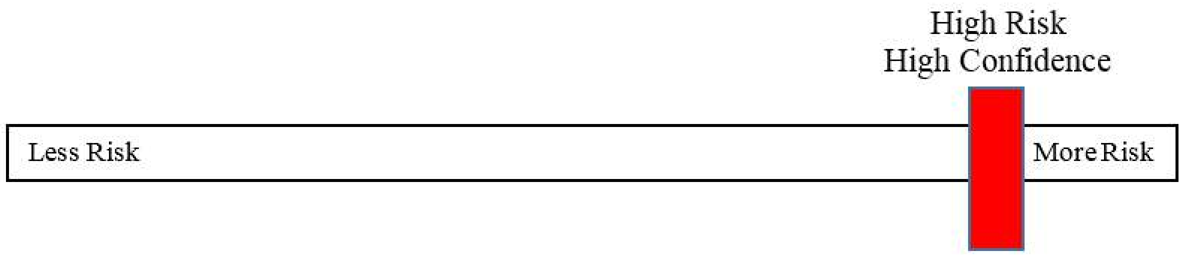
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

Table 46. Effects analysis summary table; Coho, Oregon coast ESU; designated critical habitat.

Designated Critical Habitat; Risk Hypotheses	R-plot Derived		Risk Hypothesis Supported? Yes/No
	Risk	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Southern Oregon Northern California (SONC) Coho. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.


High Risk
High Confidence
Less Risk
More Risk

15.17 Ozette Lake Sockeye Designated Critical Habitat

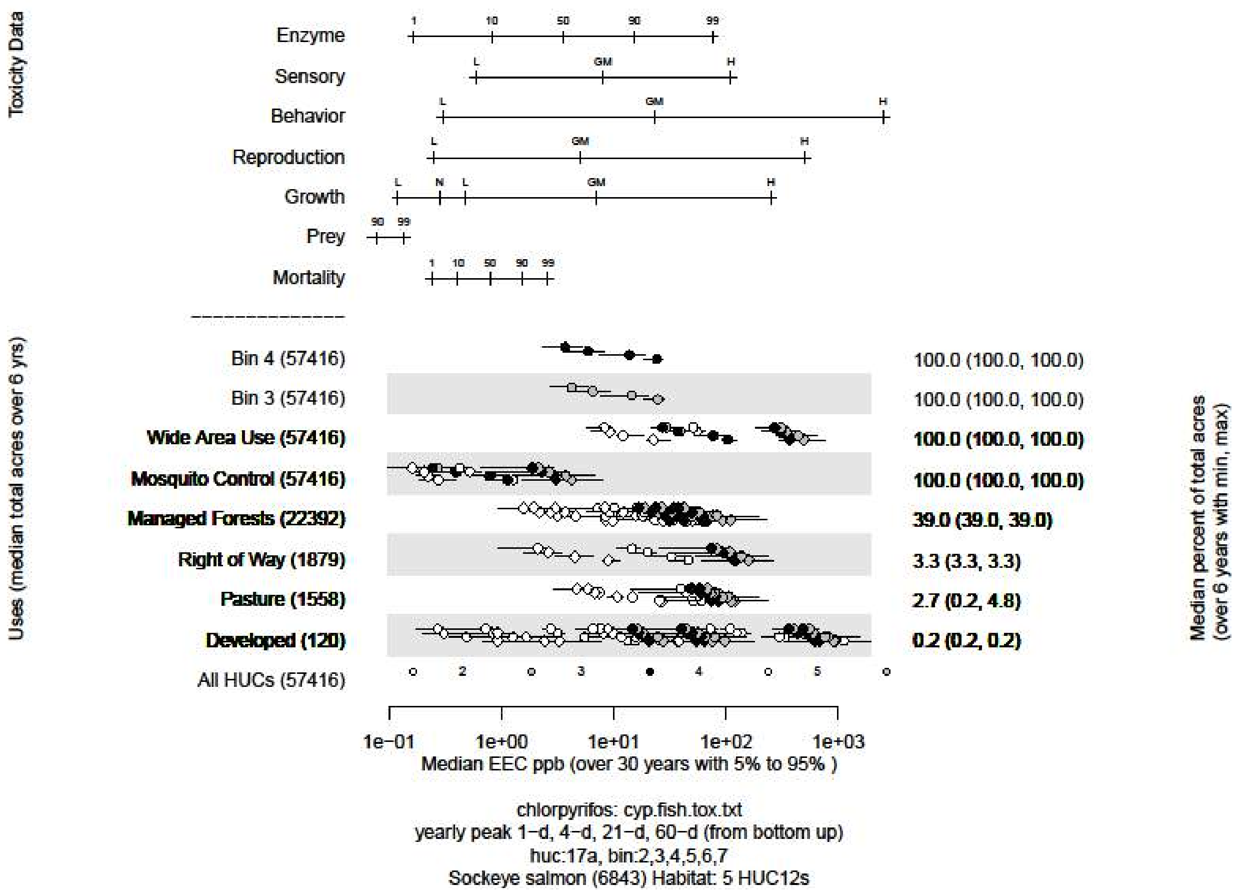


Figure 17. Effects analysis R-plot; Sockeye salmon, Ozette Lake ESU designated critical habitat.

Table 47. Prey risk hypothesis; Sockeye, Ozette Lake ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	39.00	High	High
Right of Way	3.27	High	High

Pasture	2.71	High	High
Developed	0.21	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 48. Water quality risk hypothesis; Sockeye, Ozette Lake ESU; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Sockeye, Ozette Lake ESU. Six use site categories, totaling more than 25,949 acres (over 45% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

Table 49. Effects analysis summary table; Sockeye, Ozette Lake ESU; designated critical habitat.

Designated Critical Habitat; Risk Hypotheses	**R-plot Derived**		**Risk Hypothesis Supported? Yes/No**
	Risk	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Ozette Lake Sockeye. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.

15.18 Snake River Sockeye Salmon Designated Critical Habitat

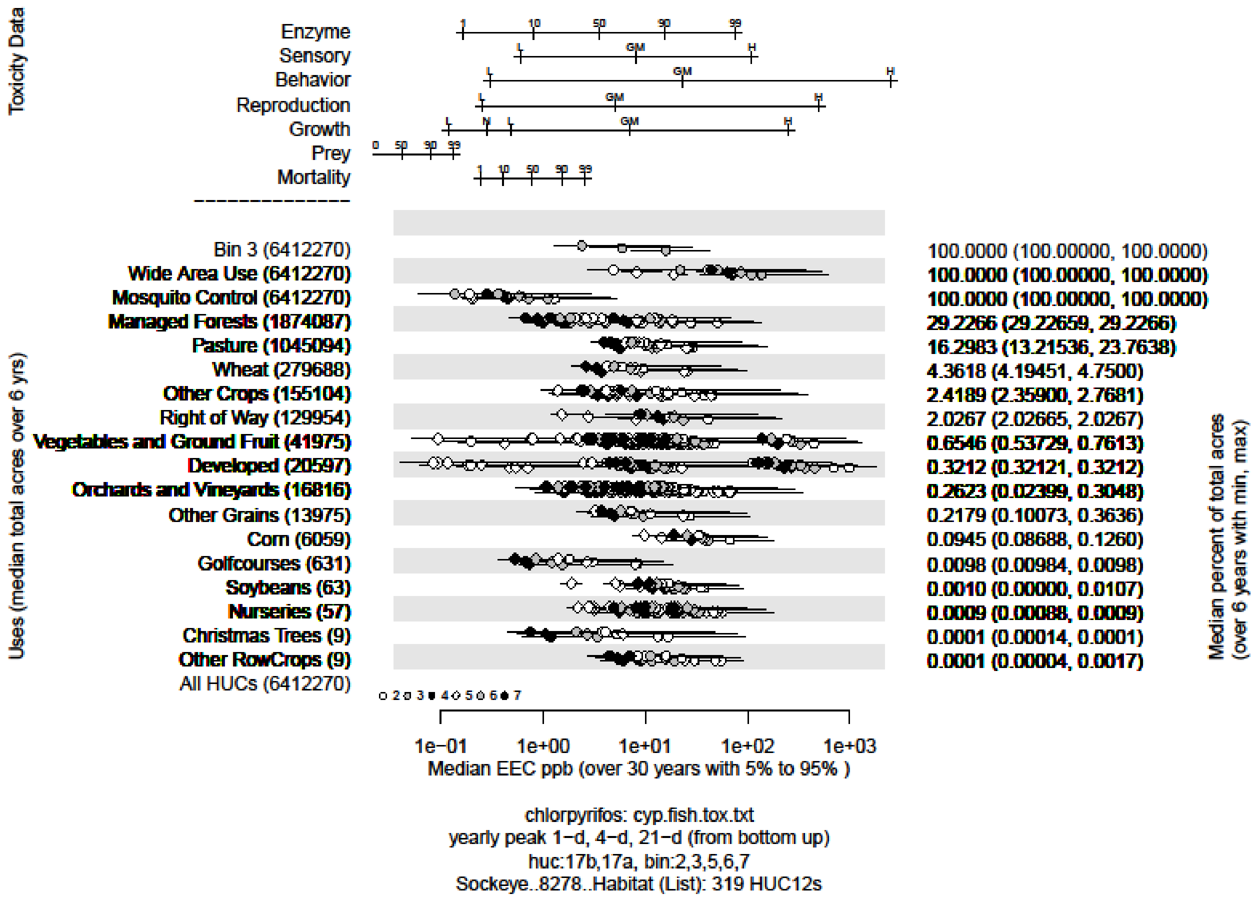


Figure 18. Effects analysis R-plot; Sockeye salmon, Snake River ESU designated critical habitat.

Table 50. Prey risk hypothesis; Sockeye, Snake River ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Managed Forests	29.23	High	High
Pasture	16.30	High	High
Wheat	4.36	High	High

Other Crops	2.42	High	High
Right of Way	2.03	High	High
Vegetables and Ground Fruit	0.65	High	Low
Developed	0.32	High	Low
Orchards and Vineyards	0.26	High	Low
Other Grains	0.22	High	Low
Corn	0.09	High	Low
Golfcourses	0.01	High	Low
Soybeans	<0.01	High	Low
Nurseries	<0.01	High	Low
Christmas Trees	<0.01	High	Low
Other RowCrops	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 51. Water quality risk hypothesis; Sockeye, Snake River ESU; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Snake River Sockeye. Seventeen use site categories, totaling more than 1,710,031 acres (over 54% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.

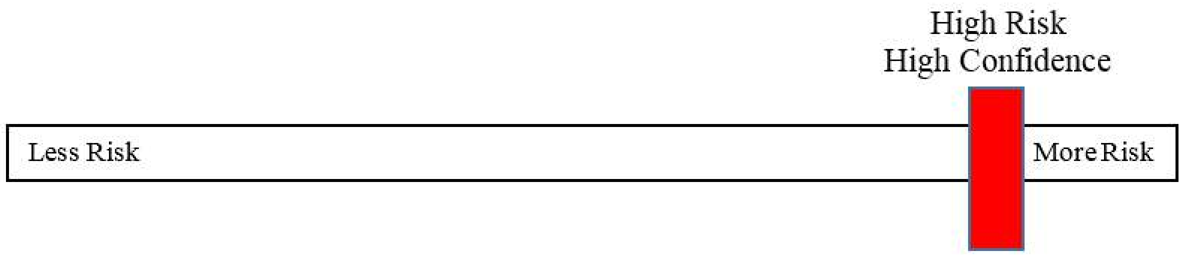
Risk	Confidence	
High	High	

Table 52. Effects analysis summary table; Sockeye, Snake River ESU; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported?
Designated Critical Habitat; Risk Hypotheses	Risk	Confidence	Yes/No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Snake River Sockeye. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.


High Risk
High Confidence
Less Risk
More Risk

15.19 California Central Valley Steelhead Designated Critical Habitat

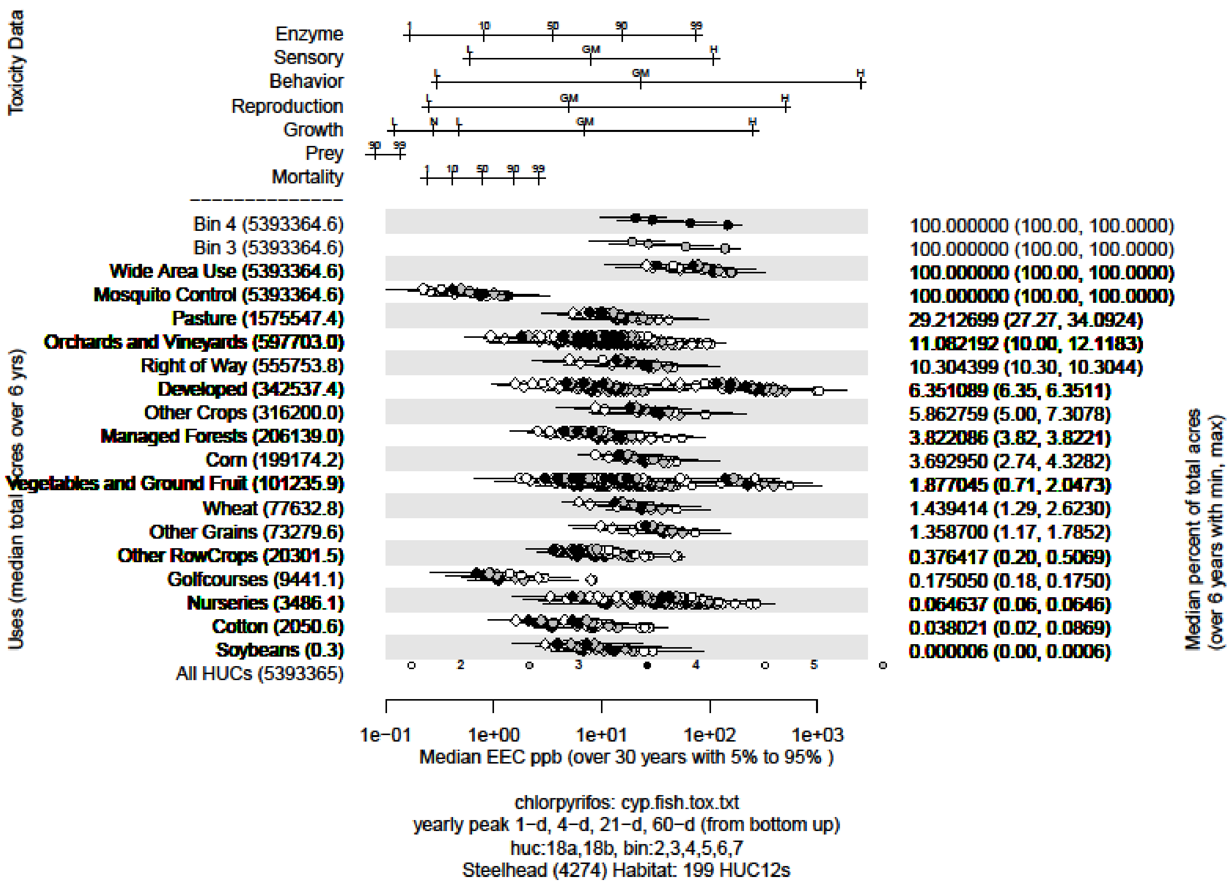


Figure 19. Effects analysis R-plot; Steelhead California Central Valley Distinct Population Segment (DPS)designated critical habitat.

Table 53. Prey (fish) risk hypothesis; Steelhead, California Central Valley DPS;designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	29.21	High	High

Orchards and Vineyards	11.08	High	High
Right of Way	10.30	High	High
Developed	6.35	High	High
Other Crops	5.86	High	High
Managed Forests	3.82	High	High
Corn	3.69	High	High
Vegetables and Ground Fruit	1.88	High	High
Wheat	1.44	High	High
Other Grains	1.36	High	High
Other RowCrops	0.38	High	Low
Golfcourses	0.18	High	Low
Nurseries	0.06	High	Low
Cotton	0.04	High	Low
Soybeans	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	

Table 54. Prey (inverts) risk hypothesis; Steelhead, California Central Valley DPS;designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	29.21	High	High
Orchards and Vineyards	11.08	High	High

Right of Way	10.30	High	High
Developed	6.35	High	High
Other Crops	5.86	High	High
Managed Forests	3.82	High	High
Corn	3.69	High	High
Vegetables and Ground Fruit	1.88	High	High
Wheat	1.44	High	High
Other Grains	1.36	High	High
Other RowCrops	0.38	High	Low
Golfcourses	0.18	High	Low
Nurseries	0.06	High	Low
Cotton	0.04	High	Low
Soybeans	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	

Table 55. Water quality risk hypothesis; Steelhead, California Central Valley DPS;designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Steelhead, California Central Valley ESU. Seventeen use site categories, totaling more than 4,080,477 acres (over 75% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.

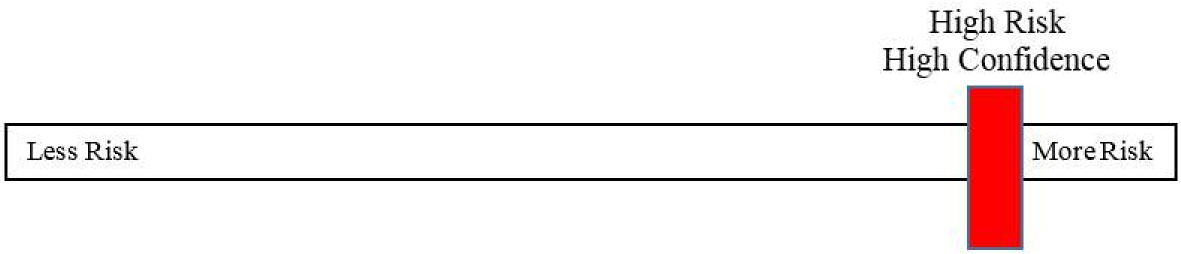
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

Table 56. Effects analysis summary table; Steelhead, California Central Valley DPS;designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported? Yes/No
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of California Central Valley Steelhead. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.


High Risk
High Confidence
Less Risk
More Risk

15.20 Central California Coast Steelhead Designated Critical Habitat

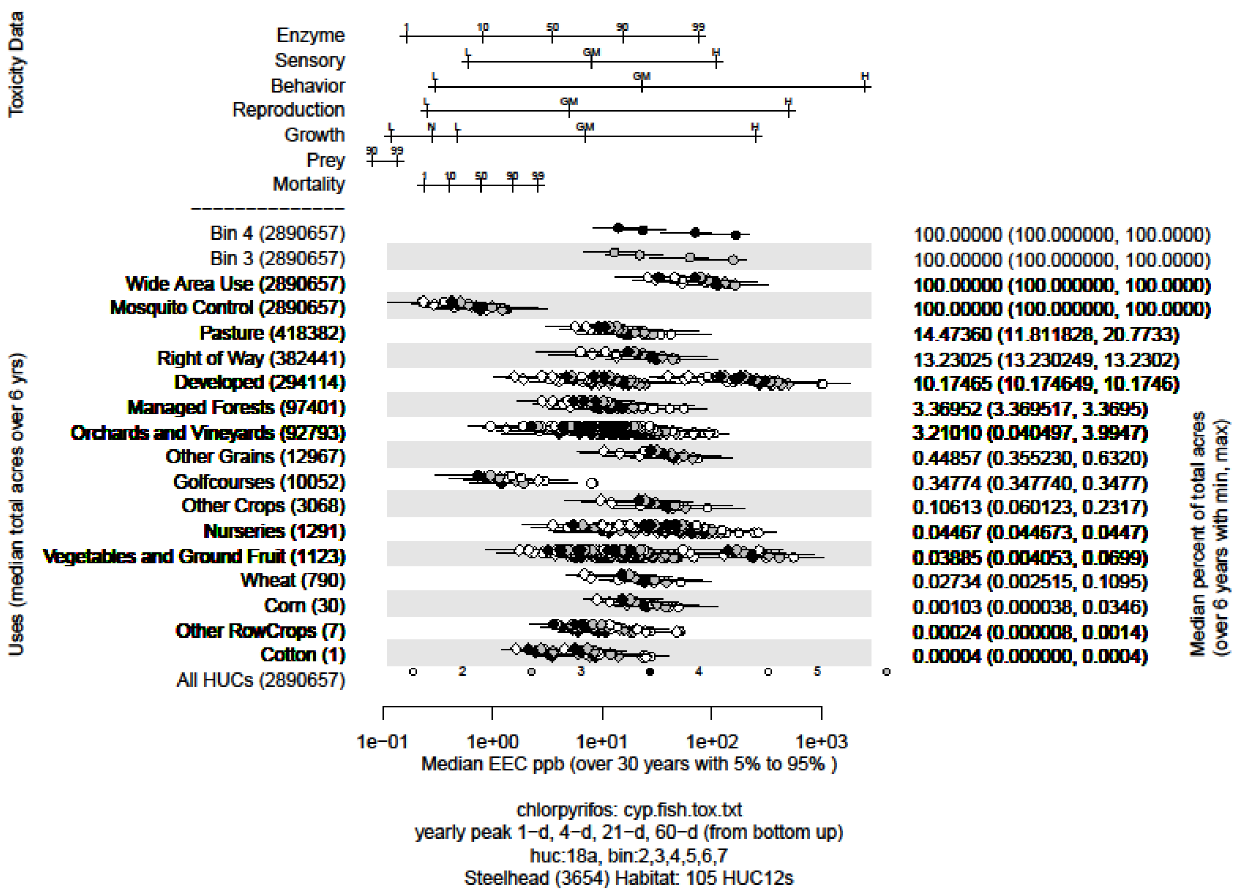


Figure 20. Effects analysis R-plot; Steelhead, Central California Coast DPS designated critical habitat.

Table 57. Prey (fish) risk hypothesis; Steelhead, Central California coast DPS;designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	14.47	High	High
Right of Way	13.23	High	High

Developed	10.17	High	High
Managed Forests	3.37	High	High
Orchards and Vineyards	3.21	High	High
Other Grains	0.45	High	Low
Golfcourses	0.35	High	Low
Other Crops	0.11	High	Low
Nurseries	0.04	High	Low
Vegetables and Ground Fruit	0.04	High	Low
Wheat	0.03	High	Low
Corn	<0.01	High	Low
Other RowCrops	<0.01	High	Low
Cotton	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 58. Prey (inverts) risk hypothesis; Steelhead, Central California coast DPS;designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	14.47	High	High
Right of Way	13.23	High	High
Developed	10.17	High	High
Managed Forests	3.37	High	High

Orchards and Vineyards	3.21	High	High
Other Grains	0.45	High	Low
Golfcourses	0.35	High	Low
Other Crops	0.11	High	Low
Nurseries	0.04	High	Low
Vegetables and Ground Fruit	0.04	High	Low
Wheat	0.03	High	Low
Corn	<0.01	High	Low
Other RowCrops	<0.01	High	Low
Cotton	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 59. Water quality risk hypothesis; Steelhead, Central California coast DPS;designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Steelhead, Central California coast ESU. Sixteen use site categories, totaling more than 3,314,460 acres (over 45% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	

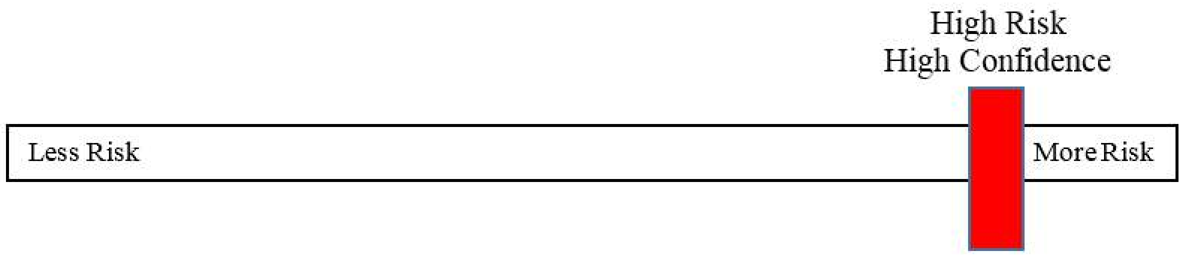
High	**High**	

Table 60. Effects analysis summary table; Steelhead, Central California coast DPS;designated critical habitat.

Designated Critical Habitat; Risk Hypotheses	**R-plot Derived**		**Risk Hypothesis Supported? Yes/No**
	Risk	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Central California Coast Steelhead. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.


High Risk
High Confidence
Less Risk
More Risk

15.21 Lower Columbia River Steelhead Designated Critical Habitat

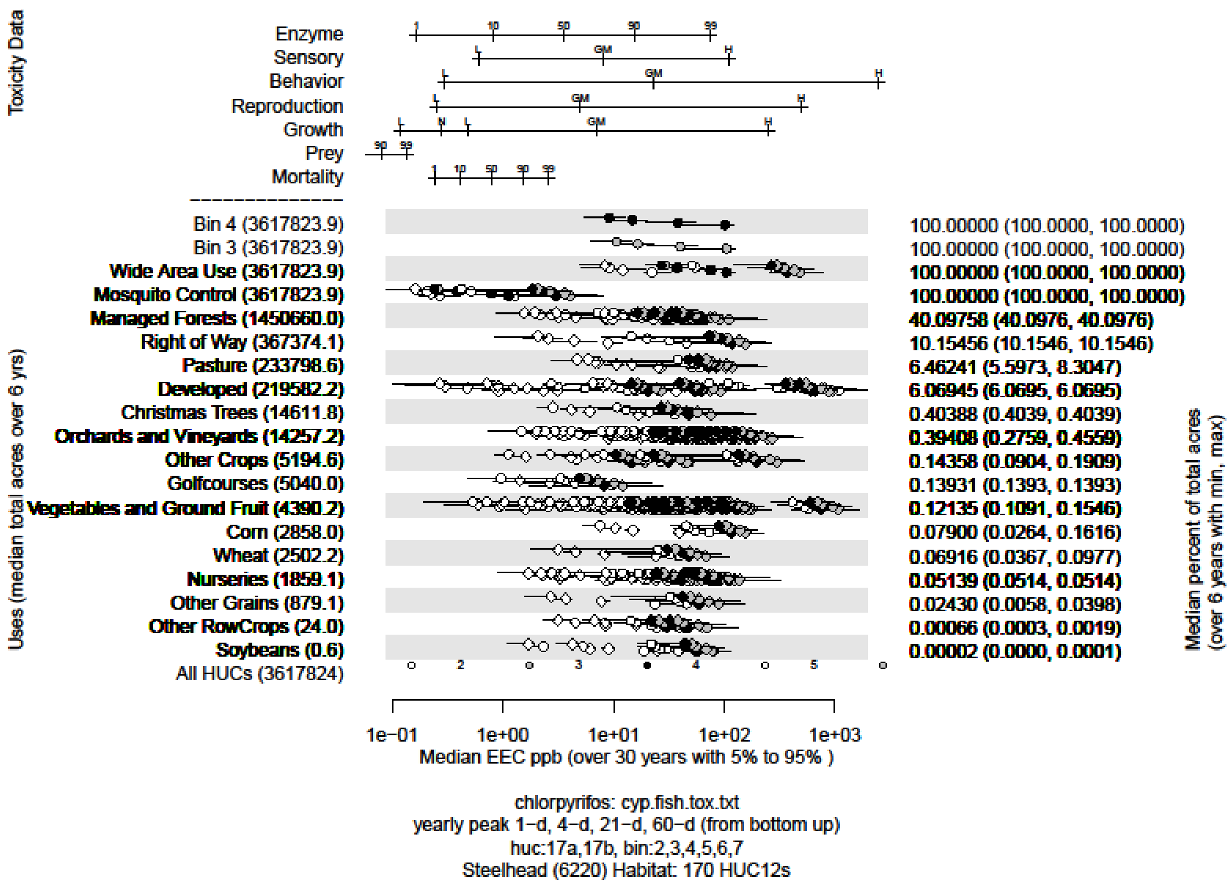


Figure 21. Effects analysis R-plot; Steelhead Lower Columbia River DPS designated critical habitat.

Table 61. Prey (fish) risk hypothesis; Steelhead, lower Columbia River DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	40.10	High	High
Right of Way	10.15	High	High

Pasture	6.46	High	High
Developed	6.07	High	High
Christmas Trees	0.40	High	Low
Orchards and Vineyards	0.39	High	Low
Other Crops	0.14	High	Low
Golfcourses	0.14	High	Low
Vegetables and Ground Fruit	0.12	High	Low
Corn	0.08	High	Low
Wheat	0.07	High	Low
Nurseries	0.05	High	Low
Other Grains	0.02	High	Low
Other RowCrops	<0.01	High	Low
Soybeans	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 62. Prey (inverts) risk hypothesis; Steelhead, lower Columbia River DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	40.10	High	High
Right of Way	10.15	High	High
Pasture	6.46	High	High
Developed	6.07	High	High

Christmas Trees	0.40	High	Low
Orchards and Vineyards	0.39	High	Low
Other Crops	0.14	High	Low
Golfcourses	0.14	High	Low
Vegetables and Ground Fruit	0.12	High	Low
Corn	0.08	High	Low
Wheat	0.07	High	Low
Nurseries	0.05	High	Low
Other Grains	0.02	High	Low
Other RowCrops	<0.01	High	Low
Soybeans	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 63. Water quality risk hypothesis; Steelhead, lower Columbia River DPS; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Steelhead, lower Columbia River ESU. Seventeen use site categories, totaling more than 2,323,028 acres (over 63% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.

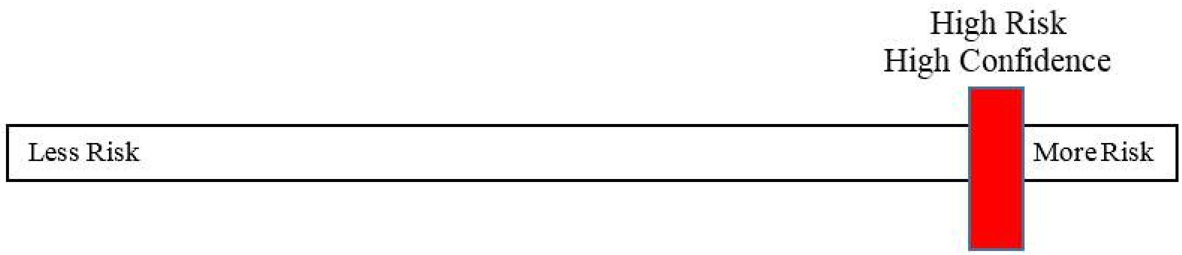
Risk	Confidence	
High	High	

Table 64. Effects analysis summary table; Steelhead, lower Columbia River DPS; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported? Yes/No
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Lower Columbia River Steelhead. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.


High Risk
High Confidence
Less Risk
More Risk

15.22 Middle Columbia River Steelhead Designated Critical Habitat

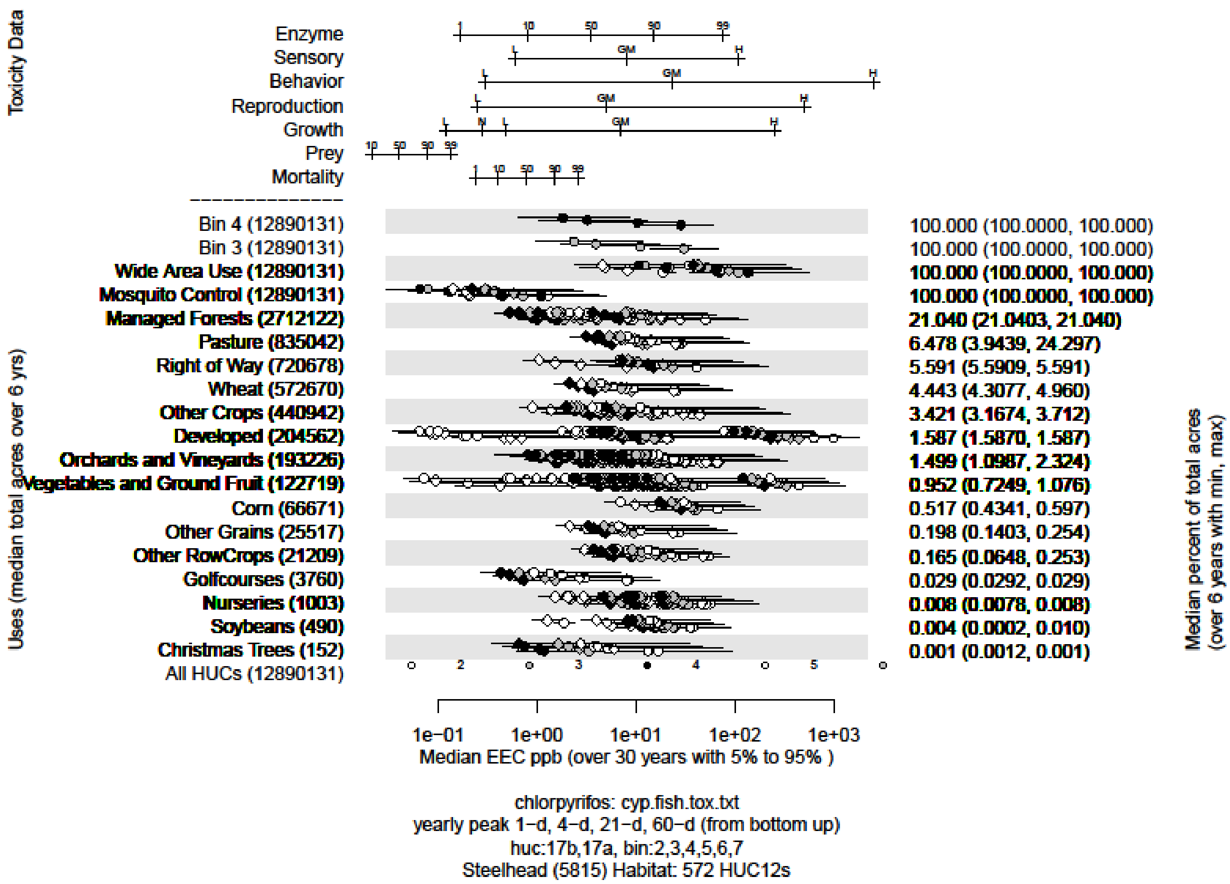


Figure 22. Effects analysis R-plot; Steelhead, Middle Columbia River DPS designated critical habitat.

Table 65. Prey (fish) risk hypothesis; Steelhead, middle Columbia River DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	21.04	High	High
Pasture	6.48	High	High

Right of Way	5.59	High	High
Wheat	4.44	High	High
Other Crops	3.42	High	High
Developed	1.59	High	High
Orchards and Vineyards	1.50	High	High
Vegetables and Ground Fruit	0.95	High	Low
Corn	0.52	High	Low
Other Grains	0.20	High	Low
Other RowCrops	0.16	High	Low
Golfcourses	0.03	High	Low
Nurseries	0.01	High	Low
Soybeans	<0.01	High	Low
Christmas Trees	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 66. Prey (inverts) risk hypothesis; Steelhead, middle Columbia River DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	21.04	High	High
Pasture	6.48	High	High
Right of Way	5.59	High	High
Wheat	4.44	High	High

Other Crops	3.42	High	High
Developed	1.59	High	High
Orchards and Vineyards	1.50	High	High
Vegetables and Ground Fruit	0.95	High	Low
Corn	0.52	High	Low
Other Grains	0.20	High	Low
Other RowCrops	0.16	High	Low
Golfcourses	0.03	High	Low
Nurseries	0.01	High	Low
Soybeans	<0.001	High	Low
Christmas Trees	<0.001	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 67. Water quality risk hypothesis; Steelhead, middle Columbia River DPS; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Steelhead, middle Columbia River DPS. Seventeen use site categories, totaling more than 5,920,763 acres (over 45% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.

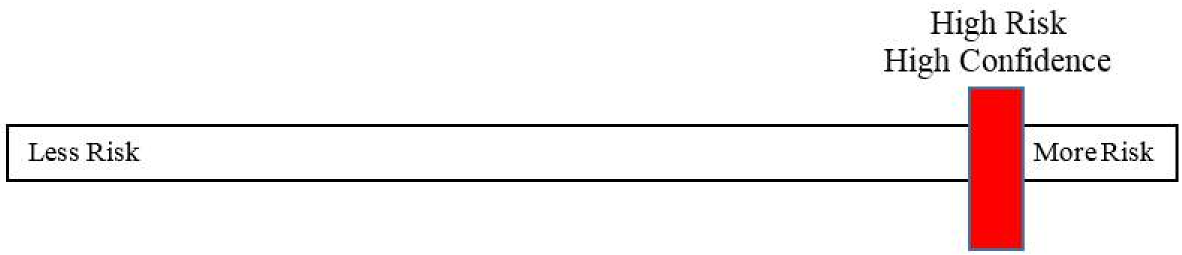
Risk	Confidence	
High	High	

Table 68. Effects analysis summary table; Steelhead, middle Columbia River DPS; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported? Yes/No
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Middle Columbia River Steelhead. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.


High Risk
High Confidence
Less Risk
More Risk

15.23 Northern California Steelhead Designated Critical Habitat

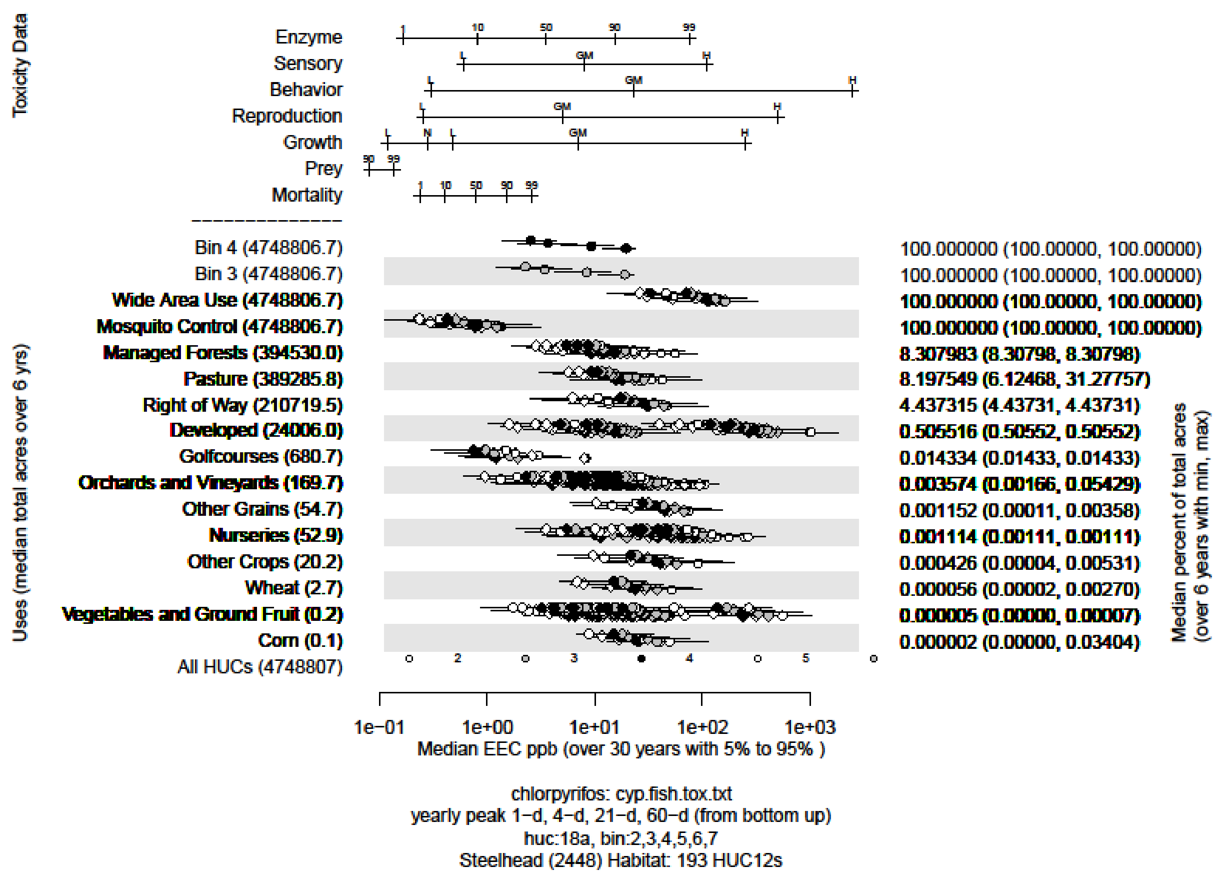


Figure 23. Effects analysis R-plot; Steelhead, Northern California DPS designated critical habitat.

Table 69. Prey (fish) risk hypothesis; Steelhead, Northern California DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	8.31	High	High
Pasture	8.20	High	High

Right of Way	4.44	High	High
Developed	0.51	High	Low
Golfcourses	0.01	High	Low
Orchards and Vineyards	<0.01	High	Low
Other Grains	<0.01	High	Low
Nurseries	<0.01	High	Low
Other Crops	<0.01	High	Low
Wheat	<0.01	High	Low
Vegetables and Ground Fruit	<0.01	High	Low
Corn	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 70. Prey (inverts) risk hypothesis; Steelhead, Northern California DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	8.31	High	High
Pasture	8.20	High	High
Right of Way	4.44	High	High
Developed	0.51	High	Low
Golfcourses	0.01	High	Low
Orchards and Vineyards	<0.01	High	Low

Other Grains	<0.01	High	Low
Nurseries	<0.01	High	Low
Other Crops	<0.01	High	Low
Wheat	<0.01	High	Low
Vegetables and Ground Fruit	<0.01	High	Low
Corn	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 71. Water quality risk hypothesis; Steelhead, Northern California DPS; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Steelhead, Northern California DPS. Fourteen use site categories, totaling more than 1,019,525 acres (over 21% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

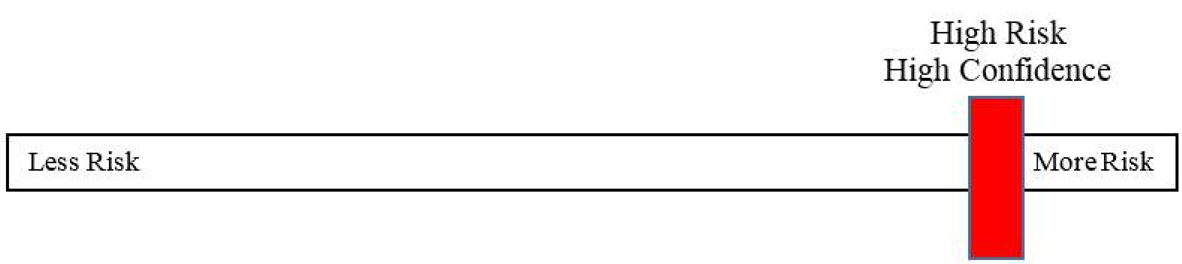
Table 72. Effects analysis summary table; Steelhead, Northern California DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	

			Yes/No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Northern California Steelhead. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



15.24 Puget Sound Steelhead Designated Critical Habitat

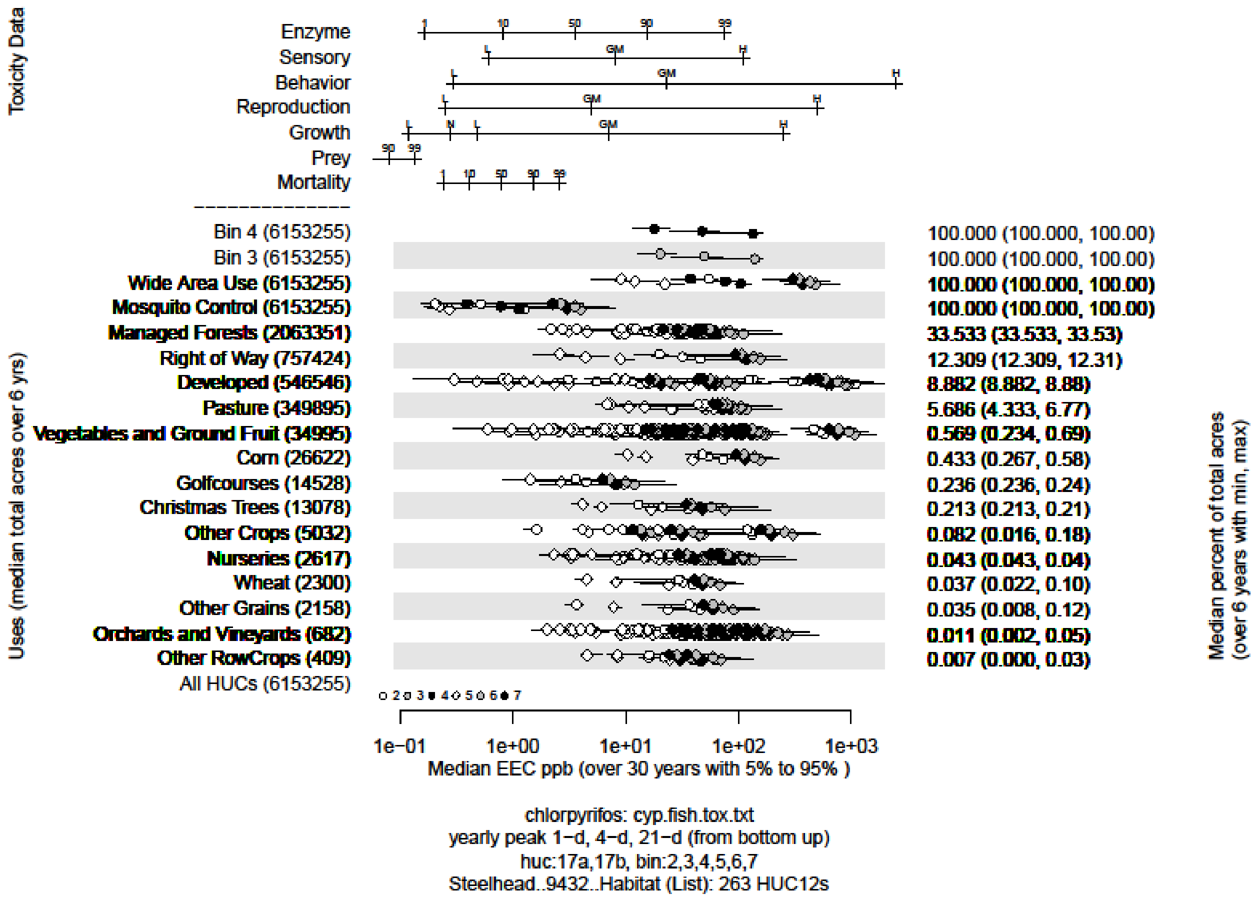


Figure 24. Effects analysis R-plot; Steelhead, Puget Sound DPS designated critical habitat.

Table 73. Prey (fish) risk hypothesis; Steelhead, Puget Sound DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	33.53	High	High
Right of Way	12.31	High	High

Developed	8.88	High	High
Pasture	5.69	High	High
Vegetables and Ground Fruit	0.57	High	Low
Corn	0.43	High	Low
Golfcourses	0.24	High	Low
Christmas Trees	0.21	High	Low
Other Crops	0.08	High	Low
Nurseries	0.04	High	Low
Wheat	0.04	High	Low
Other Grains	0.04	High	Low
Orchards and Vineyards	0.01	High	Low
Other RowCrops	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 74. Prey (inverts) risk hypothesis; Steelhead, Puget Sound DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	33.53	High	High
Right of Way	12.31	High	High
Developed	8.88	High	High
Pasture	5.69	High	High

Vegetables and Ground Fruit	0.57	High	Low
Corn	0.43	High	Low
Golfcourses	0.24	High	Low
Christmas Trees	0.21	High	Low
Other Crops	0.08	High	Low
Nurseries	0.04	High	Low
Wheat	0.04	High	Low
Other Grains	0.04	High	Low
Orchards and Vineyards	0.01	High	Low
Other RowCrops	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 75. Water quality risk hypothesis; Steelhead, Puget Sound DPS; designated critical habitat.

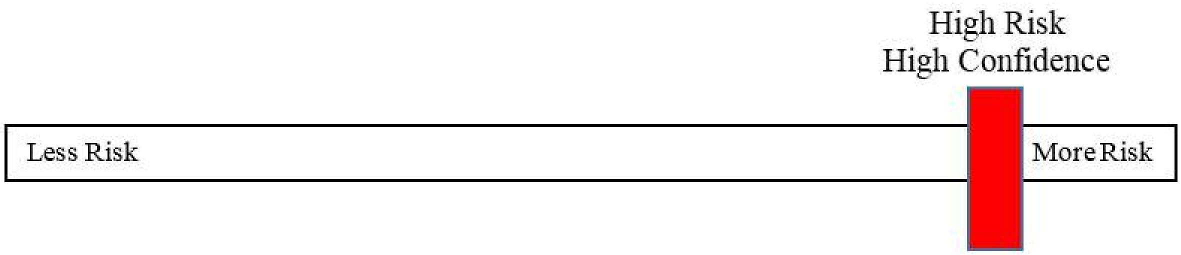
Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Steelhead, Puget Sound DPS. Sixteen use site categories, totaling more than 3,819,637 acres (over 63% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

Table 76. Effects analysis summary table; Steelhead, Puget Sound DPS; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported? Yes/No
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Puget Sound Steelhead. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.


High Risk
High Confidence
Less Risk
More Risk

15.25 Snake River Basin Steelhead Designated Critical Habitat

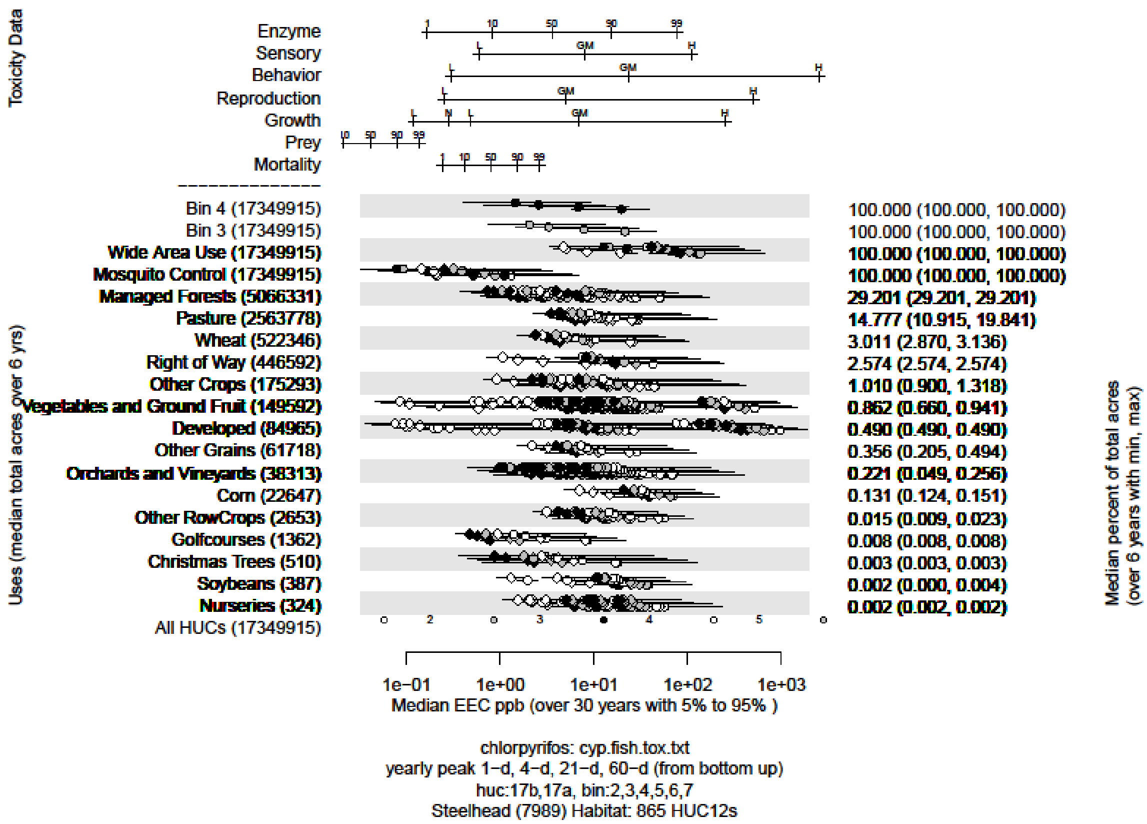


Figure 25. Effects analysis R-plot; Steelhead, Snake River Basin DPS designated critical habitat.

Table 77. Prey (fish) risk hypothesis; Steelhead, Snake River basin DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	29.20	High	High
Pasture	14.78	High	High
Wheat	3.01	High	High

Right of Way	2.57	High	High
Other Crops	1.01	High	High
Vegetables and Ground Fruit	0.86	High	Low
Developed	0.49	High	Low
Other Grains	0.36	High	Low
Orchards and Vineyards	0.22	High	Low
Corn	0.13	High	Low
Other RowCrops	0.02	High	Low
Golfcourses	0.01	High	Low
Christmas Trees	<0.01	High	Low
Soybeans	<0.01	High	Low
Nurseries	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 78. Prey (inverts) risk hypothesis; Steelhead, Snake River basin DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	29.20	High	High
Pasture	14.78	High	High
Wheat	3.01	High	High
Right of Way	2.57	High	High
Other Crops	1.01	High	High

Vegetables and Ground Fruit	0.86	High	Low
Developed	0.49	High	Low
Other Grains	0.36	High	Low
Orchards and Vineyards	0.22	High	Low
Corn	0.13	High	Low
Other RowCrops	0.02	High	Low
Golfcourses	0.01	High	Low
Christmas Trees	<0.01	High	Low
Soybeans	<0.01	High	Low
Nurseries	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 79. Water quality risk hypothesis; Steelhead, Snake River basin DPS; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Steelhead, Snake River basin DPS. Seventeen use site categories, totaling more than 9,136,811 acres (over 52% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	

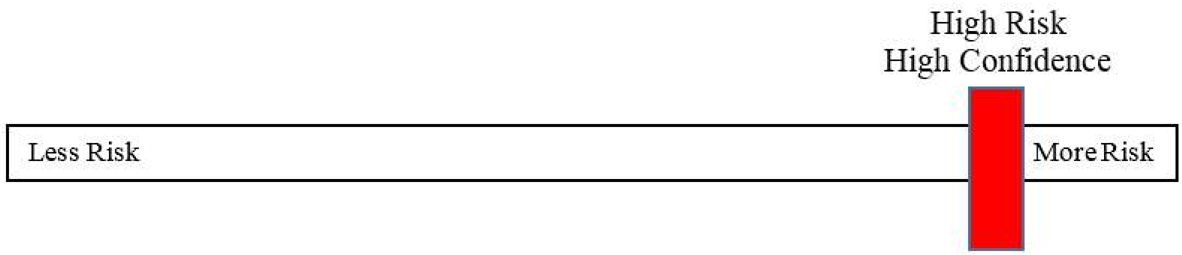
High	**High**	

Table 80. Effects analysis summary table; Steelhead, Snake River basin DPS;designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Snake River Basin Steelhead. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.


High Risk
High Confidence
Less Risk
More Risk

15.26 South Central California Coast Steelhead Designated Critical Habitat

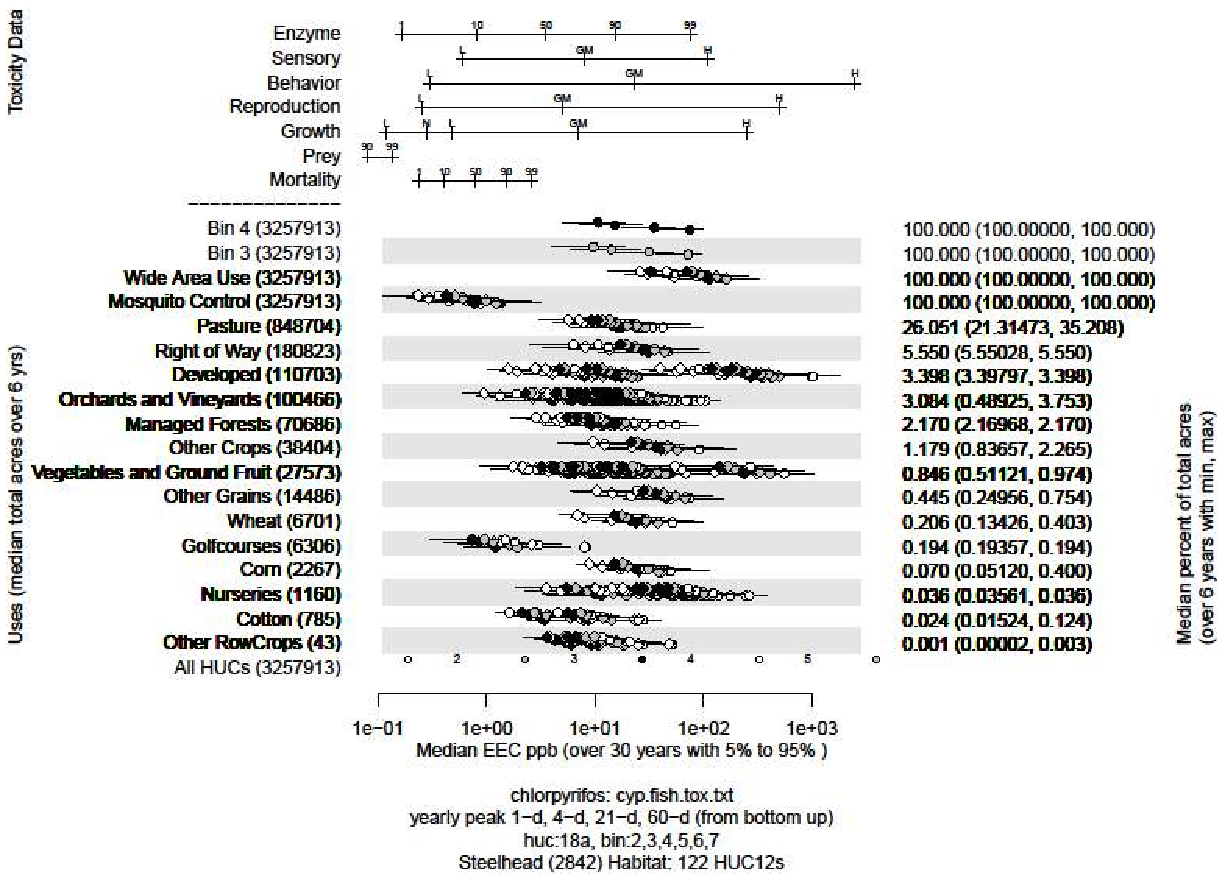


Figure 26. Effects analysis R-plot; Steelhead, South Central California Coast DPS designated critical habitat.

Table 81. Prey (fish) risk hypothesis; Steelhead, South-central California coast DPS;designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	26.05	High	High
Right of Way	5.55	High	High

Developed	3.40	High	High
Orchards and Vineyards	3.08	High	High
Managed Forests	2.17	High	High
Other Crops	1.18	High	High
Vegetables and Ground Fruit	0.85	High	Low
Other Grains	0.44	High	Low
Wheat	0.21	High	Low
Golfcourses	0.19	High	Low
Corn	0.07	High	Low
Nurseries	0.04	High	Low
Cotton	0.02	High	Low
Other RowCrops	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 82. Prey (inverts) risk hypothesis; Steelhead, South-central California coast DPS;designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	26.05	High	High
Right of Way	5.55	High	High
Developed	3.40	High	High

Orchards and Vineyards	3.08	High	High
Managed Forests	2.17	High	High
Other Crops	1.18	High	High
Vegetables and Ground Fruit	0.85	High	Low
Other Grains	0.44	High	Low
Wheat	0.21	High	Low
Golfcourses	0.19	High	Low
Corn	0.07	High	Low
Nurseries	0.04	High	Low
Cotton	0.02	High	Low
Other RowCrops	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 83. Water quality risk hypothesis; Steelhead, South-central California coast DPS;designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Steelhead, South-central California coast ESU. Sixteen use site categories, totaling more than 1,409,107 acres (over 44% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.

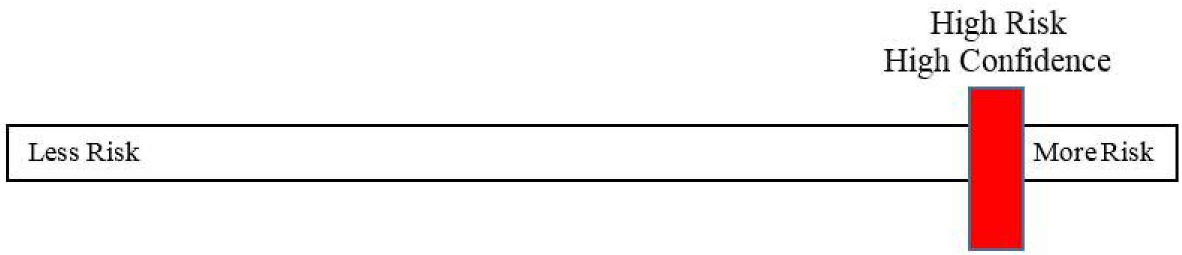
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

Table 84. Effects analysis summary table; Steelhead, South-central California coast DPS;designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported? Yes/No
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of South Central California Coast Steelhead. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.


High Risk
High Confidence
Less Risk
More Risk

15.27 Southern California Steelhead Designated Critical Habitat

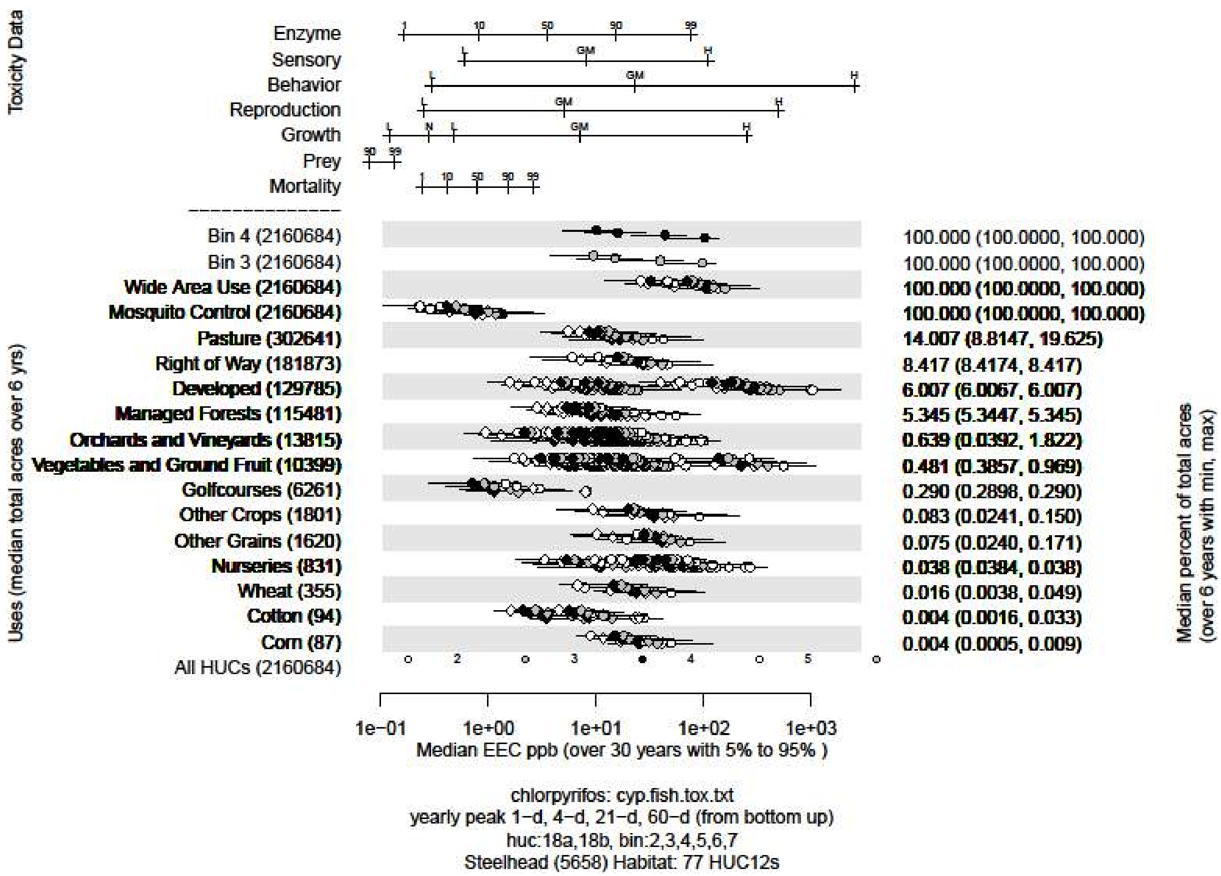


Figure 27. Effects analysis R-plot; Steelhead, Southern California DPS designated critical habitat.

Table 85. Prey (fish) risk hypothesis; Steelhead, Southern California DPS;designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	14.01	High	High
Right of Way	8.42	High	High

Developed	6.01	High	High
Managed Forests	5.34	High	High
Orchards and Vineyards	0.64	High	Low
Vegetables and Ground Fruit	0.48	High	Low
Golfcourses	0.29	High	Low
Other Crops	0.08	High	Low
Other Grains	0.07	High	Low
Nurseries	0.04	High	Low
Wheat	0.02	High	Low
Cotton	<0.01	High	Low
Corn	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 86. Prey (inverts) risk hypothesis; Steelhead, Southern California DPS;designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	14.01	High	High
Right of Way	8.42	High	High
Developed	6.01	High	High
Managed Forests	5.34	High	High
Orchards and Vineyards	0.64	High	Low

Vegetables and Ground Fruit	0.48	High	Low
Golfcourses	0.29	High	Low
Other Crops	0.08	High	Low
Other Grains	0.07	High	Low
Nurseries	0.04	High	Low
Wheat	0.02	High	Low
Cotton	<0.01	High	Low
Corn	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 87. Water quality risk hypothesis; Steelhead, Southern California DPS;designated critical habitat.

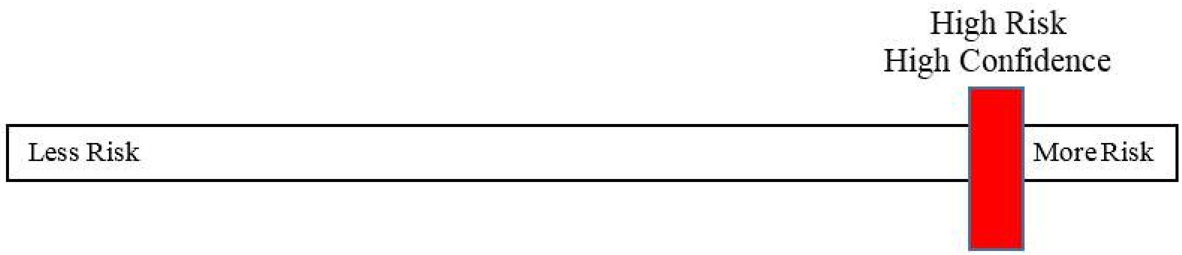
Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Steelhead, Southern California ESU. Fifteen use site categories, totaling more than 765,006 acres (over 35% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

Table 88. Effects analysis summary table; Steelhead, Southern California DPS;designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Southern California Steelhead. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.


High Risk
High Confidence
Less Risk
More Risk

15.28 Upper Columbia River Steelhead Designated Critical Habitat

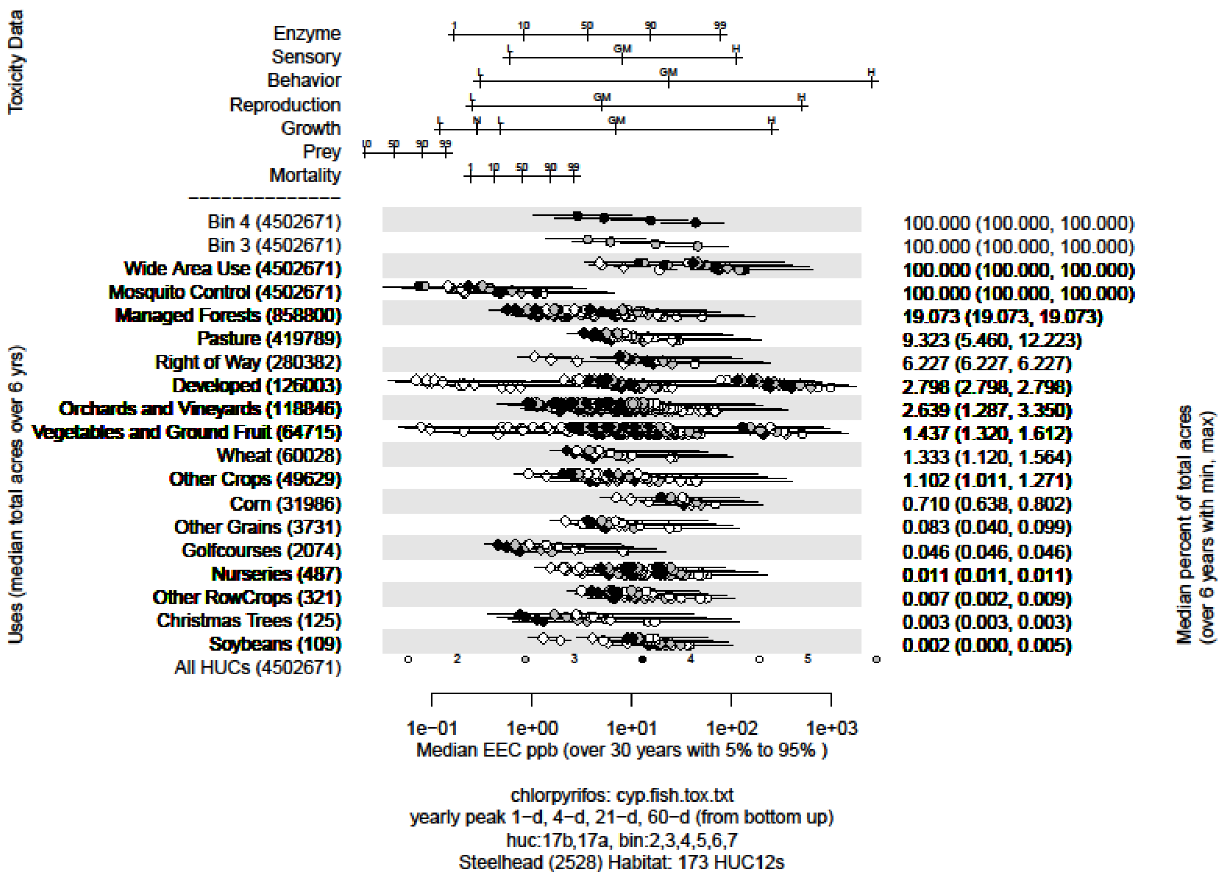


Figure 28. Effects analysis R-plot; Steelhead, Upper Columbia River DPS designated critical habitat.

Table 89. Prey (fish) risk hypothesis; Steelhead, upper Columbia River DPS;designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	19.07	High	High
Pasture	9.32	High	High

Right of Way	6.23	High	High
Developed	2.80	High	High
Orchards and Vineyards	2.64	High	High
Vegetables and Ground Fruit	1.44	High	High
Wheat	1.33	High	High
Other Crops	1.10	High	High
Corn	0.71	High	Low
Other Grains	0.08	High	Low
Golfcourses	0.05	High	Low
Nurseries	0.01	High	Low
Other RowCrops	0.01	High	Low
Christmas Trees	<0.01	High	Low
Soybeans	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 90. Prey (inverts) risk hypothesis; Steelhead, upper Columbia River DPS;designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	19.07	High	High
Pasture	9.32	High	High
Right of Way	6.23	High	High
Developed	2.80	High	High

Orchards and Vineyards	2.64	High	High
Vegetables and Ground Fruit	1.44	High	High
Wheat	1.33	High	High
Other Crops	1.10	High	High
Corn	0.71	High	Low
Other Grains	0.08	High	Low
Golfcourses	0.05	High	Low
Nurseries	0.01	High	Low
Other RowCrops	0.01	High	Low
Christmas Trees	<0.01	High	Low
Soybeans	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 91. Water quality risk hypothesis; Steelhead, upper Columbia River DPS;designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Steelhead, upper Columbia River ESU. Seventeen use site categories, totaling more than 2,017,023 acres (over 44% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.

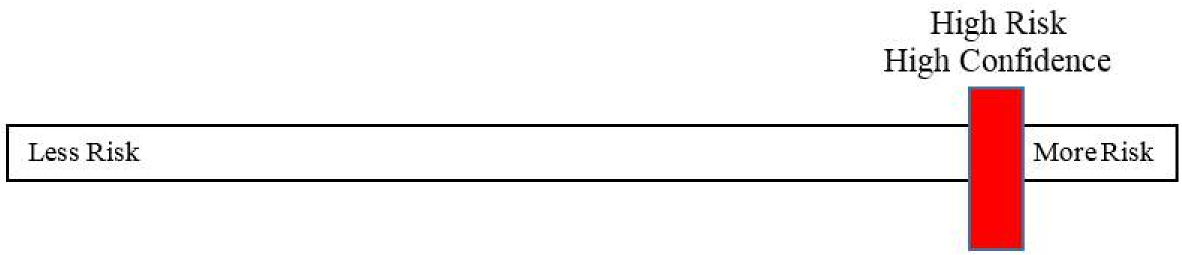
Risk	Confidence	
High	High	

Table 92. Effects analysis summary table; Steelhead, upper Columbia River DPS;designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported? Yes/No
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Upper Columbia River Steelhead. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.


High Risk
High Confidence
Less Risk
More Risk

15.29 Upper Willamette River Steelhead Designated Critical Habitat

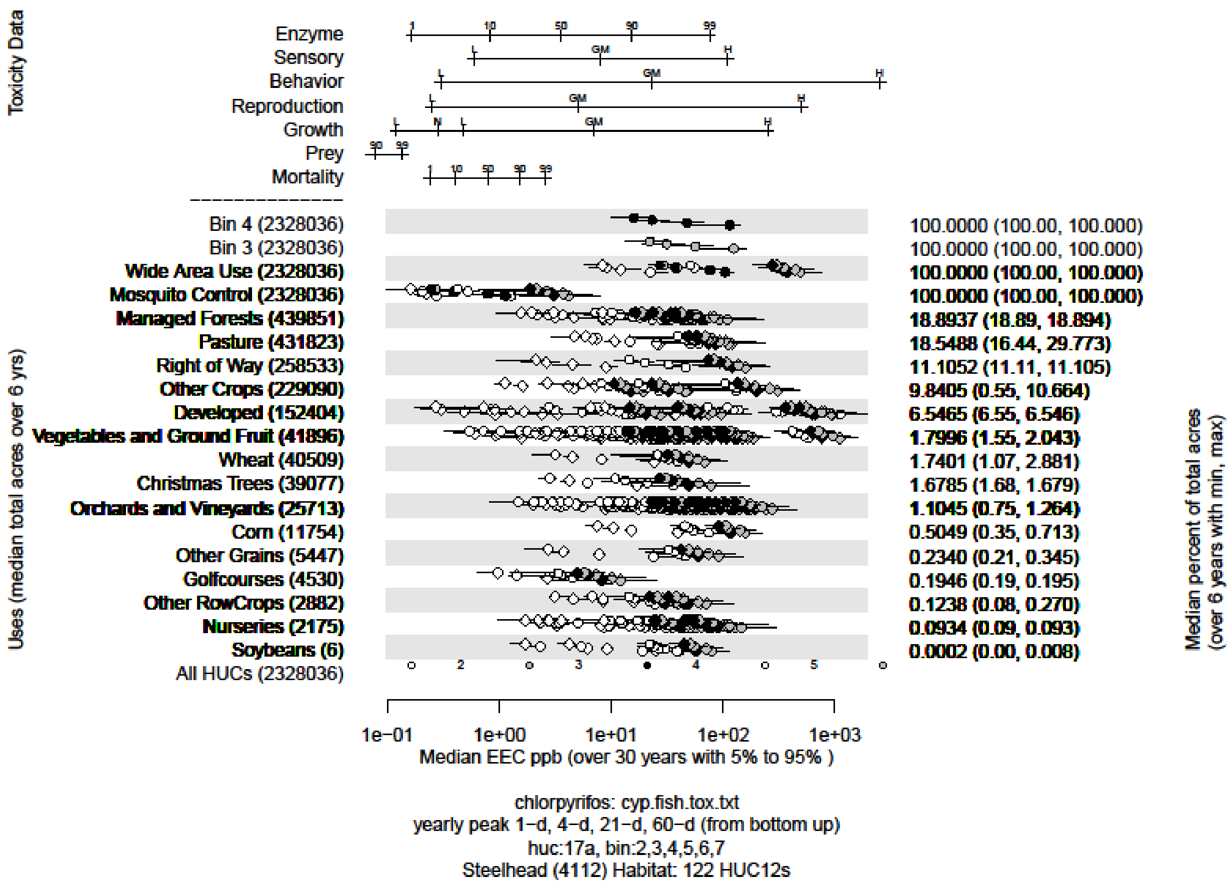


Figure 29. Effects analysis R-plot; Steelhead, Upper Willamette River DPS designated critical habitat.

Table 93. Prey (fish) risk hypothesis; Steelhead, upper Willamette River DPS;designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	18.89	High	High
Pasture	18.55	High	High

Right of Way	11.11	High	High
Other Crops	9.84	High	High
Developed	6.55	High	High
Vegetables and Ground Fruit	1.80	High	High
Wheat	1.74	High	High
Christmas Trees	1.68	High	High
Orchards and Vineyards	1.10	High	High
Corn	0.50	High	Low
Other Grains	0.23	High	Low
Golfcourses	0.19	High	Low
Other RowCrops	0.12	High	Low
Nurseries	0.09	High	Low
Soybeans	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 94. Prey (inverts) risk hypothesis; Steelhead, upper Willamette River DPS;designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	18.89	High	High
Pasture	18.55	High	High
Right of Way	11.11	High	High
Other Crops	9.84	High	High

Developed	6.55	High	High
Vegetables and Ground Fruit	1.80	High	High
Wheat	1.74	High	High
Christmas Trees	1.68	High	High
Orchards and Vineyards	1.10	High	High
Corn	0.50	High	Low
Other Grains	0.23	High	Low
Golfcourses	0.19	High	Low
Other RowCrops	0.12	High	Low
Nurseries	0.09	High	Low
Soybeans	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 95. Water quality risk hypothesis; Steelhead, upper Willamette River DPS;designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Steelhead, upper Willamette River ESU. Seventeen use site categories, totaling more than 1,685,690 acres (over 75% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.

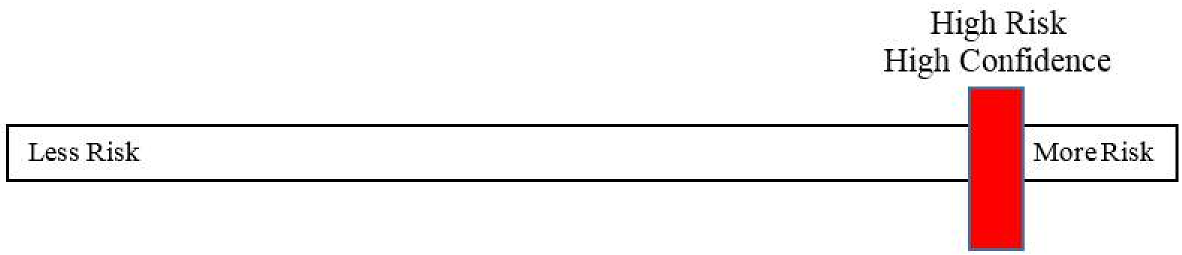
Risk	Confidence	
High	**High**	

Table 96. Effects analysis summary table; Steelhead, upper Willamette River DPS;designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported? Yes/No
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Upper Willamette River Steelhead. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.


High Risk
High Confidence
Less Risk
More Risk

15.30 Eulachon (Southern DPS) Designated Critical Habitat

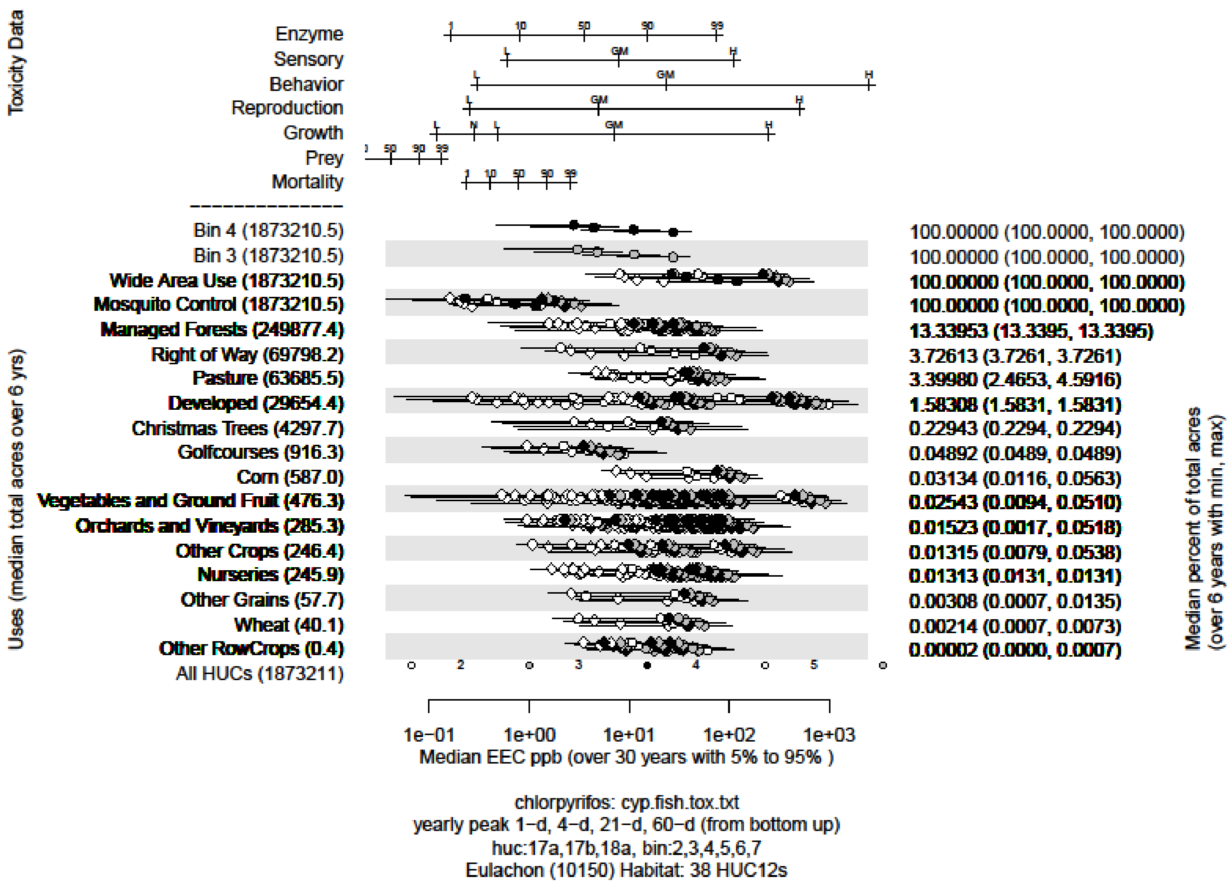


Figure 30. Effects analysis R-plot; Eulachon, Southern DPS designated critical habitat.

Table 97. Prey (inverts) risk hypothesis; Eulachon, southern DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	13.34	High	High
Right of Way	3.73	High	High

Pasture	3.40	High	High
Developed	1.58	High	High
Christmas Trees	0.23	High	Low
Golfcourses	0.05	High	Low
Corn	0.03	High	Low
Vegetables and Ground Fruit	0.03	High	Low
Orchards and Vineyards	0.02	High	Low
Other Crops	0.01	High	Low
Nurseries	0.01	High	Low
Other Grains	<0.01	High	Low
Wheat	<0.01	High	Low
Other RowCrops	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey (inverts).			
Risk	**Confidence**		
High	**High**		

Table 98. Water quality risk hypothesis; Eulachon, southern DPS; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Eulachon, southern DPS. Sixteen use site categories, totaling more than 420,163 acres (over 23% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.

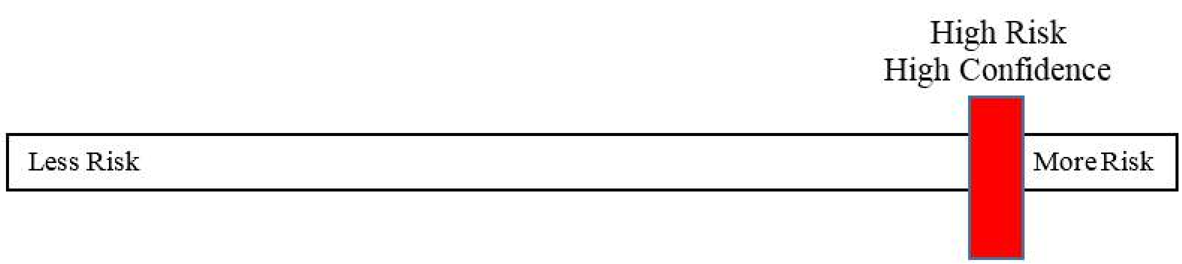
Risk	Confidence	
High	**High**	

Table 99. Effects analysis summary table; Eulachon, southern DPS; designated critical habitat.

Designated Critical Habitat; Risk Hypotheses	R-plot Derived Risk	R-plot Derived Confidence	Risk Hypothesis Supported? Yes/No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater and estuarine habitats.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in freshwater and estuarine habitats.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in nearshore and offshore habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in nearshore and offshore habitats.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Eulachon (Southern DPS). The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



15.31 Green Sturgeon (Southern DPS) Designated Critical Habitat

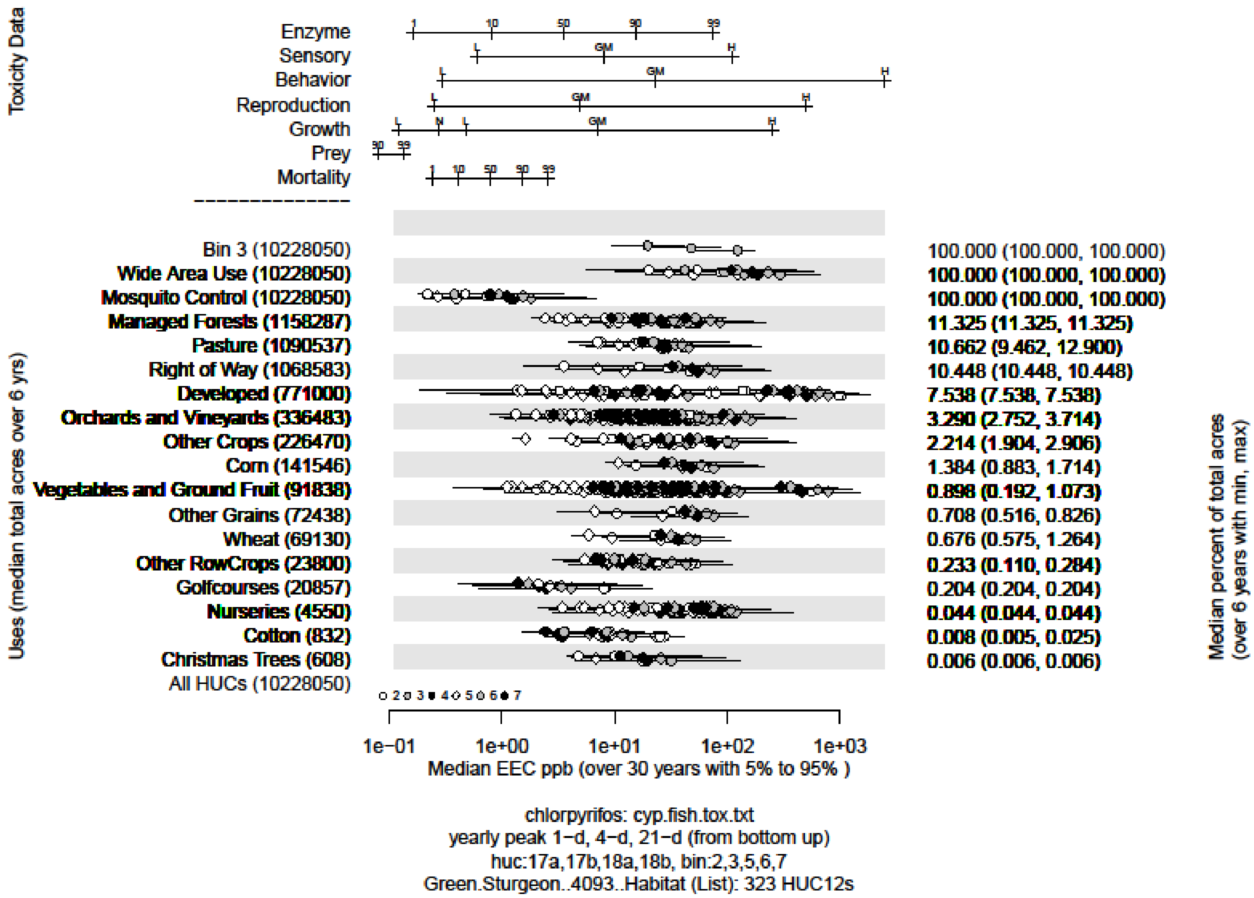


Figure 31. Effects analysis R-plot; Green Sturgeon, Southern DPS designated critical habitat.

Table 100. Prey (fish) risk hypothesis; Green Sturgeon, Southern DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Managed Forests	11.32	High	High
Pasture	10.66	High	High
Right of Way	10.45	High	High

Developed	7.54	High	High
Orchards and Vineyards	3.29	High	High
Other Crops	2.21	High	High
Corn	1.38	High	High
Vegetables and Ground Fruit	0.90	High	Low
Other Grains	0.71	High	Low
Wheat	0.68	High	Low
Other RowCrops	0.23	High	Low
Golfcourses	0.20	High	Low
Nurseries	0.04	High	Low
Cotton	0.01	High	Low
Christmas Trees	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (fish).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 101. Prey (inverts) risk hypothesis; Green Sturgeon, Southern DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Managed Forests	11.32	High	High
Pasture	10.66	High	High
Right of Way	10.45	High	High
Developed	7.54	High	High

Orchards and Vineyards	3.29	High	High
Other Crops	2.21	High	High
Corn	1.38	High	High
Vegetables and Ground Fruit	0.90	High	Low
Other Grains	0.71	High	Low
Wheat	0.68	High	Low
Other RowCrops	0.23	High	Low
Golfcourses	0.20	High	Low
Nurseries	0.04	High	Low
Cotton	0.01	High	Low
Christmas Trees	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (inverts).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 102. Water quality risk hypothesis; Green Sturgeon, Southern DPS; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Green sturgeon. Seventeen use site categories, totaling more than 5,076,959 acres (over 49% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures

occur, chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.

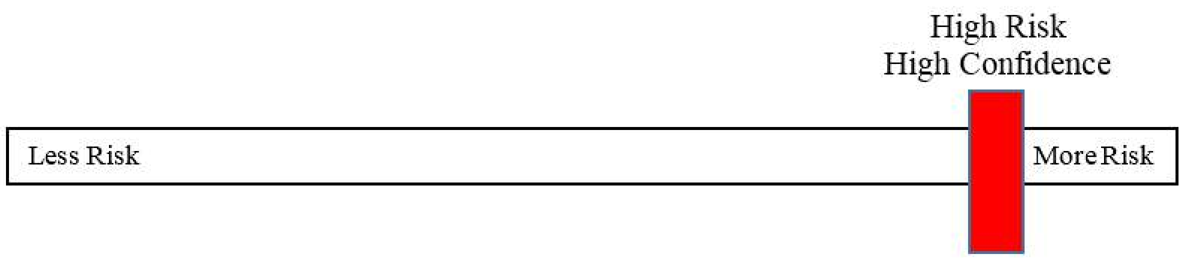
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

Table 103. Effects analysis summary table; Green Sturgeon, Southern DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater habitats.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of prey in freshwater habitats.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in estuarine habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in estuarine habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in coastal habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in coastal habitats.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Green Sturgeon (Southern DPS). The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



15.32 Gulf Sturgeon Designated Critical Habitat

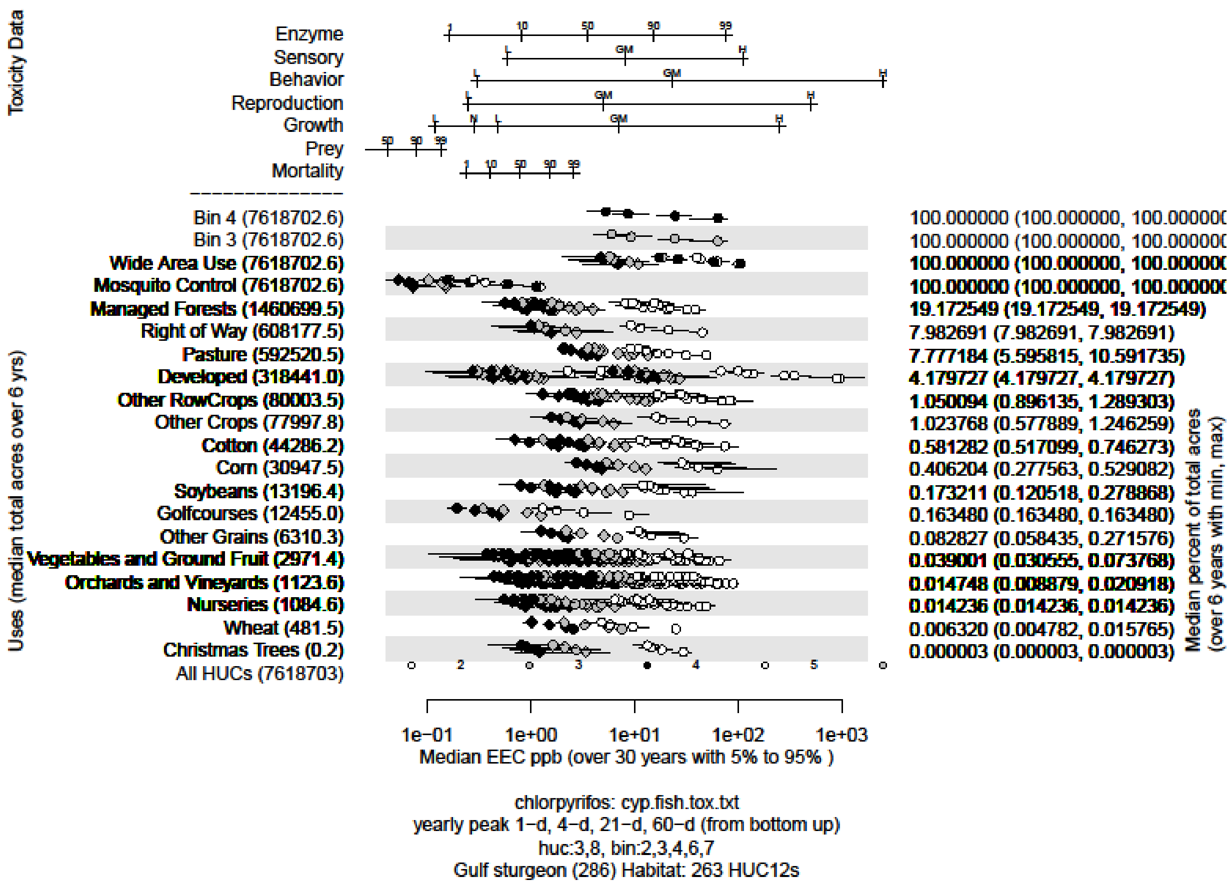


Figure 32. Effects analysis R-plot; Gulf Sturgeon designated critical habitat.

Table 104. Prey (fish) risk hypothesis; Gulf Sturgeon; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Mosquito Control	100.00	Medium	High
Managed Forests	19.17	High	High
Right of Way	7.98	High	High

Pasture	7.78	High	High
Developed	4.18	High	High
Other RowCrops	1.05	High	High
Other Crops	1.02	High	High
Cotton	0.58	High	Low
Corn	0.41	High	Low
Soybeans	0.17	High	Low
Golfcourses	0.16	High	Low
Other Grains	0.08	High	Low
Vegetables and Ground Fruit	0.04	High	Low
Orchards and Vineyards	0.01	High	Low
Nurseries	0.01	High	Low
Wheat	0.01	High	Low
Christmas Trees	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey (fish) in estuarine and coastal habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**Low**		

Table 105. Prey (inverts) risk hypothesis; Gulf Sturgeon; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	19.17	High	High
Right of Way	7.98	High	High
Pasture	7.78	High	High

Developed	4.18	High	High
Other RowCrops	1.05	High	High
Other Crops	1.02	High	High
Cotton	0.58	High	Low
Corn	0.41	High	Low
Soybeans	0.17	High	Low
Golfcourses	0.16	High	Low
Other Grains	0.08	High	Low
Vegetables and Ground Fruit	0.04	High	Low
Orchards and Vineyards	0.01	High	Low
Nurseries	0.01	High	Low
Wheat	0.01	High	Low
Christmas Trees	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey (inverts) in estuarine and coastal habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**Low**		

Table 106. Water quality risk hypothesis; Gulf Sturgeon; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Gulf Sturgeon. Eighteen use site categories, totaling more than 3,360,690 acres (over 43% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation.

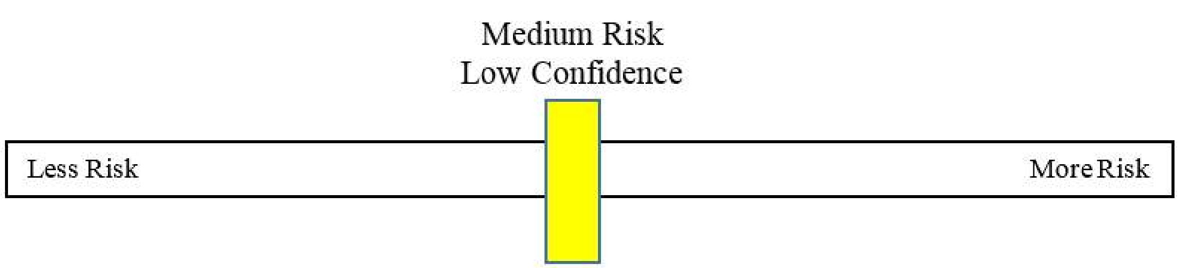
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**Low**	

Table 107. Effects analysis summary table; Gulf Sturgeon; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported? Yes/No
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in the estuarine and nearshore habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in the estuarine and nearshore habitats.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

The stressors of the action may negatively affect some physical or biological features (PBFs) within estuarine and nearshore habitats. However, we have low confidence in the EECs predicted for the nearshore habitats of Gulf Sturgeon. Within the nearshore and estuarine portions of their range, we do not anticipate that the stressors of the action will reduce the overall conservation value of the designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.



15.33 Atlantic Sturgeon, Gulf of Maine DPS; Designated Critical Habitat

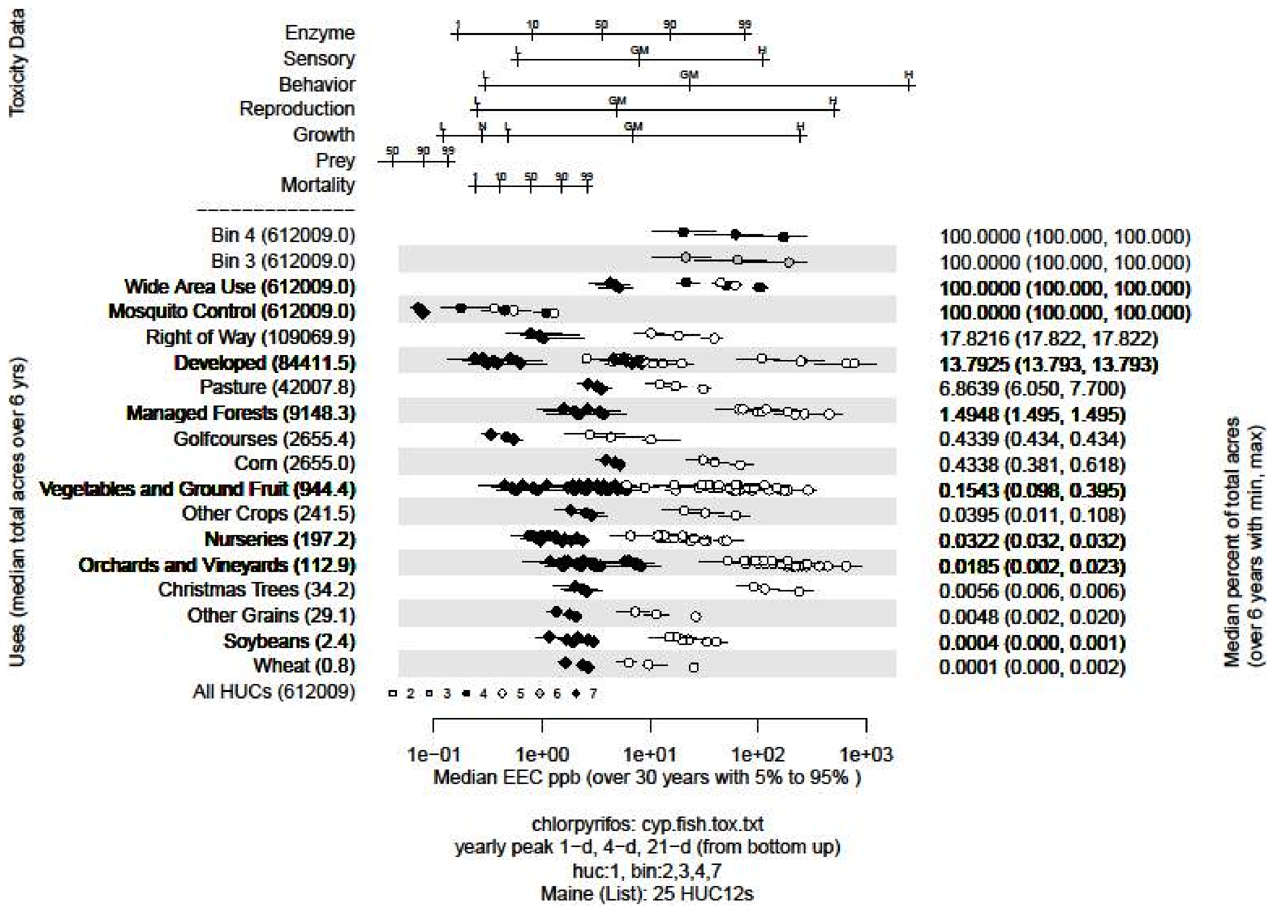


Figure 33. Effects analysis R-plot; Atlantic Sturgeon, Gulf of Maine DPS; designated critical habitat.

Table 108. Prey (fish) risk hypothesis; Atlantic Sturgeon, Gulf of Maine DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Right of Way	17.82	High	High

Developed	13.80	High	High
Pasture	6.86	High	High
Managed Forests	1.50	High	High
Golf Courses	0.43	High	Low
Corn	0.43	High	Low
Vegetables and Ground Fruit	0.15	High	Low
Other Crops	0.04	High	Low
Nurseries	0.03	High	Low
Orchards and Vineyards	0.02	High	Low
Christmas Trees	<0.01	High	Low
Other Grains	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (fish).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 109. Prey (inverts) risk hypothesis; Atlantic Sturgeon, Gulf of Maine DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Right of Way	17.82	High	High
Developed	13.80	High	High
Pasture	6.86	High	High

Managed Forests	1.50	High	High
Golf Courses	0.43	High	Low
Corn	0.43	High	Low
Vegetables and Ground Fruit	0.15	High	Low
Other Crops	0.04	High	Low
Nurseries	0.03	High	Low
Orchards and Vineyards	0.02	High	Low
Christmas Trees	<0.01	High	Low
Other Grains	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (inverts).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 110. Water quality risk hypothesis; Atlantic Sturgeon, Gulf of Maine DPS; designated critical habitat.

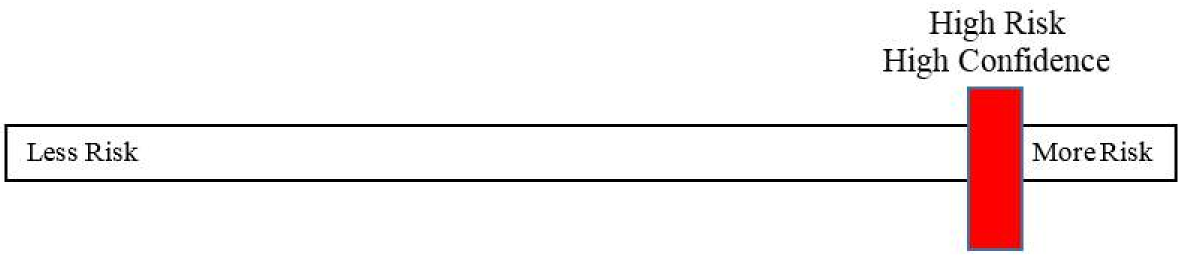
Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Atlantic sturgeon, Gulf of Maine DPS. Fourteen use site categories, totaling more than 251,500 acres (over 41% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

Table 111. Effects analysis summary table; Atlantic Sturgeon, Gulf of Maine DPS; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported?
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater habitats.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of prey in freshwater habitats.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in estuarine habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in estuarine habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in coastal habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in coastal habitats.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Atlantic Sturgeon, Gulf of Maine DPS. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.


High Risk
High Confidence
Less Risk
More Risk

15.34 Atlantic Sturgeon, New York Bight DPS; Designated Critical Habitat

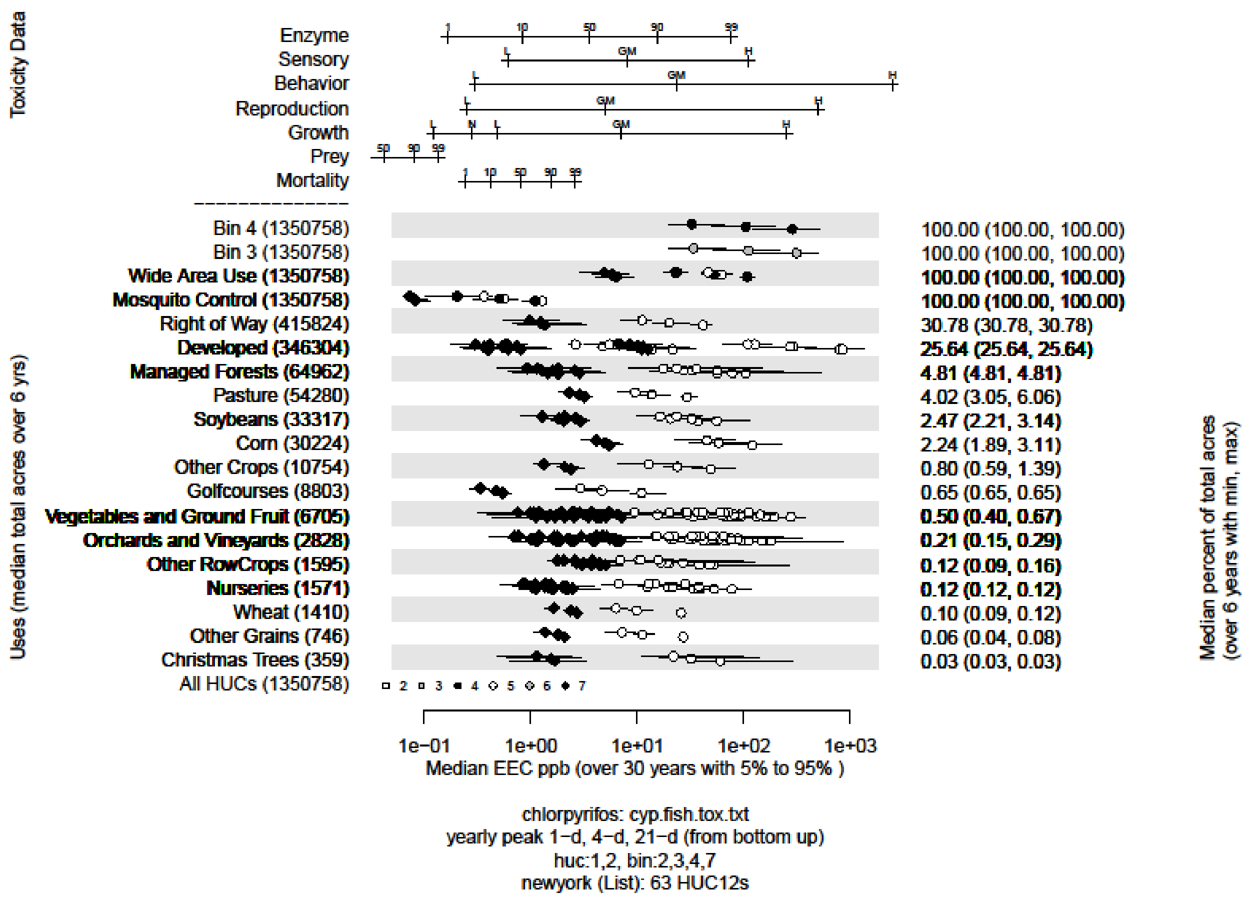


Figure 34. Effects analysis R-plot; Atlantic Sturgeon, New York Bight DPS; designated critical habitat.

Table 112. Prey (fish) risk hypothesis; Atlantic Sturgeon, New York Bight DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Right of Way	30.78	High	High
Developed	25.64	High	High

Managed Forests	4.81	High	High
Pasture	4.02	High	High
Soybeans	2.47	High	High
Corn	2.24	High	High
Other Crops	0.80	High	Low
Golf Courses	0.65	High	Low
Vegetables and Ground Fruit	0.50	High	Low
Orchards and Vineyards	0.21	High	Low
Other Row Crops	0.12	High	Low
Nurseries	0.12	High	Low
Wheat	0.10	High	Low
Other Grains	0.06	High	Low
Christmas Trees	0.03	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (fish).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 113. Prey (inverts) risk hypothesis; Atlantic Sturgeon, New York Bight DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Right of Way	30.78	High	High
Developed	25.64	High	High
Managed Forests	4.81	High	High

Pasture	4.02	High	High
Soybeans	2.47	High	High
Corn	2.24	High	High
Other Crops	0.80	High	Low
Golf Courses	0.65	High	Low
Vegetables and Ground Fruit	0.50	High	Low
Orchards and Vineyards	0.21	High	Low
Other Row Crops	0.12	High	Low
Nurseries	0.12	High	Low
Wheat	0.10	High	Low
Other Grains	0.06	High	Low
Christmas Trees	0.03	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (inverts).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 114. Water quality risk hypothesis; Atlantic Sturgeon, New York Bight DPS; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Atlantic sturgeon, New York Bight DPS. Fifteen use site categories, totaling more than 979,680 acres (over 72% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation.
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.

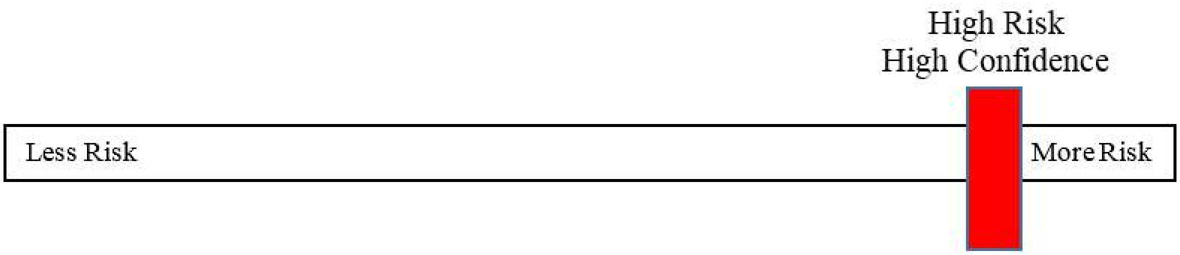
Risk	Confidence	
High	**High**	

Table 115. Effects analysis summary table; Atlantic Sturgeon, New York Bight DPS; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported? Yes/No
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater habitats.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of prey in freshwater habitats.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in estuarine habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in estuarine habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in coastal habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in coastal habitats.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Atlantic Sturgeon, New York Bight DPS. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.


High Risk
High Confidence
Less Risk
More Risk

15.35 Atlantic Sturgeon, Chesapeake Bay DPS; Designated Critical Habitat

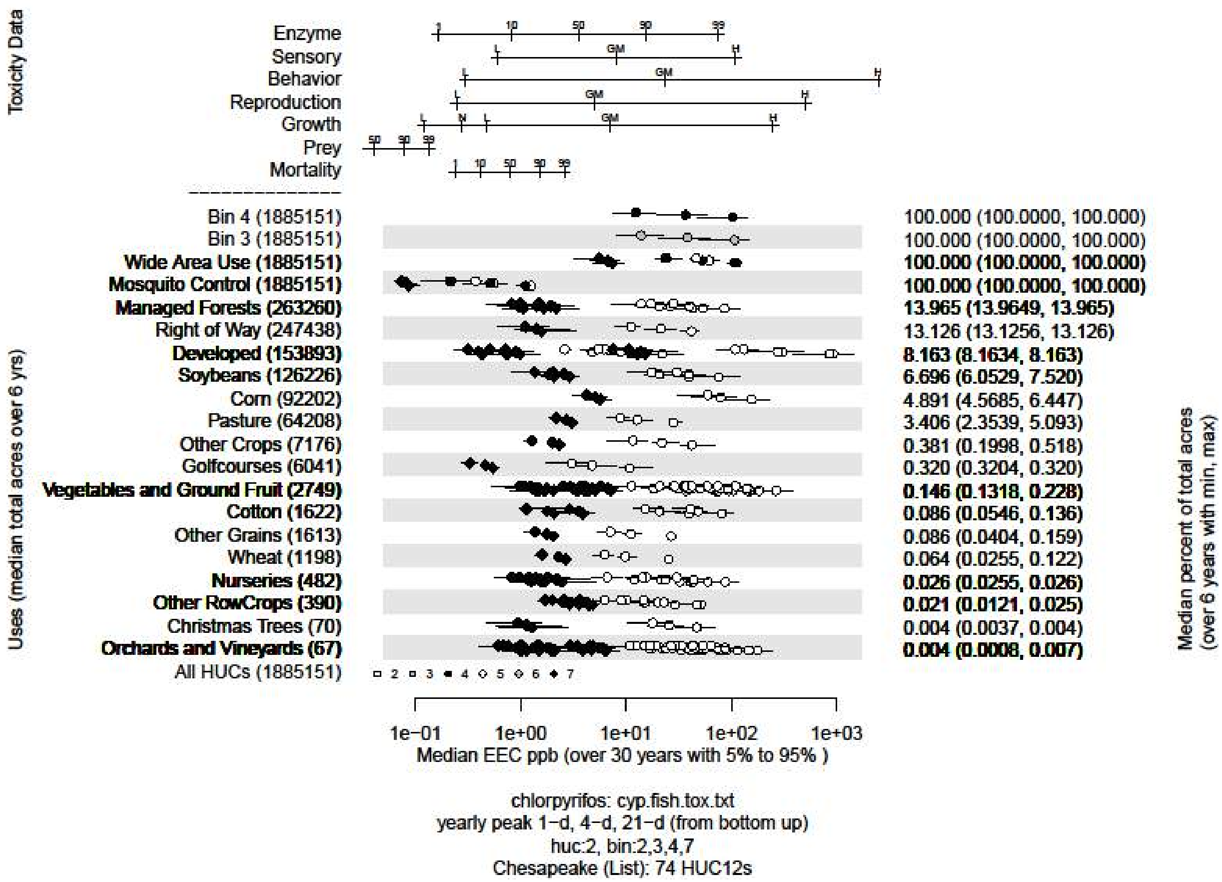


Figure 35. Effects analysis R-plot; Atlantic Sturgeon, Chesapeake Bay DPS; designated critical habitat.

Table 116. Prey (fish) risk hypothesis; Atlantic Sturgeon, Chesapeake Bay DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	13.97	High	High
Right of Way	13.12	High	High

Developed	8.13	High	High
Soybeans	6.70	High	High
Corn	4.89	High	High
Pasture	3.41	High	High
Other Crops	0.38	High	Low
Golf Courses	0.32	High	Low
Vegetables and Ground Fruit	0.15	High	Low
Cotton	0.09	High	Low
Other Grains	0.09	High	Low
Wheat	0.06	High	Low
Nurseries	0.03	High	Low
Other Row Crops	0.02	High	Low
Christmas Trees	<0.01	High	Low
Orchards and Vineyards	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (fish).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 117. Prey (inverts) risk hypothesis; Atlantic Sturgeon, Chesapeake Bay DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	13.97	High	High
Right of Way	13.12	High	High

Developed	8.13	High	High
Soybeans	6.70	High	High
Corn	4.89	High	High
Pasture	3.41	High	High
Other Crops	0.38	High	Low
Golf Courses	0.32	High	Low
Vegetables and Ground Fruit	0.15	High	Low
Cotton	0.09	High	Low
Other Grains	0.09	High	Low
Wheat	0.06	High	Low
Nurseries	0.03	High	Low
Other Row Crops	0.02	High	Low
Christmas Trees	<0.01	High	Low
Orchards and Vineyards	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (inverts).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 118. Water quality risk hypothesis; Atlantic Sturgeon, Chesapeake Bay DPS; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Atlantic sturgeon, Chesapeake Bay DPS. Sixteen use site categories, totaling more than 968,635 acres (over 51% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the

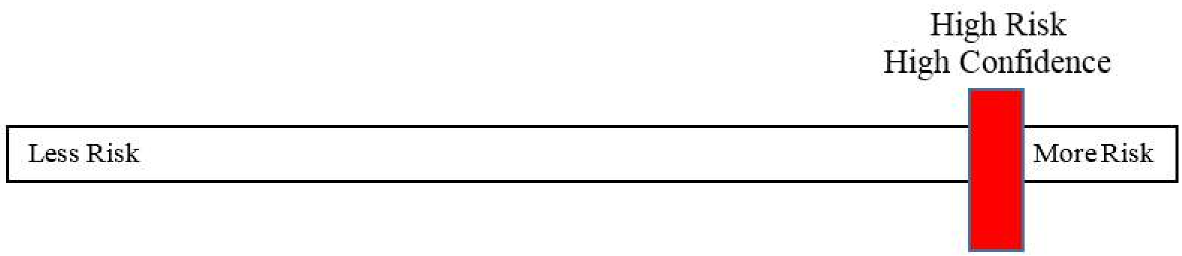
proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

Table 119. Effects analysis summary table; Atlantic Sturgeon, Chesapeake Bay DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater habitats.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of prey in freshwater habitats.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in estuarine habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in estuarine habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in coastal habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in coastal habitats.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Atlantic Sturgeon, Chesapeake Bay DPS. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



15.36 Atlantic Sturgeon, Carolina DPS, Designated Critical Habitat

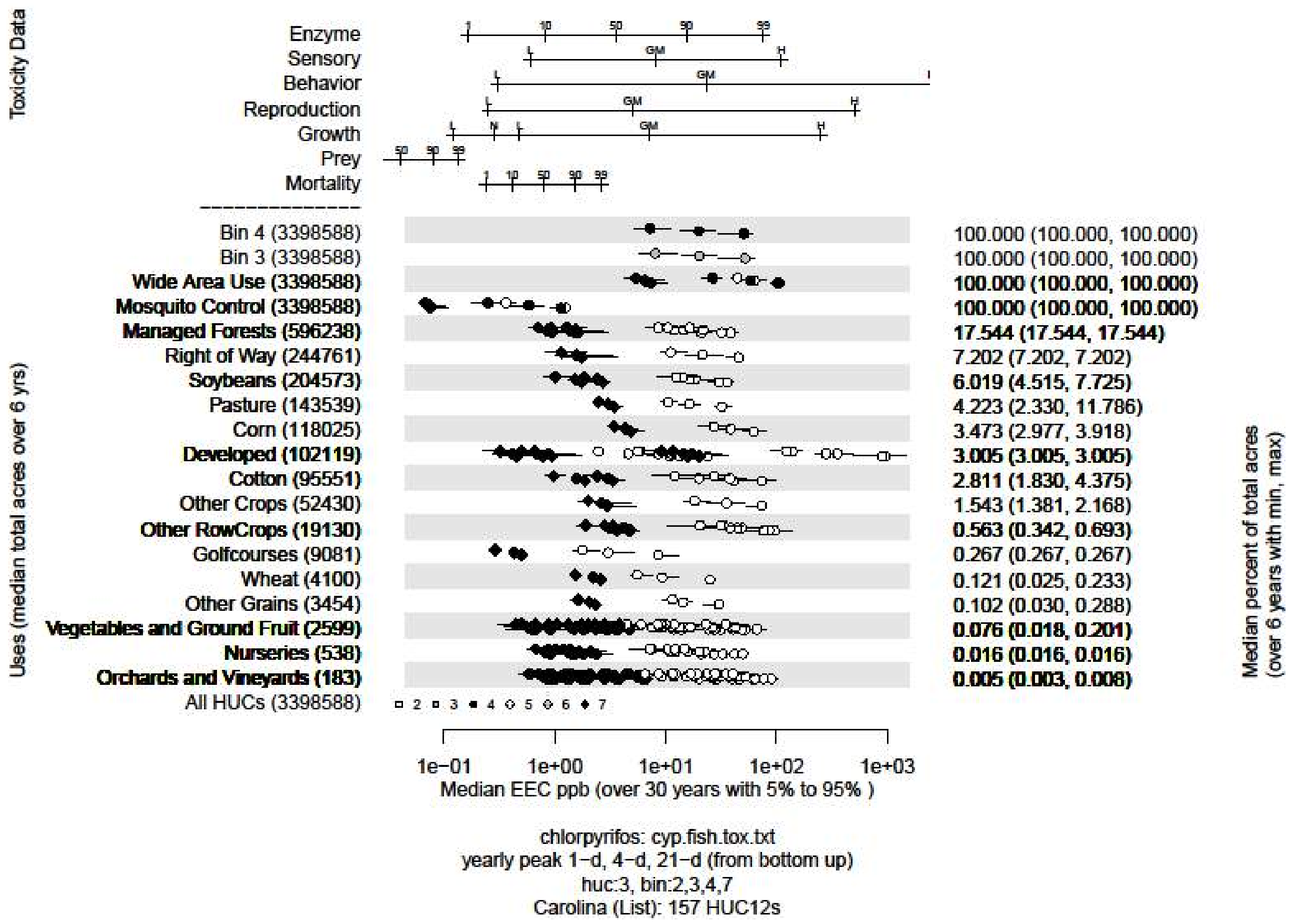


Figure 36. Effects analysis R-plot; Atlantic Sturgeon, Carolina DPS; designated critical habitat.

Table 120. Prey (fish) risk hypothesis; Atlantic Sturgeon, Carolina DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	17.54	High	High
Right of Way	7.20	High	High

Soybeans	6.02	High	High
Pasture	4.22	High	High
Corn	3.47	High	High
Developed	3.01	High	High
Cotton	2.81	High	High
Other Crops	1.54	High	High
Other Row Crops	0.56	High	Low
Golf Courses	0.27	High	Low
Wheat	0.12	High	Low
Other Grains	0.10	High	Low
Vegetables and Ground Fruit	0.08	High	Low
Nurseries	0.02	High	Low
Orchards and Vineyards	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (fish).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 121. Prey (inverts) risk hypothesis; Atlantic Sturgeon, Carolina DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	17.54	High	High
Right of Way	7.20	High	High
Soybeans	6.02	High	High
Pasture	4.22	High	High

Corn	3.47	High	High
Developed	3.01	High	High
Cotton	2.81	High	High
Other Crops	1.54	High	High
Other Row Crops	0.56	High	Low
Golf Courses	0.27	High	Low
Wheat	0.12	High	Low
Other Grains	0.10	High	Low
Vegetables and Ground Fruit	0.08	High	Low
Nurseries	0.02	High	Low
Orchards and Vineyards	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (inverts).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 122. Water quality risk hypothesis; Atlantic Sturgeon, Carolina DPS; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Atlantic sturgeon, Carolina DPS. Fifteen use site categories, totaling more than 1,596,321 acres (over 47% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	

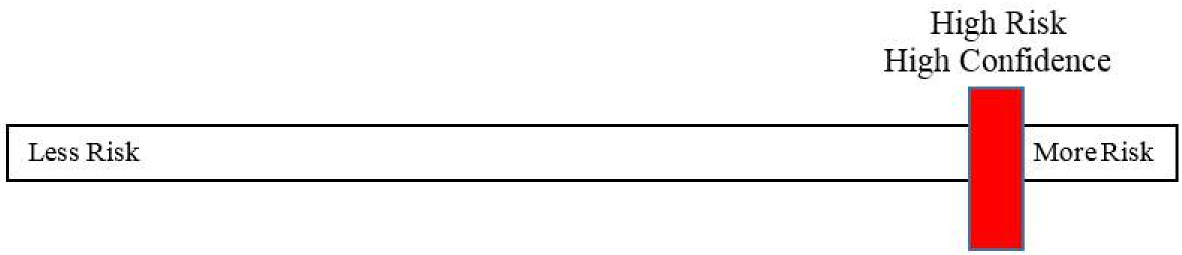
High	**High**	

Table 123. Effects analysis summary table; Atlantic Sturgeon, Carolina DPS; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported? Yes/No
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater habitats.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of prey in freshwater habitats.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in estuarine habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in estuarine habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in coastal habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in coastal habitats.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Atlantic Sturgeon, Carolina DPS. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.


High Risk
High Confidence
Less Risk
More Risk

15.37 Atlantic Sturgeon, South Atlantic DPS, Designated Critical Habitat

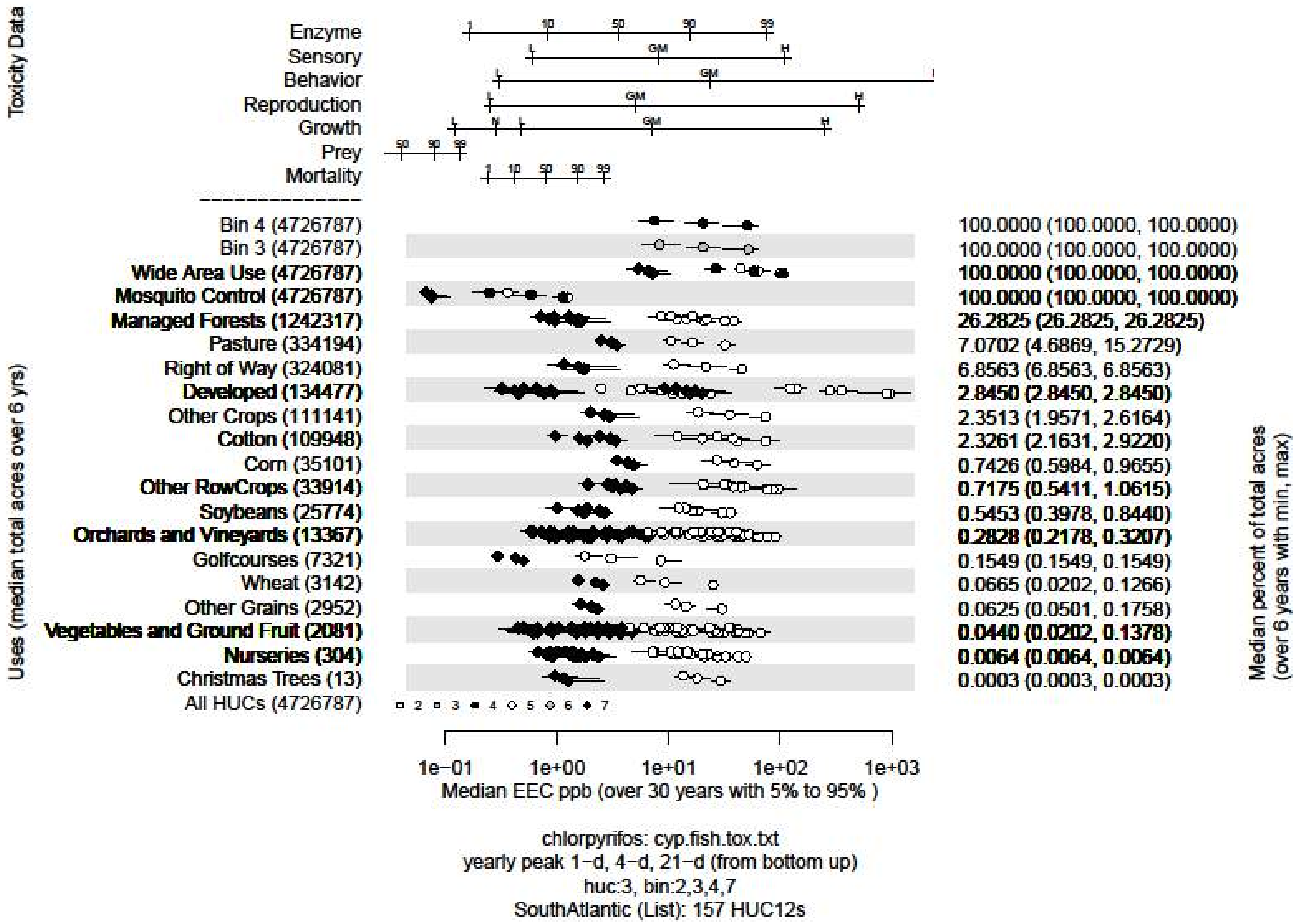


Figure 37. Effects analysis R-plot; Atlantic Sturgeon, South Atlantic DPS; designated critical habitat.

Table 124. Prey (fish) risk hypothesis; Atlantic Sturgeon, South Atlantic DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	26.28	High	High

Pasture	7.07	High	High
Right of Way	6.86	High	High
Developed	2.85	High	High
Other Crops	2.35	High	High
Cotton	2.33	High	High
Corn	0.74	High	Low
Other Row Crops	0.72	High	Low
Soybeans	0.55	High	Low
Orchards and Vineyards	0.28	High	Low
Golf Courses	0.15	High	Low
Wheat	0.07	High	Low
Other Grains	0.06	High	Low
Vegetables and Ground Fruit	0.04	High	Low
Nurseries	0.01	High	Low
Christmas Trees	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (fish).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 125. Prey (inverts) risk hypothesis; Atlantic Sturgeon, South Atlantic DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	26.28	High	High
Pasture	7.07	High	High

Right of Way	6.86	High	High
Developed	2.85	High	High
Other Crops	2.35	High	High
Cotton	2.33	High	High
Corn	0.74	High	Low
Other Row Crops	0.72	High	Low
Soybeans	0.55	High	Low
Orchards and Vineyards	0.28	High	Low
Golf Courses	0.15	High	Low
Wheat	0.07	High	Low
Other Grains	0.06	High	Low
Vegetables and Ground Fruit	0.04	High	Low
Nurseries	0.01	High	Low
Christmas Trees	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (inverts).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 126. Water quality risk hypothesis; Atlantic Sturgeon, South Atlantic DPS; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Atlantic sturgeon, South Atlantic DPS. Sixteen use site categories, totaling more than 2,380,127 acres (over 50% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the

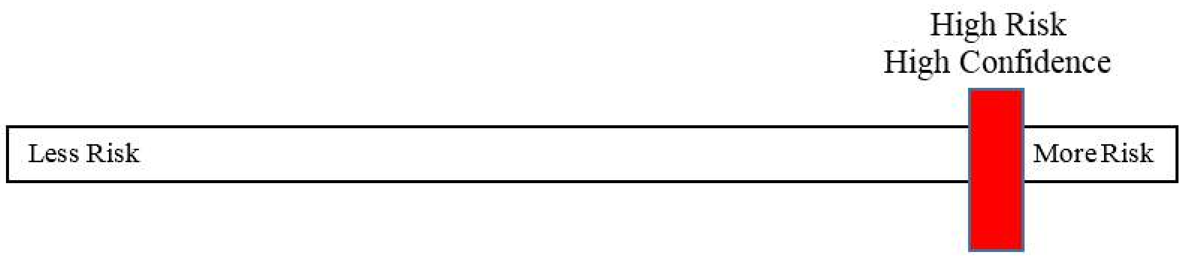
proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

Table 127. Effects analysis summary table; Atlantic Sturgeon, South Atlantic DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater habitats.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of prey in freshwater habitats.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in estuarine habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in estuarine habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in coastal habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in coastal habitats.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Atlantic Sturgeon, South Atlantic DPS. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



15.38 Yelloweye Rockfish (Puget Sound/Georgia Basin DPS) Designated Critical Habitat

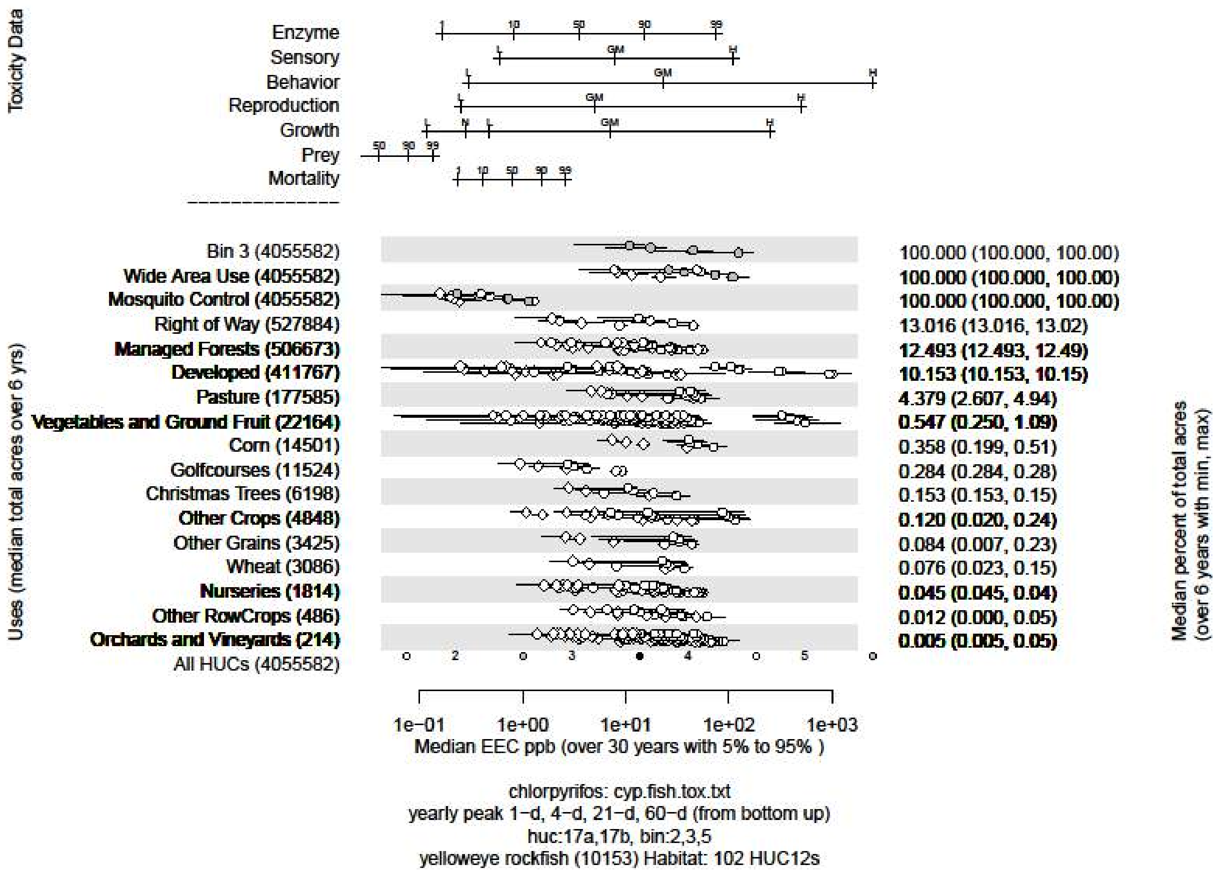


Figure 38. Effects analysis R-plot; Yelloweye rockfish, Puget Sound/Georgia Basin DPS designated critical habitat.

Table 128. Prey (fish) risk hypothesis; Yelloweye rockfish, Puget Sound/Georgia Basin DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Mosquito Control	100.00	Medium	High
Right of Way	13.02	High	High
Managed Forests	12.49	High	High

Developed	10.15	High	High
Pasture	4.38	High	High
Vegetables and Ground Fruit	0.55	High	Low
Corn	0.36	High	Low
Golfcourses	0.28	High	Low
Christmas Trees	0.15	High	Low
Other Crops	0.12	High	Low
Other Grains	0.08	High	Low
Wheat	0.08	High	Low
Nurseries	0.04	High	Low
Other RowCrops	0.01	High	Low
Orchards and Vineyards	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey (fish)			
Risk	**Confidence**		
High	**Low**		

Table 129. Prey (inverts) risk hypothesis; Yelloweye rockfish, Puget Sound/Georgia Basin DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Right of Way	13.02	High	High
Managed Forests	12.49	High	High
Developed	10.15	High	High
Pasture	4.38	High	High
Vegetables and Ground Fruit	0.55	High	Low

Corn	0.36	High	Low
Golfcourses	0.28	High	Low
Christmas Trees	0.15	High	Low
Other Crops	0.12	High	Low
Other Grains	0.08	High	Low
Wheat	0.08	High	Low
Nurseries	0.04	High	Low
Other RowCrops	0.01	High	Low
Orchards and Vineyards	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey (inverts).			
Risk	**Confidence**		
High	**Low**		

Table 130. Water quality risk hypothesis; Yelloweye rockfish, Puget Sound/Georgia Basin DPS; designated critical habitat.

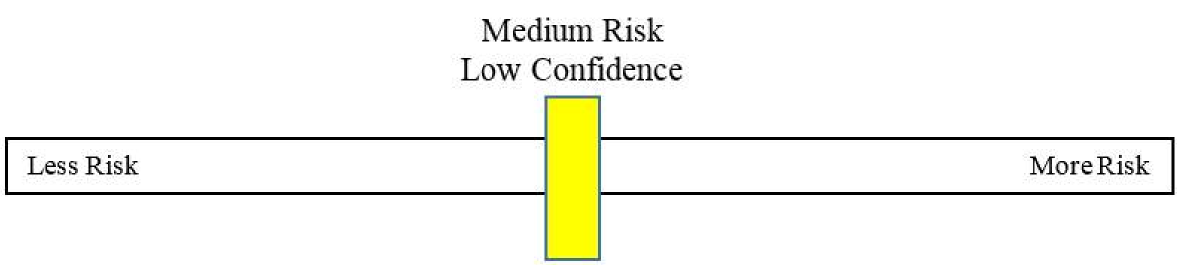
Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Yelloweye rockfish. Sixteen use site categories, totaling more than 1,691,119 acres (over 41% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types may experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**Low**	

Table 131. Effects analysis summary table; Yelloweye rockfish, Puget Sound/Georgia Basin DPS; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported? Yes/No
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

The stressors of the action may negatively affect relevant physical or biological features within estuarine and nearshore habitats. However, we have low confidence in the EECs predicted for the marine nearshore habitats of Yelloweye Rockfish (Puget Sound/Georgia Basin DPS). Within the nearshore and estuarine portions of their range, we do not anticipate that the stressors of the action will reduce the overall conservation value of the designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.



15.39 Bocaccio (Puget Sound/Georgia Basin DPS) Designated Critical Habitat

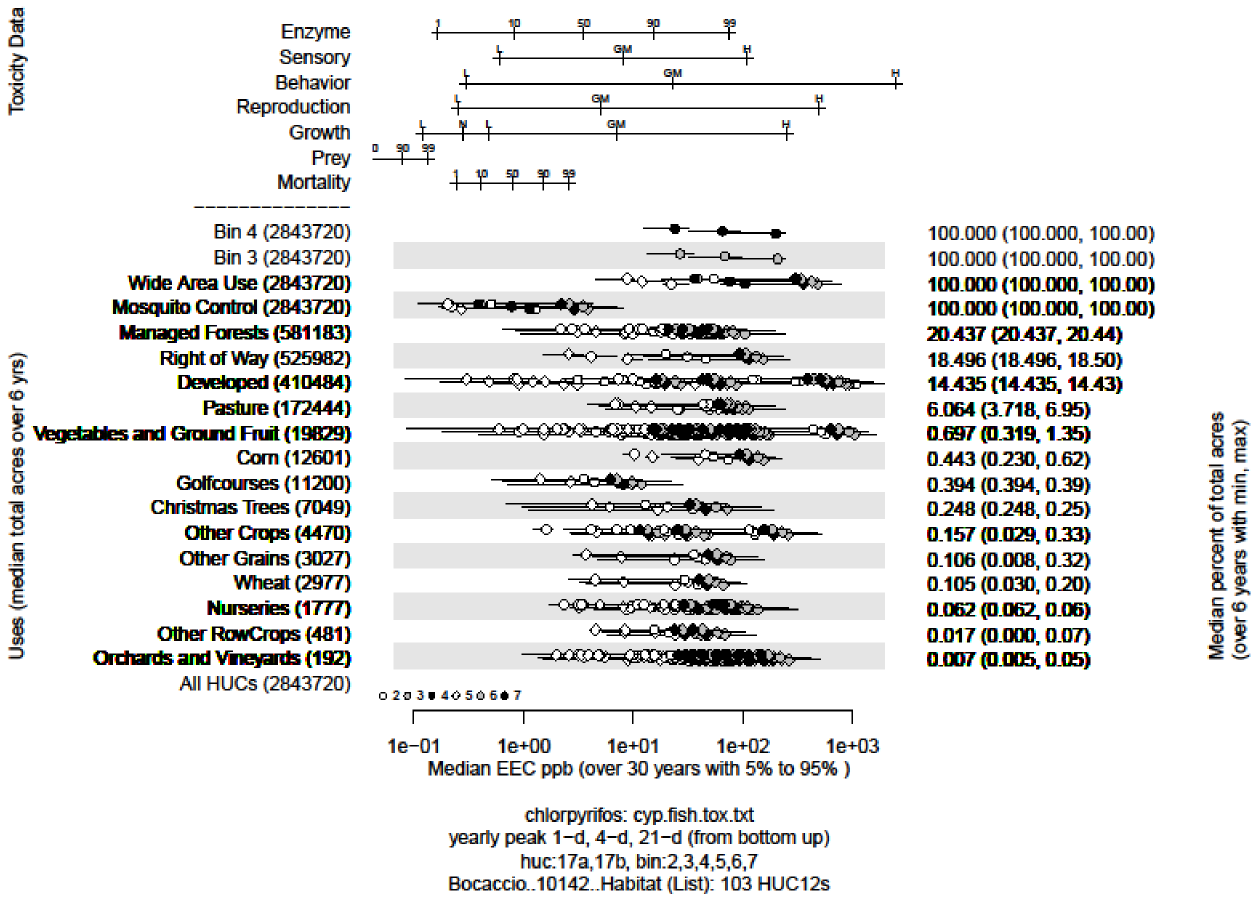


Figure 39. Effects analysis R-plot; Bocaccio rockfish, Puget Sound/Georgia Basin DPS designated critical habitat.

Table 132. Prey (fish) risk hypothesis; Bocaccio rockfish, Puget Sound/Georgia Basin DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	20.44	High	High

Right of Way	18.50	High	High
Developed	14.43	High	High
Pasture	6.06	High	High
Vegetables and Ground Fruit	0.70	High	Low
Corn	0.44	High	Low
Golfcourses	0.39	High	Low
Christmas Trees	0.25	High	Low
Other Crops	0.16	High	Low
Other Grains	0.11	High	Low
Wheat	0.10	High	Low
Nurseries	0.06	High	Low
Other RowCrops	0.02	High	Low
Orchards and Vineyards	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey (fish).			
Risk	**Confidence**		
High	**Low**		

Table 133. Prey (inverts) risk hypothesis; Bocaccio rockfish, Puget Sound/Georgia Basin DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	20.44	High	High
Right of Way	18.50	High	High
Developed	14.43	High	High
Pasture	6.06	High	High

Vegetables and Ground Fruit	0.70	High	Low
Corn	0.44	High	Low
Golfcourses	0.39	High	Low
Christmas Trees	0.25	High	Low
Other Crops	0.16	High	Low
Other Grains	0.11	High	Low
Wheat	0.10	High	Low
Nurseries	0.06	High	Low
Other RowCrops	0.02	High	Low
Orchards and Vineyards	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey (inverts).			
Risk	**Confidence**		
High	**Low**		

Table 134. Water quality risk hypothesis; Bocaccio rockfish, Puget Sound/Georgia Basin DPS; designated critical habitat.

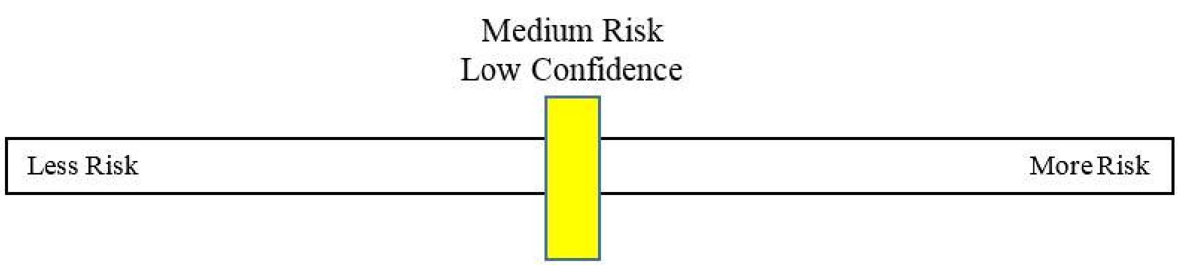
Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Bocaccio. Sixteen use site categories, totaling more than 1,753,696 acres (over 59% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth can result. Multiple (*perhaps all*) habitat types may experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, chlorpyrifos and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**Low**	

Table 135. Effects analysis summary table; Bocaccio rockfish, Puget Sound/Georgia Basin DPS; designated critical habitat.

Designated Critical Habitat; Risk Hypotheses	R-plot Derived Risk	R-plot Derived Confidence	Risk Hypothesis Supported? Yes/No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

The stressors of the action may negatively affect relevant physical or biological features within estuarine and nearshore habitats. However, we have low confidence in the EECs predicted for the marine nearshore habitats. Within the nearshore and estuarine portions of their range, we do not anticipate that the stressors of the action will reduce the overall conservation value of the designated critical habitat of Bocaccio (Puget Sound/Georgia Basin DPS). We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.



15.40 Smalltooth Sawfish Designated Critical Habitat

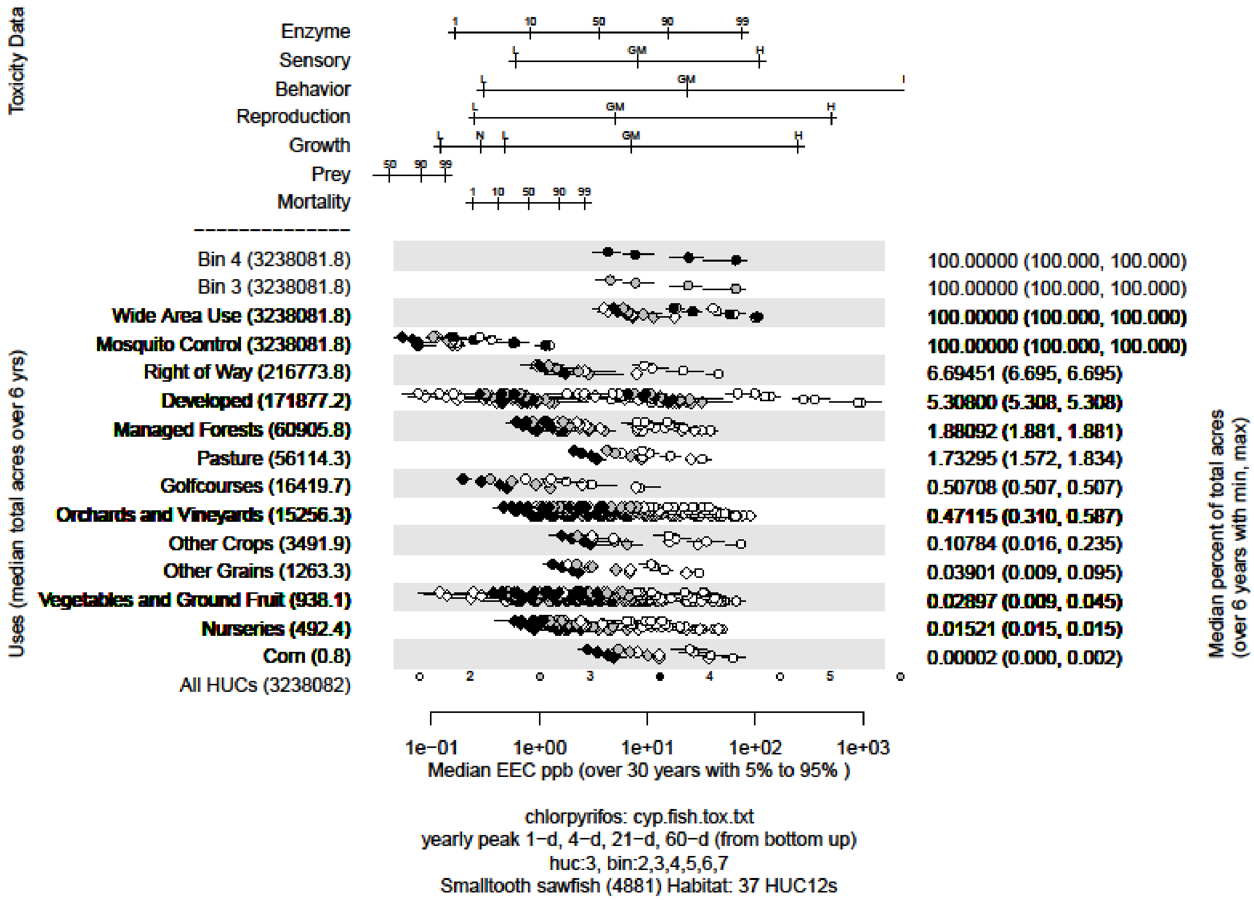


Figure 40. Effects analysis R-plot; Smalltooth Sawfish designated critical habitat.

Table 136. Prey (fish) risk hypothesis; Smalltooth sawfish, US DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Mosquito Control	100.00	Medium	High
Right of Way	6.69	High	High
Developed	5.31	High	High

Managed Forests	1.88	High	High
Pasture	1.73	High	High
Golfcourses	0.51	High	Low
Orchards and Vineyards	0.47	High	Low
Other Crops	0.11	High	Low
Other Grains	0.04	High	Low
Vegetables and Ground Fruit	0.03	High	Low
Nurseries	0.02	High	Low
Corn	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey (fish).			
Risk	**Confidence**		
High	**High**		

Table 137. Prey (inverts) risk hypothesis; Smalltooth sawfish, US DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Right of Way	6.69	High	High
Developed	5.31	High	High
Managed Forests	1.88	High	High
Pasture	1.73	High	High
Golfcourses	0.51	High	Low
Orchards and Vineyards	0.47	High	Low
Other Crops	0.11	High	Low
Other Grains	0.04	High	Low

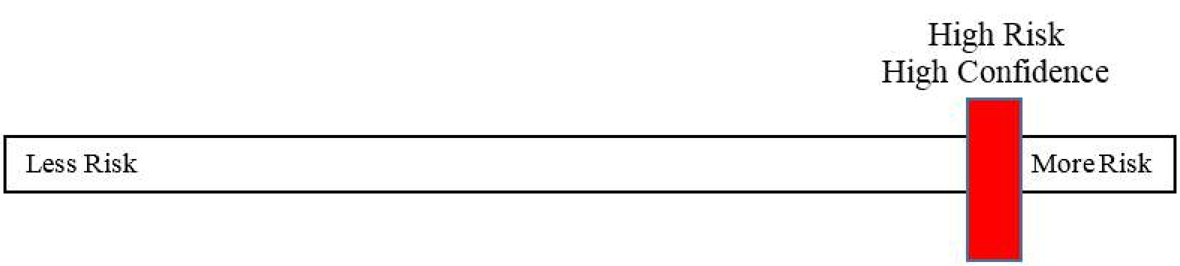
Vegetables and Ground Fruit	0.03	High	Low
Nurseries	0.02	High	Low
Corn	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey (inverts).			
Risk	**Confidence**		
High	**High**		

Table 138. Effects analysis summary table; Smalltooth sawfish, US DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in shallow euryhaline habitats.	High	High	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that that the stressors of the action will negatively affect a key physical and biological feature. Reductions in prey are likely throughout designated critical habitat of Smalltooth Sawfish. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



15.41 Black Abalone Designated Critical Habitat

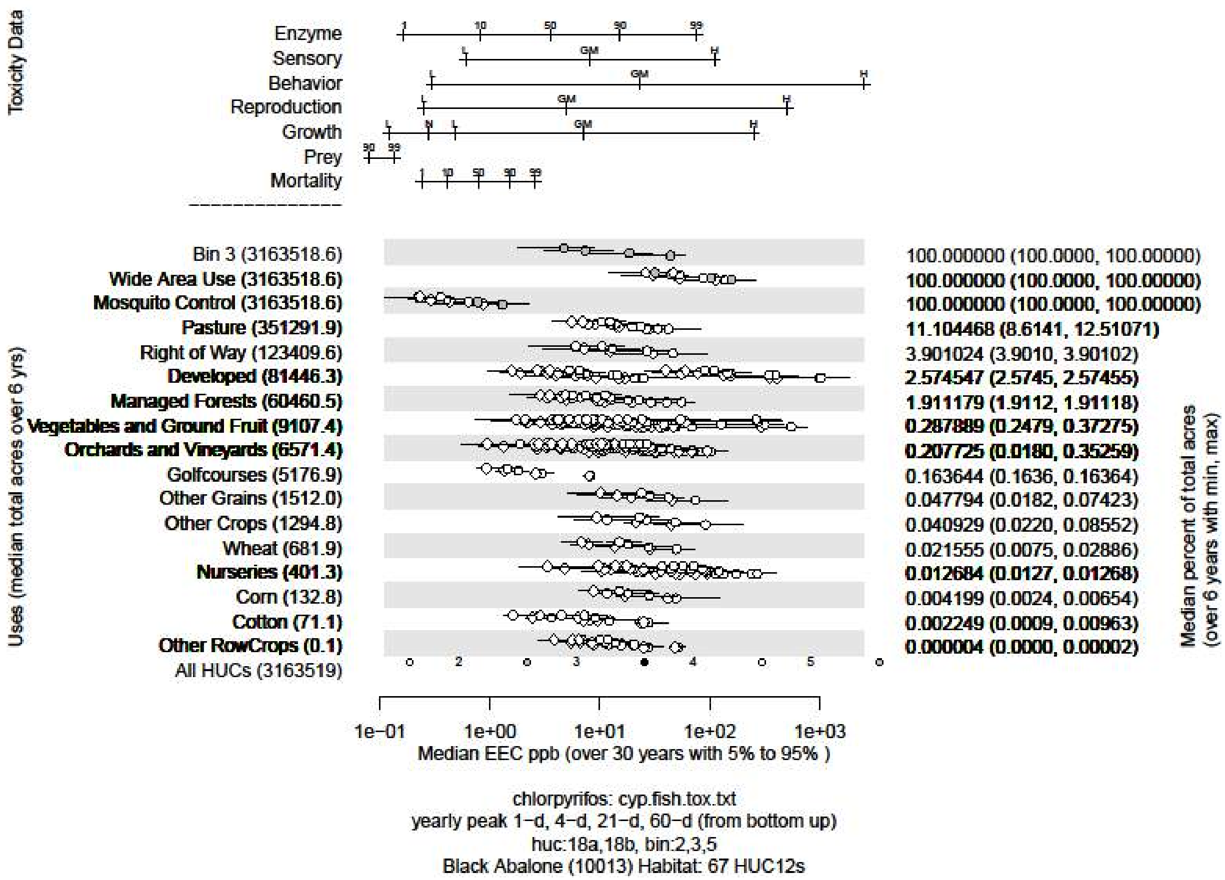


Figure 41. Effects analysis R-plot; Black Abalone designated critical habitat.

Table 139. Prey (inverts) risk hypothesis; Black abalone; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Pasture	11.10	High	High
Right of Way	3.90	High	High
Developed	2.57	High	High

Managed Forests	1.91	High	High
Vegetables and Ground Fruit	0.29	High	Low
Orchards and Vineyards	0.21	High	Low
Golfcourses	0.16	High	Low
Other Grains	0.05	High	Low
Other Crops	0.04	High	Low
Wheat	0.02	High	Low
Nurseries	0.01	High	Low
Corn	<0.01	High	Low
Cotton	<0.01	High	Low
Other RowCrops	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey (inverts).			
Risk	**Confidence**		
High	**Low**		

Table 140. Water quality risk hypothesis; Black abalone; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur within the designated critical habitat of Black abalone. Sixteen use site categories, totaling more than 641,555 acres (over 21% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are sufficient to kill aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**Low**	

Table 141. Effects analysis summary table; Black abalone; designated critical habitat.

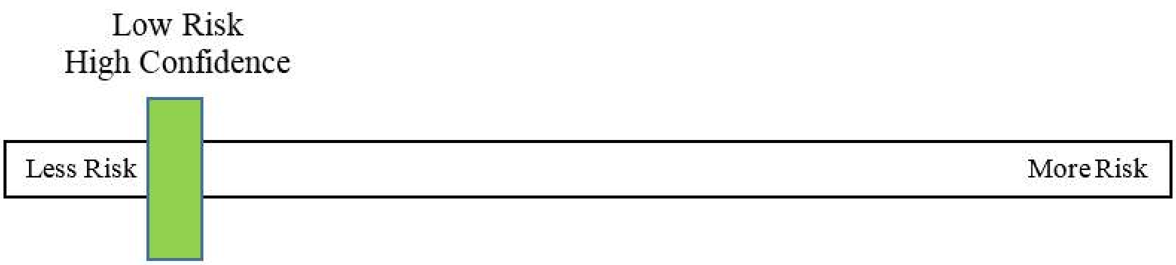
Designated Critical Habitat; Risk Hypotheses	R-plot Derived		Risk Hypothesis Supported? Yes/No
	Risk	Confidence	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

The stressors of the action may negatively affect relevant physical or biological features within nearshore habitats. However, we have low confidence in the EECs predicted for the marine nearshore habitats. We do not anticipate that the stressors of the action will reduce the overall conservation value of the designated critical habitat of Black Abalone. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.

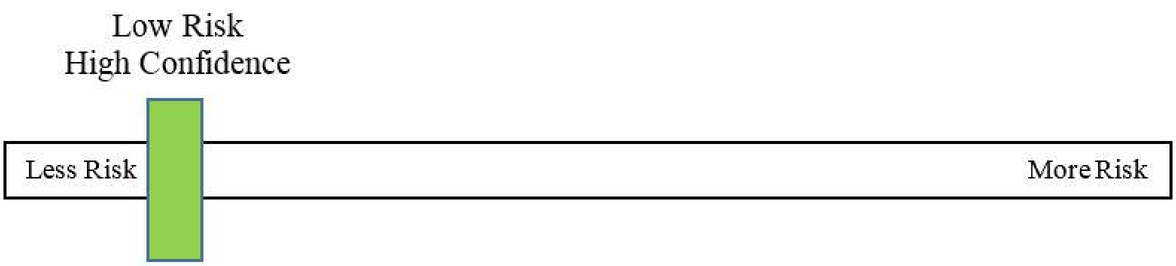
15.42 Staghorn Coral Designated Critical Habitat

There are no physical or biological features identified in Staghorn Coral designated critical habitat that could be affected by the proposed action. We find that the overall risk is low and the confidence associated with that risk is high over the 15-year duration of the action.



15.43 Elkhorn Coral Designated Critical Habitat

There are no physical or biological features identified in Elkhorn Coral designated critical habitat that could be affected by the proposed action. We find that the overall risk is low and the confidence associated with that risk is high over the 15-year duration of the action.



15.44 Green Sea Turtle (North Atlantic DPS) Designated Critical Habitat

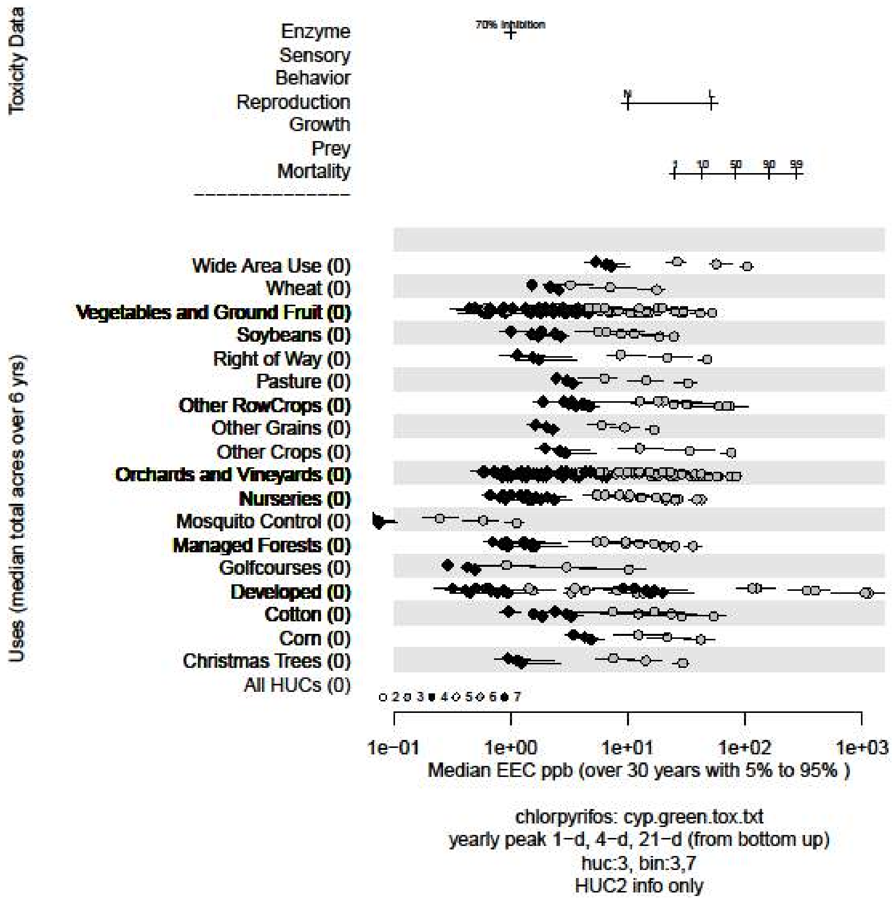


Figure 42. Effects analysis R-plot; Green Sea Turtle, North Atlantic DPS designated critical habitat.

Table 142. Water quality risk hypothesis; Green sea turtle, North Atlantic DPS; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products may occur within the designated critical habitat of Green sea turtle, North Atlantic DPS. Proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat may be sufficient to cause adverse effects to sea turtles. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation.
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.

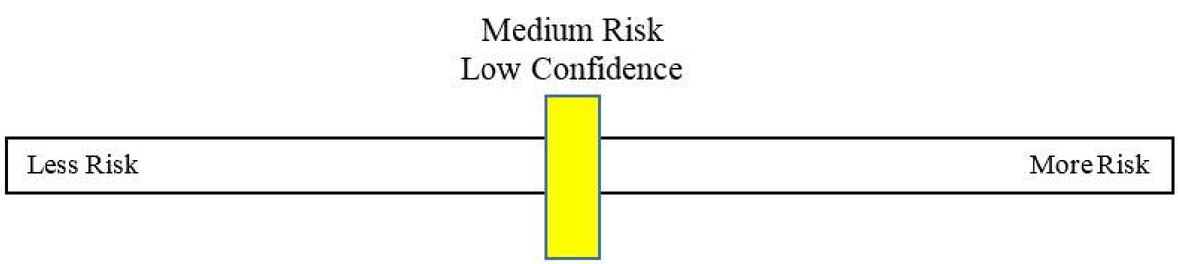
Risk	Confidence	
High	**Low**	

Table 143. Effects analysis summary table; Green sea turtle, North Atlantic DPS; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported?
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

The stressors of the action may negatively affect a relevant physical and biological feature within nearshore designated critical habitat of Green Sea Turtle (North Atlantic DPS). However, we have low confidence in the EECs predicted for the marine nearshore habitats. The likelihood and magnitude of toxic effects are not likely to reduce the overall conservation value of designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.



15.45 Hawksbill Sea Turtle Designated Critical Habitat

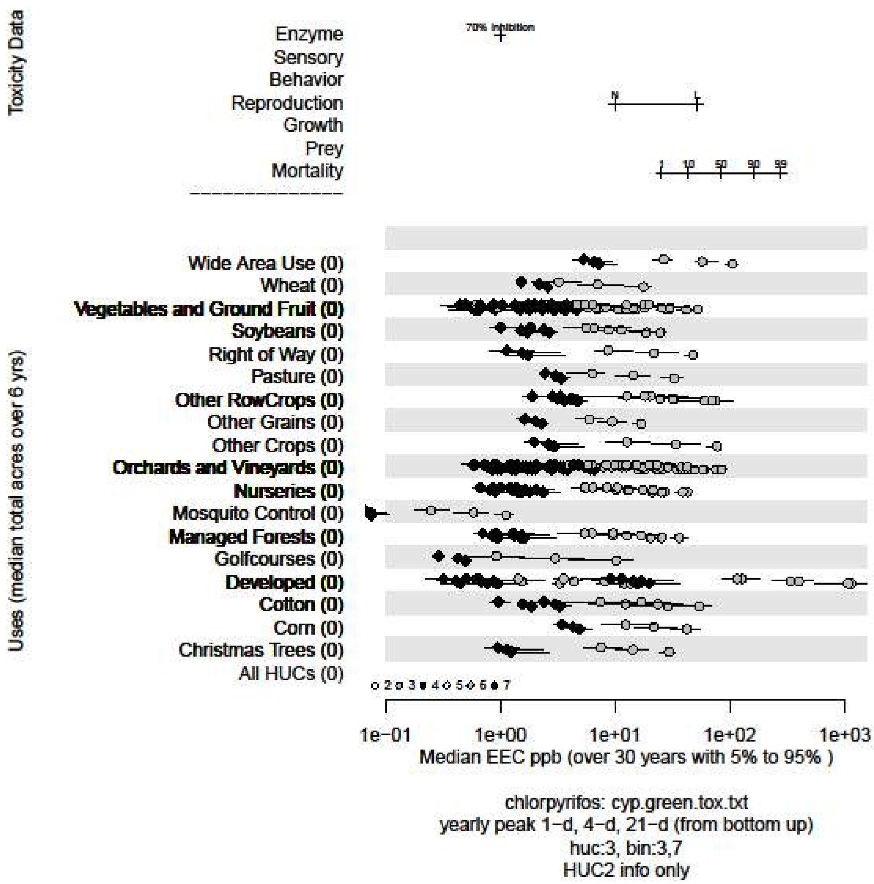


Figure 43. Effects analysis R-plot; Hawksbill sea turtle DPS designated critical habitat.

Table 144. Water quality risk hypothesis; Hawksbill sea turtle designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products may occur within the designated critical habitat of the Hawksbill sea turtle. Proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat may be sufficient to cause adverse effects to sea turtles. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation.
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.

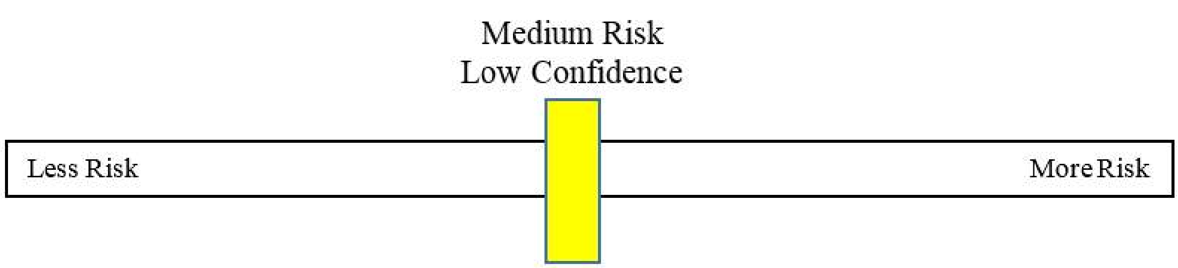
Risk	Confidence	
High	Low	

Table 145. Effects analysis summary table; Hawksbill sea turtle; designated critical habitat.

Designated Critical Habitat; Risk Hypotheses	R-plot Derived Risk	R-plot Derived Confidence	Risk Hypothesis Supported? Yes/No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

The stressors of the action may negatively affect a relevant physical and biological feature within nearshore designated critical habitat of Hawksbill Sea Turtle. However, we have low confidence in the EECs predicted for the marine nearshore habitats. The likelihood and magnitude of toxic effects are not likely to reduce the overall conservation value of designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.



15.46 Leatherback Sea Turtle Designated Critical Habitat

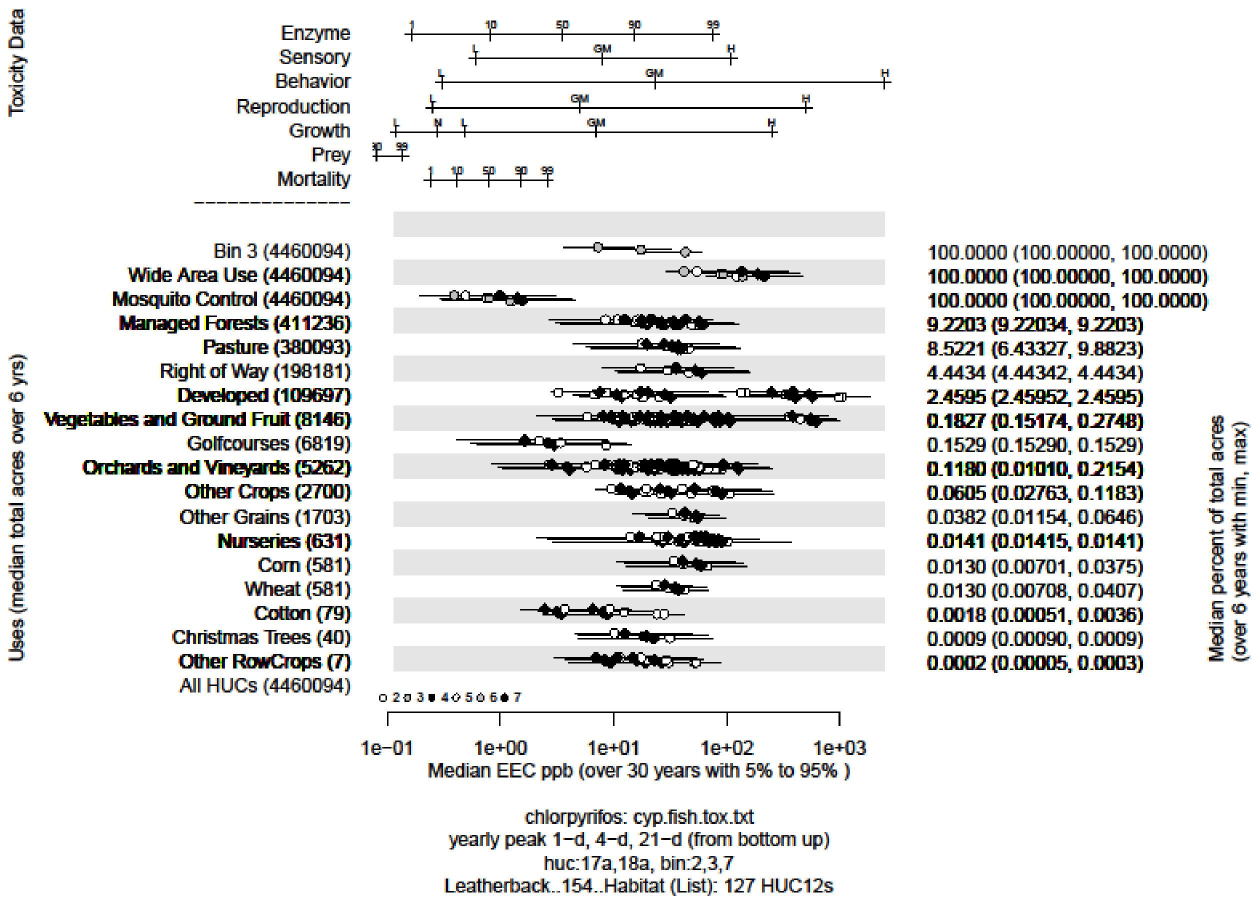


Figure 44. Effects analysis R-plot; Leatherback sea turtle, U.S. West Coast designated critical habitat.

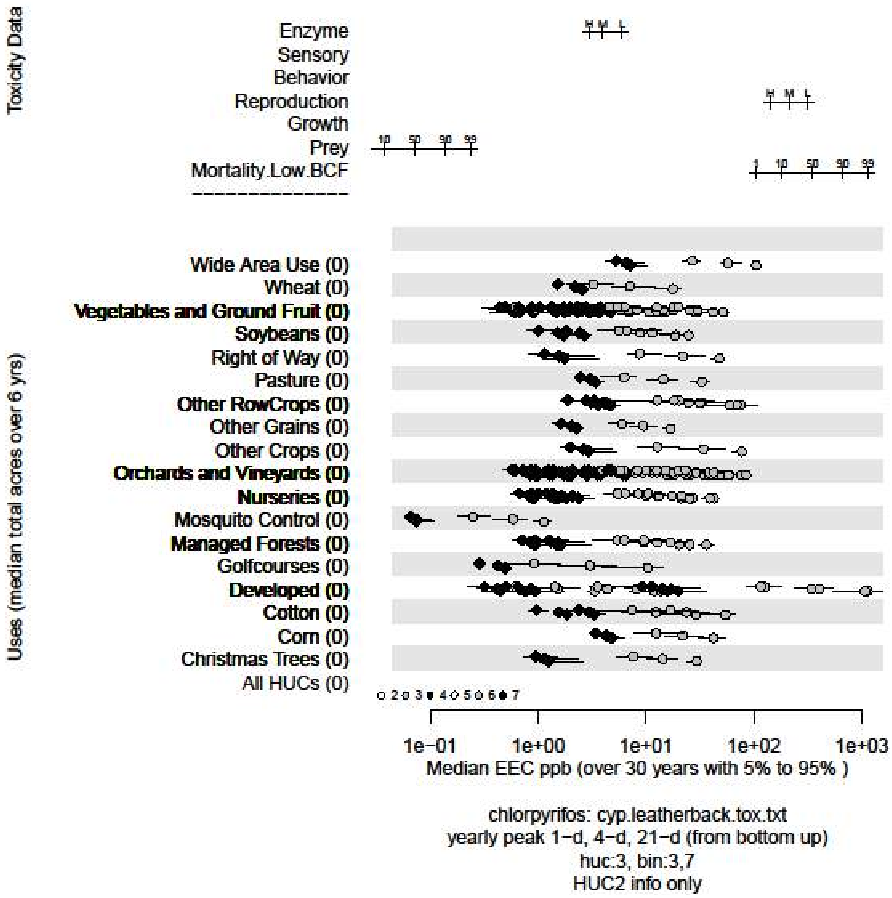


Figure 45. Effects analysis R-plot; Leatherback sea turtle, U.S. Virgin Islands designated critical habitat.

Table 146. Prey (inverts) risk hypothesis; Leatherback sea turtle; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Managed Forests	9.22	High	High
Pasture	8.52	High	High
Right of Way	4.44	High	High
Developed	2.46	High	High

Vegetables and Ground Fruit	0.18	High	Low
Golfcourses	0.15	High	Low
Orchards and Vineyards	0.12	High	Low
Other Crops	0.06	High	Low
Other Grains	0.04	High	Low
Nurseries	0.01	High	Low
Corn	0.01	High	Low
Wheat	0.01	High	Low
Cotton	<0.01	High	Low
Christmas Trees	<0.01	High	Low
Other RowCrops	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey (inverts).			
Risk	**Confidence**		
High	**Low**		

Table 147. Effects analysis summary table; Leatherback sea turtle; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

The stressors of the action may negatively affect a relevant physical and biological feature within the nearshore of each of the designated critical habitat areas of Leatherback Sea Turtle. However, we have low confidence in the EECs predicted for the marine nearshore habitats. The likelihood and magnitude of toxic effects are not likely to reduce the overall conservation value of designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.


Medium Risk
Low Confidence
Less Risk
More Risk

15.47 Loggerhead Sea Turtle (NW Atlantic Ocean DPS) Designated Critical Habitat

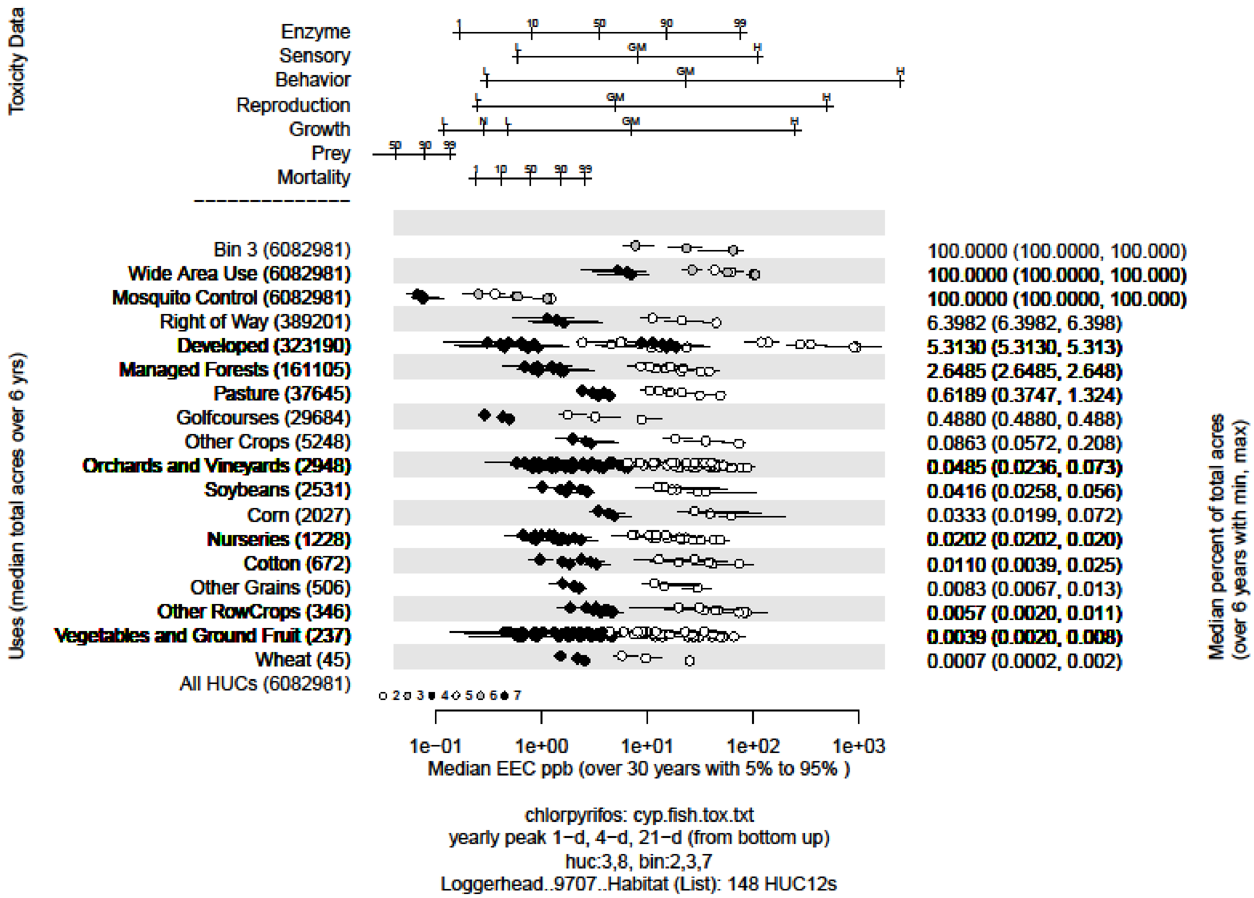


Figure 46. Effects analysis R-plot; Loggerhead sea turtle, NW Atlantic DPS designated critical habitat.

Table 148. Prey (inverts) risk hypothesis; Loggerhead sea turtle; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Right of Way	6.40	High	High
Developed	5.31	High	High

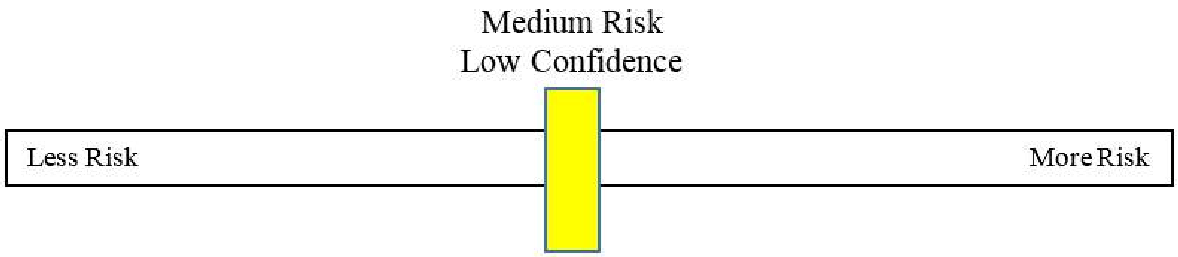
Managed Forests	2.65	High	High
Pasture	0.62	High	Low
Golfcourses	0.49	High	Low
Other Crops	0.09	High	Low
Orchards and Vineyards	0.05	High	Low
Soybeans	0.04	High	Low
Corn	0.03	High	Low
Nurseries	0.02	High	Low
Cotton	0.01	High	Low
Other Grains	0.01	High	Low
Other RowCrops	0.01	High	Low
Vegetables and Ground Fruit	<0.01	High	Low
Wheat	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey (inverts).			
Risk	**Confidence**		
High	**Low**		

Table 149. Effects analysis summary table; Loggerhead sea turtle; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

The stressors of the action may negatively affect a relevant physical and biological feature within nearshore designated critical habitat of Loggerhead Sea Turtle (NW Atlantic Ocean DPS). However, we have low confidence in the EECs predicted for the marine nearshore habitats. The likelihood and magnitude of toxic effects are not likely to reduce the overall conservation value of designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.



15.48 Southern Resident Killer Whale Designated Critical Habitat

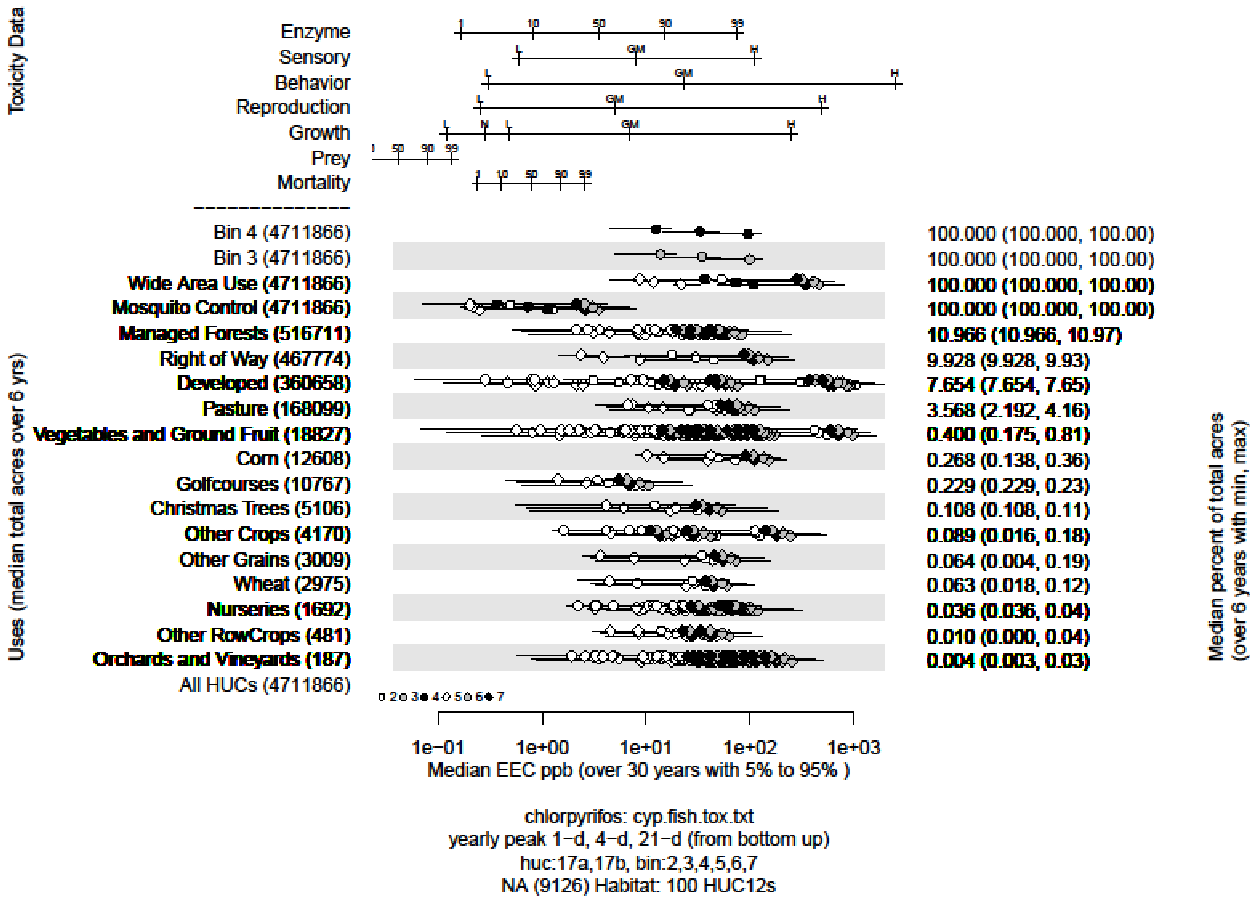


Figure 47. Effects analysis R-plot; Southern Resident Killer Whale designated critical habitat.

Table 150. Prey (fish) risk hypothesis; Killer whale, Southern resident DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	10.97	High	High
Right of Way	9.93	High	High

Developed	7.65	High	High
Pasture	3.57	High	High
Vegetables and Ground Fruit	0.40	High	Low
Corn	0.27	High	Low
Golfcourses	0.23	High	Low
Christmas Trees	0.11	High	Low
Other Crops	0.09	High	Low
Other Grains	0.06	High	Low
Wheat	0.06	High	Low
Nurseries	0.04	High	Low
Other RowCrops	0.01	High	Low
Orchards and Vineyards	<0.01	High	Low
Risk Hypothesis: Direct exposure to the stressors of the action within designated critical habitat is sufficient to reduce prey (fish).			
Risk	**Confidence**		
Low	**High**		
Risk Hypothesis: Exposure to the stressors of the action outside of designated critical habitat is sufficient to in-directly reduce prey availability (Chinook salmon).			
Risk	**Confidence**	**Affecting the availability of prey species of sufficient quantity and quality. Jeopardy determinations were made for all ESU's of Chinook salmon with regard to the proposed action.**	
High	**Low**		

Table 151. Water quality risk hypothesis; Killer whale, Southern resident DPS; designated critical habitat.

Endpoint: Water Quality

Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of chlorpyrifos-containing products occur in proximity to the designated critical habitat of Killer whale, Southern resident DPS. Sixteen use site categories, totaling more than 1,573,064 acres (over 33% of acres) are currently present. In addition, proposed labels for chlorpyrifos allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated chlorpyrifos levels in designated critical habitat are not sufficient to cause adverse effects to killer whales.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Low	**High**	

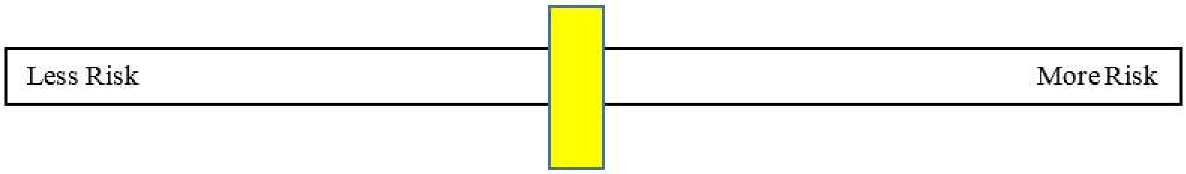
Table 152. Effects analysis summary table; Killer whale, Southern resident DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Direct exposure to the stressors of the action within designated critical habitat is sufficient to reduce the conservation value via reductions in prey (fish).	Low	High	No
Exposure to the stressors of the action outside of designated critical habitat is sufficient to in-directly reduce the conservation value via reductions in prey availability (Chinook salmon).	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality.	Low	High	No

Designated Critical Habitat Effects Analysis Summary:

We do not anticipate stressors of the action will directly affect physical or biological features (PBFs). Reductions in suitable prey (within designated critical habitat) and degradation of water quality are unlikely throughout designated critical habitat of Southern Resident Killer Whale. However, indirectly, prey species (salmon) will be adversely affected by exposures anticipated in their freshwater habitats. The likelihood and magnitude of toxic effects will reduce the overall conservation value of designated critical habitat by reducing the availability of these important prey. We find that the overall risk is medium and the confidence associated with that risk is medium over the 15-year duration of the action.

Medium Risk
Medium Confidence



15.49 Steller Sea Lion (Western DPS) Designated Critical Habitat

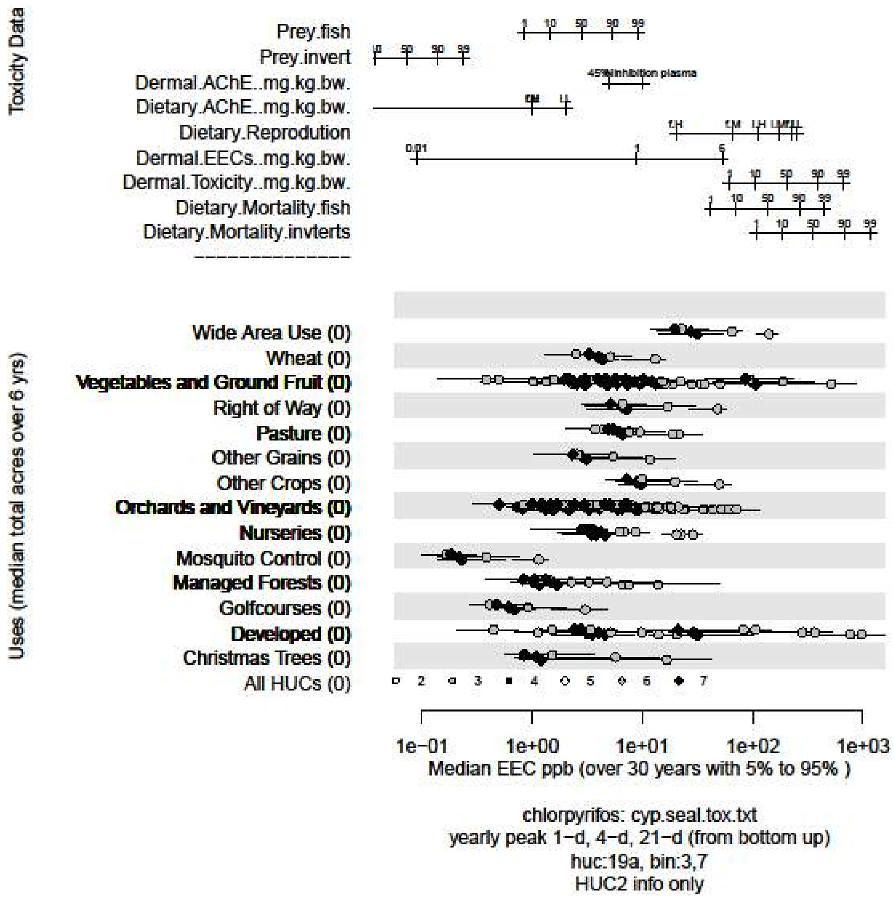


Figure 48. Effects analysis R-plot; Steller sealion, Western DPS designated critical habitat.

Table 153. Effects analysis summary table; Steller sealion, Western DPS; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported?
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce prey.	Medium	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

The stressors of the action may negatively affect a relevant physical and biological feature within nearshore designated critical habitat of Steller Sea Lion (Western DPS). However, we have low confidence in the EECs predicted for the marine nearshore habitats. The likelihood and magnitude of toxic effects are not likely to reduce the overall conservation value of designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.

15.50 Hawaiian Monk Seal Designated Critical Habitat

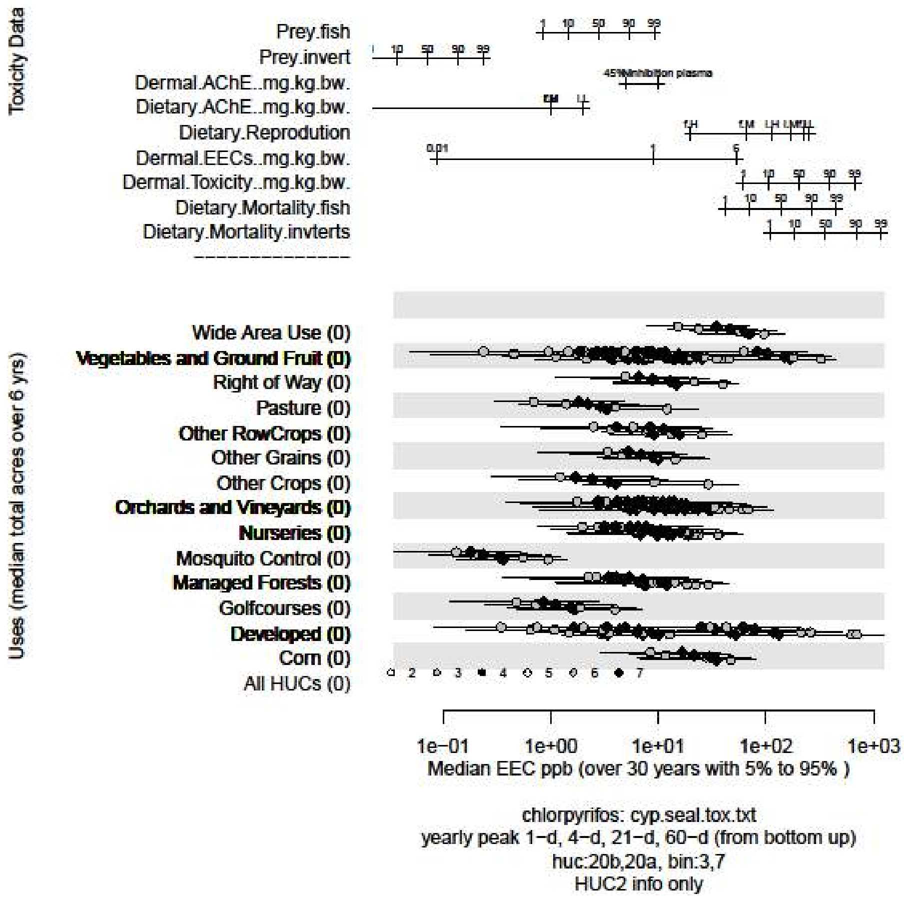


Figure 49. Effects analysis R-plot; Hawaiian Monk Seal designated critical habitat.

Table 154. Effects analysis summary table; Hawaiian Monk Seal designated critical habitat.

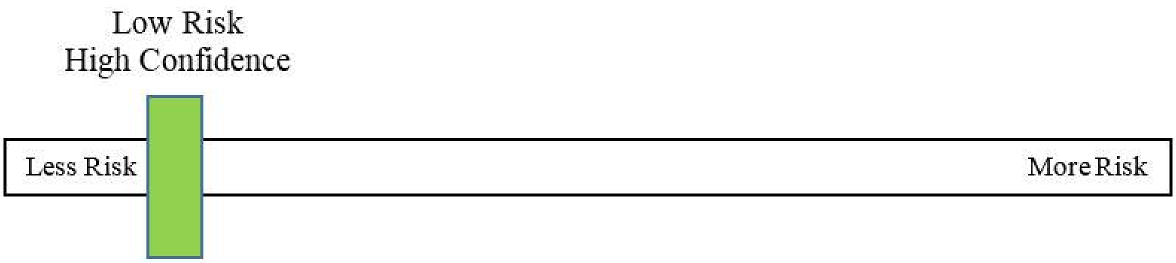
Designated Critical Habitat; Risk Hypotheses	R-plot Derived Risk	R-plot Derived Confidence	Risk Hypothesis Supported? Yes/No
Exposure to the stressors of the action is sufficient to reduce prey.	Medium	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

The stressors of the action may negatively affect a relevant physical and biological feature within nearshore designated critical habitat of Hawaiian Monk Seal. However, we have low confidence in the EECs predicted for the marine nearshore habitats. The likelihood and magnitude of toxic effects are not likely to reduce the overall conservation value of designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.

15.51 Johnson's Seagrass Designated Critical Habitat

Water quality, in terms of water clarity for photosynthesis, is a physical or biological features identified in Johnson's seagrass designated critical habitat. However, we do not anticipate exposures from the stressors of the action to be sufficient to reduce conservation values of this PBF. We find that the overall risk is low and the confidence associated with that risk is high over the 15-year duration of the action.



15.52 Summary of the Effects of the Action on Physical or Biological Features

We conclude that the available information on exposure and response of aquatic habitats to the stressors of the action supports risk hypotheses for many of the species. Table 155 summarizes for chlorpyrifos and for the species habitats where risk hypotheses are supported. We expect water quality and prey abundance to be reduced in spawning, rearing, migratory, estuarine, or nearshore marine habitats for many of the species' designated critical habitats. Next, within the *Integration and Synthesis for Designated Critical Habitat* section, we evaluate whether these adverse changes to PBFs affect the conservation value of designated critical habitat.

Table 155. Summary of species critical habitat risk assessments to key physical and biological features – chlorpyrifos.

Species Designated Critical Habitat	Water Quality and/or Prey Risk Hypotheses Supported (Chlorpyrifos)
Chum salmon , Columbia River ESU	Yes
Chum salmon, Hood Canal summer-run ESU	Yes
Chinook salmon, California coastal ESU	Yes
Chinook salmon, Central Valley spring-run ESU	Yes
Chinook salmon, Lower Columbia River ESU	Yes
Chinook salmon, Puget Sound ESU	Yes
Chinook salmon, Sacramento River winter-run ESU	Yes
Chinook salmon, Snake River fall-run ESU	Yes
Chinook salmon, Snake River spring/summer run ESU	Yes
Chinook salmon, Upper Columbia River spring-run ESU	Yes
Chinook salmon, Upper Willamette River ESU	Yes
Coho salmon, Central California coast ESU	Yes
Coho salmon, Lower Columbia River ESU	Yes
Coho salmon, Oregon coast ESU	Yes
Coho salmon, S. Oregon and N. California coasts ESU	Yes
Sockeye, Ozette Lake ESU	Yes
Sockeye, Snake River ESU	Yes
Steelhead, California Central Valley ESU	Yes

Steelhead, Central California coast ESU	Yes
Steelhead, Lower Columbia River ESU	Yes
Steelhead, Middle Columbia River ESU	Yes
Steelhead, Northern California ESU	Yes
Steelhead, Puget Sound ESU	Yes
Steelhead, Snake River Basin ESU	Yes
Steelhead, South-Central California coast ESU	Yes
Steelhead, Southern California ESU	Yes
Steelhead, Upper Columbia River ESU	Yes
Steelhead, Upper Willamette River ESU	Yes
Eulachon, Pacific smelt, Southern DPS	Yes
Green sturgeon, Southern DPS	Yes
Gulf sturgeon	No
Atlantic sturgeon, Carolina DPS	Yes
Atlantic sturgeon, Chesapeake Bay DPS	Yes
Atlantic sturgeon, Gulf of Maine DPS	Yes
Atlantic sturgeon, New York Bight DPS	Yes
Atlantic sturgeon, South Atlantic DPS	Yes
Yelloweye rockfish	No
Bocaccio, Puget Sound/Georgia Basin	No
Smalltooth sawfish, U.S. DPS	Yes
Black abalone	No
Staghorn coral	No
Elkhorn coral	No
Green sea turtle, North Atlantic DPS	No
Hawksbill sea turtle	No
Leatherback sea turtle	No
Loggerhead sea turtle, Northwest Atlantic Ocean DPS	No

Killer whale, Southern Resident DPS	Yes
Steller sea lion, Western	No
Hawaiian monk seal	No
Johnson's seagrass	No

CHAPTER 16

DESIGNATED CRITICAL HABITAT EFFECTS ANALYSIS

DIAZINON

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16.1 Introduction

The National Marine Fisheries Services (NMFS') critical habitat analysis determines whether the proposed action is likely to destroy or adversely modify critical habitat for Endangered Species Act (ESA)-listed species by examining potential reductions in the conservation value of the essential features of designated critical habitat. "Destruction or adverse modification" means a direct or indirect alteration that appreciably diminishes the value of designated critical habitat for the conservation of an ESA-listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features (PBFs) essential to the conservation of a species or that preclude or significantly delay development of such features (50 C.F.R. §402.02).

In this section, NMFS evaluates the potential consequences to designated critical habitat from exposure to the stressors of the proposed action. A diagram of our analysis framework is shown in ***Figure 1***. It is similar in structure to the jeopardy analysis, but focuses on whether the proposed action is likely to destroy or adversely modify designated critical habitat for listed species. NMFS reviews the status of designated and proposed critical habitat affected by the proposed action separate from species effects by examining the condition and trends of the designated essential physical or biological features (PBFs) of critical habitat throughout the action area. We first determine whether critical habitat is likely to be exposed to the stressors of the proposed action (exposure profile). To conduct this analysis, we relied on R-plots showing expected pesticide concentrations in the species' designated critical habitat. If we find that critical habitat is likely to be exposed, we determined the relevant PBFs for each species' designated critical habitat that would be at risk from this proposed action and assess the consequences of that exposure on the quality, quantity, or availability of those PBFs (response profile) (Appendix C). We relied heavily on EPA provided Crop Land Data Layers of crop uses and conducted an overlap of critical habitat analysis to determine exposure potential to designated critical habitat.

In all of the critical habitat designations that are exposed to the stressors of this action, water quality and forage (prey availability) are key attributes that are either designated as PBFs of the critical habitat, or are relevant to the PBFs. Water quality encompasses a range of typically measured parameters, including dissolved oxygen, temperature, turbidity, and presence of contaminants. Here, we use the presence of chemical contaminants as an indicator of degraded water quality. The proposed action would degrade water quality by introducing chlorpyrifos, diazinon, malathion, and other associated chemicals into designated critical habitats. Therefore, we use the pesticide concentrations likely to adversely affect listed species or prey (e.g. invertebrates and juvenile fish) as measures of degraded water quality. We also note that the PBF's for most of the critical habitats at issue include availability and quality of prey. The three a.i.s are expected to affect prey at concentrations within the range predicted to occur in most freshwater and estuarine habitats by exposure models. This analysis is conducted by comparing toxicity information (e.g., aquatic invertebrate LC_{50} values) provided in EPA's "Effects Characterization" in their BE, with expected pesticide concentrations derived from R-plots using data from EPA's MagTool.

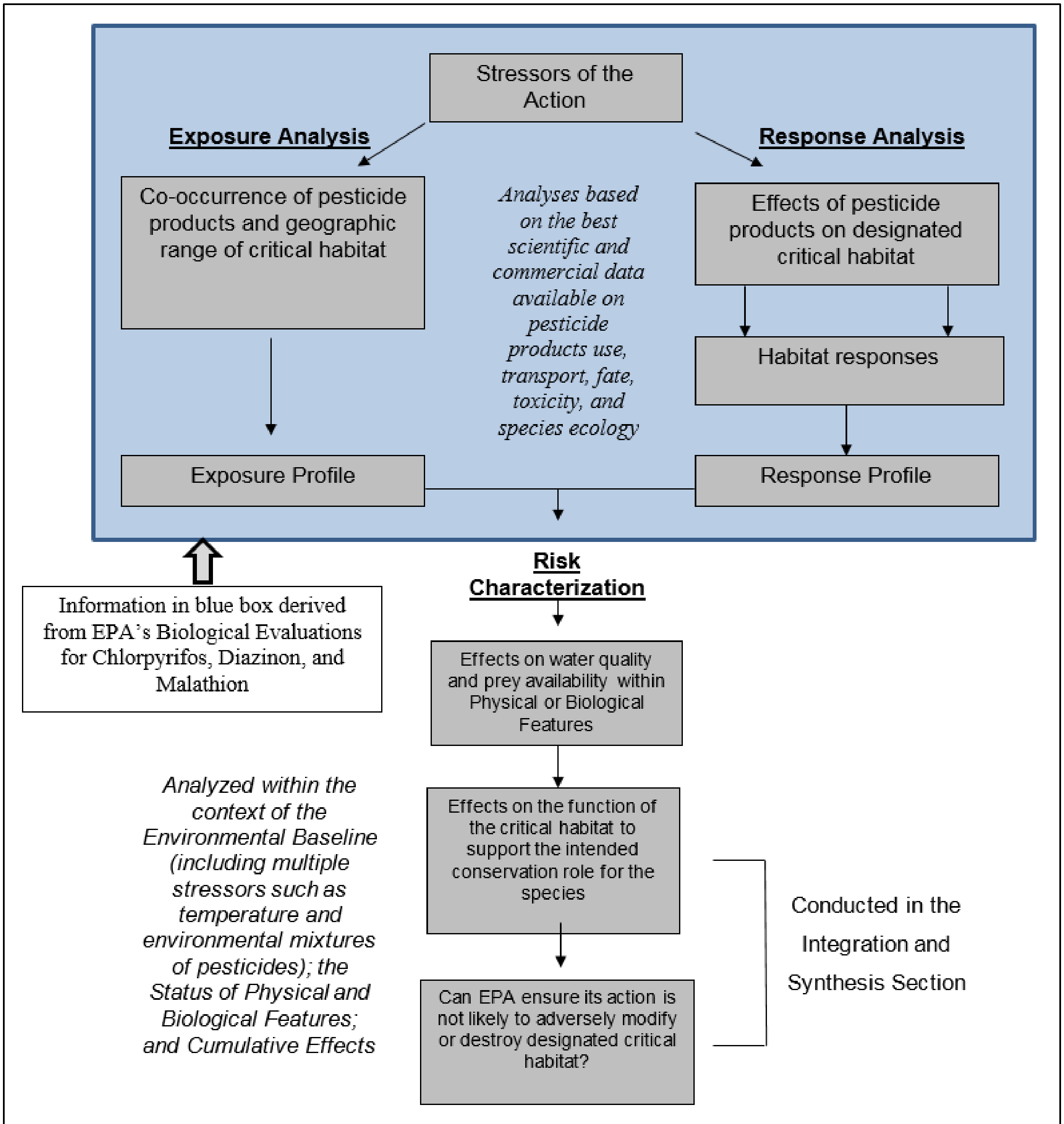


Figure 1. Assessment Framework for Designated Critical Habitat

Figure 1. Assessment Framework for Designated Critical Habitat

We translated each PBF into a risk hypothesis to assess potential impacts on designated critical habitat. The analysis of risk hypotheses is based on: 1) the likely concentrations of the three pesticides that would be observed in critical habitat; and 2) the response of PBFs to those anticipated concentrations.

The action area for this Opinion encompasses all designated critical habitat for listed species within the continental U.S., Hawaii, Alaska, and U.S. Protectorates. These species include Pacific salmonids in Washington, Oregon, California and Idaho. As the species of salmonids addressed in this Opinion have similar life history characteristics, they share many of the same PBFs. These PBFs include sites that support one or more life stages and contain physical or biological features essential to the conservation of the Evolutionarily Significant Unit (ESU)/ Distinct Population Segment (DPS). PBFs include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, estuarine areas, nearshore marine areas, and offshore marine areas. Other species include two Puget Sound rockfish species, eulachon, two sturgeon species, two species of corals, black abalone, several species of sea turtles, Southern Resident Killer Whale, two pinniped species, Johnson's seagrass, and Smalltooth sawfish. For each of these species we determined the relevant PBFs that would be affected by the proposed action. Descriptions of species' designated critical habitats and associated PBFs are provided in Appendix C.

Water quality and prey availability in freshwater and estuarine areas may be susceptible to pesticide effects where critical habitat overlaps with or is adjacent to use sites. Effects to water quality and prey availability will be evaluated to determine the likelihood of reducing the quality of freshwater, estuarine, and nearshore marine areas. Given the use and environmental fate profile of the pesticide formulations containing these active ingredients, we do not expect offshore marine areas to be directly affected. Therefore, a risk hypothesis was not developed for this area and further evaluation of this PBF is not warranted.

Sufficient water quality is a necessary attribute of many aquatic PBFs to support the conservation role of designated critical habitat, and water quality unimpaired by toxins is necessary to the PBFs of the critical habitats affected by the stressors of this action. For example, all species of juvenile salmon need clean cold water. Clean and cold water is essential support for producing abundant prey for salmonid growth and development. This is also true for green sturgeon. Eggs and larvae develop in freshwater. Development of early life stages is affected by water flow and temperature. Juvenile sturgeon rear and feed in fresh and estuarine waters from one to 4 years prior to dispersing into marine waters as subadults. During this time, their growth and development relies on adequate water quality to support abundant prey production. Water quality is clearly degraded when pesticides and other stressors of the action reach levels in habitat that are sufficient to adversely affect aquatic organisms and reduce individual fitness of exposed ESA-listed species. Impacts to species fitness were evaluated earlier in the document and these impacts are used as indicators of degraded water quality. We evaluate exposure and effect concentrations presented in the Environmental Protection Agency's (EPA's) BEs to determine whether PBFs are impacted.

We also evaluate effects on prey because forage is an essential attribute of many PBFs. Freshwater juvenile rearing and migratory habitats as well as estuarine and nearshore marine areas must provide sufficient forage to support growth and development of the listed species. Reductions in the abundance of prey items can decrease the quality of rearing, migration, and estuarine PBFs, as less available food will support fewer individuals. Reductions in prey can reduce a PBF's potential to support species (juvenile development, growth, maturation, survival), thereby reducing the carrying capacity of critical habitat. We evaluated the toxicity assessment endpoints including prey and fish survival (EC_{50}/LC_{50}) to determine whether expected concentrations of the stressors of the action are sufficient to affect PBFs of species critical habitats.

Designated critical habitat is located within the action area. Many freshwater areas overlap with the allowable uses of the three a.i.'s. The stressors of the action contaminate these habitats via drift and runoff (including from irrigation returns), and to a lesser extent from atmospheric deposition. Once in species habitats, the three active ingredients persist for varying periods of time, depending in part on the chemical, biological, and physical environment of the contaminated aquatic habitats. The most persistent of the three, chlorpyrifos (soil half-life 171 days),[1] may accumulate in soils and contribute to aquatic loading via runoff months later affecting organisms beyond those exposed initially from application events. Expected concentrations of other/inert ingredients and adjuvants added to formulations prior to application remain unknown, and are an identified data gap.

We use the toxicity information provided in the BEs and presented earlier in the Effects Analysis Chapters (Chapters 12, 13, and 14) to evaluate the scientific lines of evidence that support or refute risk hypotheses developed for designated and proposed critical habitats. Freshwater spawning and rearing sites, migration corridors, estuarine areas, and nearshore marine areas within designated critical habitats are likely to be exposed to the stressors of the action over the 15-year registration duration. We estimate expected concentrations and durations of exposure for these habitats based on pesticide use information, surface water monitoring data, EPA modeling estimates, and NMFS modeling estimates.

For each risk hypothesis in ***Table 1*** (also refer to Appendix E for specific risk hypotheses for each species PBFs relevant to this analysis) we qualitatively weigh the evidence to determine whether the PBF attributes of water quality and prey availability are affected for each species designated critical habitat. Water quality is degraded when pesticides and other stressors of the action reach levels in habitat that are sufficient to adversely affect aquatic organisms and reduce individual fitness of exposed ESA-listed species (this was evaluated earlier in the document). We ultimately determine whether the degradation of water quality and reduction in prey availability within freshwater spawning and rearing sites, migration corridors, estuarine areas, and nearshore marine areas will rise to the level expected to reduce the intended conservation role of designated critical habitats. This analysis is conducted by evaluating toxicity information (e.g., aquatic invertebrate LC50 values), as well as by characterizing the likelihood of exposure within the designated critical habitat. Likelihood of exposure for critical habitat considers three factors: 1) percent overlap; 2) chemical persistence, and; 3) number of repeated applications allowed. See Chapter 3 for a description of how these factors are considered to determine the overall likelihood of exposure.

See Chapters 22 – 24 (Integration and Synthesis for Designated Critical Habitat) for the final conclusion of whether EPA's proposed action with end-use products containing chlorpyrifos, diazinon, or malathion are likely to adversely modify or destroy a species' designated or proposed critical habitat.

[1] Diazinon soil half-life is 34 days, malathion soil half-life is 1 day.

Table 1. Generalized risk hypotheses for relevant PBF's.

Risk hypothesis for relevant physical or biological features
1. Exposure to the stressors of the action is sufficient to degrade water quality and/or reduce prey resources in freshwater spawning sites.
2. Exposure to the stressors of the action is sufficient to degrade water quality and/or reduce prey resources in freshwater rearing sites.
3. Exposure to the stressors of the action is sufficient to degrade water quality, and/or reduce prey resources in freshwater migratory corridors.
4. Exposure to the stressors of the action is sufficient to degrade water quality and/or reduce prey resources in estuarine areas.
5. Exposure to the stressors of the action is sufficient to degrade water quality and/or reduce prey resources in nearshore marine areas.

The following sections provide the chemical-specific assessments of risk hypotheses for each designated critical habitats involved in this consultation (defined by the action area).

16.2 Columbia River Chum Salmon (O. keta) Designated Critical Habitat

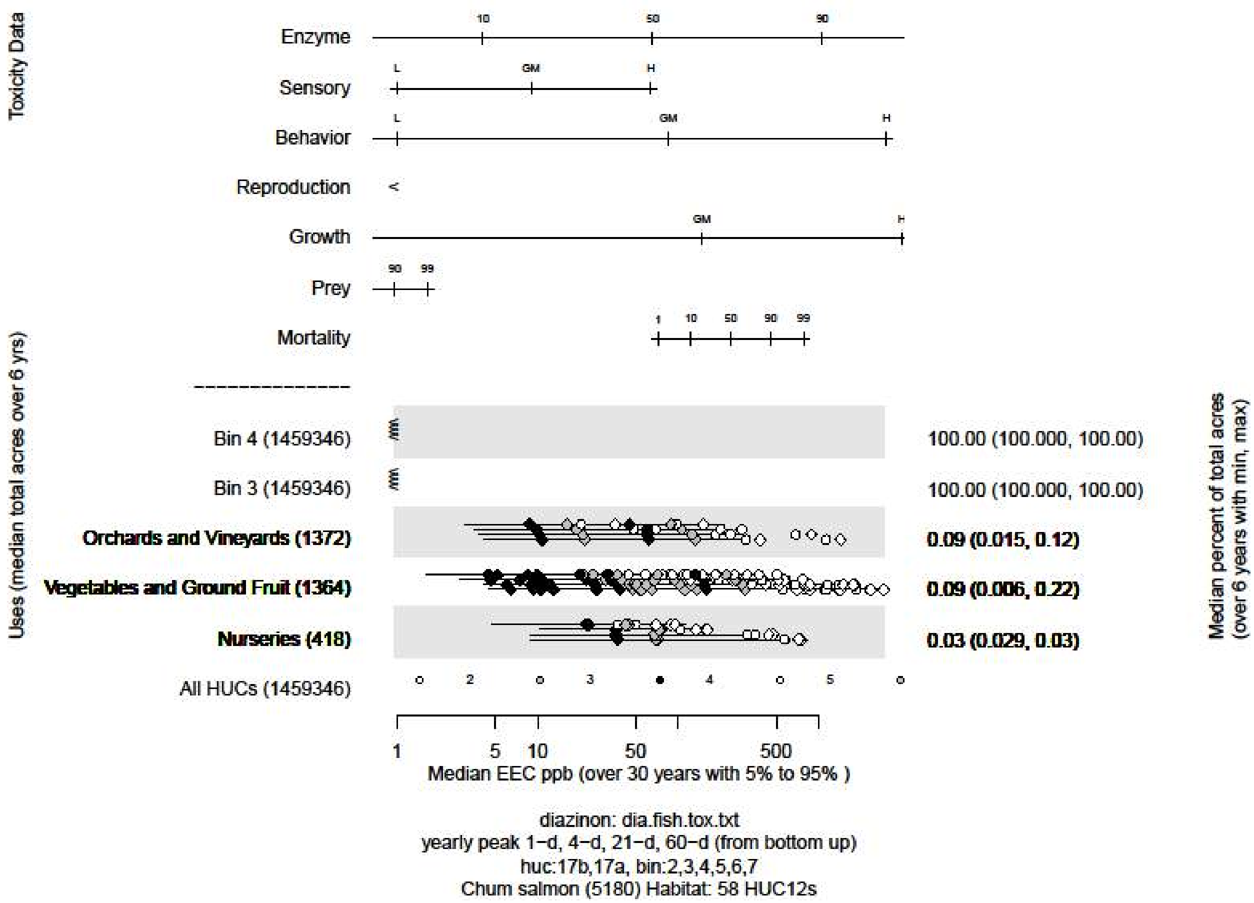


Figure 2. Effects analysis R-plot; chum salmon, Columbia River ESU designated critical habitat.

Table 2. Prey risk hypothesis; chum salmon, Columbia River ESU designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Medium	High
Bin 4	100.00	Low	High
Orchards and Vineyards	0.09	High	Low
Vegetables and Ground Fruit	0.09	High	Low
Nurseries	0.03	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***we have low confidence in EECs associated with marine and estuarine habitats.**	
Low	**High**		

Table 3. Water quality risk hypothesis; chum salmon, Columbia River ESU designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within Columbia River Chum designated critical habitat. Three use site categories, totaling approximately 3,154 acres (less than one percent of acres) are currently present.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Low	**High**	

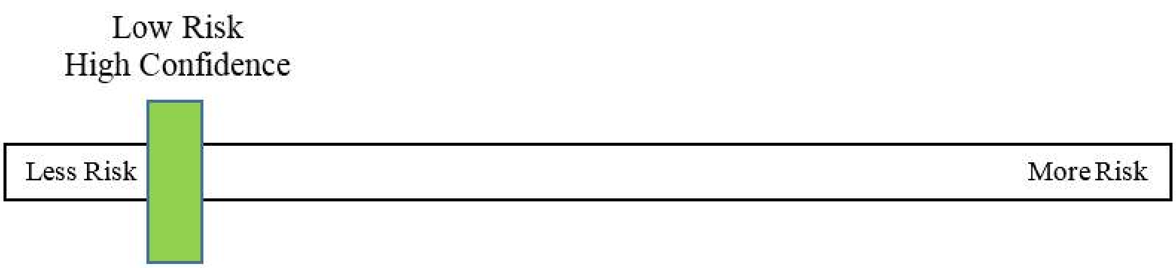
Table 4. Effects analysis summary table; chum salmon, Columbia River ESU designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	Low	Medium	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water	Low	Medium	No

quality and/or reductions in prey in nearshore marine areas.			

Designated Critical Habitat Effects Analysis Summary:

We do not anticipate that the stressors of the action will negatively affect physical and biological features (PBFs). Neither reductions in prey, nor degradation of water quality are likely throughout designated critical habitat of Columbia River Chum Salmon. The magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses the overall conservation value of designated critical habitat is not anticipated to decrease. We have greater confidence in the risk determinations associated with the freshwater habitats than we do in the estuarine and nearshore habitats. Overall the risk is low and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.



16.3 Hood Canal summer-run Chum (O. keta) Designated Critical Habitat

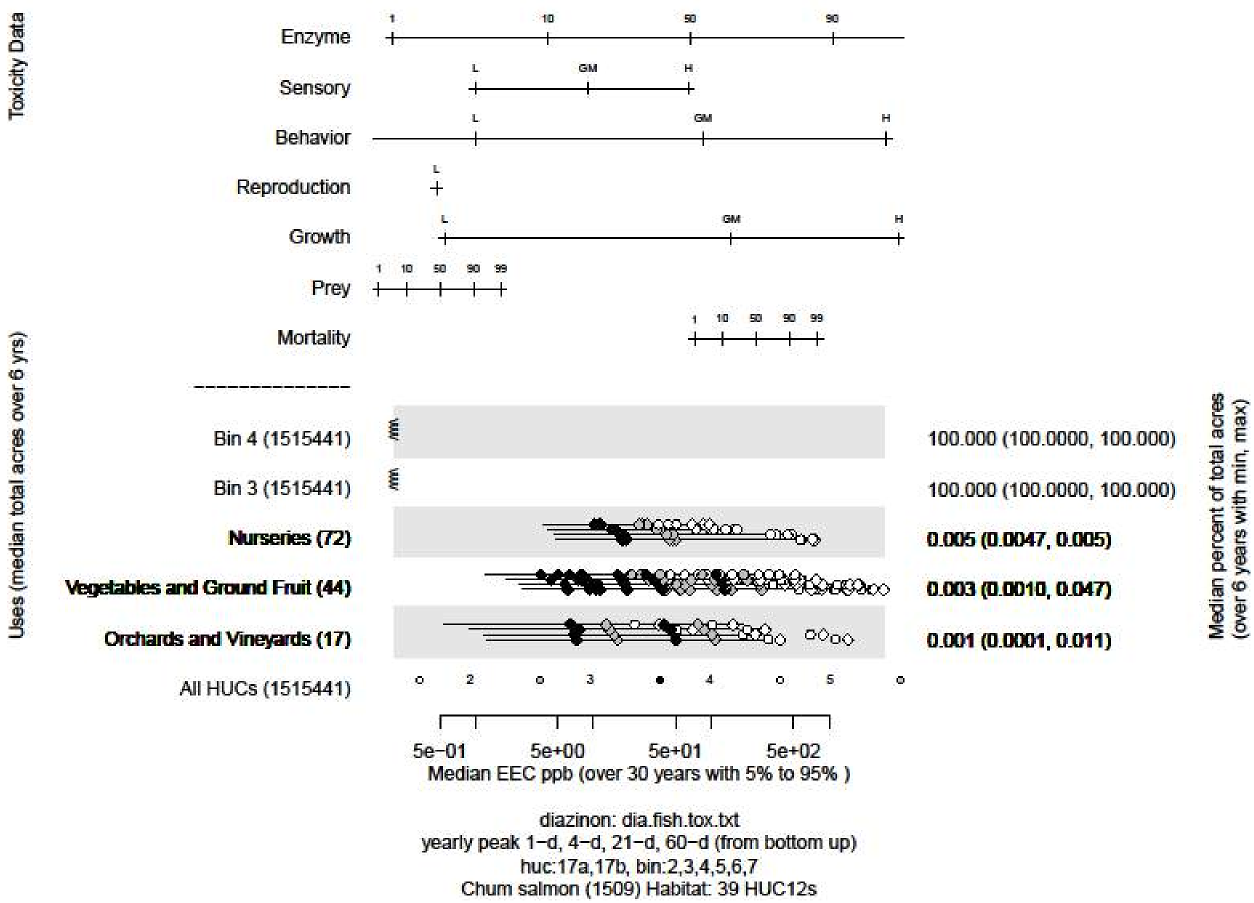


Figure 3. Effects analysis R-plot; chum salmon, Hood-Canal summer-run ESU designated critical habitat.

Table 5. Prey Risk Hypothesis; Chum salmon, Hood Canal summer-run ESU designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Nurseries	<0.01	High	Low
Vegetables and Ground Fruit	<0.01	High	Low
Orchards and Vineyards	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Low	**High**		

Table 6. Water quality risk hypothesis; Chum salmon, Hood Canal summer-run ESU; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within Hood Canal summer chum designated critical habitat. Three use site categories, totaling approximately 133 acres (less than one percent of acres) are currently present.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Low	**High**	

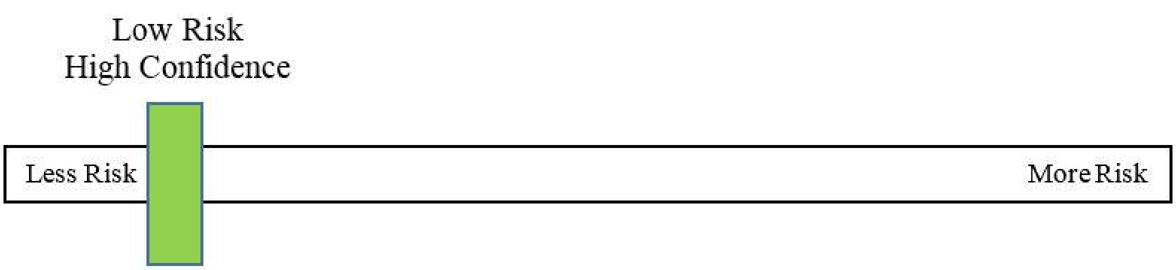
Table 7. Effects analysis summary table; chum salmon, Hood Canal summer-run ESU; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	Low	Medium	No

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	Low	Medium	No

Designated Critical Habitat Effects Analysis Summary:

We do not anticipate that the stressors of the action will negatively affect physical and biological features (PBFs). Neither reductions in prey, nor degradation of water quality are likely throughout designated critical habitat of Hood Canal summer-run Chum. The magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses the overall conservation value of designated critical habitat is not anticipated to decrease. We have greater confidence in the risk determinations associated with the freshwater habitats than we do in the estuarine and nearshore habitats. Overall the risk is low and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.



16.4 California Coastal Chinook (O. tshawytscha) Designated Critical Habitat

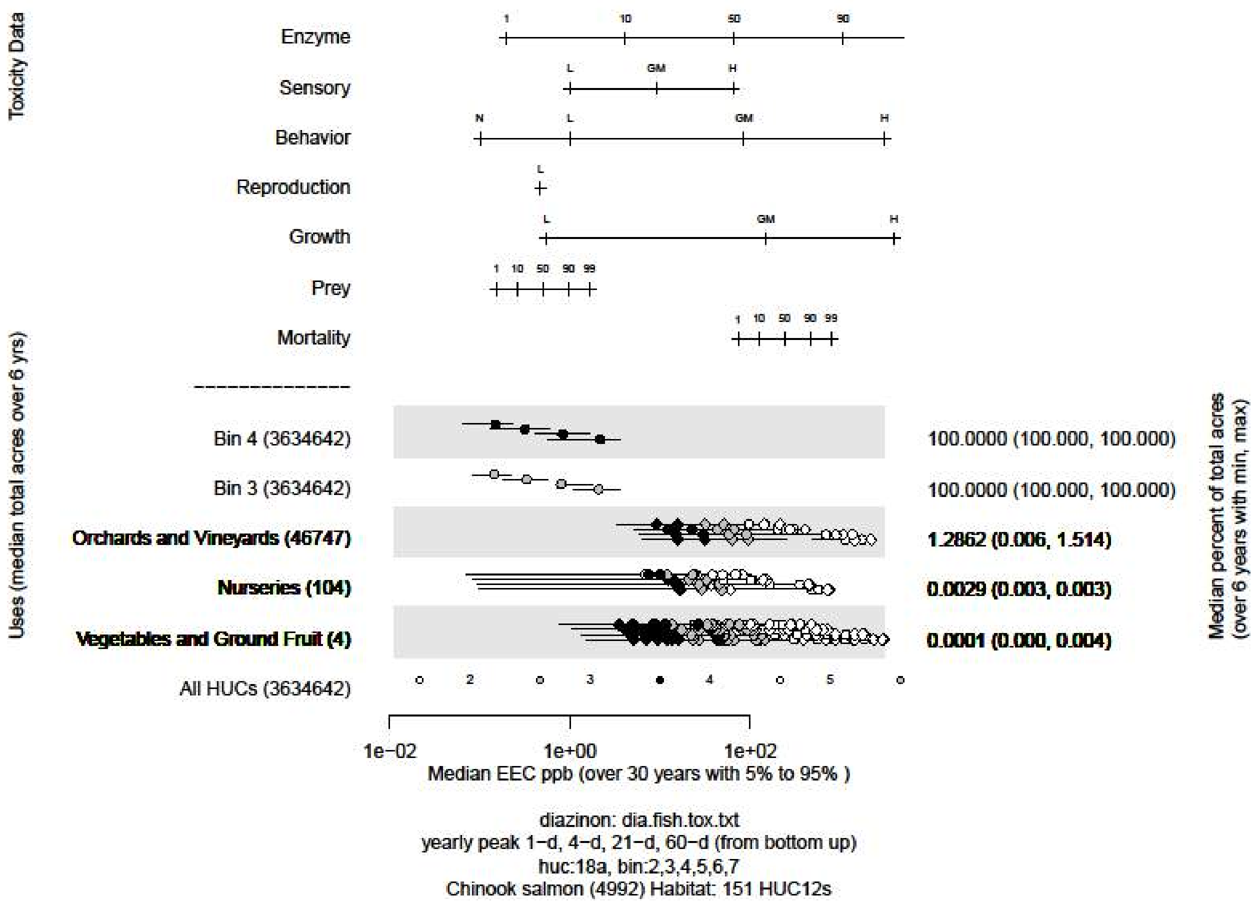


Figure 4. Effects analysis R-plot; Chinook salmon, California Coastal ESU designated critical habitat.

Table 8. Prey Risk Hypothesis; Chinook salmon, California Coastal ESU designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Orchards and Vineyards	1.29	High	Medium
Nurseries	<0.01	High	Low
Vegetables and Ground Fruit	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**		

Medium	**Medium**	***We have low confidence in EECs associated with marine and estuarine habitats.**

Table 9. Water quality risk hypothesis; Chinook, California coastal ESU; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of diazinon-containing products occur within the designated critical habitat of Chinook, California coastal ESU. Three use site categories, totaling more than 46,855 acres (over one percent of acres) are currently present. The anticipated diazinon levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Medium	**Medium**	

Table 10. Effects analysis summary table; Chinook, California coastal ESU; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	Medium	Medium	Yes

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	Medium	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	Medium	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a medium likelihood that the stressors of the action will negatively affect physical and biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of California Coastal Chinook. The magnitude of toxic effects may result in some adverse effects. Due to the extent of diazinon-containing uses, we anticipate the overall conservation value of designated critical habitat to decrease moderately. We find that the overall risk is medium and the confidence associated with that risk is medium over the 15-year duration of the action.

16.5 Central Valley Spring-run Chinook Designated Critical Habitat

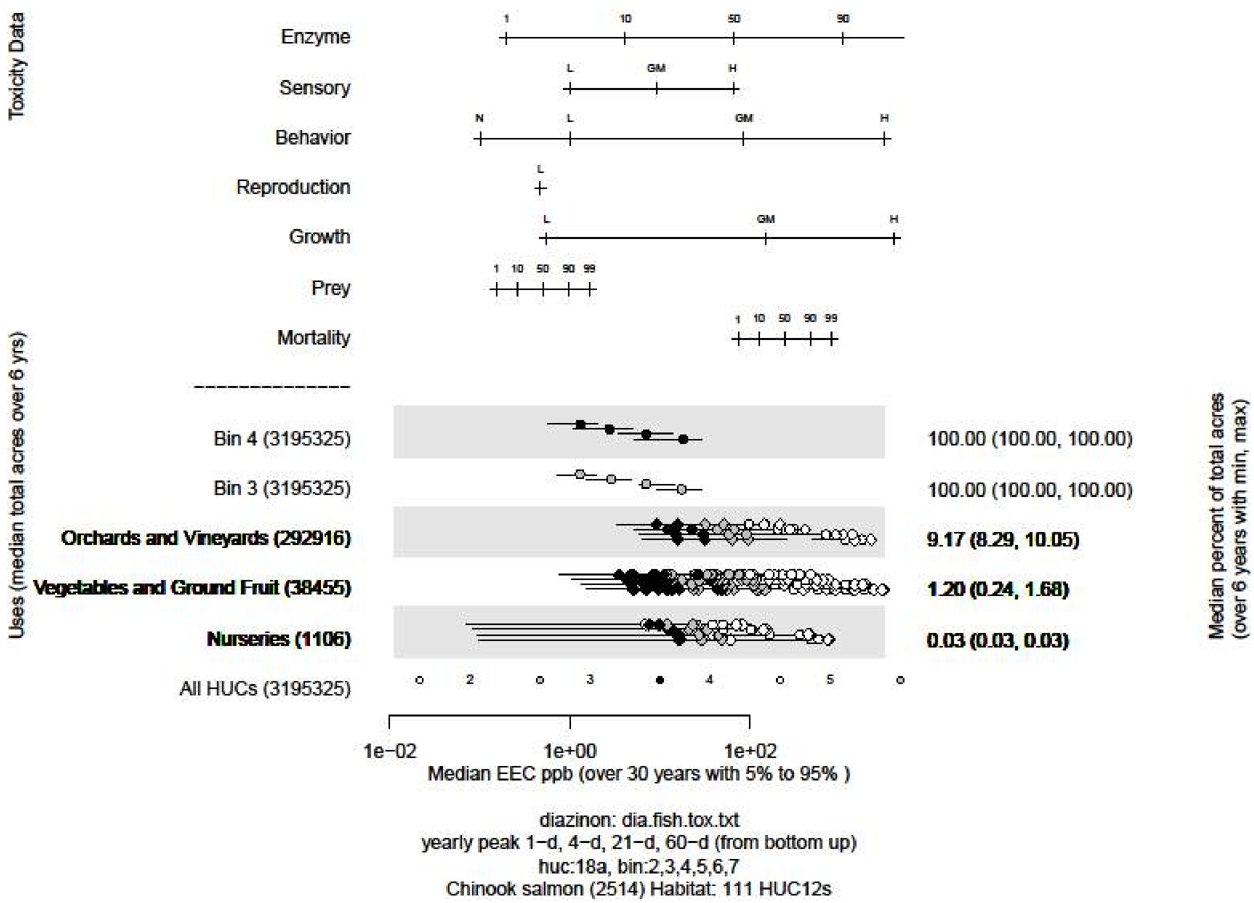


Figure 5. Effects analysis R-plot; Chinook salmon, Central Valley spring-run ESU designated critical habitat.

Table 11. Prey risk hypothesis; Chinook, Central Valley spring-run ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Orchards and Vineyards	9.17	High	High
Vegetables and Ground Fruit	1.20	High	Medium
Nurseries	0.03	High	Low

Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*		
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**
High	**High**	

Table 12. Water quality risk hypothesis; Chinook, Central Valley spring-run ESU; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of diazinon-containing products occur within the designated critical habitat of Chinook, Central Valley spring-run ESU. Three use site categories, totaling more than 332,480 acres (over 10% of acres) are currently present. The anticipated diazinon levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

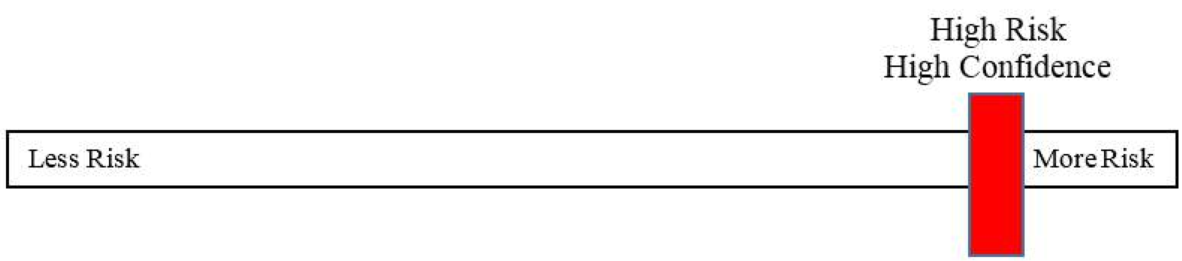
Table 13. Effects analysis summary table; Chinook, Central Valley spring-run ESU; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported? Yes/No
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water	High	High	Yes

quality, natural cover, and/or reductions in prey in freshwater migratory corridors.			
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical and biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Central Valley Spring-run Chinook. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



16.6 Lower Columbia River Chinook Designated Critical Habitat

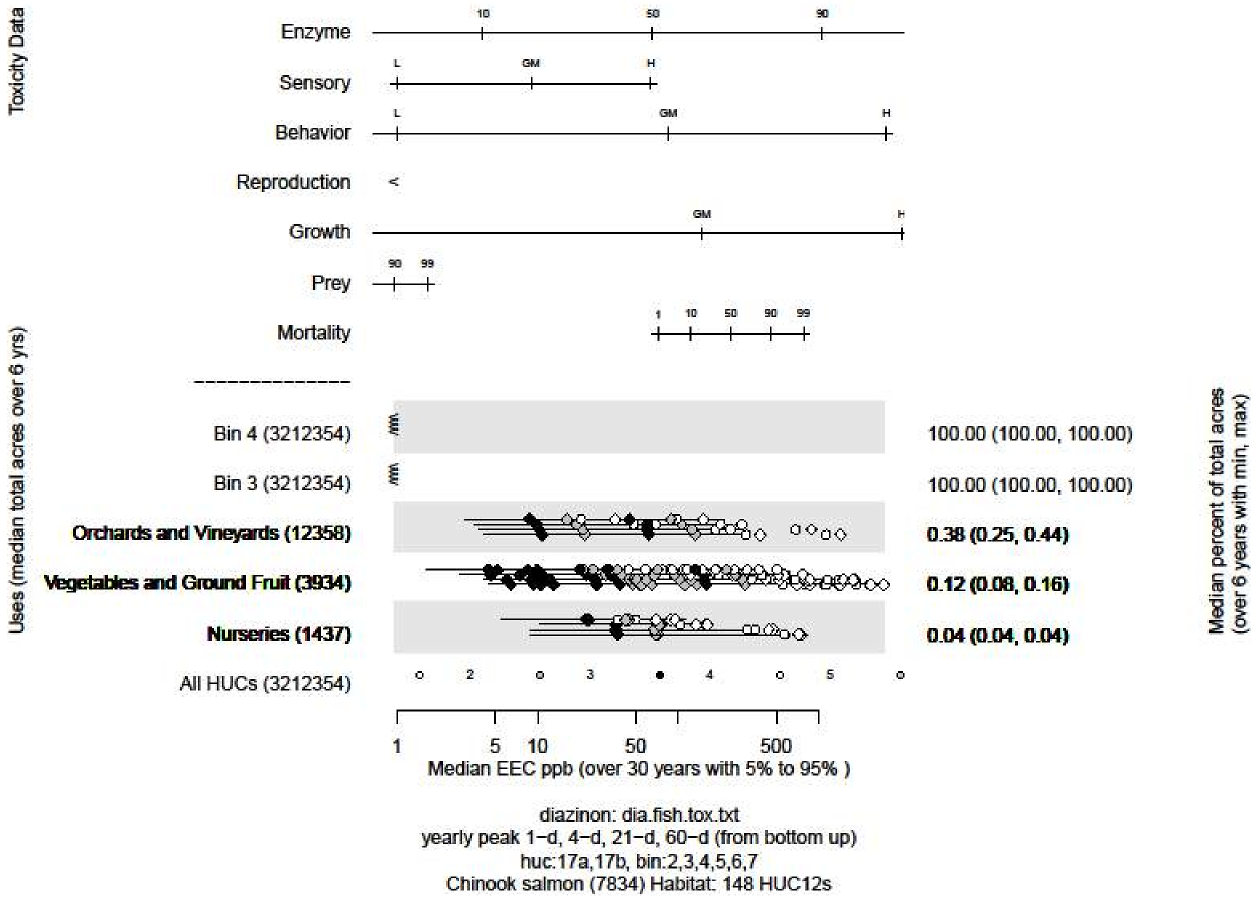


Figure 6. Effects analysis R-plot; Chinook salmon, Lower Columbia River ESU designated critical habitat.

Table 14. Prey risk hypothesis; Chinook, Lower Columbia River ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Medium	High
Bin 4	100.00	Medium	High
Orchards and Vineyards	0.38	High	Low

Vegetables and Ground Fruit	0.12	High	Low
Nurseries	0.04	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Low	**High**		

Table 15. Water quality risk hypothesis; Chinook, Lower Columbia River ESU; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within Lower Columbia River Chinook designated critical habitat. Three use site categories, totaling approximately 17,729 acres (less than one percent of acres) are currently present.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Low	**High**	

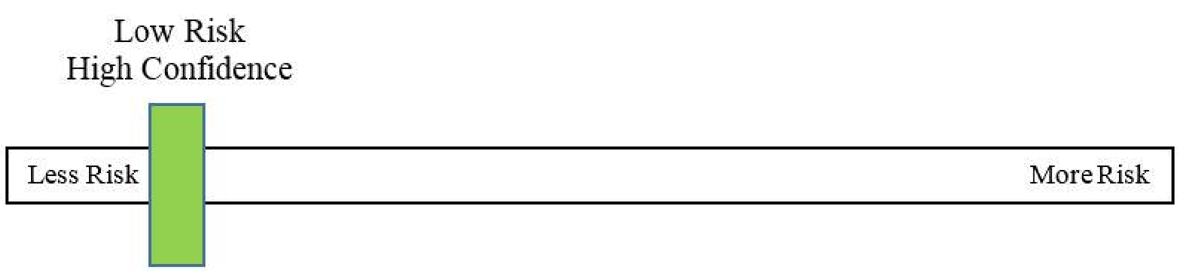
Table 16. Effects analysis summary table; Chinook, Lower Columbia River ESU; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	Low	High	No

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	Low	Medium	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	Low	Medium	No

Designated Critical Habitat Effects Analysis Summary:

We do not anticipate that the stressors of the action will negatively affect physical and biological features (PBFs). Neither reductions in prey, nor degradation of water quality are likely throughout designated critical habitat of Lower Columbia River Chinook. The magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses the overall conservation value of designated critical habitat is not anticipated to decrease. We have greater confidence in the risk determinations associated with the freshwater habitats than we do in the estuarine and nearshore habitats. Overall the risk is low and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.



16.7 Puget Sound Chinook Designated Critical Habitat

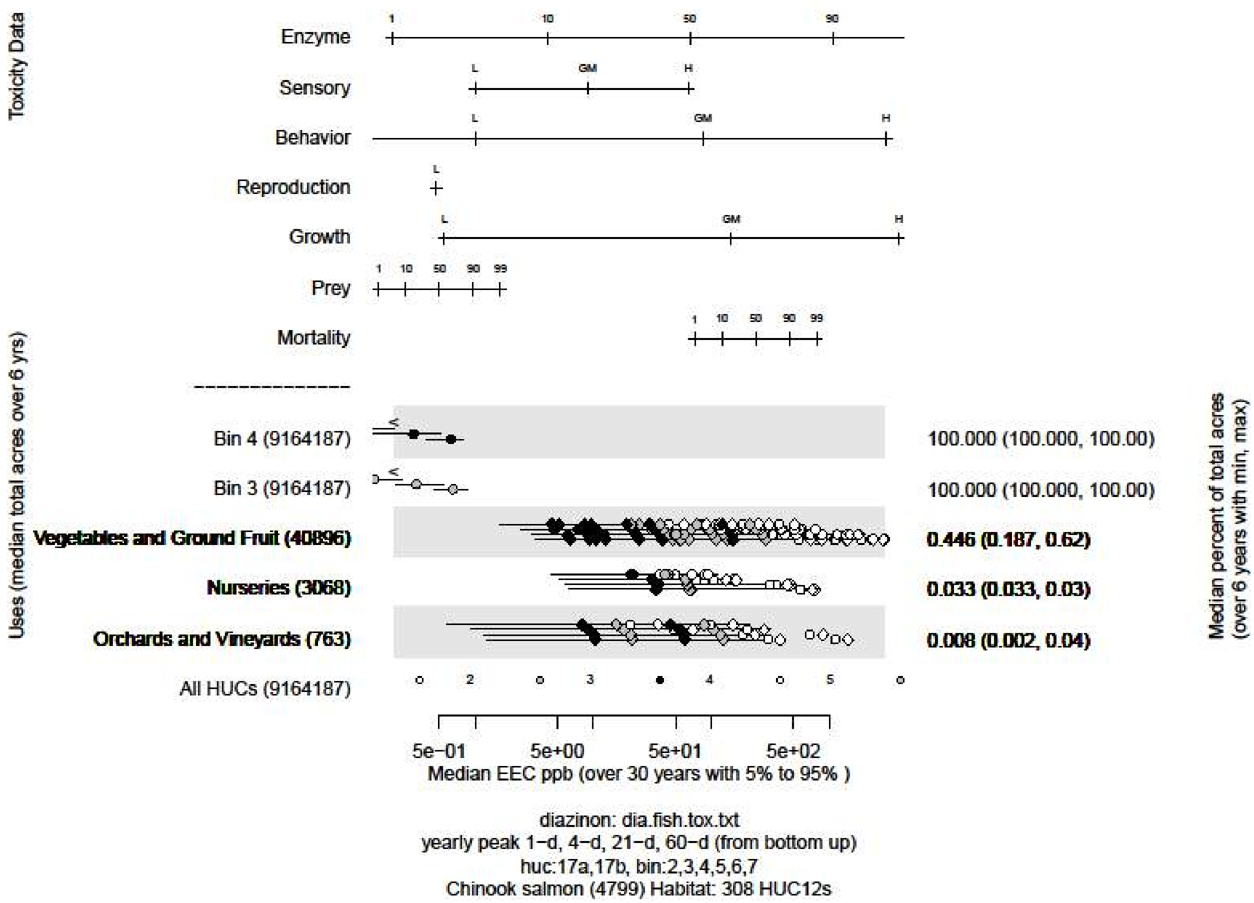


Figure 7. Effects naalysis R-plot; Chinook salmon, Puget Sound ESU designated critical habitat.

Table 17. Prey risk hypothesis; Chinook, Puget Sound ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	High	High
Bin 4	100.00	Medium	High
Vegetables and Ground Fruit	0.45	High	Low
Nurseries	0.03	High	Low

Orchards and Vineyards	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Low	**High**		

Table 18. Water quality risk hypothesis; Chinook, Puget Sound ESU; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within Puget Sound Chinook designated critical habitat. Three use site categories, totaling approximately 44,727 acres (less than one percent of acres) are currently present.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Low	**High**	

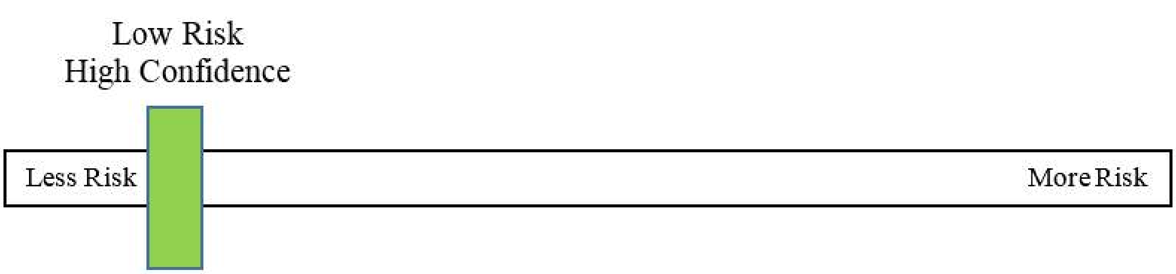
Table 19. Effects analysis summary table; Chinook, Puget Sound ESU; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water	Low	High	No

quality, natural cover, and/or reductions in prey in freshwater migratory corridors.			
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	Low	Low	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	Low	Low	No

Designated Critical Habitat Effects Analysis Summary:

We do not anticipate that the stressors of the action will negatively affect physical and biological features (PBFs). Neither reductions in prey, nor degradation of water quality are likely throughout designated critical habitat of Puget Sound Chinook. The magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses the overall conservation value of designated critical habitat is not anticipated to decrease. We have greater confidence in the risk determinations associated with the freshwater habitats than we do in the estuarine and nearshore habitats. Overall the risk is low and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.



16.8 Sacramento River Winter-run Chinook Salmon Designated Critical Habitat

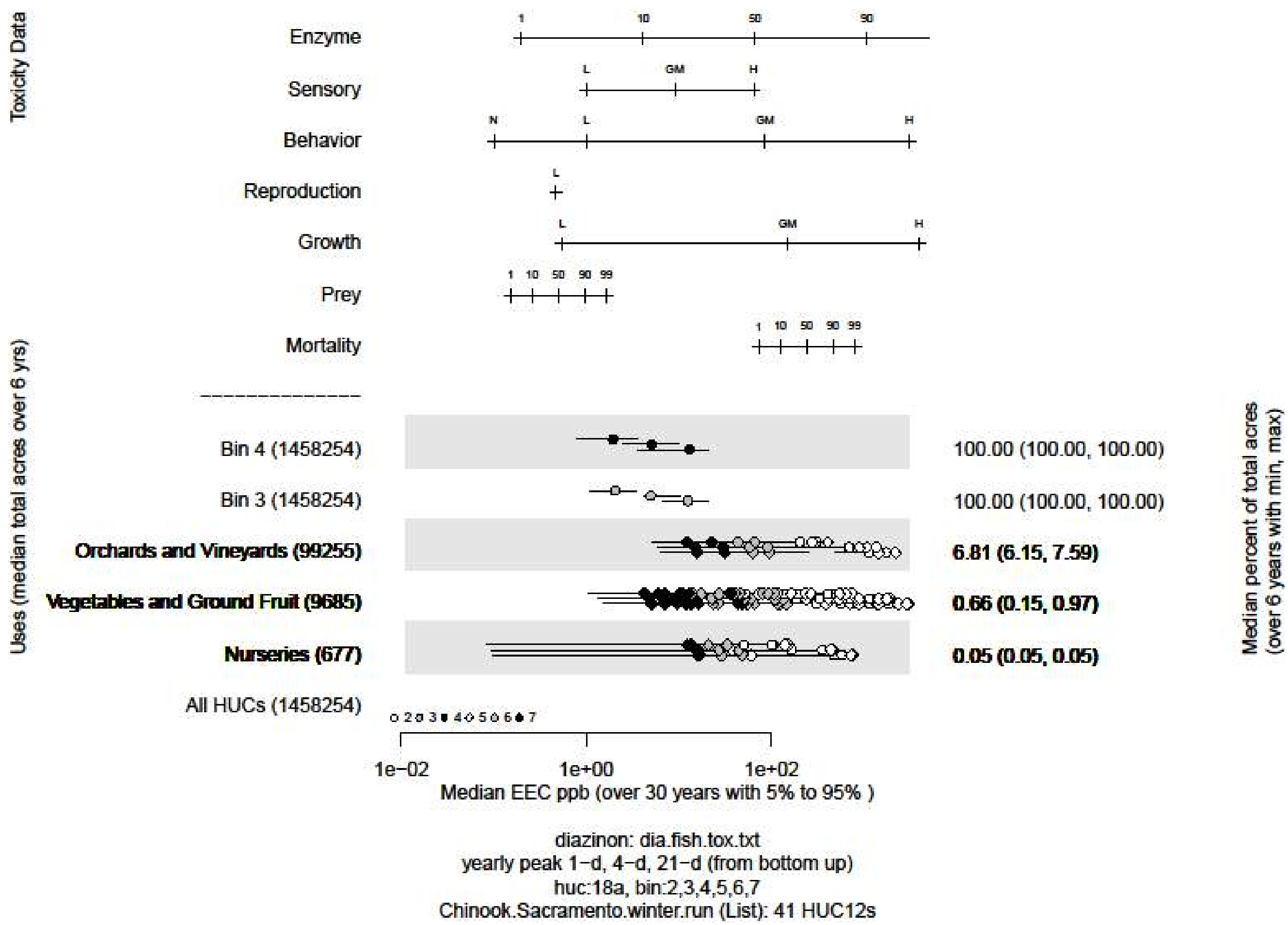


Figure 8. Effects analysis R-plot; Chinook salmon, Sacramento River winter-run ESU designated critical habitat.

Table 20. Prey risk hypothesis; Chinook, Sacramento River winter-run ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Orchards and Vineyards	6.81	High	High
Vegetables and Ground Fruit	0.66	High	Low
Nurseries	0.05	High	Low

Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*		
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**
High	**High**	

Table 21. Water quality risk hypothesis; Chinook, Sacramento River winter-run ESU; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of diazinon-containing products occur within the designated critical habitat of Chinook, Sacramento River winter-run ESU. Three use site categories, totaling more than 106,617 acres (over 8% of acres) are currently present. The anticipated diazinon levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

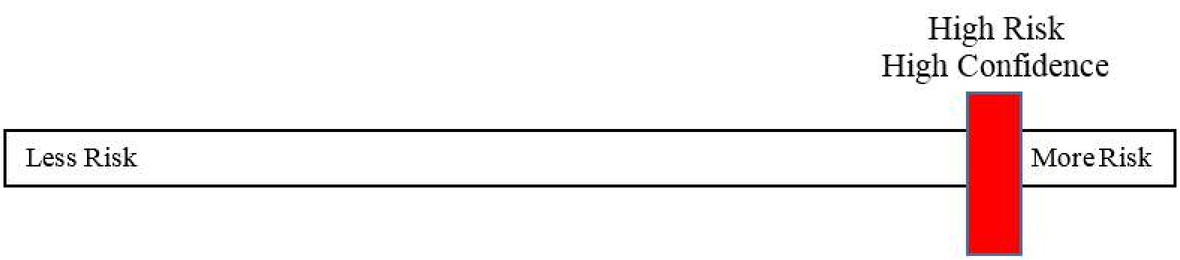
Table 22. Effects analysis summary table; Chinook, Sacramento River winter-run ESU; designated critical habitat.

Designated Critical Habitat; Risk Hypotheses	R-plot Derived Risk	R-plot Derived Confidence	Risk Hypothesis Supported? Yes/No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical and biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Sacramento River Winter-run Chinook. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



16.9 Snake River Fall-run Chinook Salmon Designated Critical Habitat

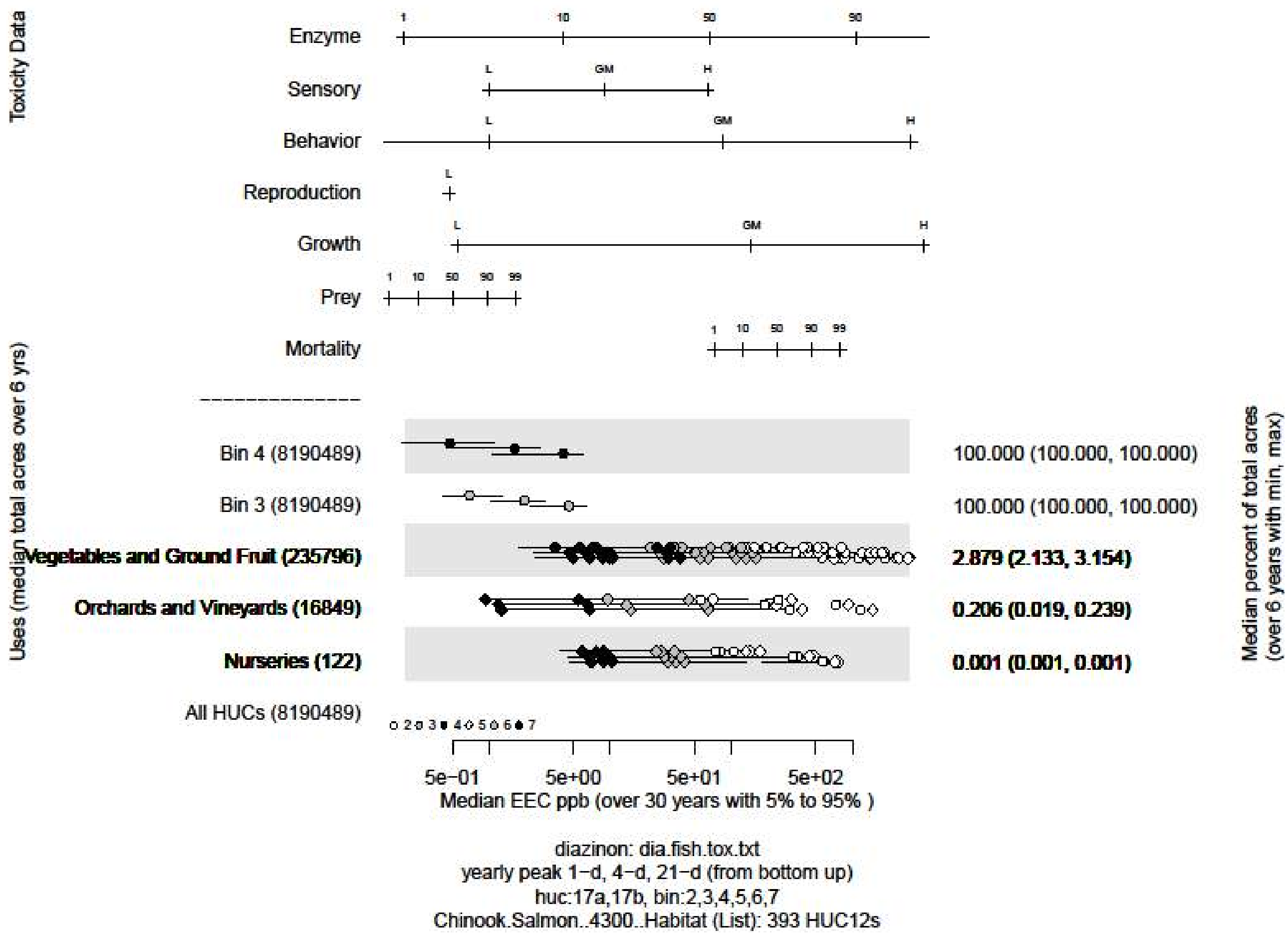


Figure 9. Effects analysis R-plot; Chinook salmon, Snake River fall-run ESU designated critical habitat.

Table 23. Prey risk hypothesis; Chinook salmon, Snake River fall-run ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Vegetables and Ground Fruit	2.88	High	Medium
Orchards and Vineyards	0.21	High	Low
Nurseries	<0.01	High	Low

Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*		
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**
Medium	**Medium**	

Table 24. Water quality risk hypothesis; Chinook salmon, Snake River fall-run ESU; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within Chinook salmon, Snake River fall-run ESU designated critical habitat. Three use site categories, totaling approximately 251,769 acres (less than 4% of acres) are currently present.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Medium	**Medium**	

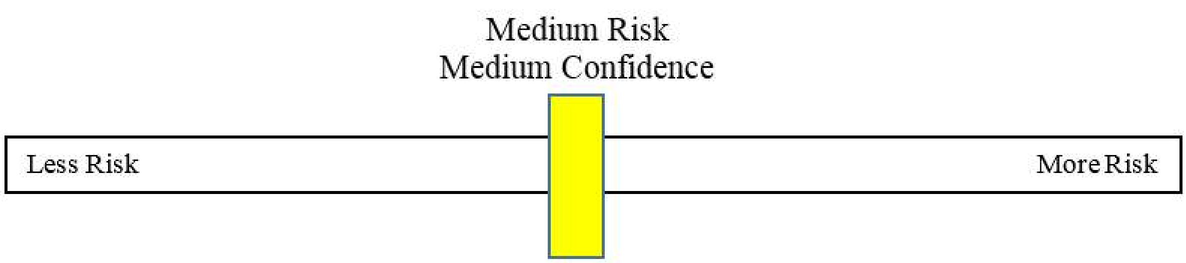
Table 25. Effects analysis summary table; Chinook salmon, Snake River fall-run ESU; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported? Yes/No
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	**Medium**	**Medium**	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	**Medium**	**Medium**	Yes

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	**Medium**	**Medium**	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	**Medium**	**Low**	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	**Medium**	**Low**	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a medium likelihood that the stressors of the action will negatively affect physical and biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Snake River Fall-run Chinook Salmon. The magnitude of toxic effects may result in some adverse effects. Due to the extent of diazinon-containing uses, we anticipate the overall conservation value of designated critical habitat to decrease moderately. We find that the overall risk is medium and the confidence associated with that risk is medium over the 15-year duration of the action.



16.10 Snake River Spring/Summer-run Chinook Salmon Designated Critical Habitat

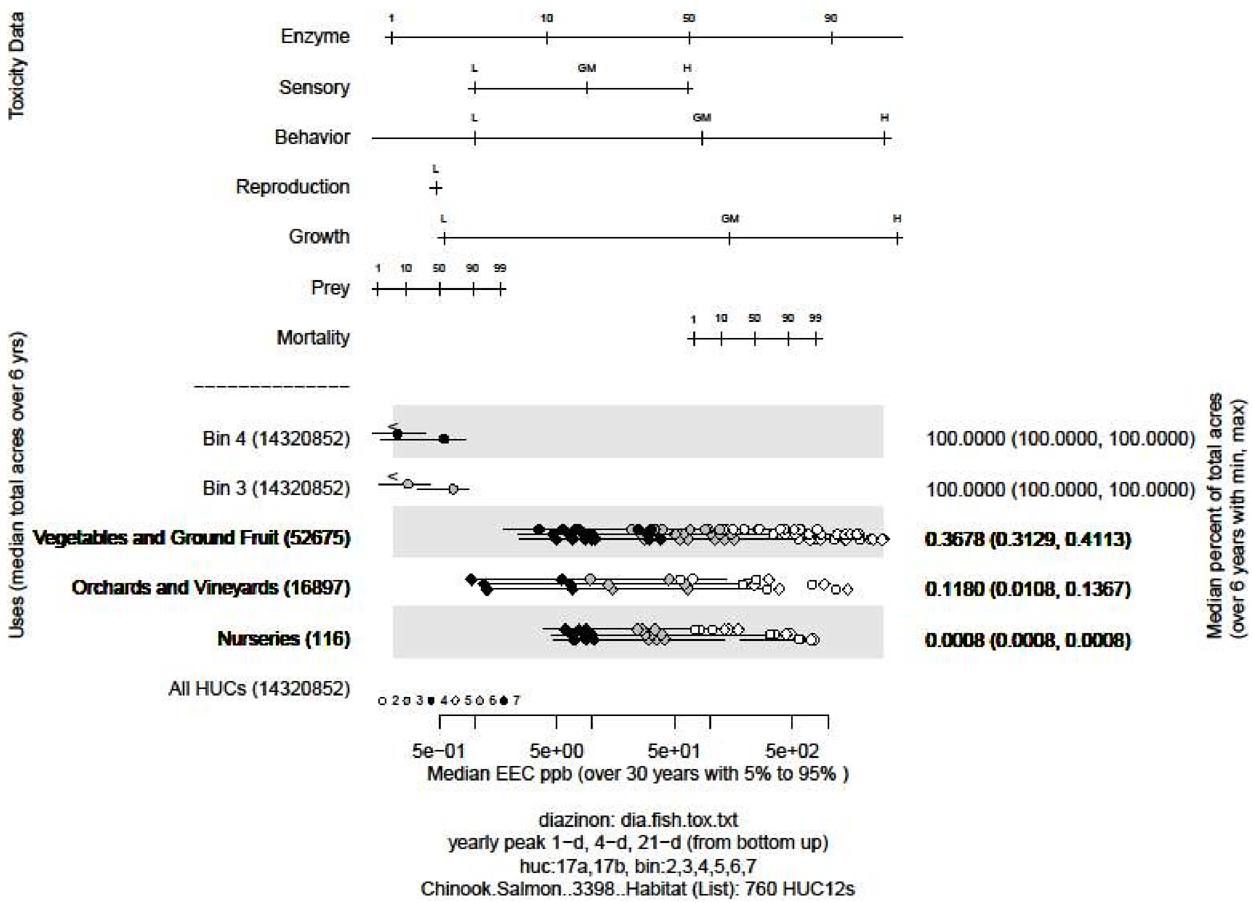


Figure 10. Effects analysis R-plot; Chinook salmon, Snake River spring/summer-run ESU designated critical habitat.

Table 26. Prey risk hypothesis; Chinook salmon, Snake River spring/summer-run ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	High	High
Bin 4	100.00	Medium	High
Vegetables and Ground Fruit	0.37	High	Low
Orchards and Vineyards	0.12	High	Low
Nurseries	<0.01	High	Low

Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*.		
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**
Low	**High**	

Table 27. Water quality risk hypothesis; Chinook, Snake River spring/summer-run ESU; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within Snake River spring/summer-run Chinook salmon designated critical habitat. Three use site categories, totaling approximately 69,688 acres (less than one Percent of acres) are currently present.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Low	**High**	

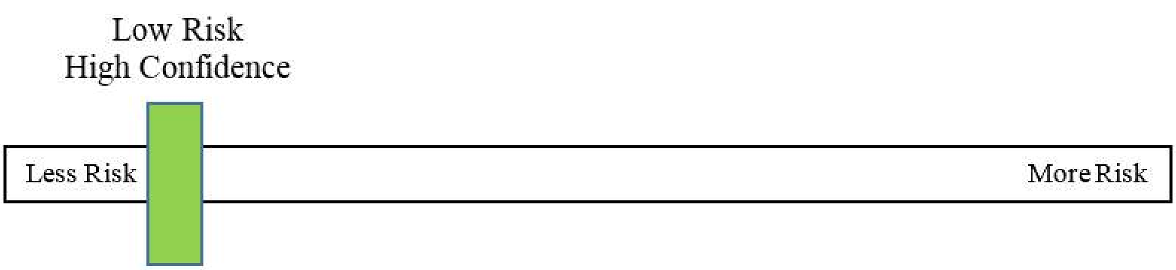
Table 28. Effects analysis summary table; Chinook, Snake River spring/summer-run ESU; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported?
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	Low	High	No

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	Low	Medium	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	Low	Medium	No

Designated Critical Habitat Effects Analysis Summary:

We do not anticipate that the stressors of the action will negatively affect physical and biological features (PBFs). Neither reductions in prey, nor degradation of water quality are likely throughout designated critical habitat of Snake River Spring/Summer-run Chinook. The magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses the overall conservation value of designated critical habitat is not anticipated to decrease. We have greater confidence in the risk determinations associated with the freshwater habitats than we do in the estuarine and nearshore habitats. Overall the risk is low and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.



16.11 Upper Columbia River Spring-run Chinook Salmon Designated Critical Habitat

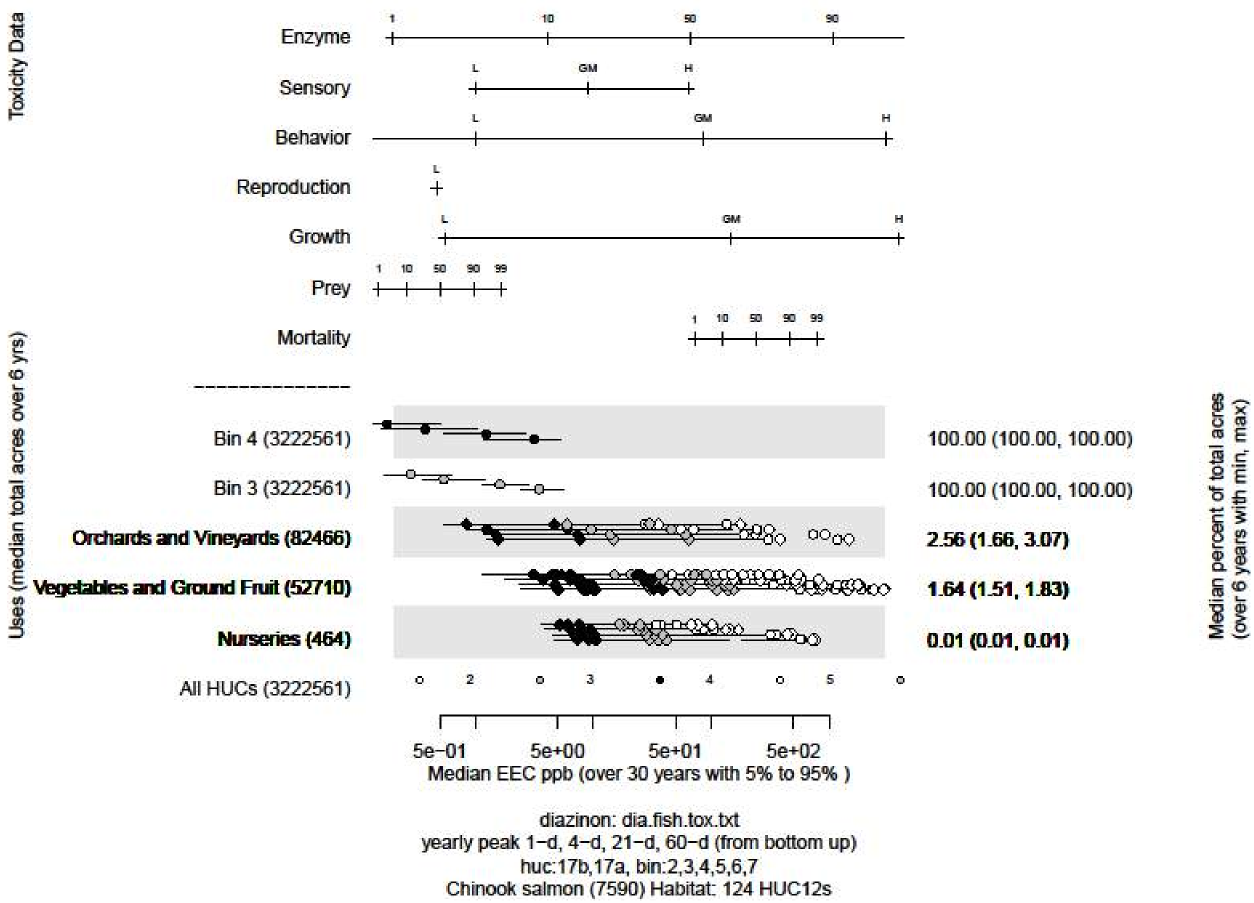


Figure 11. Effects Analysis R-plot; Chinook salmon, Upper Columbia River Spring-run ESU designated critical habitat.

Table 29. Prey risk hypothesis; Chinook salmon, upper Columbia River spring-run ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Orchards and Vineyards	2.56	High	Medium

Vegetables and Ground Fruit	1.64	High	Medium
Nurseries	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Medium	**Medium**		

Table 30. Water quality risk hypothesis; Chinook salmon, upper Columbia River spring-run ESU; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of diazinon-containing products occur within the designated critical habitat of Chinook salmon, upper Columbia River spring-run ESU. Three use site categories, totaling more than 135,640 acres (over 4% of acres) are currently present. The anticipated diazinon levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Medium	**Medium**	

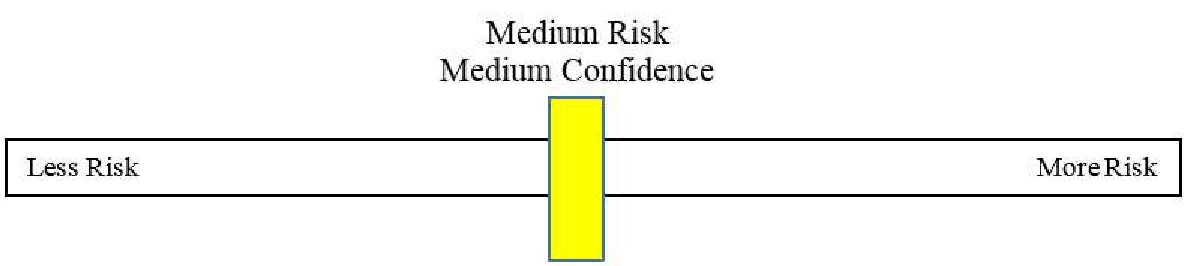
Table 31. Effects analysis summary table; Chinook salmon, upper Columbia River spring-run ESU; designated critical habitat

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water	Medium	Medium	Yes

quality and/or reductions in prey in freshwater rearing sites.			
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	Medium	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	Medium	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a medium likelihood that the stressors of the action will negatively affect physical and biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Upper Columbia River Spring-run Chinook. The magnitude of toxic effects may result in some adverse effects. Due to the extent of diazinon-containing uses, we anticipate the overall conservation value of designated critical habitat to decrease moderately. We find that the overall risk is medium and the confidence associated with that risk is medium over the 15-year duration of the action.



16.12 Upper Willamette River Chinook Salmon Designated Critical Habitat

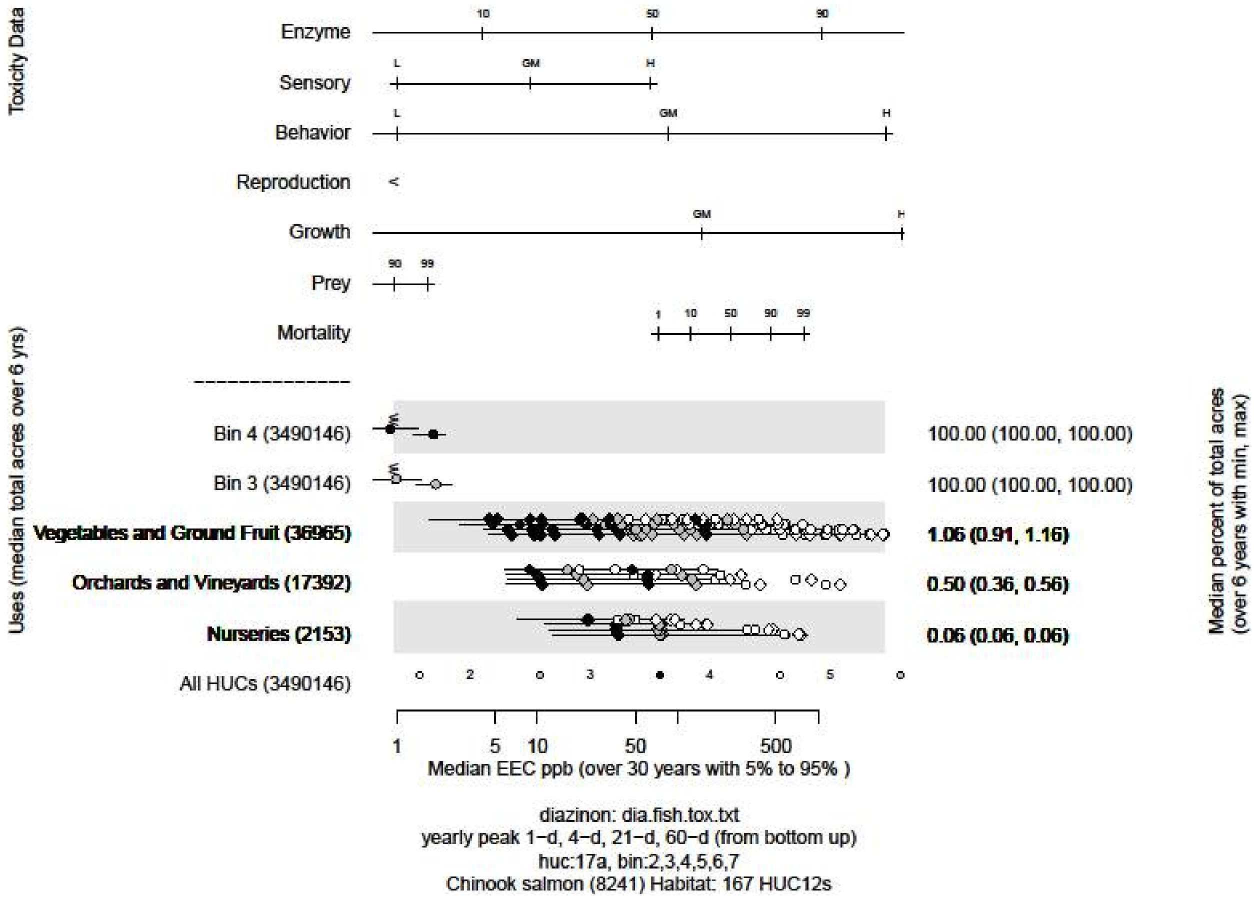


Figure 12. Effects analysis R-plot; Chinook salmon, Upper Willamette River ESU designated critical habitat.

Table 32. Prey risk hypothesis; Chinook, upper Willamette River ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Vegetables and Ground Fruit	1.06	High	Medium

Orchards and Vineyards	0.50	High	Low
Nurseries	0.06	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Medium	**Medium**		

Table 33. Water quality risk hypothesis; Chinook, upper Willamette River ESU; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within Upper Willamette River Chinook designated critical habitat. Three use site categories, totaling approximately 56,510 acres (over one percent of acres) are currently present.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Medium	**Medium**	

Table 34. Effects analysis summary table; Chinook, upper Willamette River ESU; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water	Medium	Medium	Yes

quality and/or reductions in prey in freshwater rearing sites.			
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	Medium	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	Medium	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a medium likelihood that the stressors of the action will negatively affect physical and biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Upper Willamette River Chinook Salmon. The magnitude of toxic effects may result in some adverse effects. Due to the extent of diazinon-containing uses, we anticipate the overall conservation value of designated critical habitat to decrease moderately. We find that the overall risk is medium and the confidence associated with that risk is medium over the 15-year duration of the action.

16.13 Central California Coast Coho Salmon Designated Critical Habitat

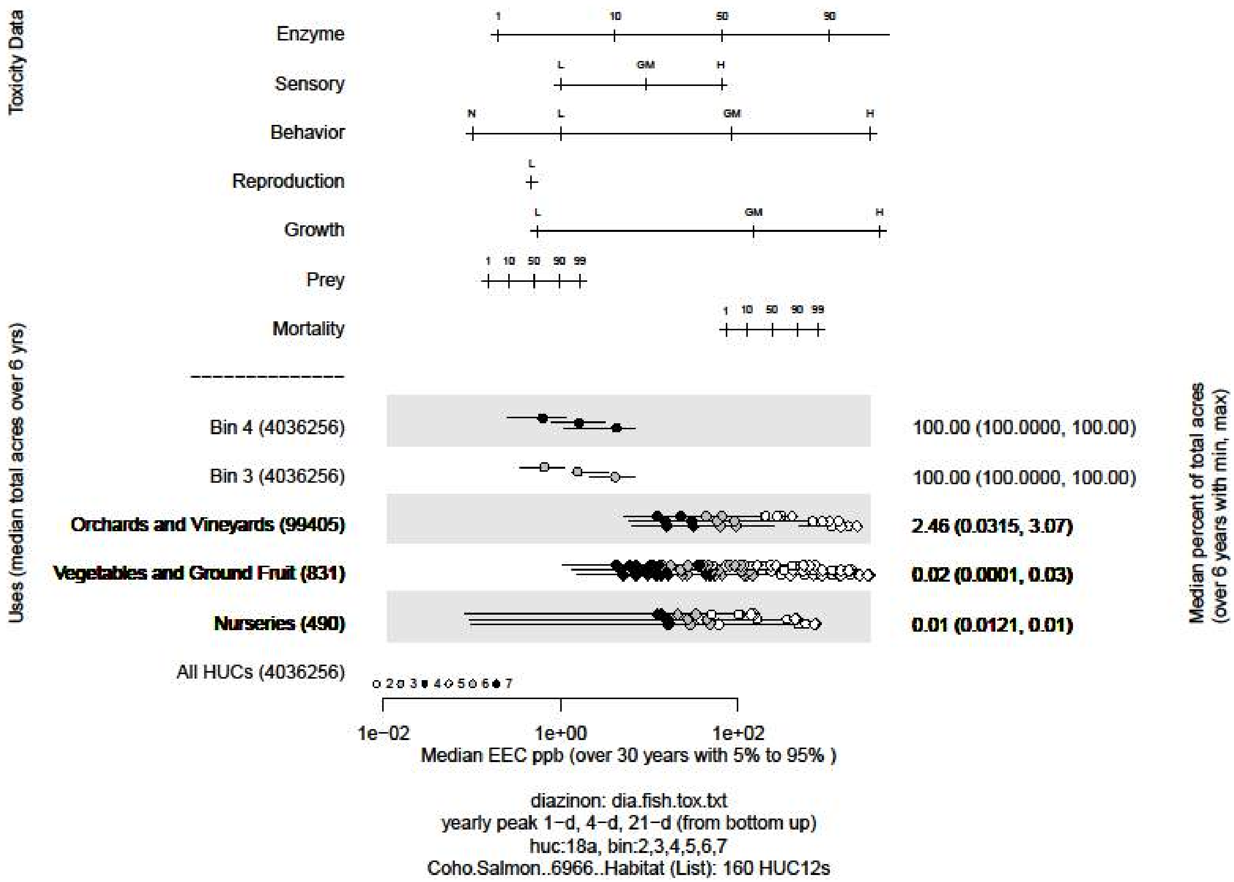


Figure 13. Effects analysis R-plot; Coho, Central California Coast ESU designated critical habitat.

Table 35. Prey risk hypothesis; Coho, Central California Coast ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Orchards and Vineyards	2.46	High	Medium
Vegetables and Ground Fruit	0.02	High	Low
Nurseries	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**		

Medium	**Medium**	***We have low confidence in EECs associated with marine and estuarine habitats.**

Table 36. Water quality risk hypothesis; Coho, Central California Coast ESU; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within central California coast Coho designated critical habitat. Three use site categories, totaling approximately 100,726 acres (less than three percent of acres) are currently present.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Medium	**Medium**	

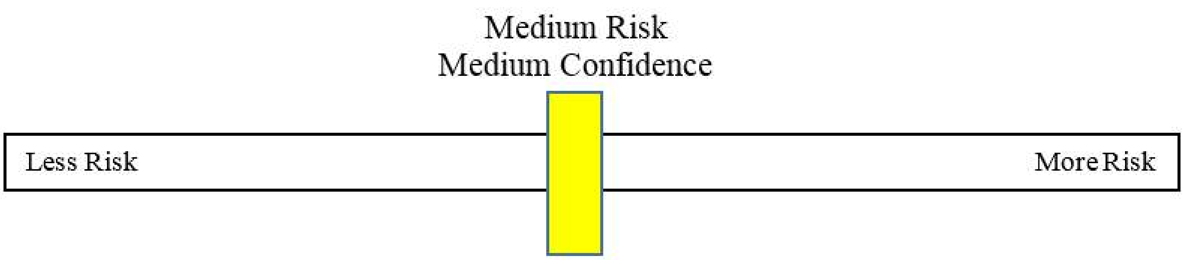
Table 37. Effects analysis summary table; Coho, Central California Coast ESU; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	Medium	Medium	Yes

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	Medium	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	Medium	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a medium likelihood that the stressors of the action will negatively affect physical and biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Central California Coast Coho. The magnitude of toxic effects may result in some adverse effects. Due to the extent of diazinon-containing uses, we anticipate the overall conservation value of designated critical habitat to decrease moderately. We find that the overall risk is medium and the confidence associated with that risk is medium over the 15-year duration of the action.



16.14 Lower Columbia River Coho Salmon Designated Critical Habitat

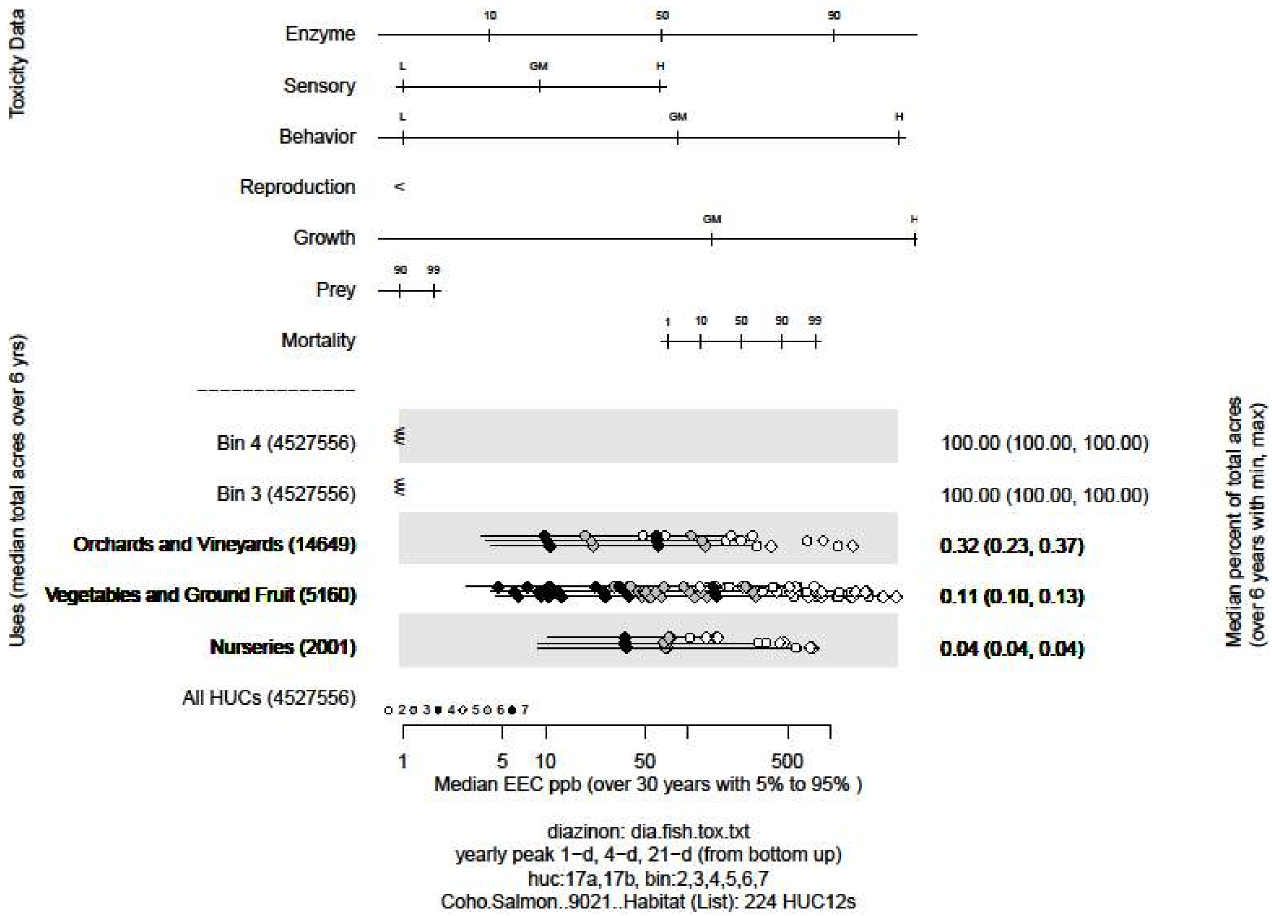


Figure 14. Effects analysis R-plot; Coho, Lower Columbia River ESU designated critical habitat.

Table 38. Prey risk hypothesis; Coho, Lower Columbia River ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Medium	High
Bin 4	100.00	Medium	High
Orchards and Vineyards	0.32	High	Low
Vegetables and Ground Fruit	0.11	High	Low
Nurseries	0.04	High	Low

Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*		
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**
Low	**High**	

Table 39. Water quality risk hypothesis; Coho, Lower Columbia River ESU; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within lower Columbia River Coho designated critical habitat. Three use site categories, totaling approximately 21,810 acres (less than one percent of acres) are currently present.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Low	**High**	

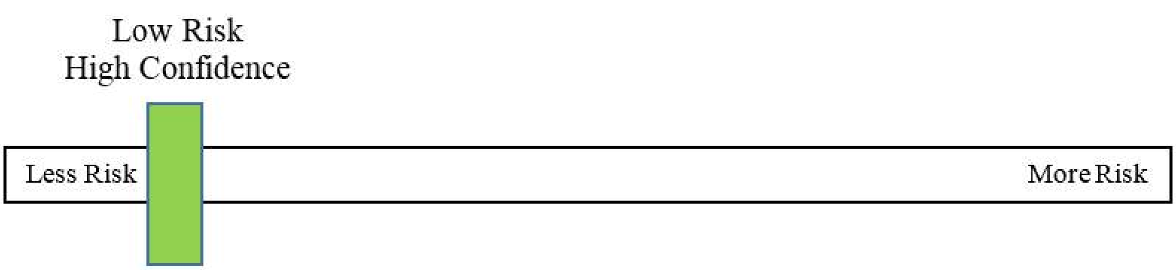
Table 40. Effects analysis summary table; Coho, Lower Columbia River ESU; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported? Yes/No
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water	Low	High	No

quality, natural cover, and/or reductions in prey in freshwater migratory corridors.			
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	Low	Medium	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	Low	Medium	No

Designated Critical Habitat Effects Analysis Summary:

We do not anticipate that the stressors of the action will negatively affect physical and biological features (PBFs). Neither reductions in prey, nor degradation of water quality are likely throughout designated critical habitat of Lower Columbia River Coho. The magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses the overall conservation value of designated critical habitat is not anticipated to decrease. We have greater confidence in the risk determinations associated with the freshwater habitats than we do in the estuarine and nearshore habitats. Overall the risk is low and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.



16.15 Oregon Coast Coho Salmon Designated Critical Habitat

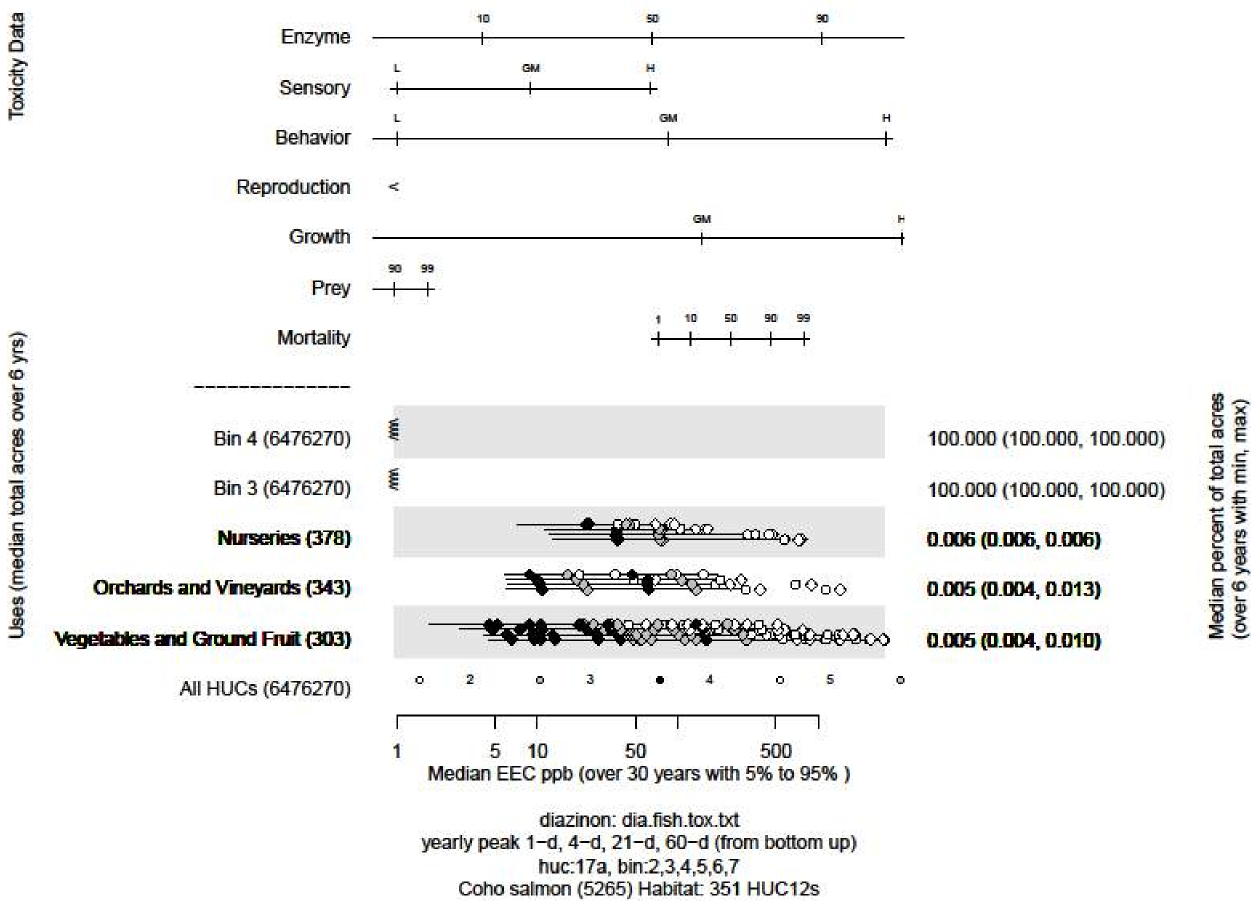


Figure 15. Effects analysis R-plot; Coho salmon, Oregon Coast ESU designated critical habitat.

Table 41. Prey risk hypothesis; Coho, Oregon coast ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Nurseries	0.01	High	Low
Orchards and Vineyards	0.01	High	Low

Vegetables and Ground Fruit	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Low	**High**		

Table 42. Water quality risk hypothesis; Coho, Oregon coast ESU; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within Oregon Coast coho designated critical habitat. Three use site categories, totaling approximately 1,024 acres (less than one percent of acres) are currently present.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Low	**High**	

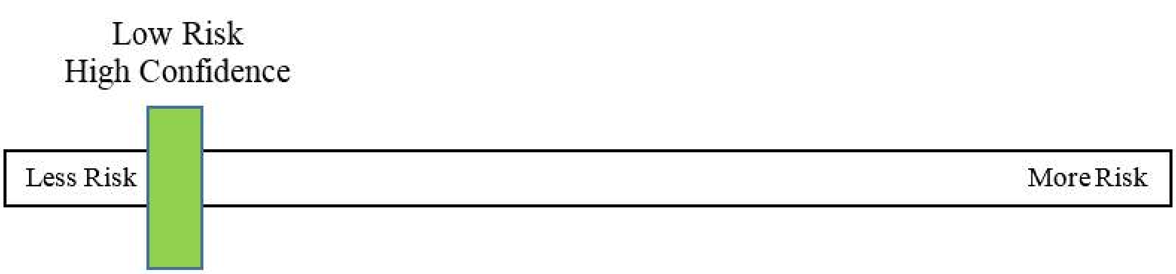
Table 43. Effects analysis summary table; Coho, Oregon coast ESU; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water	Low	High	No

quality, natural cover, and/or reductions in prey in freshwater migratory corridors.			
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	Low	Medium	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	Low	Medium	No

Designated Critical Habitat Effects Analysis Summary:

We do not anticipate that the stressors of the action will negatively affect physical and biological features (PBFs). Neither reductions in prey, nor degradation of water quality are likely throughout designated critical habitat og Oregon Coast Coho Salmon. The magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses the overall conservation value of designated critical habitat is not anticipated to decrease. We have greater confidence in the risk determinations associated with the freshwater habitats than we do in the estuarine and nearshore habitats. Overall the risk is low and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.



16.16 Southern Oregon Northern California (SONC) Coho Salmon Designated Critical Habitat

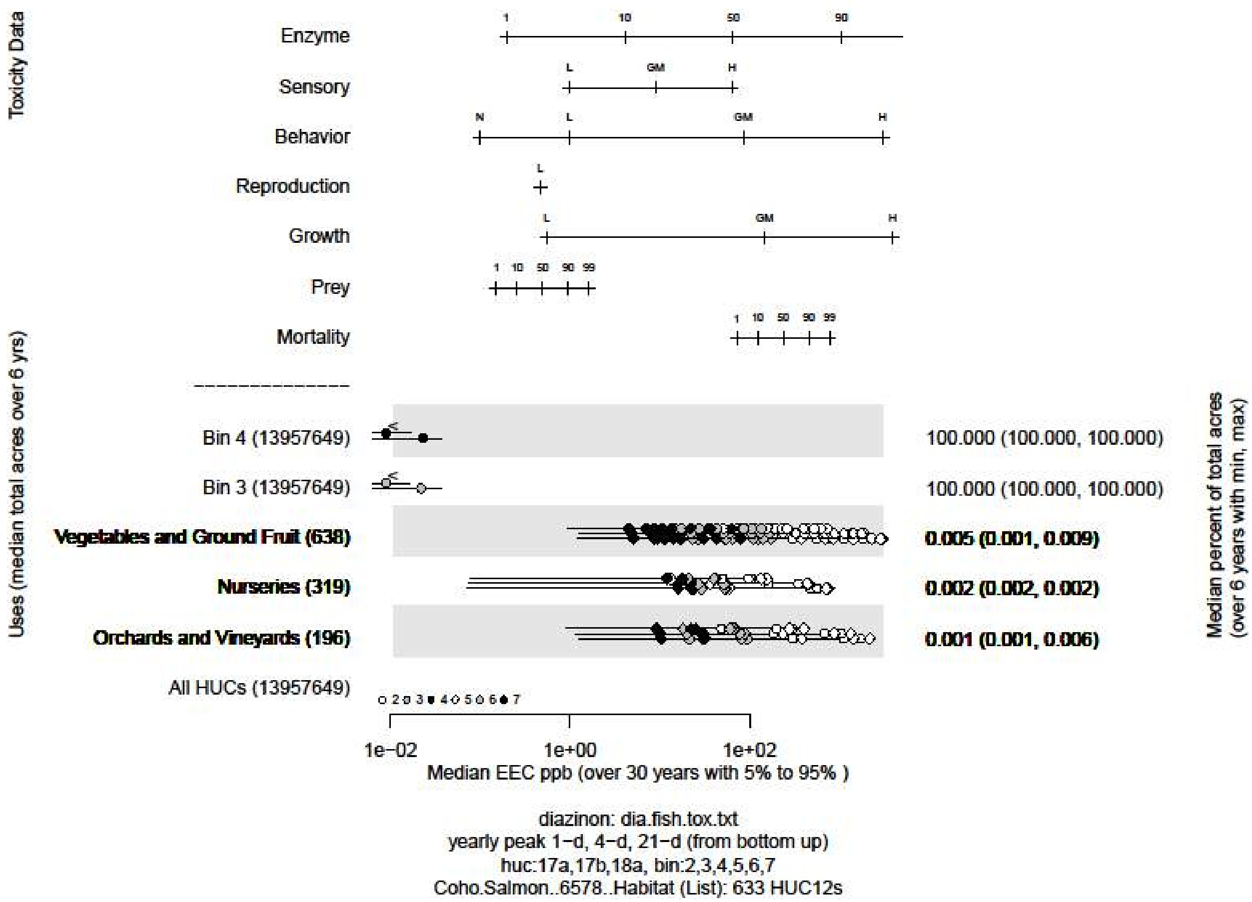


Figure 16. Effects analysis R-plot; Coho salmon, SONC ESU designated critical habitat.

Table 44. Prey risk hypothesis; Coho, SONC ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Vegetables and Ground Fruit	<0.01	High	Low
Nurseries	<0.01	High	Low
Orchards and Vineyards	<0.01	High	Low

Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*		
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**
Low	**High**	

Table 45. Water quality risk hypothesis; Coho, SONC ESU; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within Southern Oregon/Northern California ESU Coho designated critical habitat. Three use site categories, totaling approximately 1,153 acres (less than one percent of acres) are currently present.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Low	**High**	

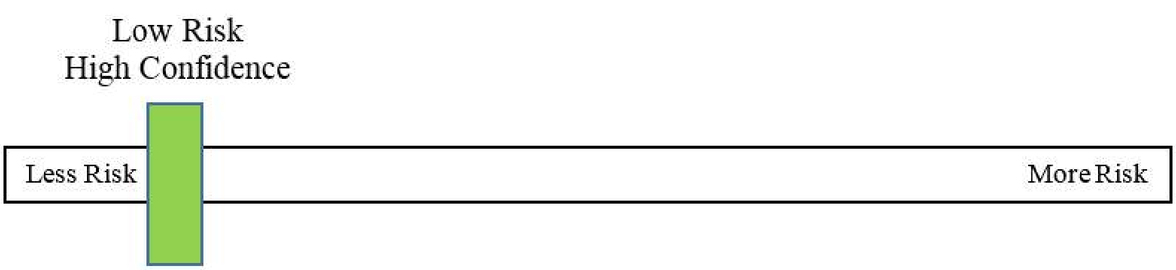
Table 46. Effects analysis summary table; Coho, SONC ESU; designated critical habitat.

Designated Critical Habitat; Risk Hypotheses	R-plot Derived		Risk Hypothesis Supported? Yes/No
	Risk	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water	Low	High	No

quality, natural cover, and/or reductions in prey in freshwater migratory corridors.			
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	Low	Medium	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	Low	Medium	No

Designated Critical Habitat Effects Analysis Summary:

We do not anticipate that the stressors of the action will negatively affect physical and biological features (PBFs). Neither reductions in prey, nor degradation of water quality are likely throughout designated critical habitat of Southern Oregon Northern California Coho. The magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses the overall conservation value of designated critical habitat is not anticipated to decrease. We have greater confidence in the risk determinations associated with the freshwater habitats than we do in the estuarine and nearshore habitats. Overall the risk is low and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.



16.17 Ozette Lake Sockeye Designated Critical Habitat

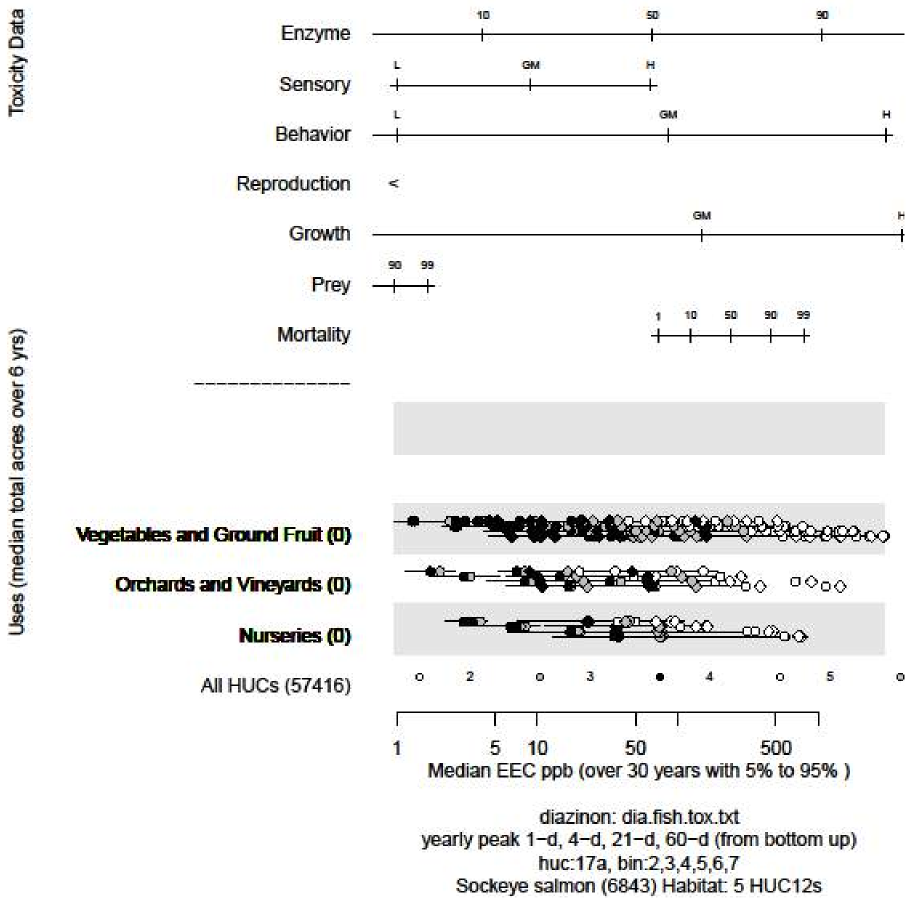


Figure 17. Effects analysis R-plot; Sockeye salmon, Ozette Lake ESU designated critical habitat.

Table 47. Prey risk hypothesis; Sockeye, Ozette Lake ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Vegetables and Ground Fruit	<0.01	-	Low
Orchards and Vineyards	<0.01	-	Low

Nurseries	<0.01	-	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Low	**High**		

Table 48. Water quality risk hypothesis; Sockeye, Ozette Lake ESU; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products do not occur within Ozette Lake sockeye designated critical habitat.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Low	**High**	

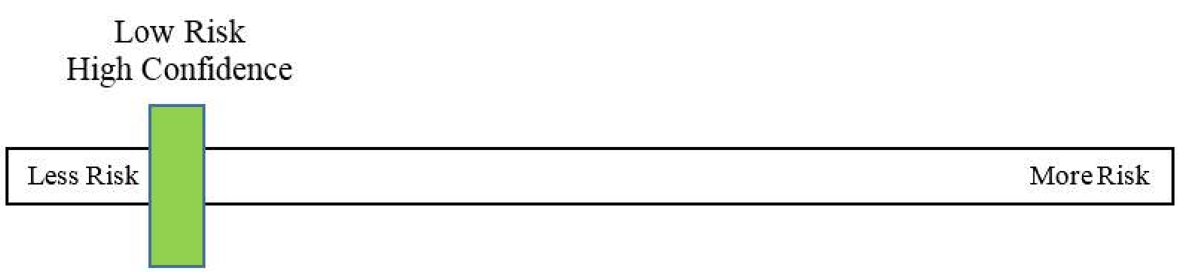
Table 49. Effects analysis summary table; Sockeye, Ozette Lake ESU; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water	Low	High	No

quality, natural cover, and/or reductions in prey in freshwater migratory corridors.			
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	Low	High	No

Designated Critical Habitat Effects Analysis Summary:

We do not anticipate that the stressors of the action will negatively affect physical and biological features (PBFs). Neither reductions in prey, nor degradation of water quality are likely throughout designated critical habitat of Ozette Lake Sockeye. Overall the risk is low and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.



16.18 Snake River Sockeye Salmon Designated Critical Habitat

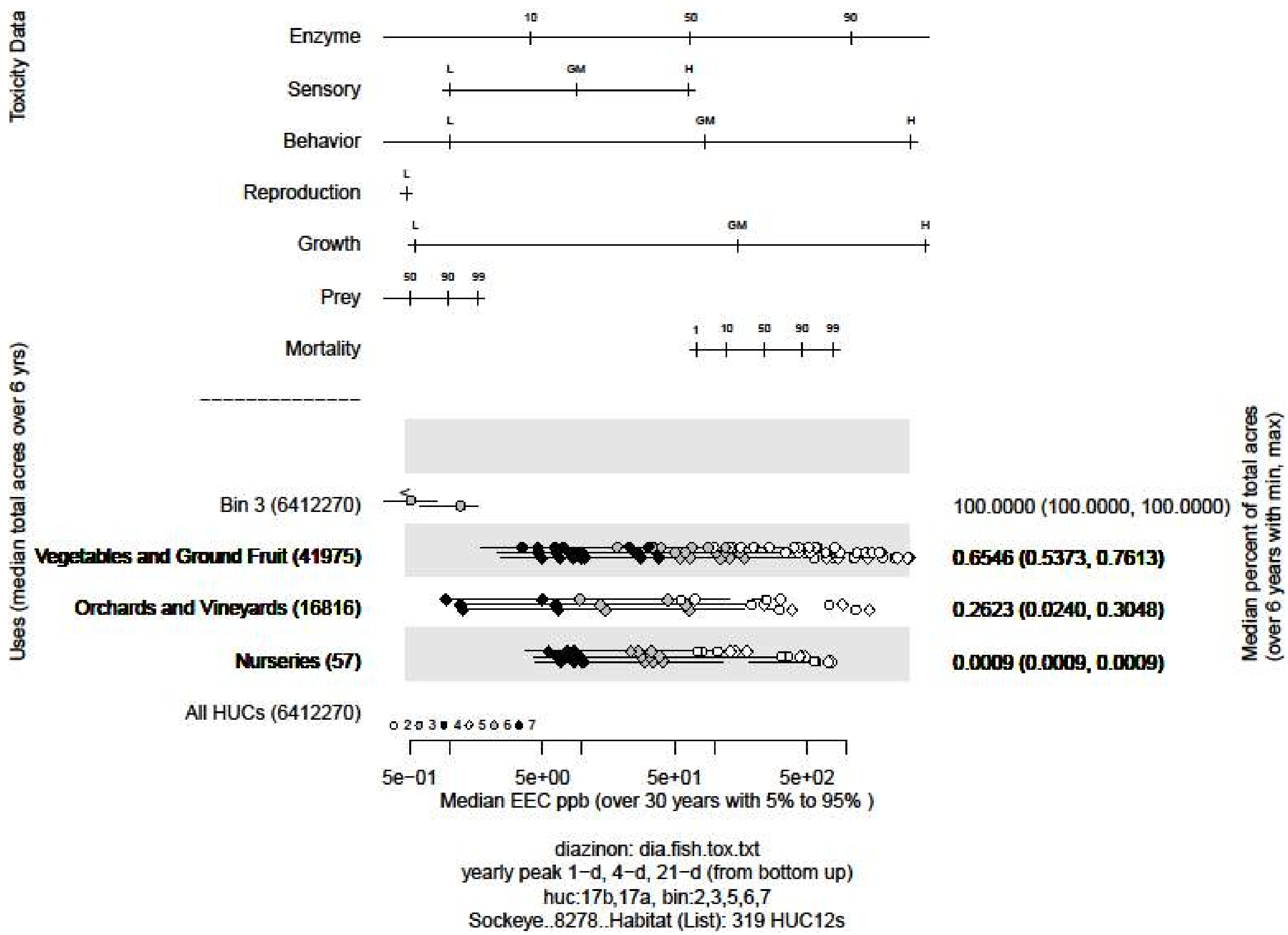


Figure 18. Effects analysis R-plot; Sockeye salmon, Snake River ESU designated critical habitat.

Table 50. Prey risk hypothesis; Sockeye, Snake River ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	High	High
Vegetables and Ground Fruit	0.65	High	Low
Orchards and Vineyards	0.26	High	Low
Nurseries	<0.01	High	Low

Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*		
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**
Medium	**Medium**	

Table 51. Water quality risk hypothesis; Sockeye, Snake River ESU; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within Snake River sockeye ESU designated critical habitat. Three use site categories, totaling approximately 58,848 acres (more than one percent of acres) are currently present.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Medium	**Medium**	

Table 52. Effects analysis summary table; Sockeye, Snake River ESU; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water	Medium	Medium	Yes

quality, natural cover, and/or reductions in prey in freshwater migratory corridors.			
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	Medium	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	Medium	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a medium likelihood that the stressors of the action will negatively affect physical and biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Snake River Sockeye. The magnitude of toxic effects may result in some adverse effects. Due to the extent of diazinon-containing uses, we anticipate the overall conservation value of designated critical habitat to decrease moderately. We find that the overall risk is medium and the confidence associated with that risk is medium over the 15-year duration of the action.

16.19 California Central Valley Steelhead Designated Critical Habitat

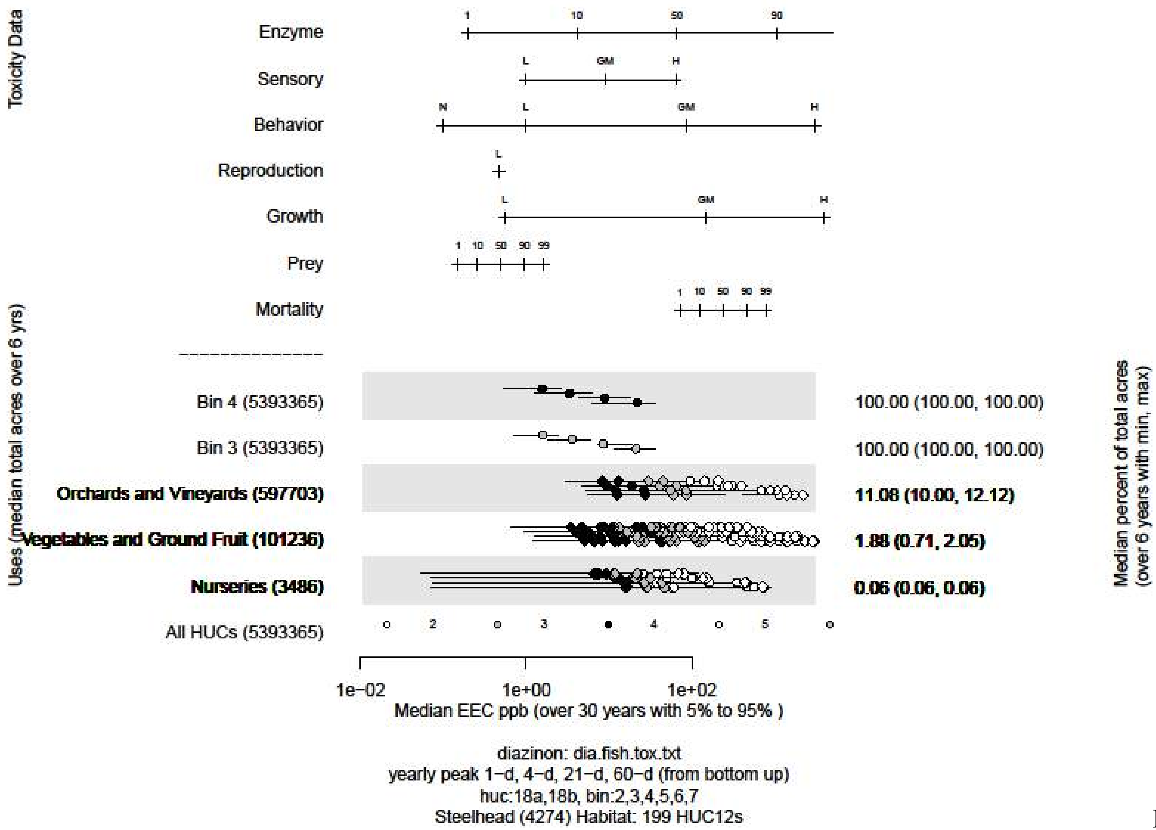


Figure 19. Effects analysis R-plot; Steelhead California Central Valley DPS designated critical habitat.

Table 53. Prey (fish) risk hypothesis; Steelhead, California Central Valley DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Orchards and Vineyards	11.08	High	High
Vegetables and Ground Fruit	1.88	High	Medium
Nurseries	0.06	High	Low

Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*		
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**
High	**High**	

Table 54. Prey (inverts) risk hypothesis; Steelhead, California Central Valley DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Orchards and Vineyards	11.08	High	High
Vegetables and Ground Fruit	1.88	High	Medium
Nurseries	0.06	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 55. Water quality risk hypothesis; Steelhead, California Central Valley DPS; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of diazinon-containing products occur within the designated critical habitat of Steelhead, California Central Valley DPS. Three use site categories, totaling more than 702,424 acres (over 13% of acres) are currently present. The anticipated diazinon levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated

temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

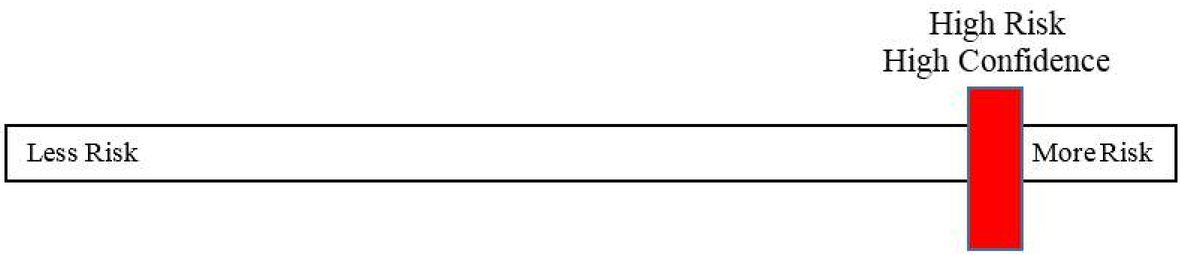
Table 56. Effects analysis summary table; Steelhead, California Central Valley DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical and biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of California Central Valley Steelhead. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical

habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



16.20 Central California Coast Steelhead Designated Critical Habitat

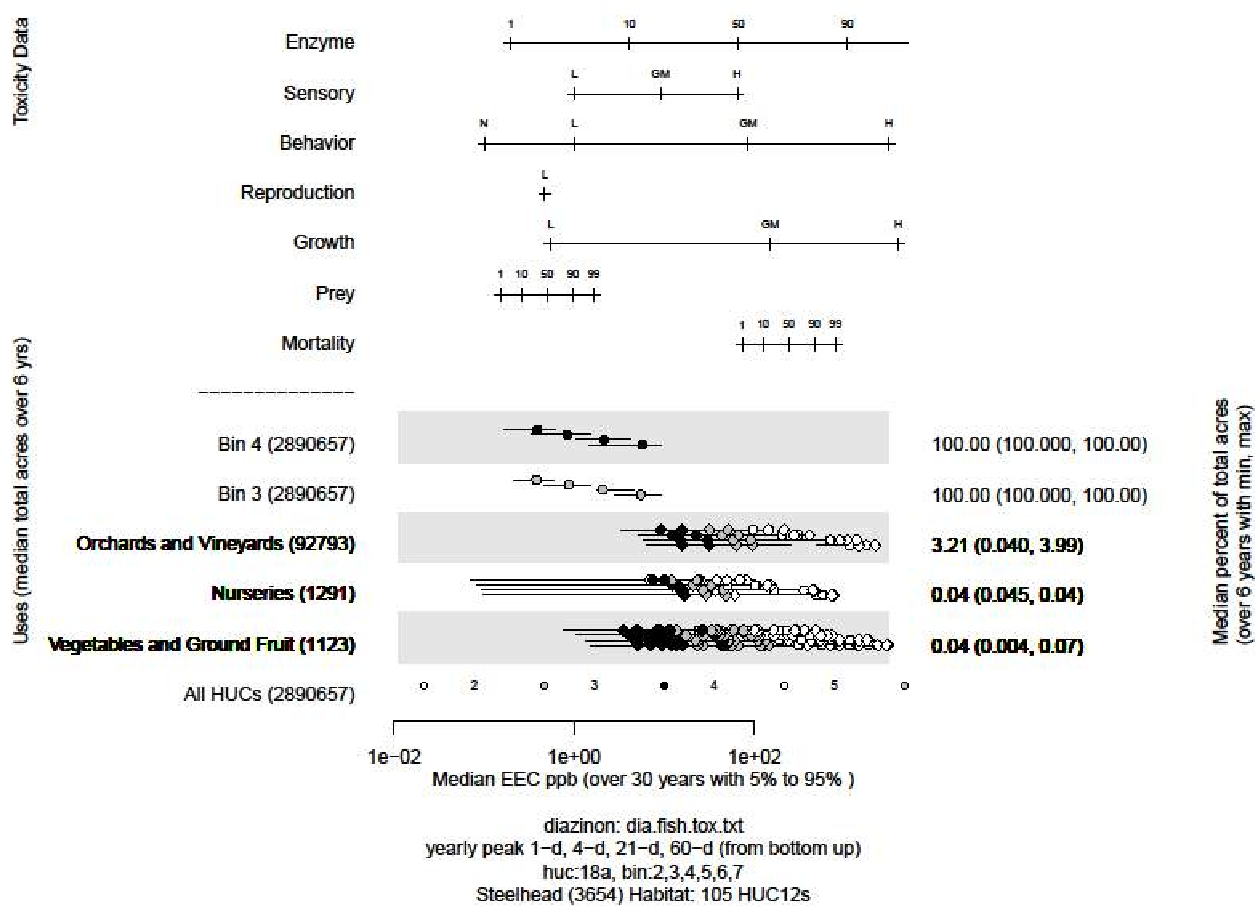


Figure 20. Effects analysis R-plot; Steelhead, Central California Coast DPS designated critical habitat.

Table 57. Prey (fish) risk hypothesis; Steelhead, Central California coast DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Orchards and Vineyards	3.21	High	Medium
Nurseries	0.04	High	Low

Vegetables and Ground Fruit	0.04	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Medium	**Medium**		

Table 58. Prey (inverts) risk hypothesis; Steelhead, Central California coast DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Orchards and Vineyards	3.21	High	Medium
Nurseries	0.04	High	Low
Vegetables and Ground Fruit	0.04	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Medium	**Medium**		

Table 59. Water quality risk hypothesis; Steelhead, Central California coast DPS; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within Central California Coast steelhead DPS designated critical habitat.

Three use site categories, totaling approximately 95,207 acres (less than four percent of acres) are currently present.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Medium	**Medium**	

Table 60. Effects analysis summary table; Steelhead, Central California coast DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	Medium	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	Medium	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a medium likelihood that the stressors of the action will negatively affect physical and biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Central California Coast Steelhead. The magnitude of toxic effects may result in some adverse effects. Due to the extent of diazinon-containing uses, we anticipate the overall conservation value of designated critical habitat to decrease moderately. We find that the overall risk is medium and the confidence associated with that risk is medium over the 15-year duration of the action.

16.21 Lower Columbia River Steelhead Designated Critical Habitat

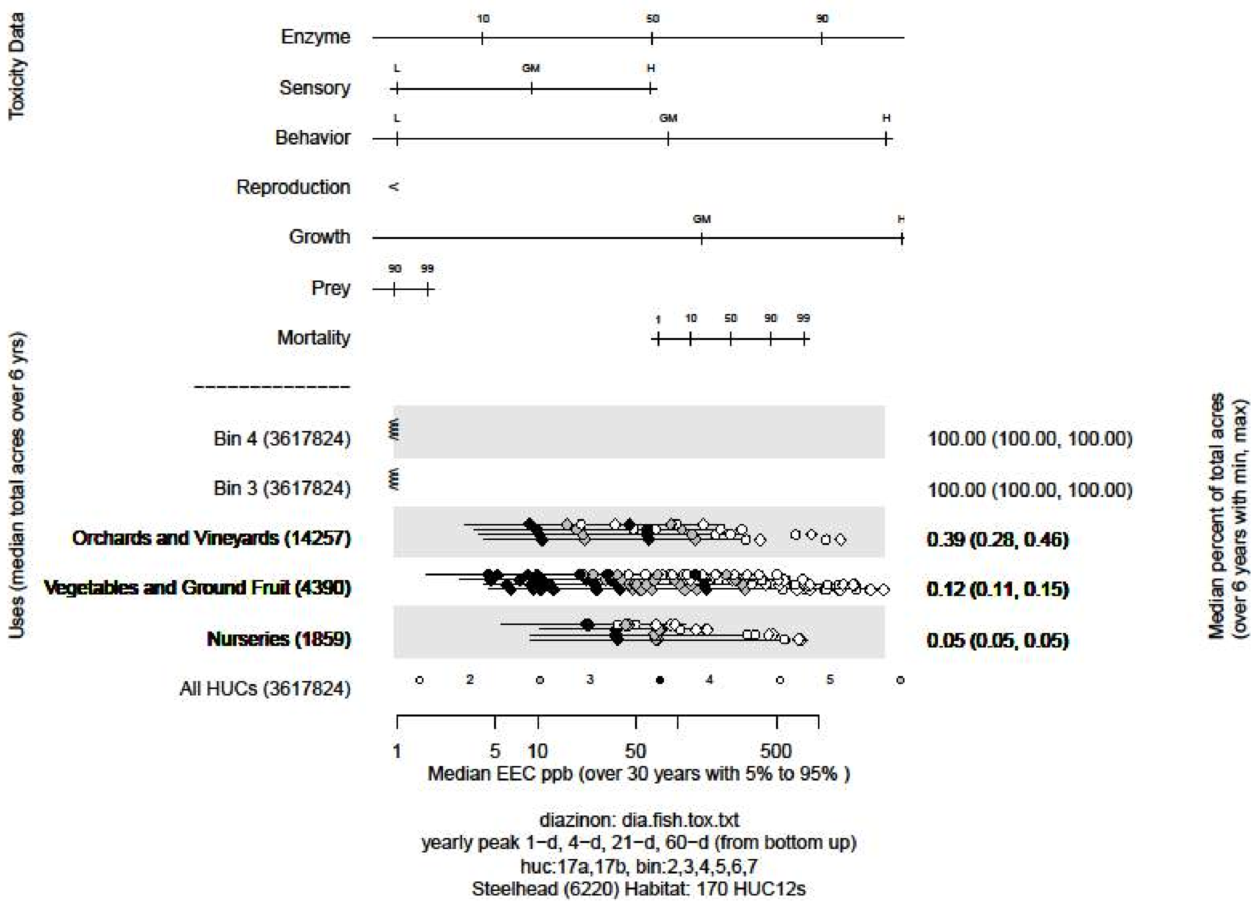


Figure 21. Effects analysis R-plot; Steelhead Lower Columbia River DPS designated critical habitat.

Table 61. Prey (fish) risk hypothesis; Steelhead, lower Columbia River DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Orchards and Vineyards	0.39	High	Low
Vegetables and Ground Fruit	0.12	High	Low

Nurseries	0.05	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Low	**High**		

Table 62. Prey (inverts) risk hypothesis; Steelhead, lower Columbia River DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Medium	High
Bin 4	100.00	Medium	High
Orchards and Vineyards	0.39	High	Low
Vegetables and Ground Fruit	0.12	High	Low
Nurseries	0.05	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Low	**High**		

Table 63. Water quality risk hypothesis; Steelhead, lower Columbia River DPS; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within lower Columbia River steelhead designated critical habitat. Three use

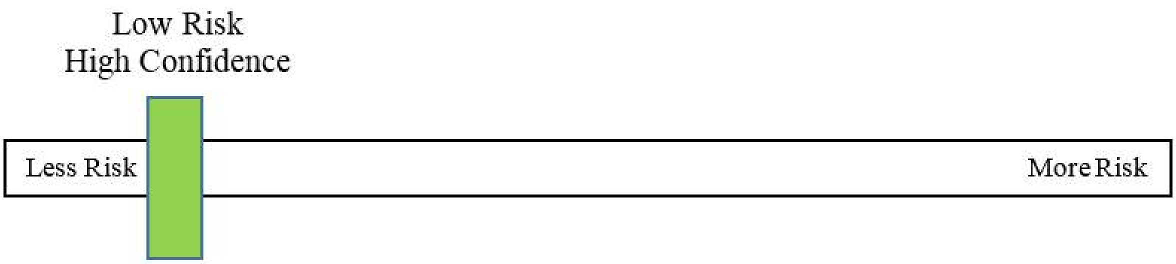
site categories, totaling approximately 20,506 acres (less than one percent of acres) are currently present.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Low	**High**	

Table 64. Effects analysis summary table; Steelhead, lower Columbia River DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	Low	Medium	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	Low	Medium	No

Designated Critical Habitat Effects Analysis Summary:

We do not anticipate that the stressors of the action will negatively affect physical and biological features (PBFs). Neither reductions in prey, nor degradation of water quality are likely throughout designated critical habitat of Lower Columbia River Steelhead. The magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses the overall conservation value of designated critical habitat is not anticipated to decrease. We have greater confidence in the risk determinations associated with the freshwater habitats than we do in the estuarine and nearshore habitats. Overall the risk is low and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.



16.22 Middle Columbia River Steelhead Designated Critical Habitat

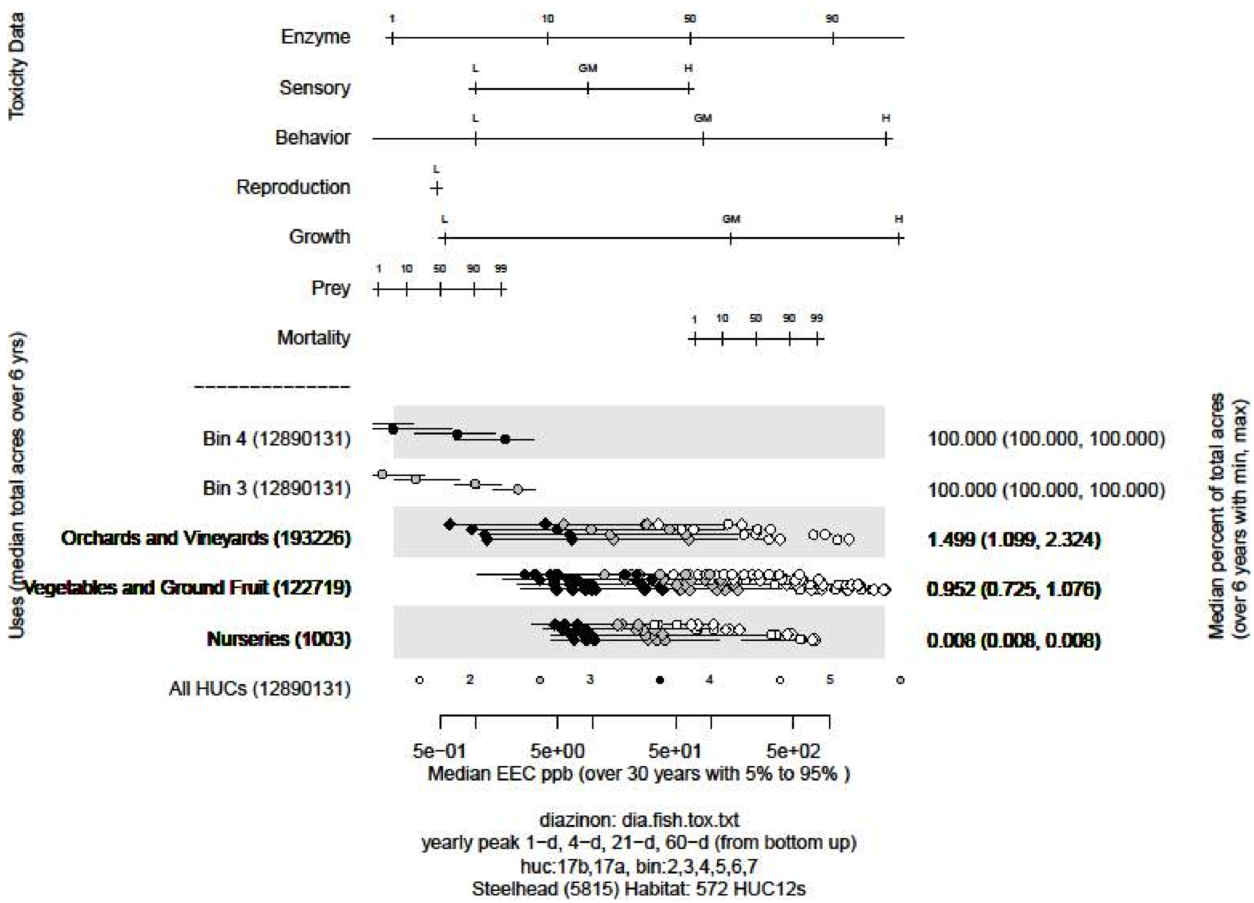


Figure 22. Effects analysis R-plot; Steelhead, Middle Columbia River DPS designated critical habitat.

Table 65. Prey (fish) risk hypothesis; Steelhead, middle Columbia River DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Orchards and Vineyards	1.50	High	Medium
Vegetables and Ground Fruit	0.95	High	Low

Nurseries	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Medium	**Medium**		

Table 66. Prey (inverts) risk hypothesis; Steelhead, middle Columbia River DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Orchards and Vineyards	1.50	High	Medium
Vegetables and Ground Fruit	0.95	High	Low
Nurseries	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Medium	**Medium**		

Table 67. Water quality risk hypothesis; Steelhead, middle Columbia River DPS; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within middle Columbia River steelhead designated critical habitat. Three

use site categories, totaling approximately 316,948 acres (less than three percent of acres) are currently present.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Medium	**Medium**	

Table 68. Effects analysis summary table; Steelhead, middle Columbia River DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	Medium	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	Medium	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a medium likelihood that the stressors of the action will negatively affect physical and biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Middle Columbia River Steelhead. The magnitude of toxic effects may result in some adverse effects. Due to the extent of diazinon-containing uses, we anticipate the overall conservation value of designated critical habitat to decrease moderately.

We find that the overall risk is medium and the confidence associated with that risk is medium over the 15-year duration of the action.

16.23 Northern California Steelhead Designated Critical Habitat

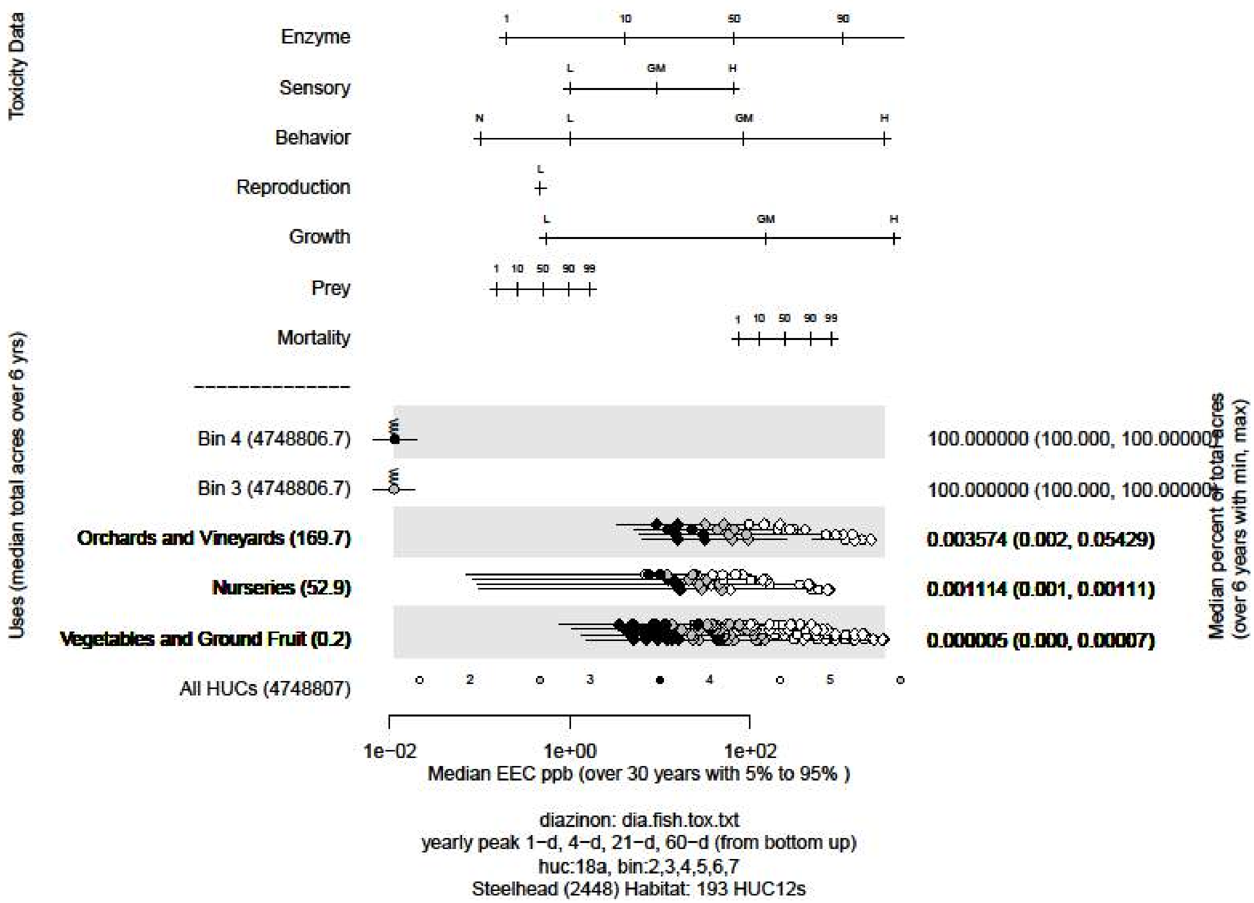


Figure 23. Effects analysis R-plot; Steelhead, Northern California DPS designated critical habitat.

Table 69. Prey (fish) risk hypothesis; Steelhead, Northern California DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Orchards and Vineyards	<0.001	High	Low
Nurseries	<0.001	High	Low

Vegetables and Ground Fruit	<0.001	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Low	**High**		

Table 70. Prey (inverts) risk hypothesis; Steelhead, Northern California DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Orchards and Vineyards	<0.001	High	Low
Nurseries	<0.001	High	Low
Vegetables and Ground Fruit	<0.001	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Low	**High**		

Table 71. Water quality risk hypothesis; Steelhead, Northern California DPS; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within northern California steelhead designated critical habitat. Three use site categories, totaling approximately 223 acres (less than one percent of acres) are currently present.

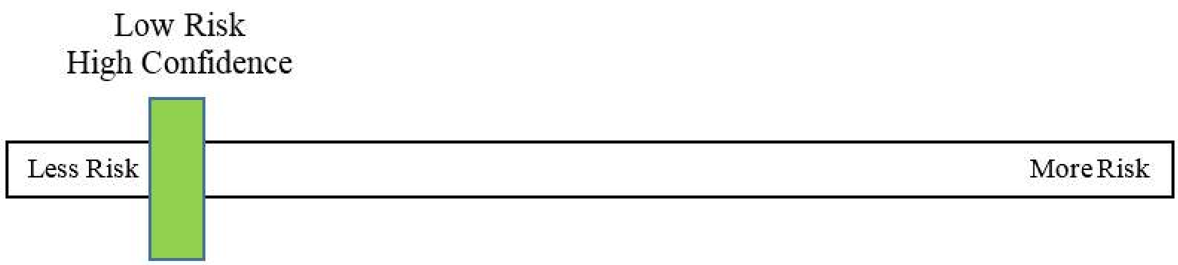
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Low	**High**	

Table 72. Effects analysis summary table; Steelhead, Northern California DPS; designated critical habitat.

Designated Critical Habitat; Risk Hypotheses	R-plot Derived Risk	R-plot Derived Confidence	Risk Hypothesis Supported? Yes/No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	Low	High	No

Designated Critical Habitat Effects Analysis Summary:

We do not anticipate that the stressors of the action will negatively affect physical and biological features (PBFs). Neither reductions in prey, nor degradation of water quality are likely throughout designated critical habitat of Northern California Steelhead. The magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses the overall conservation value of designated critical habitat is not anticipated to decrease. We have greater confidence in the risk determinations associated with the freshwater habitats than we do in the estuarine and nearshore habitats. Overall the risk is low and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.


Low Risk
High Confidence
Less Risk
More Risk

16.24 Puget Sound Steelhead Designated Critical Habitat

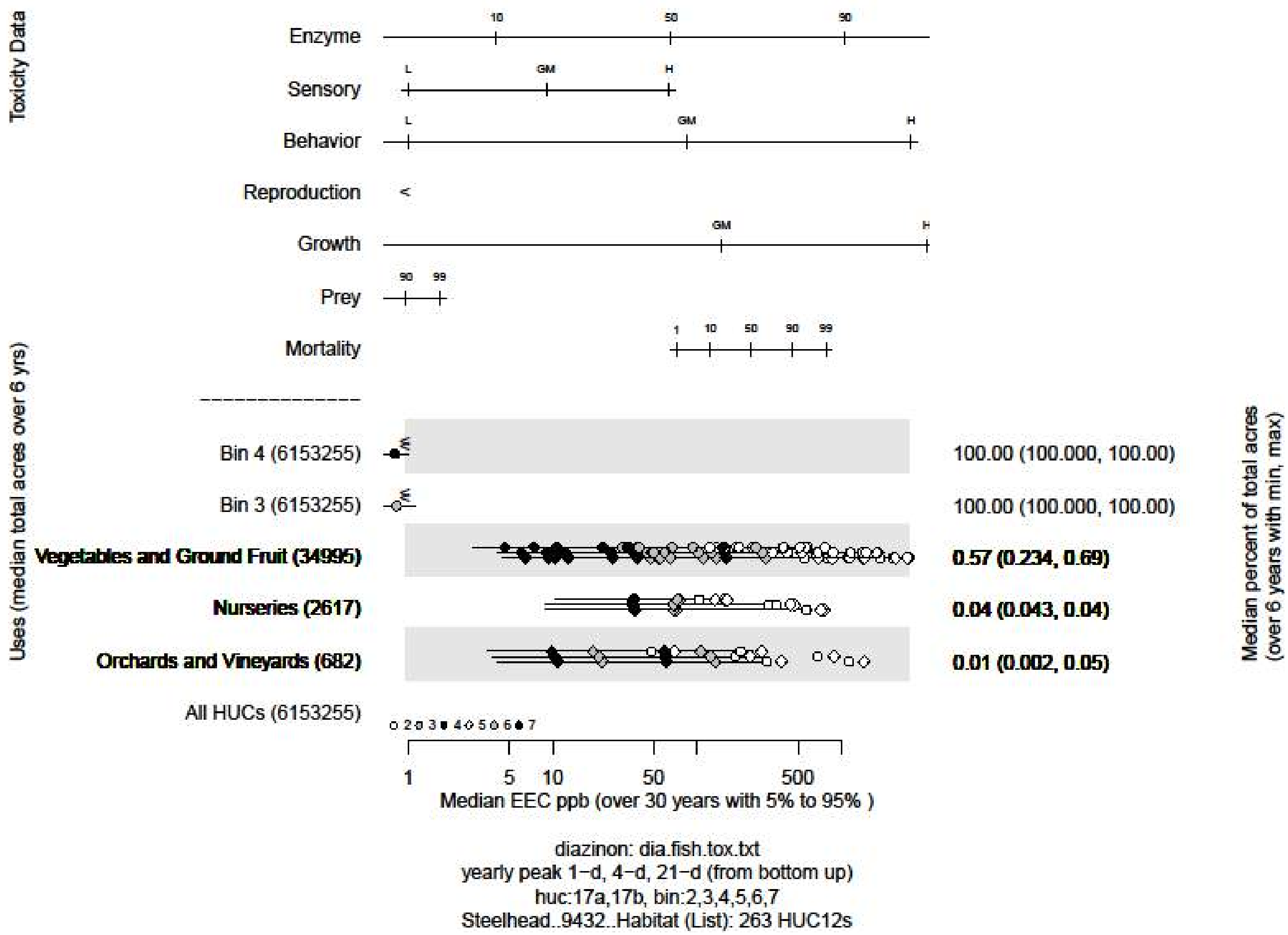


Figure 24. Effects analysis R-plot; Steelhead, Puget Sound DPS designated critical habitat.

Table 73. Prey (fish) risk hypothesis; Steelhead, Puget Sound DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Vegetables and Ground Fruit	0.57	High	Low
Nurseries	0.04	High	Low
Orchards and Vineyards	0.01	High	Low

Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*		
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**
Low	**High**	

Table 74. Prey (inverts) risk hypothesis; Steelhead, Puget Sound DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Vegetables and Ground Fruit	0.57	High	Low
Nurseries	0.04	High	Low
Orchards and Vineyards	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Low	**High**		

Table 75. Water quality risk hypothesis; Steelhead, Puget Sound DPS; designated critical habitat.

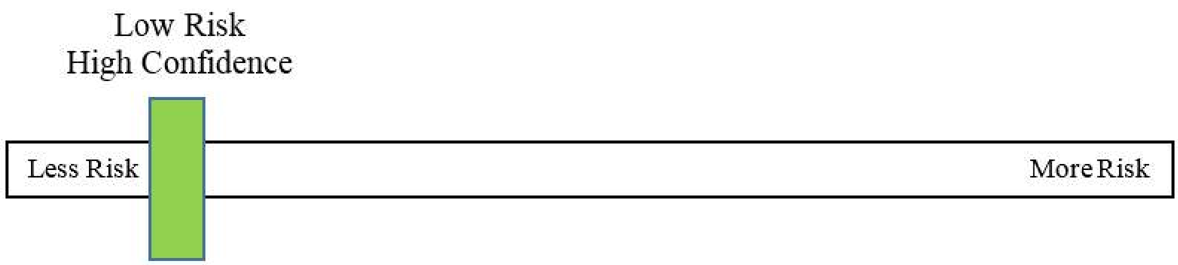
Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within Puget Sound steelhead DPS designated critical habitat. Three use site categories, totaling approximately 38,294 acres (less than one percent of acres) are currently present.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Low	**High**	

Table 76. Effects analysis summary table; Steelhead, Puget Sound DPS; designated critical habitat.

Designated Critical Habitat; Risk Hypotheses	R-plot Derived		Risk Hypothesis Supported? Yes/No
	Risk	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	Low	Medium	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	Low	Medium	No

Designated Critical Habitat Effects Analysis Summary:

We do not anticipate that the stressors of the action will negatively affect physical and biological features (PBFs). Neither reductions in prey, nor degradation of water quality are likely throughout designated critical habitat of Puget Sound Steelhead. The magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses the overall conservation value of designated critical habitat is not anticipated to decrease. We have greater confidence in the risk determinations associated with the freshwater habitats than we do in the estuarine and nearshore habitats. Overall the risk is low and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.


Low Risk
High Confidence
Less Risk
More Risk

16.25 Snake River Basin Steelhead Designated Critical Habitat

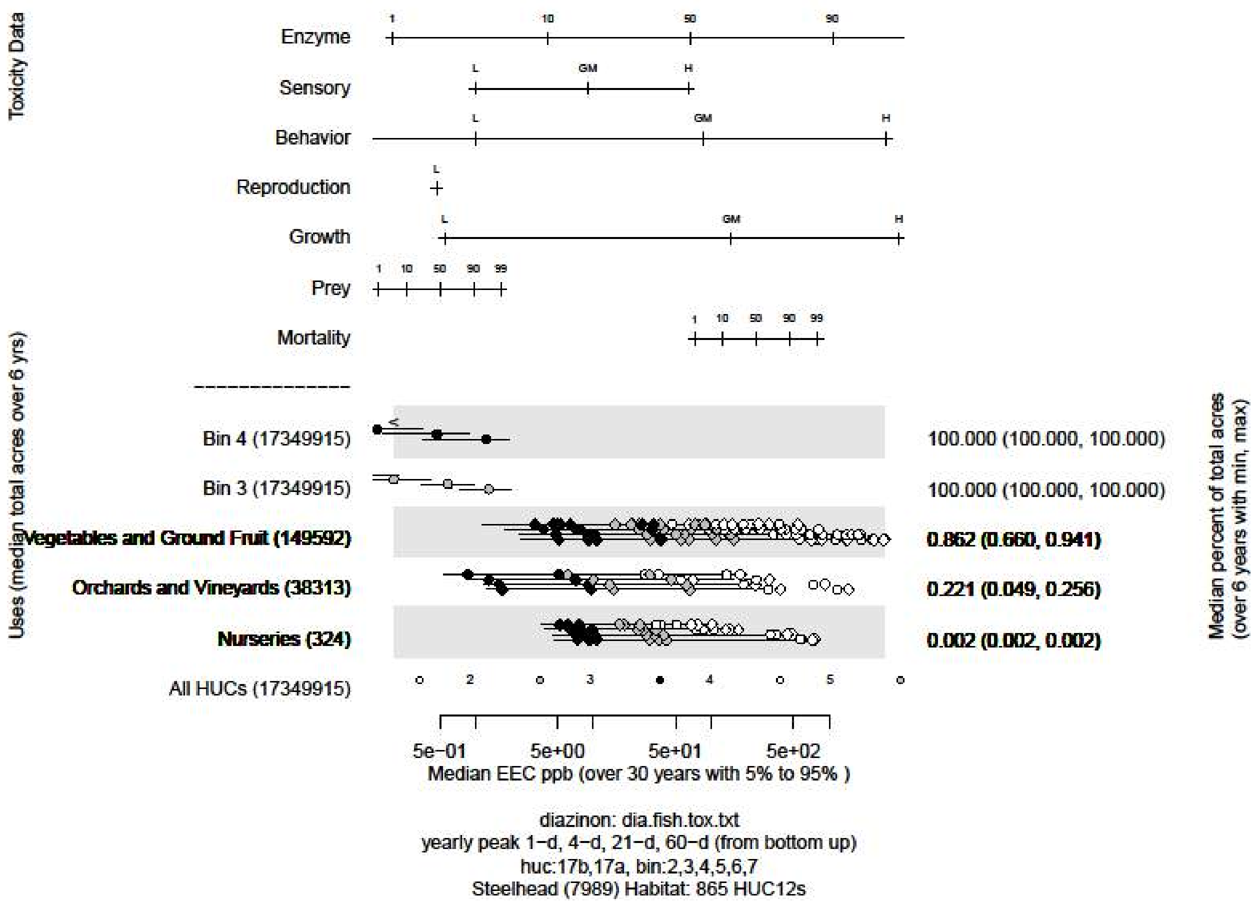


Figure 25. Effects analysis R-plot; Steelhead, Snake River Basin DPS designated critical habitat.

Table 77. Prey (fish) risk hypothesis; Steelhead, Snake River basin DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Vegetables and Ground Fruit	0.86	High	Low
Orchards and Vineyards	0.22	High	Low

Nurseries	0.00	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	**Medium risk due to combined overlap of the three use categories >1%** ***We have low confidence in EECs associated with marine and estuarine habitats.**	
Medium	**Medium**		

Table 78. Prey (inverts) risk hypothesis; Steelhead, Snake River basin DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Vegetables and Ground Fruit	0.86	High	Low
Orchards and Vineyards	0.22	High	Low
Nurseries	0.00	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	**Medium risk due to combined overlap of the three use categories >1%** ***We have low confidence in EECs associated with marine and estuarine habitats.**	
Medium	**Medium**		

Table 79. Water quality risk hypothesis; Steelhead, Snake River basin DPS; designated critical habitat.

Endpoint: Water Quality

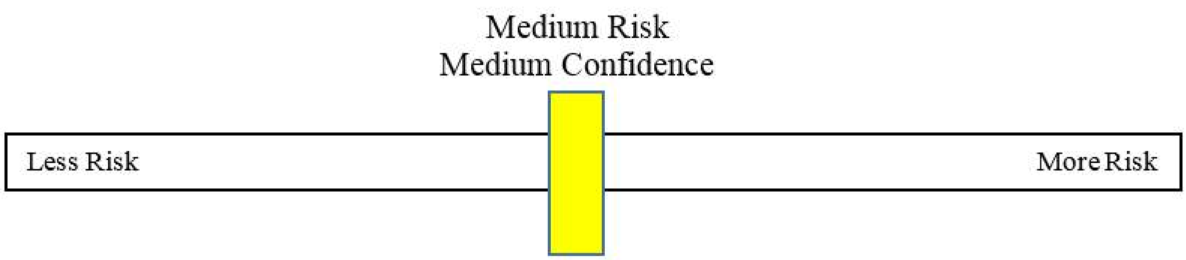
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within Snake River Basin steelhead designated critical habitat. Three use site categories, totaling approximately 188,229 acres (less than 2% of acres) are currently present.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Medium	**Medium**	

Table 80. Effects analysis summary table; Steelhead, Snake River basin DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	Medium	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	Medium	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a medium likelihood that the stressors of the action will negatively affect physical and biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Snake River Basin Steelhead The magnitude of toxic effects may result in some adverse effects. Due to the extent of diazinon-containing uses, we anticipate the overall conservation value of designated critical habitat to decrease moderately. We find that the overall risk is medium and the confidence associated with that risk is medium over the 15-year duration of the action.



16.26 South Central California Coast Steelhead Designated Critical Habitat

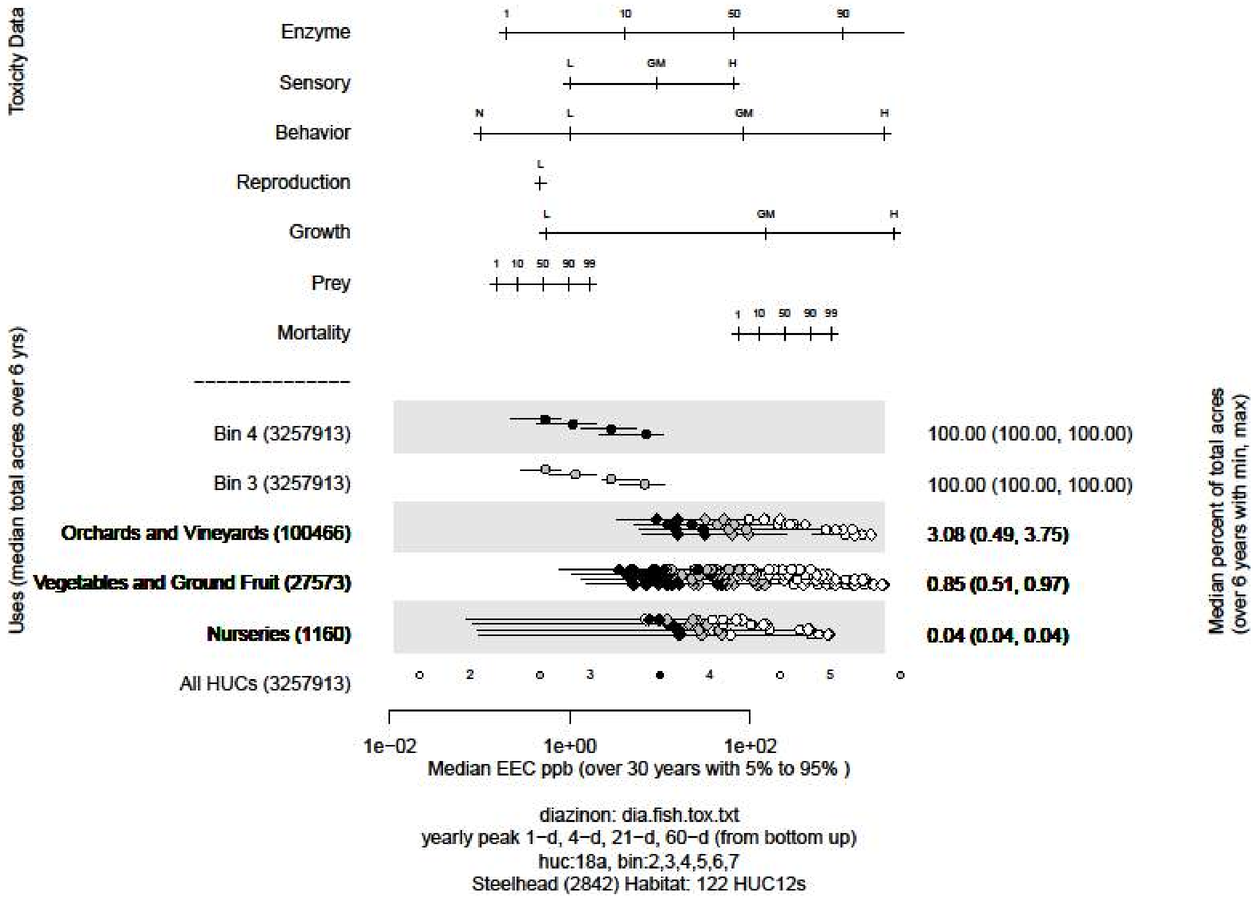


Figure 26. Effects analysis R-plot; Steelhead, South Central California Coast DPS designated critical habitat.

Table 81. Prey (fish) risk hypothesis; Steelhead, South-central California coast DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Orchards and Vineyards	3.08	High	Medium
Vegetables and Ground Fruit	0.85	High	Low

Nurseries	0.04	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Medium	**Medium**		

Table 82. Prey (inverts) risk hypothesis; Steelhead, South-central California coast DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Orchards and Vineyards	3.08	High	Medium
Vegetables and Ground Fruit	0.85	High	Low
Nurseries	0.04	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Medium	**Medium**		

Table 83. Water quality risk hypothesis; Steelhead, South-central California coast DPS; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within south-central California coast steelhead designated critical habitat. Three use site categories, totaling approximately 129,200 acres (four percent of acres) are currently present.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Medium	**Medium**	

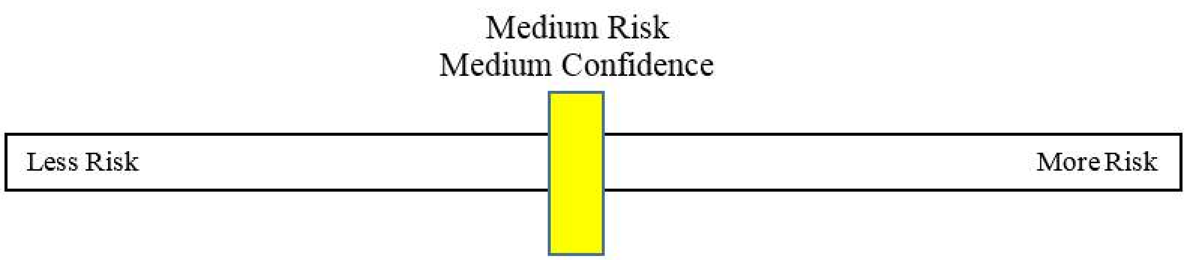
Table 84. Effects analysis summary table; Steelhead, South-central California coast DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	Medium	Low	Yes

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	Medium	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a medium likelihood that the stressors of the action will negatively affect physical and biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of South Central California Coast Steelhead. The magnitude of toxic effects may result in some adverse effects. Due to the extent of diazinon-containing uses, we anticipate the overall conservation value of designated critical habitat to decrease moderately. We find that the overall risk is medium and the confidence associated with that risk is medium over the 15-year duration of the action.



16.27 Southern California Steelhead Designated Critical Habitat

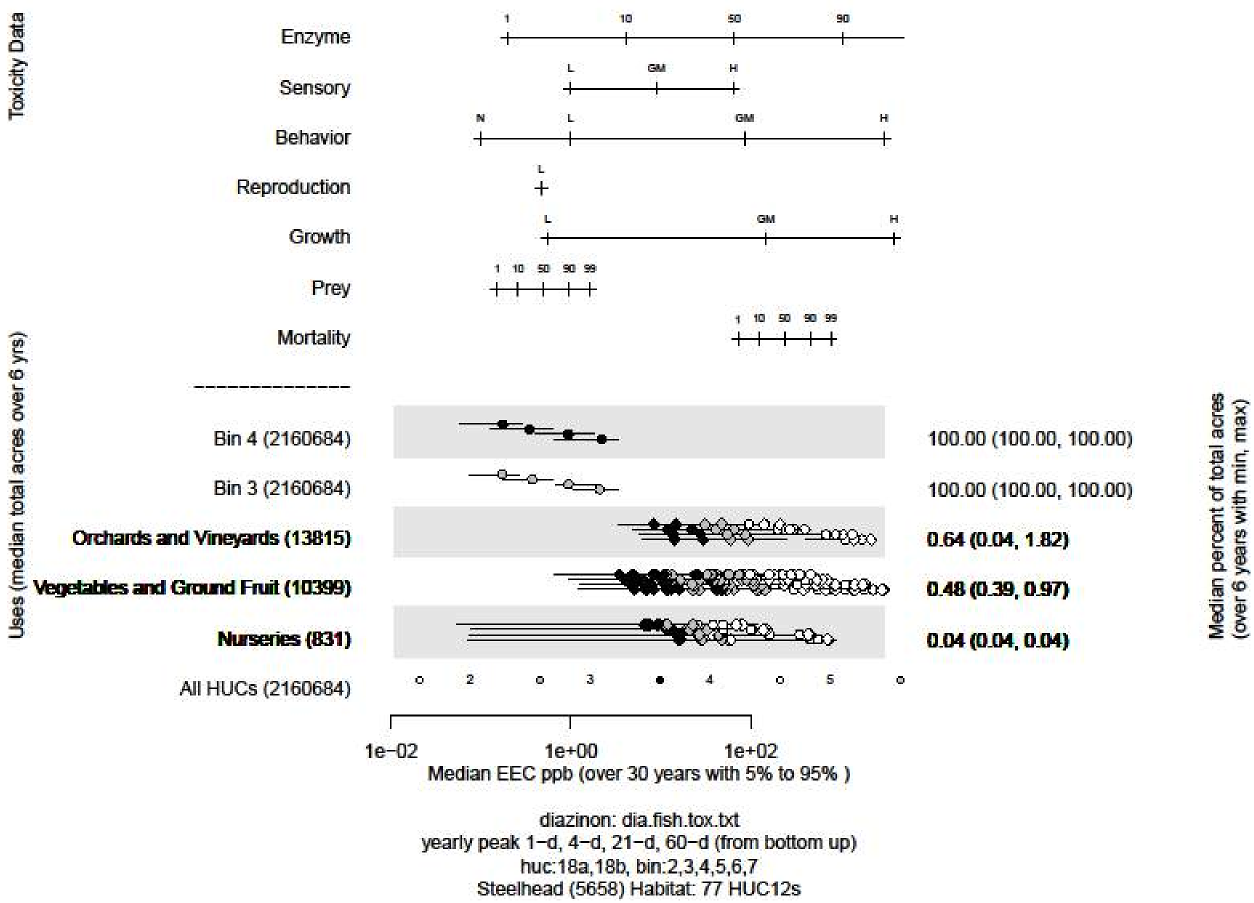


Figure 27. Effects analysis R-plot; Steelhead, Southern California DPS designated critical habitat.

Table 85. Prey (fish) risk hypothesis; Steelhead, Southern California DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Orchards and Vineyards	0.64	High	Low
Vegetables and Ground Fruit	0.48	High	Low
Nurseries	0.04	High	Low

Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*		
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**
Medium	**Medium**	

Table 86. Prey (inverts) risk hypothesis; Steelhead, Southern California DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Orchards and Vineyards	0.64	High	Low
Vegetables and Ground Fruit	0.48	High	Low
Nurseries	0.04	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Medium	**Medium**		

Table 87. Water quality risk hypothesis; Steelhead, Southern California DPS; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within southern California steelhead designated critical habitat. Three use site categories, totaling approximately 25,045 acres (less than 2% of acres) are currently present.
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.

Risk	Confidence	
Medium	**Medium**	

Table 88. Effects analysis summary table; Steelhead, Southern California DPS; designated critical habitat.

Designated Critical Habitat; Risk Hypotheses	R-plot Derived Risk	R-plot Derived Confidence	Risk Hypothesis Supported? Yes/No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	Medium	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	Medium	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a medium likelihood that the stressors of the action will negatively affect physical and biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Southern California Steelhead. The magnitude of toxic effects may result in some adverse effects. Due to the extent of diazinon-containing uses, we anticipate the overall conservation value of designated critical habitat to decrease moderately. We find that the overall risk is medium and the confidence associated with that risk is medium over the 15-year duration of the action.


Medium Risk
Medium Confidence
Less Risk
More Risk

16.28 Upper Columbia River Steelhead Designated Critical Habitat

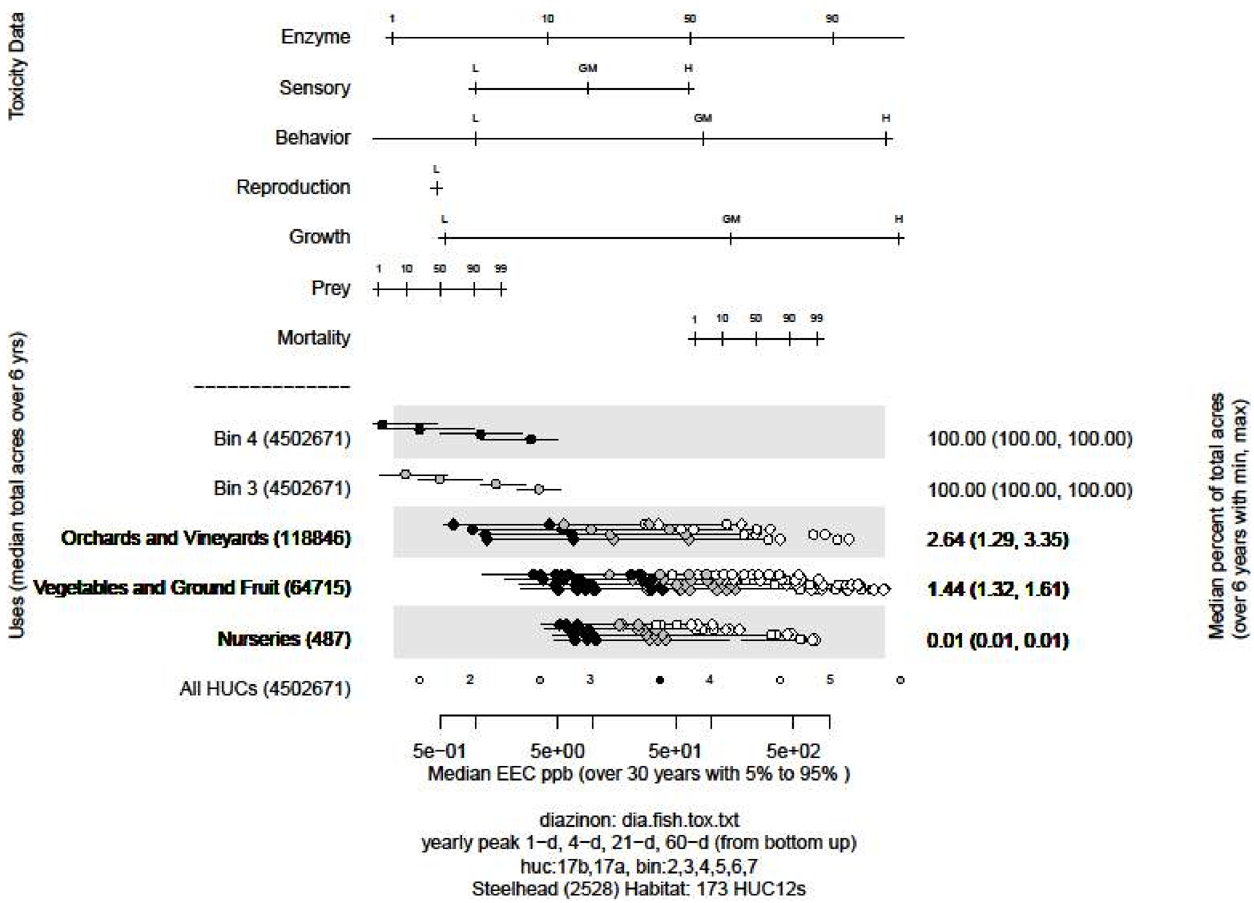


Figure 28. Effects analysis R-plot; Steelhead, Upper Columbia River DPS designated critical habitat.

Table 89. Prey (fish) risk hypothesis; Steelhead, upper Columbia River DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Orchards and Vineyards	2.64	High	Medium
Vegetables and Ground Fruit	1.44	High	Medium
Nurseries	0.01	High	Low

Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*		
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**
Medium	**Medium**	

Table 90. Prey (inverts) risk hypothesis; Steelhead, upper Columbia River DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Orchards and Vineyards	2.64	High	Medium
Vegetables and Ground Fruit	1.44	High	Medium
Nurseries	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Medium	**Medium**		

Table 91. Water quality risk hypothesis; Steelhead, upper Columbia River DPS; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within upper Columbia River steelhead designated critical habitat. Three use site categories, totaling approximately 184,048 acres (four percent of acres) are currently present.
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.

Risk	Confidence	
Medium	**Medium**	

Table 92. Effects analysis summary table; Steelhead, upper Columbia River DPS; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported?
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	Medium	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	Medium	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a medium likelihood that the stressors of the action will negatively affect physical and biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Upper Columbia River Steelhead. The magnitude of toxic effects may result in some adverse effects. Due to the extent of diazinon-containing uses, we anticipate the overall conservation value of designated critical habitat to decrease moderately. We find that the overall risk is medium and the confidence associated with that risk is medium over the 15-year duration of the action.


Medium Risk
Medium Confidence
Less Risk
More Risk

16.29 Upper Willamette River Steelhead Designated Critical Habitat

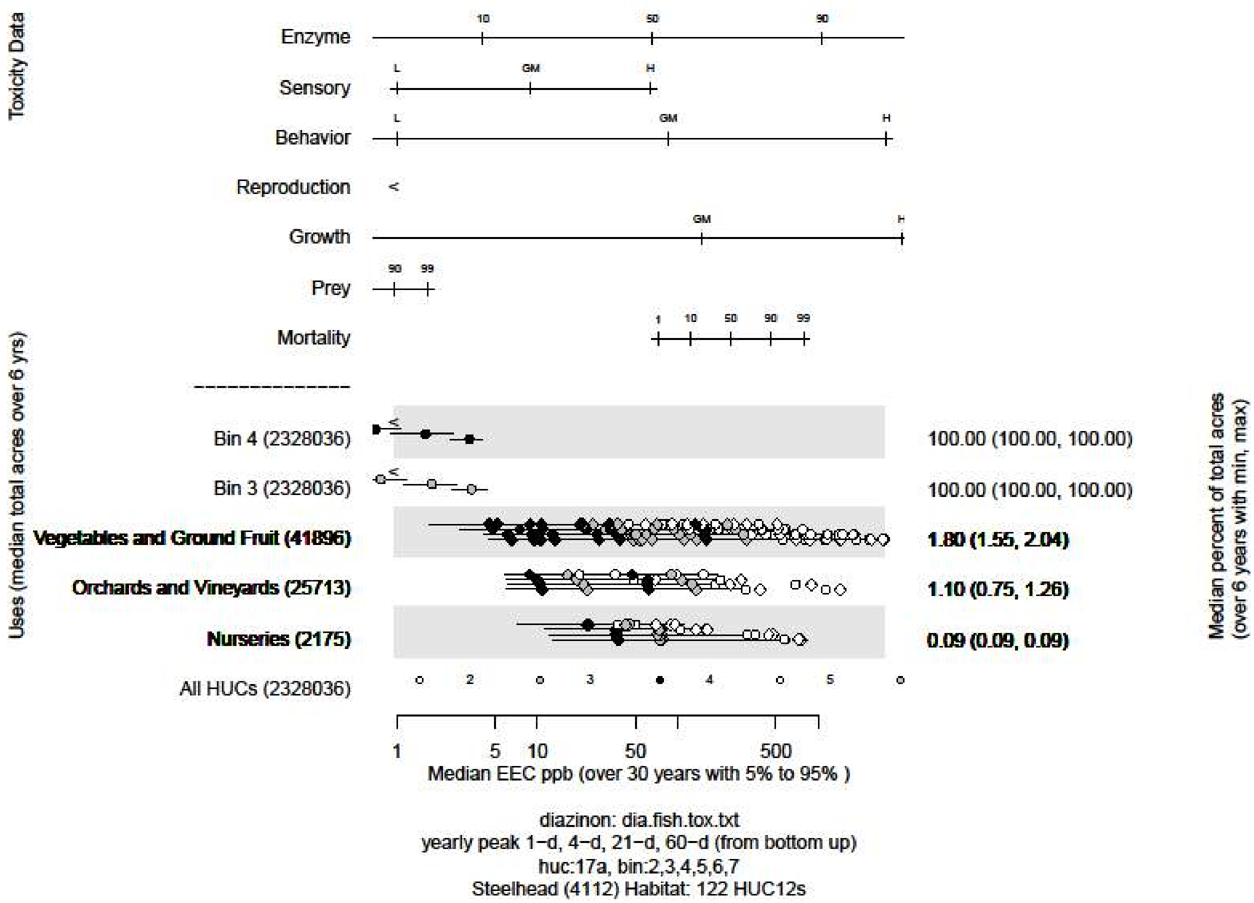


Figure 29. Effects analysis R-plot; Steelhead, Upper Willamette River DPS designated critical habitat.

Table 93. Prey (fish) risk hypothesis; Steelhead, upper Willamette River DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Vegetables and Ground Fruit	1.80	High	Medium
Orchards and Vineyards	1.10	High	Medium

Nurseries	0.09	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Medium	**Medium**		

Table 94. Prey (inverts) risk hypothesis; Steelhead, upper Willamette River DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Vegetables and Ground Fruit	1.80	High	Medium
Orchards and Vineyards	1.10	High	Medium
Nurseries	0.09	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Medium	**Medium**		

Table 95. Water quality risk hypothesis; Steelhead, upper Willamette River DPS; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within upper Willamette River steelhead designated critical habitat. Three use site categories, totaling approximately 69,784 acres (three percent of acres) are currently present.

Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Medium	**Medium**	

Table 96. Effects analysis summary table; Steelhead, upper Willamette River DPS; designated critical habitat.

Designated Critical Habitat; Risk Hypotheses	R-plot Derived		Risk Hypothesis Supported? Yes/No
	Risk	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	Medium	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	Medium	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a medium likelihood that the stressors of the action will negatively affect physical and biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Upper Willamette River Steelhead. The magnitude of toxic effects may result in some adverse effects. Due to the extent of diazinon-containing uses, we anticipate the overall conservation value of designated critical habitat to decrease moderately. We find that the overall risk is medium and the confidence associated with that risk is medium over the 15-year duration of the action.


Medium Risk
Medium Confidence
Less Risk
More Risk

16.30 Eulachon (Southern DPS) Designated Critical Habitat

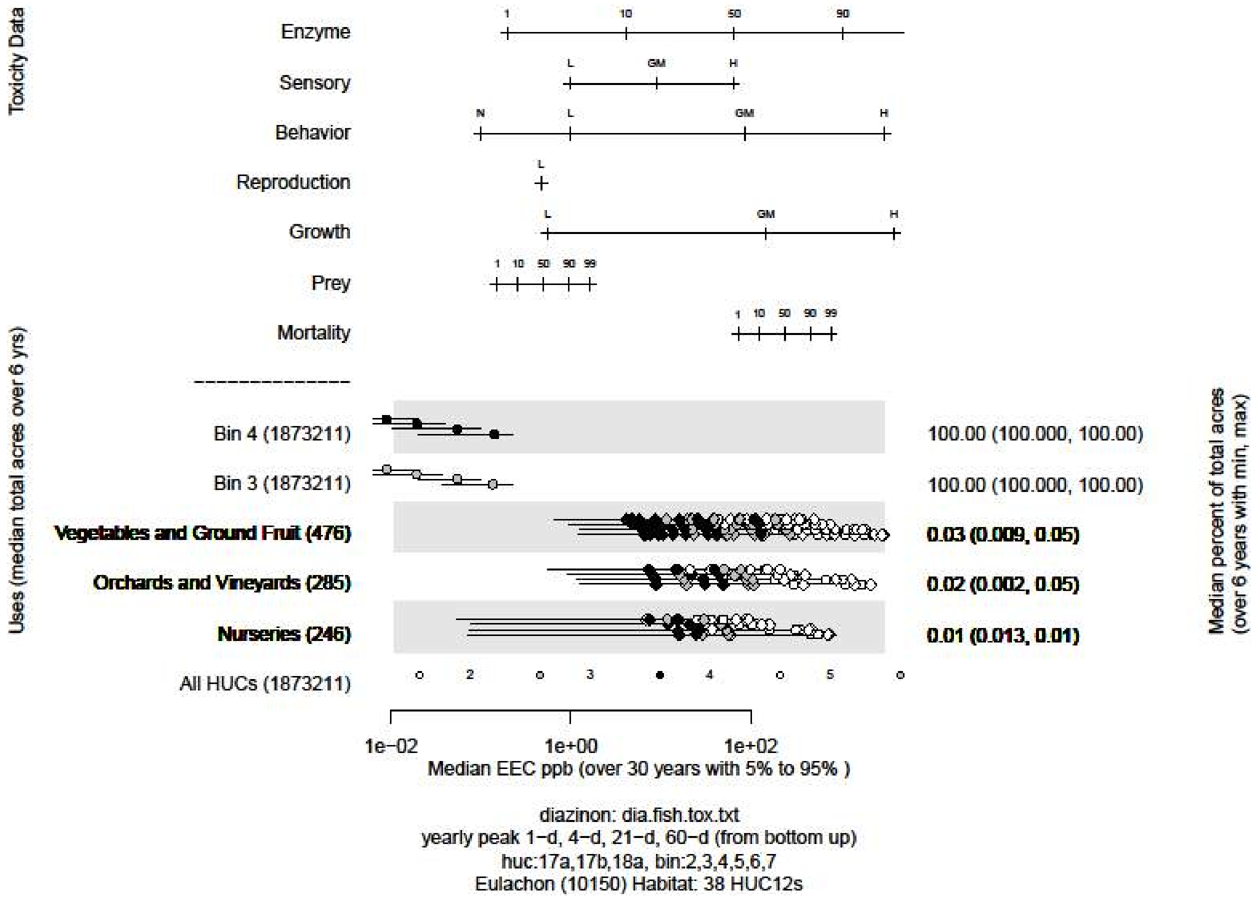


Figure 30. Effects analysis R-plot; Eulachon, Southern DPS designated critical habitat.

Table 97. Prey (inverts) risk hypothesis; Eulachon, southern DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Vegetables and Ground Fruit	0.03	High	Low
Orchards and Vineyards	0.02	High	Low
Nurseries	0.01	High	Low

Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey (inverts).		
Risk	**Confidence**	
Low	**High**	

Table 98. Water quality risk hypothesis; Eulachon, southern DPS; designated critical habitat.

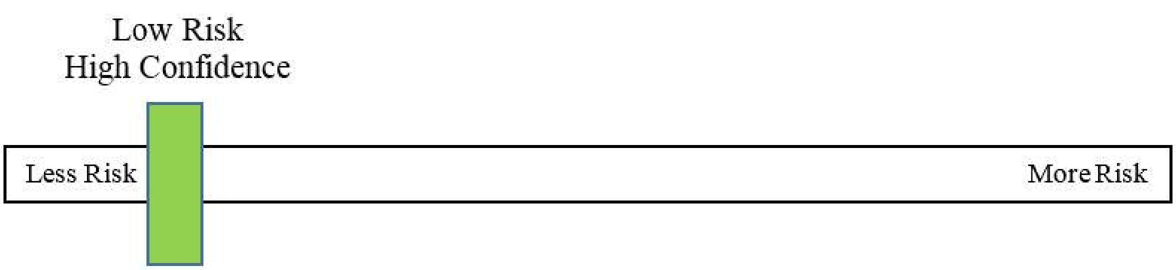
Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within eulachon, southern DPS designated critical habitat. Three use site categories, totaling approximately 1,009 acres (less than one percent of acres) are currently present.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Low	**High**	

Table 99. Effects analysis summary table; Eulachon, southern DPS; designated critical habitat.

Designated Critical Habitat; Risk Hypotheses	R-plot Derived		Risk Hypothesis Supported? Yes/No
	Risk	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater and estuarine habitats.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in freshwater and estuarine habitats.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in nearshore and offshore habitats.	Low	Low	No
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in nearshore and offshore habitats.	Low	Low	No

Designated Critical Habitat Effects Analysis Summary:

We do not anticipate that the stressors of the action will negatively affect physical and biological features (PBFs). Neither reductions in prey, nor degradation of water quality are likely throughout designated critical habitat of Eulachon (Southern DPS). The magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses the overall conservation value of designated critical habitat is not anticipated to decrease. We have greater confidence in the risk determinations associated with the freshwater habitats than we do in the estuarine and nearshore habitats. Overall the risk is low and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.



16.31 Green Sturgeon (Southern DPS) Designated Critical Habitat

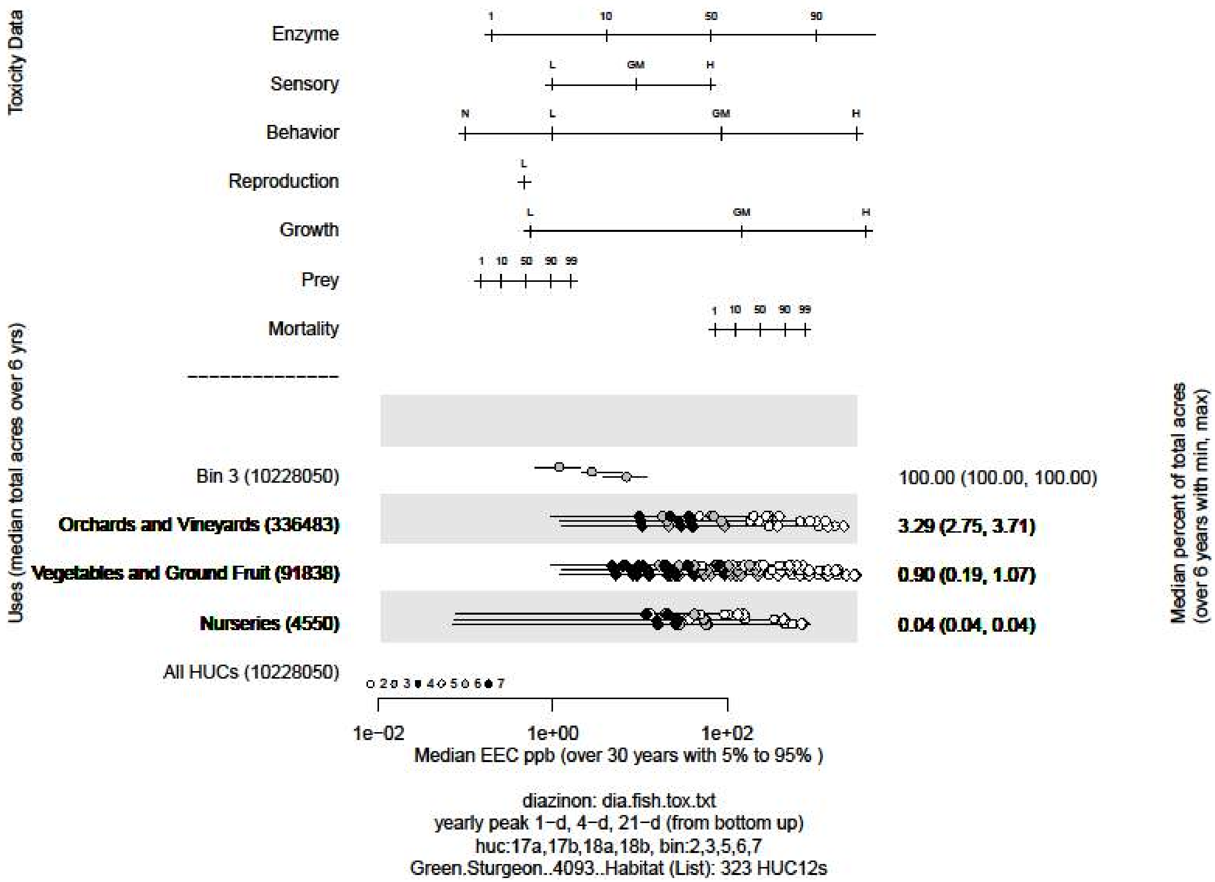


Figure 31. Effects analysis R-plot; Green Sturgeon, Southern DPS designated critical habitat.

Table 100. Prey (fish) risk hypothesis; Green Sturgeon, Southern DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Orchards and Vineyards	3.29	High	Medium
Vegetables and Ground Fruit	0.90	High	Low
Nurseries	0.04	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (fish).*			

Risk	Confidence	*We have low confidence in EECs associated with marine and estuarine habitats.
Medium	**Medium**	

Table 101. Prey (inverts) risk hypothesis; Green Sturgeon, Southern DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	High	High
Orchards and Vineyards	3.29	High	Medium
Vegetables and Ground Fruit	0.90	High	Low
Nurseries	0.04	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (inverts).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Medium	**Medium**		

Table 102. Water quality risk hypothesis; Green Sturgeon, Southern DPS; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within Green Sturgeon, Southern DPS designated critical habitat. Three use site categories, totaling approximately 432,871 acres (less than four percent of acres) are currently present.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	

Medium	**Medium**	

Table 103. Effects analysis summary table; Green Sturgeon, Southern DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater habitats.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of prey in freshwater habitats.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in estuarine habitats.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in estuarine habitats.	Medium	Medium	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in coastal habitats.	Medium	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in coastal habitats.	Medium	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a medium likelihood that the stressors of the action will negatively affect physical and biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Green Stugeon (Southern DPS). The magnitude of toxic effects may result in some adverse effects. Due to the extent of diazinon-containing uses, we anticipate the overall conservation value of designated critical habitat to decrease moderately. We find that the overall risk is medium and the confidence associated with that risk is medium over the 15-year duration of the action.


Medium Risk
Medium Confidence
Less Risk
More Risk

16.32 Gulf Sturgeon Designated Critical Habitat

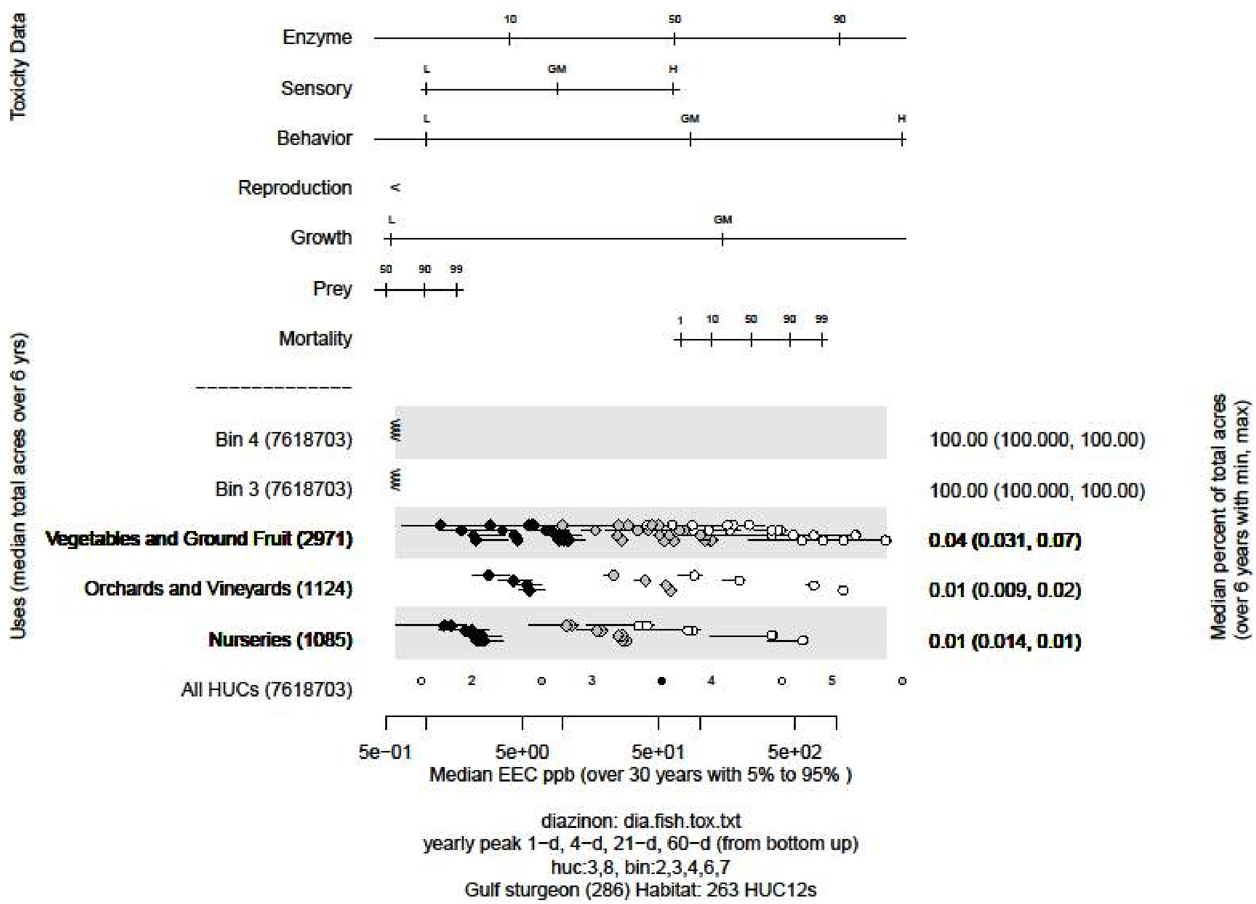


Figure 32. Effects analysis R-plot; Gulf Sturgeon designated critical habitat.

Table 104. Prey (fish) risk hypothesis; Gulf Sturgeon; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Vegetables and Ground Fruit	0.04	High	Low

Orchards and Vineyards	0.01	High	Low
Nurseries	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey (fish) in estuarine and coastal habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Low	**High**		

Table 105. Prey (inverts) risk hypothesis; Gulf Sturgeon; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Vegetables and Ground Fruit	0.04	High	Low
Orchards and Vineyards	0.01	High	Low
Nurseries	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey (inverts) in estuarine and coastal habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Low	**High**		

Table 106. Water quality risk hypothesis; Gulf Sturgeon; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing

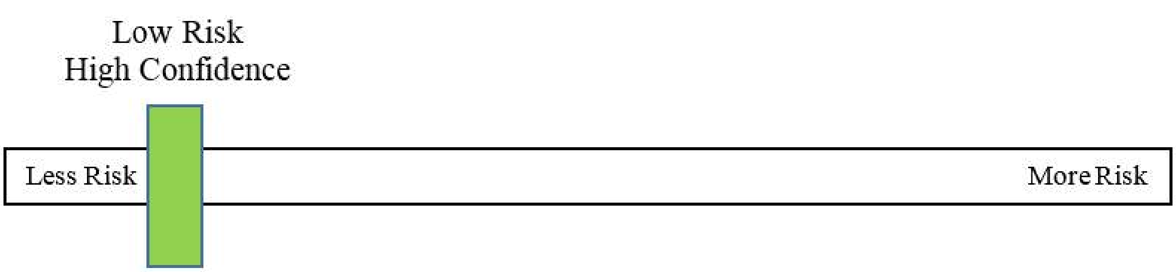
products occur minimally within Gulf sturgeon designated critical habitat. Three use site categories, totaling approximately 5,180 acres (less than one percent of acres) are currently present.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Low	**High**	

Table 107. Effects analysis summary table; Gulf Sturgeon; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in the estuarine and nearshore habitats.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in the estuarine and nearshore habitats.	Low	High	No

Designated Critical Habitat Effects Analysis Summary:

We do not anticipate that the stressors of the action will negatively affect physical or biological features (PBFs). Neither reductions in prey, nor degradation of water quality are likely throughout designated critical habitat of Gulf Stugeon. The magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses the overall conservation value of designated critical habitat is not anticipated to decrease. Overall the risk is low and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.



16.33 Atlantic Sturgeon, Gulf of Maine DPS, Designated Critical Habitat

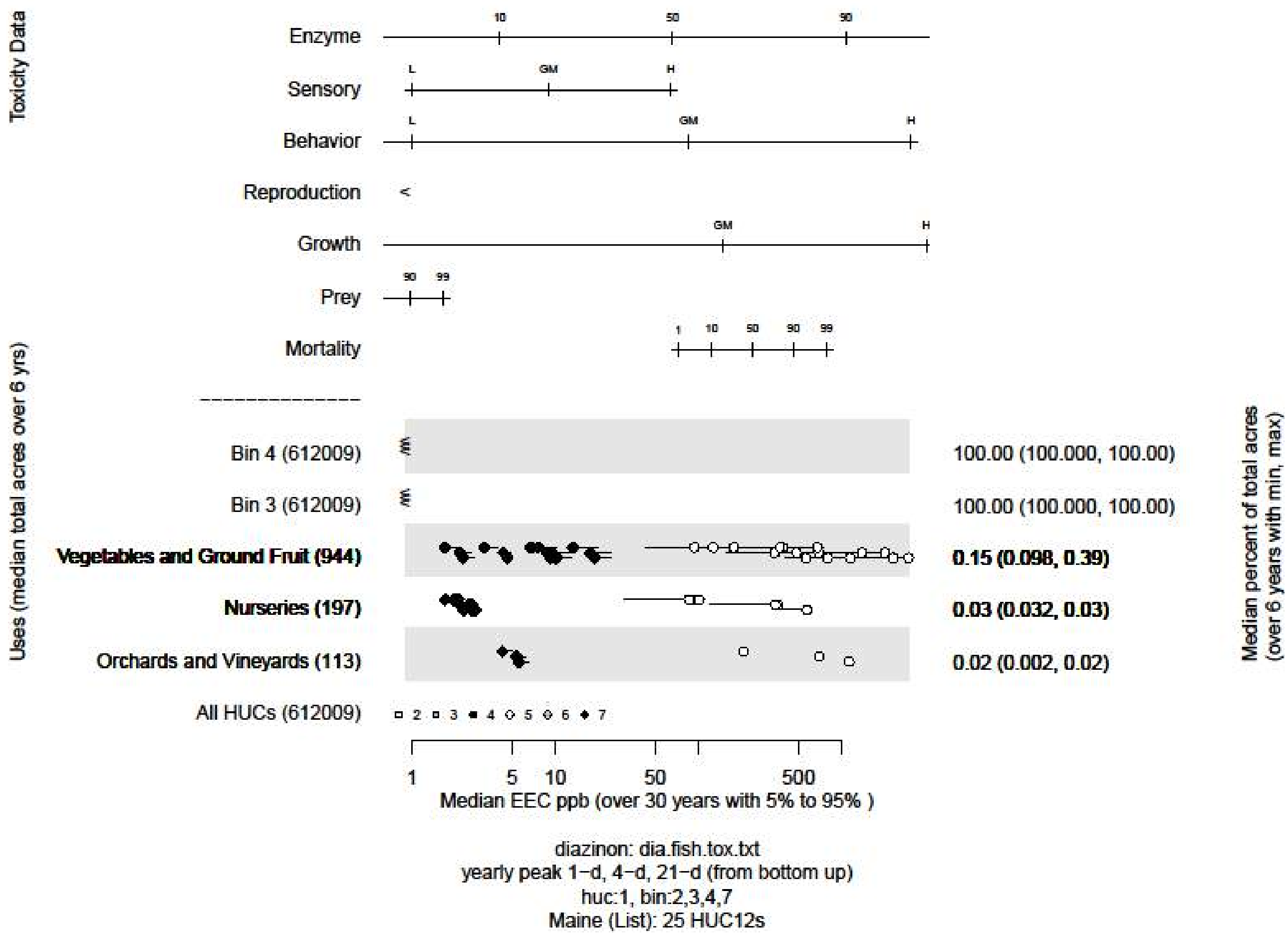


Figure 33. Effects analysis R-plot; Atlantic Sturgeon, Gulf of Maine DPS; designated critical habitat.

Table 108. Prey (fish) risk hypothesis; Atlantic Sturgeon, Gulf of Maine DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Vegetables and Ground Fruit	0.15	High	Low
Nurseries	0.03	High	Low

Orchards and Vineyards	0.02	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (fish).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Low	**High**		

Table 109. Prey (inverts) risk hypothesis; Atlantic Sturgeon, Gulf of Maine DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Vegetables and Ground Fruit	0.15	High	Low
Nurseries	0.03	High	Low
Orchards and Vineyards	0.02	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (inverts).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Low	**High**		

Table 110. Water quality risk hypothesis; Atlantic Sturgeon, Gulf of Maine DPS; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within Atlantic sturgeon, Gulf of Maine DPS designated critical habitat.

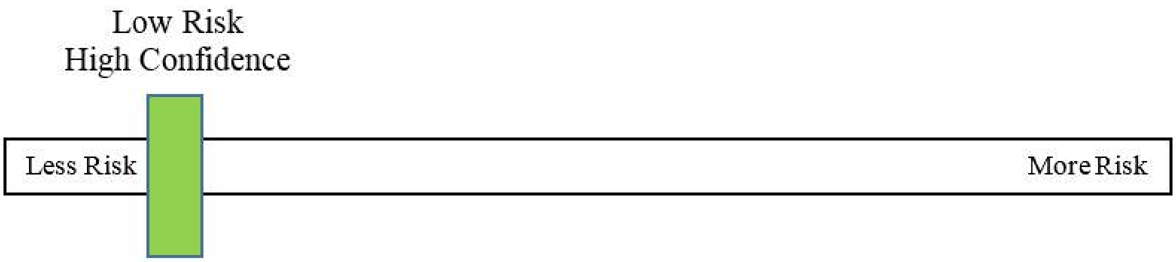
Three use site categories, totaling approximately 1254 acres (less than one percent of acres) are currently present.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Low	**High**	

Table 111. Effects analysis summary table; Atlantic Sturgeon, Gulf of Maine DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater habitats.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of prey in freshwater habitats.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in estuarine habitats.	Low	Low	No
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in estuarine habitats.	Low	Low	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in coastal habitats.	Low	Low	No
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in coastal habitats.	Low	Low	No

Designated Critical Habitat Effects Analysis Summary:

We do not anticipate that the stressors of the action will negatively affect physical and biological features (PBFs). Neither reductions in prey, nor degradation of water quality are likely throughout designated critical habitat of Atlantic sturgeon, Gulf of Maine DPS. The magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses the overall conservation value of designated critical habitat is not anticipated to decrease. We have greater confidence in the risk determinations associated with the freshwater habitats than we do in the estuarine and nearshore habitats. Overall the risk is low and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.



16.34 Atlantic Sturgeon, New York Bight DPS, Designated Critical Habitat

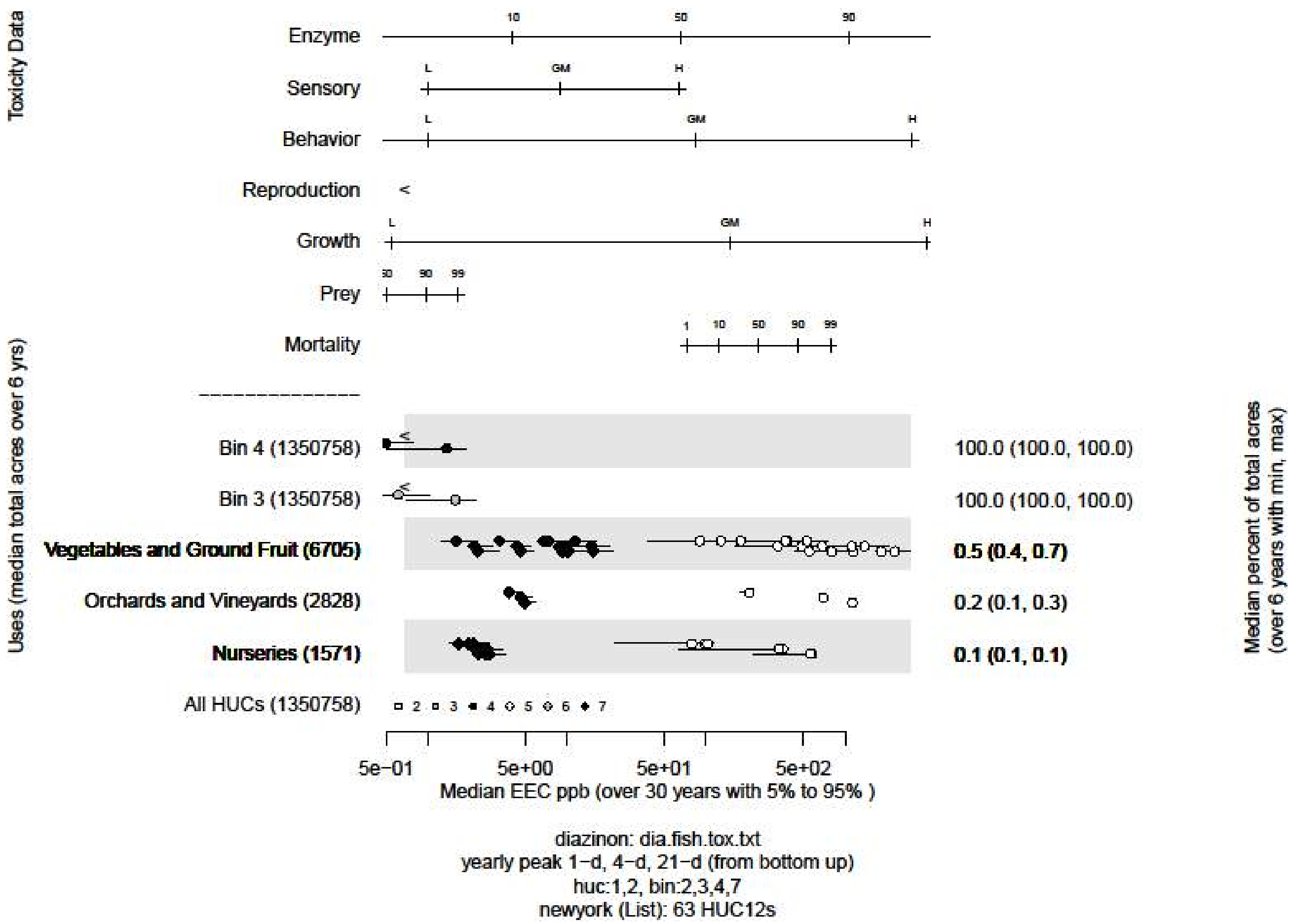


Figure 34. Effects analysis R-plot; Atlantic Sturgeon, New York Bight DPS; designated critical habitat.

Table 112. Prey (fish) risk hypothesis; Atlantic Sturgeon, New York Bight DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Vegetables and Ground Fruit	0.50	High	Low
Orchards and Vineyards	0.21	High	Low

Nurseries	0.12	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (fish).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Low	**High**		

Table 113. Prey (inverts) risk hypothesis; Atlantic Sturgeon, New York Bight DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Vegetables and Ground Fruit	0.50	High	Low
Orchards and Vineyards	0.21	High	Low
Nurseries	0.12	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (inverts).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Low	**High**		

Table 114. Water quality risk hypothesis; Atlantic Sturgeon, New York Bight DPS; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing

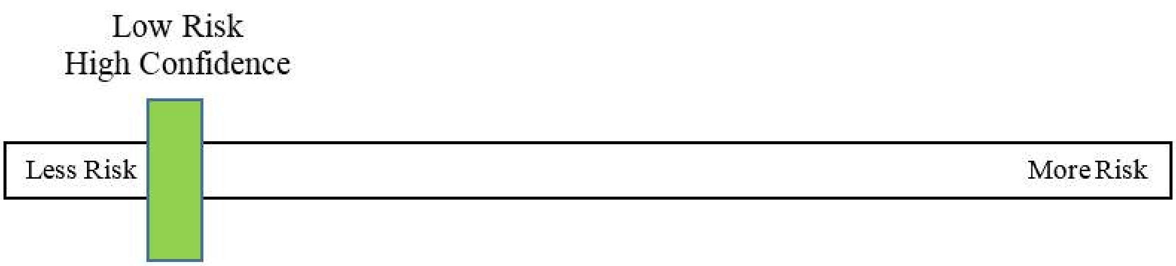
products occur minimally within Atlantic sturgeon, New York Bight DPS designated critical habitat. Three use site categories, totaling approximately 11,104 acres (less than one percent of acres) are currently present.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Low	**High**	

Table 115. Effects analysis summary table; Atlantic Sturgeon, New York Bight DPS; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported?
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater habitats.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of prey in freshwater habitats.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in estuarine habitats.	Low	Low	No
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in estuarine habitats.	Low	Low	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in coastal habitats.	Low	Low	No
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in coastal habitats.	Low	Low	No

Designated Critical Habitat Effects Analysis Summary:

We do not anticipate that the stressors of the action will negatively affect physical and biological features (PBFs). Neither reductions in prey, nor degradation of water quality are likely throughout designated critical habitat of Atlantic sturgeon, New York Bight DPS. The magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses the overall conservation value of designated critical habitat is not anticipated to decrease. We have greater confidence in the risk determinations associated with the freshwater habitats than we do in the estuarine and nearshore habitats. Overall the risk is low and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.



16.35 Atlantic Sturgeon, Chesapeake Bay DPS, Designated Critical Habitat

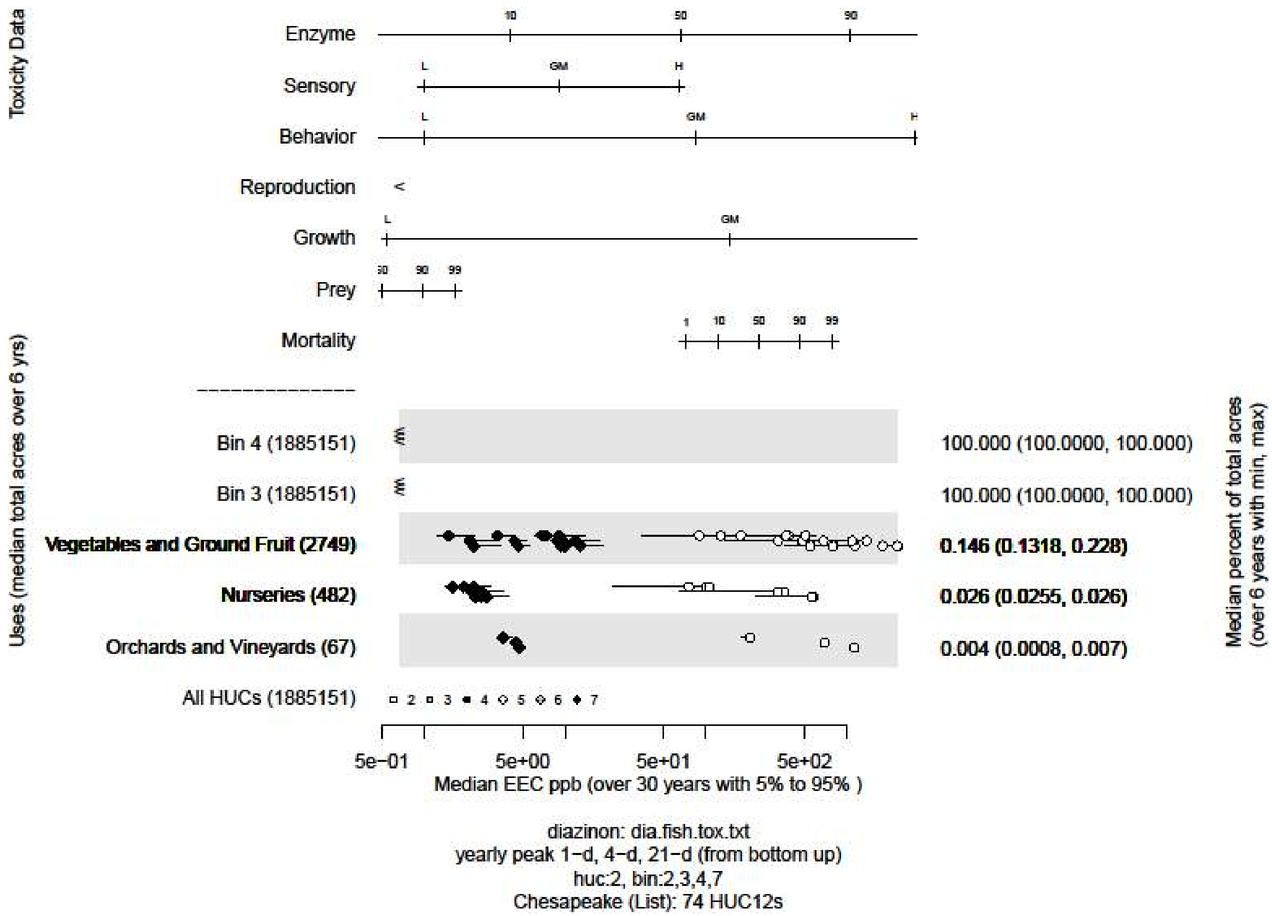


Figure 35. Effects analysis R-plot; Atlantic Sturgeon, Chesapeake Bay DPS; designated critical habitat.

Table 116. Prey (fish) risk hypothesis; Atlantic Sturgeon, Chesapeake Bay DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Vegetables and Ground Fruit	0.15	High	Low
Nurseries	0.03	High	Low

Orchards and Vineyards	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (fish).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Low	**High**		

Table 117. Prey (inverts) risk hypothesis; Atlantic Sturgeon, Chesapeake Bay DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Vegetables and Ground Fruit	0.15	High	Low
Nurseries	0.03	High	Low
Orchards and Vineyards	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (inverts).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Low	**High**		

Table 118. Water quality risk hypothesis; Atlantic Sturgeon, Chesapeake Bay DPS; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and

invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within Atlantic sturgeon, Chesapeake Bay DPS designated critical habitat. Three use site categories, totaling approximately 3,298 acres (less than one percent of acres) are currently present.

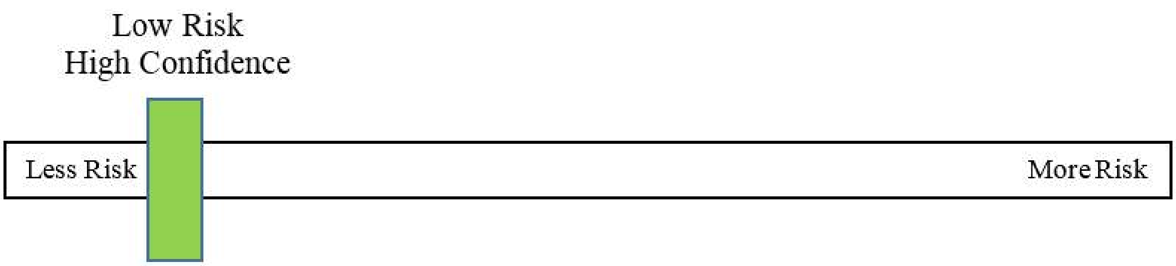
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Low	**High**	

Table 119. Effects analysis summary table; Atlantic Sturgeon, Chesapeake Bay DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater habitats.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of prey in freshwater habitats.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in estuarine habitats.	Low	Low	No
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in estuarine habitats.	Low	Low	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in coastal habitats.	Low	Low	No
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in coastal habitats.	Low	Low	No

Designated Critical Habitat Effects Analysis Summary:

We do not anticipate that the stressors of the action will negatively affect physical and biological features (PBFs). Neither reductions in prey, nor degradation of water quality are likely throughout designated critical habitat of Atlantic sturgeon, Chesapeake Bay DPS. The magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses the overall conservation value of designated critical habitat is not anticipated to decrease. We have greater confidence in the risk determinations associated with the freshwater habitats than we do in the estuarine and nearshore habitats. Overall the risk is low and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.



16.36 Atlantic Sturgeon, Carolina DPS, Designated Critical Habitat

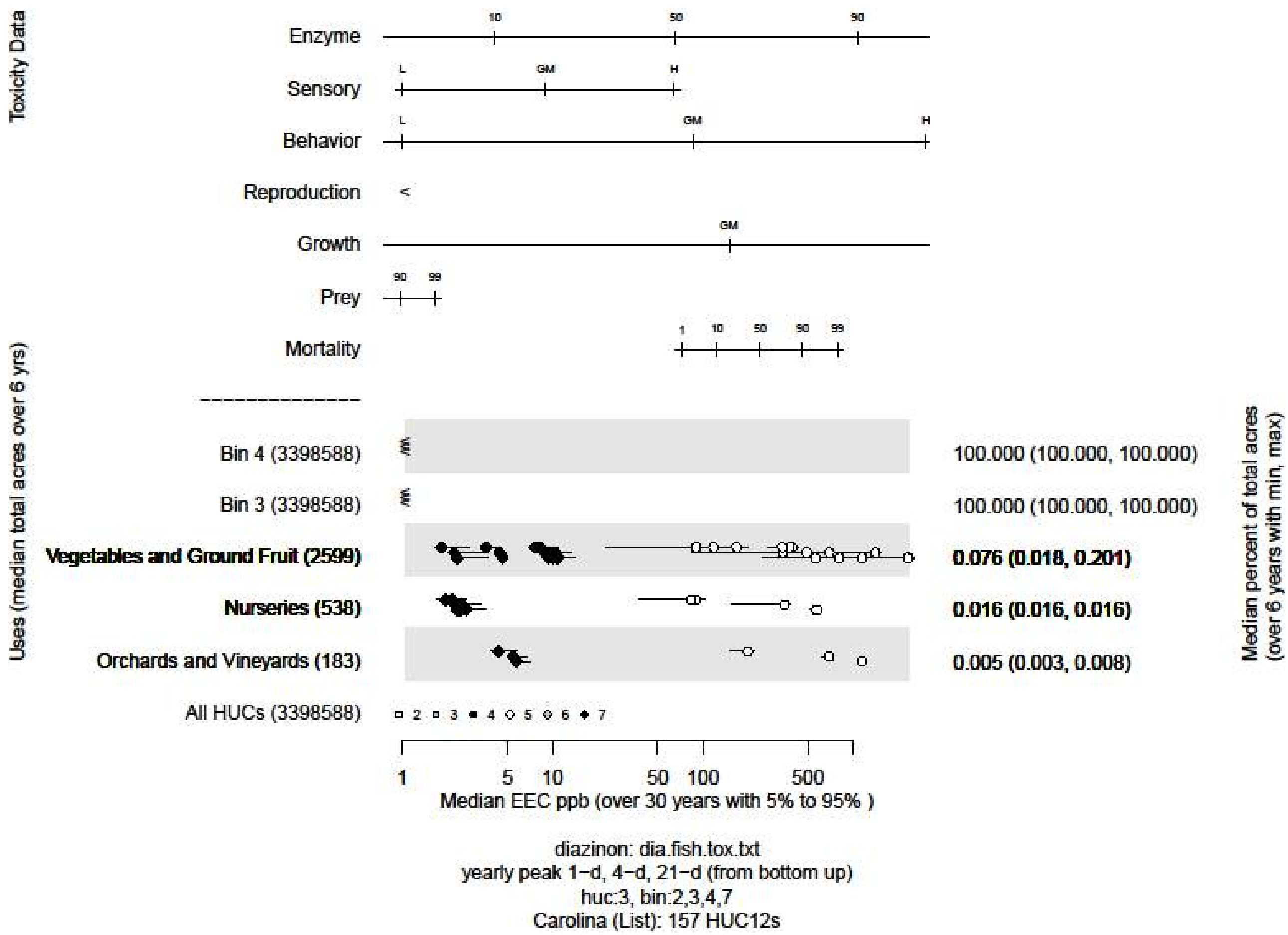


Figure 36. Effects analysis R-plot; Atlantic Sturgeon, Carolina DPS; designated critical habitat.

Table 120. Prey (fish) risk hypothesis; Atlantic Sturgeon, Carolina DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Vegetables and Ground Fruit	0.08	High	Low
Nurseries	0.02	High	Low

Orchards and Vineyards	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (fish).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Low	**High**		

Table 121. Prey (inverts) risk hypothesis; Atlantic Sturgeon, Carolina DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Vegetables and Ground Fruit	0.08	High	Low
Nurseries	0.02	High	Low
Orchards and Vineyards	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (inverts).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Low	**High**		

Table 122. Water quality risk hypothesis; Atlantic Sturgeon, Carolina DPS; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing

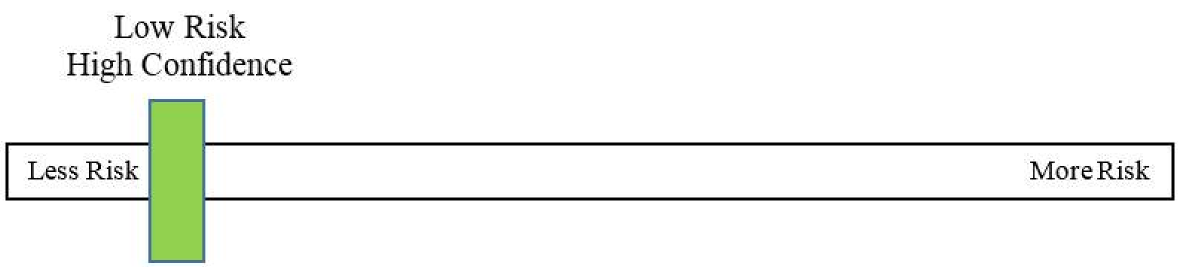
products occur minimally within Atlantic sturgeon, Carolina DPS designated critical habitat. Three use site categories, totaling approximately 3,320 acres (less than one percent of acres) are currently present.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Low	**High**	

Table 123. Effects analysis summary table; Atlantic Sturgeon, Carolina DPS; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported?
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater habitats.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of prey in freshwater habitats.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in estuarine habitats.	Low	Low	No
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in estuarine habitats.	Low	Low	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in coastal habitats.	Low	Low	No
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in coastal habitats.	Low	Low	No

Designated Critical Habitat Effects Analysis Summary:

We do not anticipate that the stressors of the action will negatively affect physical and biological features (PBFs). Neither reductions in prey, nor degradation of water quality are likely throughout designated critical habitat of Atlantic sturgeon, Carolina DPS. The magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses the overall conservation value of designated critical habitat is not anticipated to decrease. We have greater confidence in the risk determinations associated with the freshwater habitats than we do in the estuarine and nearshore habitats. Overall the risk is low and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.



16.37 Atlantic Sturgeon, South Atlantic DPS, Designated Critical Habitat

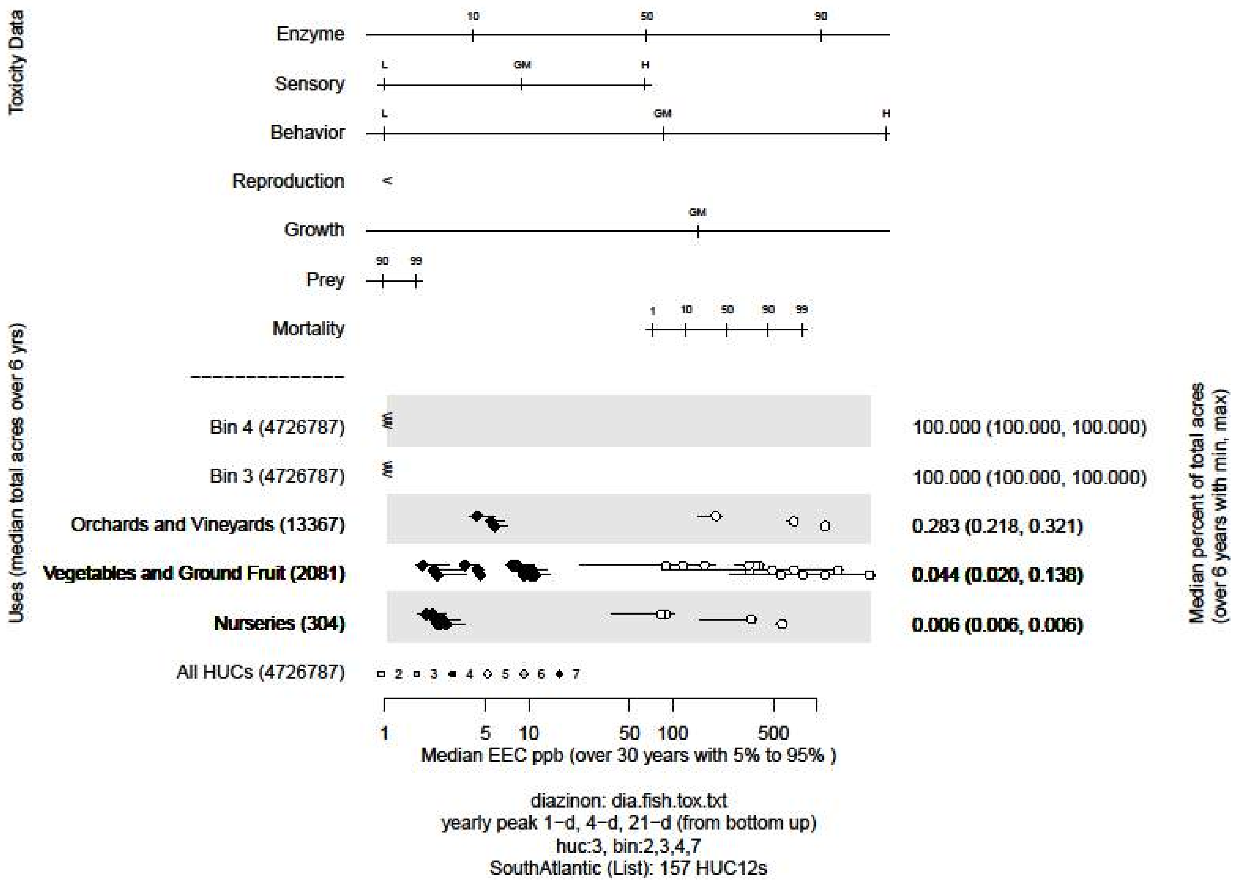


Figure 37. Effects analysis R-plot; Atlantic Sturgeon, South Atlantic DPS; designated critical habitat.

Table 124. Prey (fish) risk hypothesis; Atlantic Sturgeon, South Atlantic DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Medium	High
Bin 4	100.00	Medium	High
Orchards and Vineyards	0.28	High	Low
Vegetables and Ground Fruit	0.04	High	Low
Nurseries	0.01	High	Low

Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (fish).*		
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**
Low	**High**	

Table 125. Prey (inverts) risk hypothesis; Atlantic Sturgeon, South Atlantic DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Orchards and Vineyards	0.28	High	Low
Vegetables and Ground Fruit	0.04	High	Low
Nurseries	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (inverts).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
Low	**High**		

Table 126. Water quality risk hypothesis; Atlantic Sturgeon, South Atlantic DPS; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within Atlantic sturgeon, South Atlantic DPS designated critical habitat. Three use site categories, totaling approximately 15,752 acres (less than one percent of acres) are currently present.

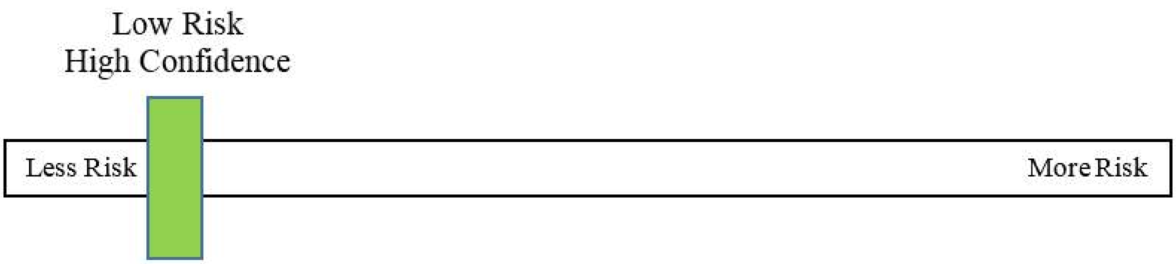
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Low	**High**	

Table 127. Effects analysis summary table; Atlantic Sturgeon, South Atlantic DPS; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported? Yes/No
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater habitats.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of prey in freshwater habitats.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in estuarine habitats.	Low	Low	No
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in estuarine habitats.	Low	Low	No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in coastal habitats.	Low	Low	No
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in coastal habitats.	Low	Low	No

Designated Critical Habitat Effects Analysis Summary:

We do not anticipate that the stressors of the action will negatively affect physical and biological features (PBFs). Neither reductions in prey, nor degradation of water quality are likely throughout designated critical habitat of Atlantic sturgeon, South Atlantic DPS. The magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses the overall conservation value of designated critical habitat is not anticipated to decrease. We have greater confidence in the risk determinations associated with the freshwater habitats than we do in the estuarine and nearshore habitats. Overall the risk is low and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.



16.38 Yelloweye Rockfish (Puget Sound/Georgia Basin DPS) Designated Critical Habitat

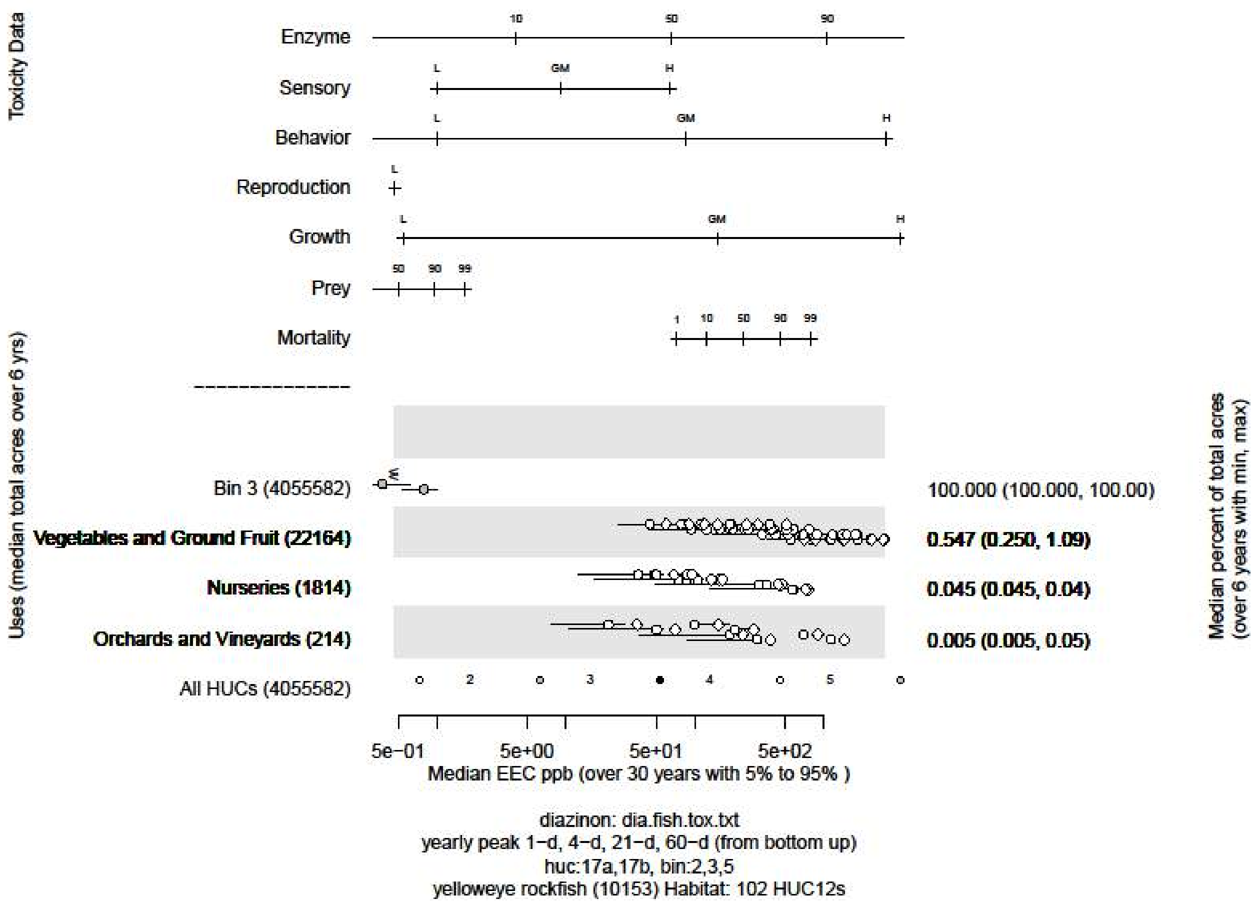


Figure 38. Effects analysis R-plot; Yelloweye rockfish, Puget Sound/Georgia Basin DPS designated critical habitat.

Table 128. Prey (fish) risk hypothesis; Yelloweye rockfish, Puget Sound/Georgia Basin DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Vegetables and Ground Fruit	0.55	High	Low
Nurseries	0.04	High	Low

Orchards and Vineyards	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce (fish).			
Risk	**Confidence**		
Low	**High**		

Table 129. Prey (inverts) risk hypothesis; Yelloweye rockfish, Puget Sound/Georgia Basin DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	High	High
Vegetables and Ground Fruit	0.55	High	Low
Nurseries	0.04	High	Low
Orchards and Vineyards	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey (inverts).			
Risk	**Confidence**		
Low	**High**		

Table 130. Water quality risk hypothesis; Yelloweye rockfish, Puget Sound/Georgia Basin DPS; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within yelloweye rockfish Puget Sound/Georgia Basin designated critical habitat. Three use site categories, totaling approximately 24,192 acres (less than one percent of acres) are currently present.

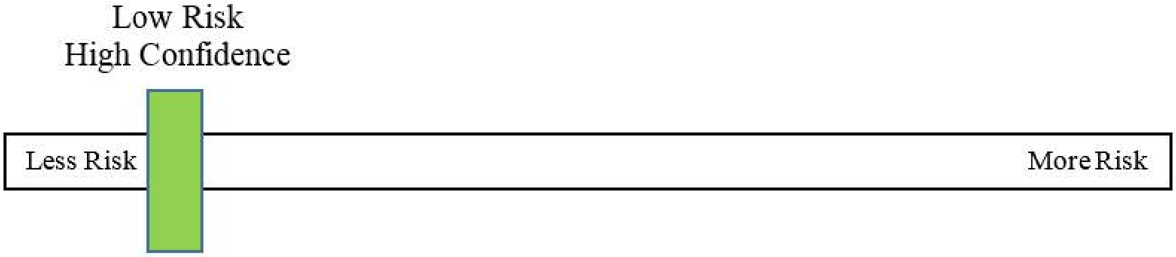
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**Low**	

Table 131. Effects analysis summary table; Yelloweye rockfish, Puget Sound/Georgia Basin DPS; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported? Yes/No
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We do not anticipate that the stressors of the action will negatively affect physical and biological features (PBFs). Neither reductions in prey, nor degradation of water quality are likely throughout designated critical habitat of Yelloweye Rockfish (Puget Sound/Georgia Basin DPS). The magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses the overall conservation value of designated critical habitat is not anticipated to decrease. We have greater confidence in the risk determinations associated with the freshwater habitats than we do in the estuarine and nearshore habitats. Overall the risk is low and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.



16.39 Bocaccio (Puget Sound/Georgia Basin DPS) Designated Critical Habitat

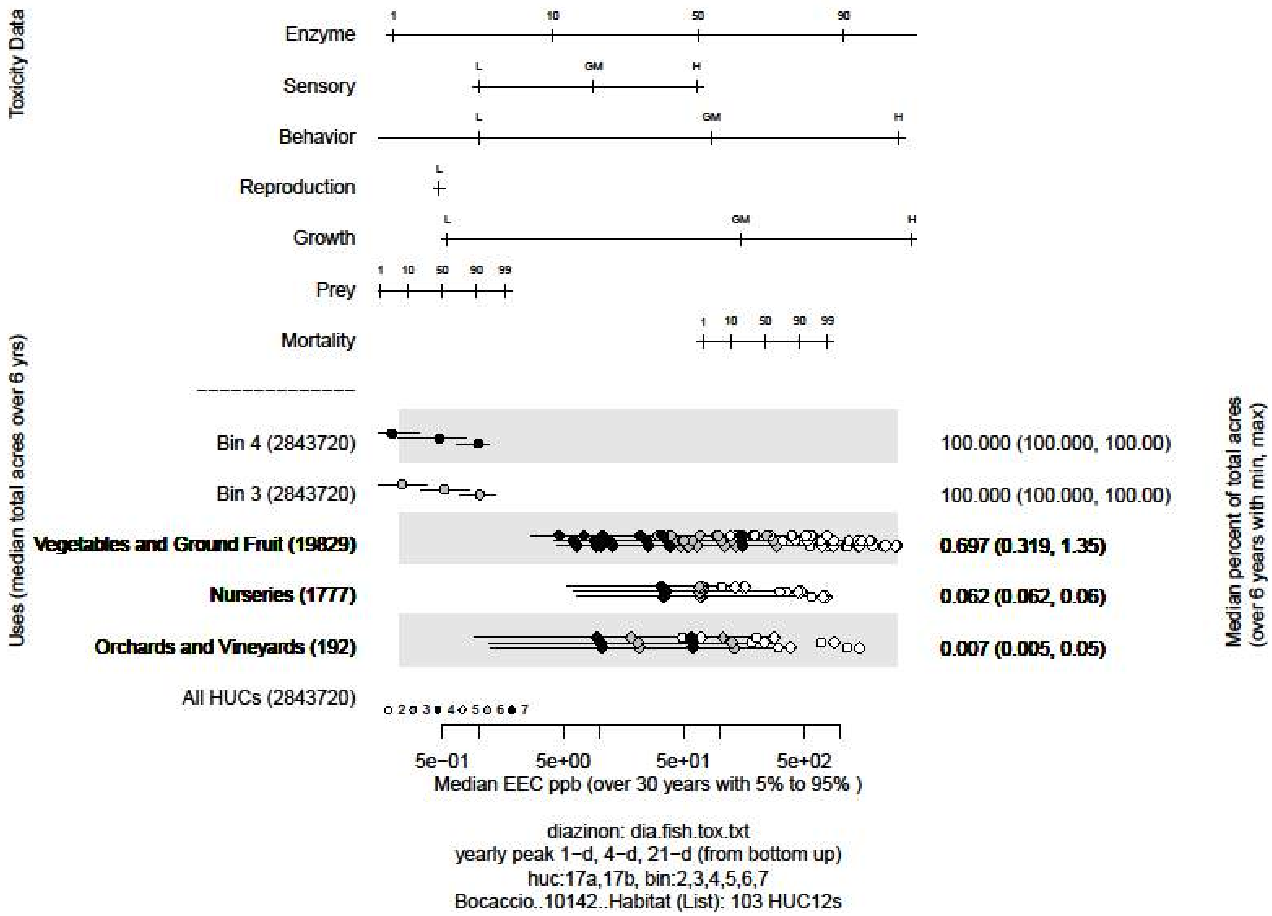


Figure 39. Effects analysis R-plot; Bocaccio rockfish, Puget Sound/Georgia Basin DPS designated critical habitat.

Table 132. Prey (fish) risk hypothesis; Bocaccio rockfish, Puget Sound/Georgia Basin DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Vegetables and Ground Fruit	0.70	High	Low
Nurseries	0.06	High	Low

Orchards and Vineyards	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey (fish).			
Risk	**Confidence**		
Low	**High**		

Table 133. Prey (inverts) risk hypothesis; Bocaccio rockfish, Puget Sound/Georgia Basin DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Vegetables and Ground Fruit	0.70	High	Low
Nurseries	0.06	High	Low
Orchards and Vineyards	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey (inverts).			
Risk	**Confidence**		
Low	**High**		

Table 134. Water quality risk hypothesis; Bocaccio rockfish, Puget Sound/Georgia Basin DPS; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within Bocaccio, Puget Sound/Georgia Basin DPS designated critical

habitat. Three use site categories, totaling approximately 21,798 acres (less than one percent of acres) are currently present.
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.

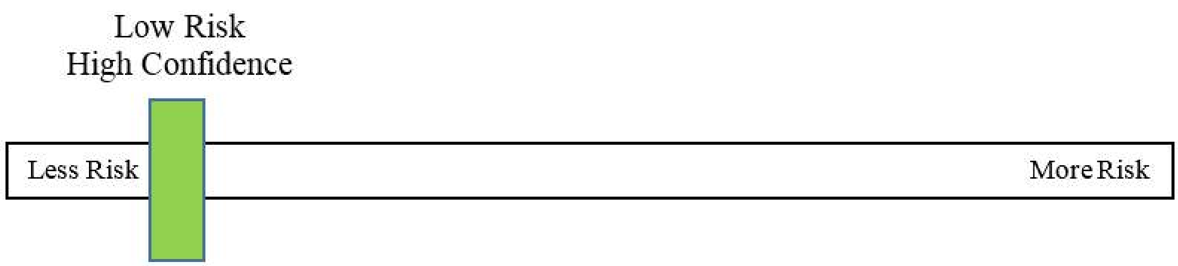
Risk	**Confidence**	
Low	**High**	

Table 135. Effects analysis summary table; Bocaccio rockfish, Puget Sound/Georgia Basin DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality.	Low	Medium	No
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey.	Low	Medium	No

Designated Critical Habitat Effects Analysis Summary:

We do not anticipate that the stressors of the action will negatively affect physical and biological features (PBFs). Neither reductions in prey, nor degradation of water quality are likely throughout designated critical habitat of Bocaccio (Puget Sound/Georgia Basin DPS). The magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses the overall conservation value of designated critical habitat is not anticipated to decrease. We have greater confidence in the risk determinations associated with the freshwater habitats than we do in the estuarine and nearshore habitats. Overall the risk is low and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.


Low Risk
High Confidence
Less Risk
More Risk

16.40 Smalltooth Sawfish Designated Critical Habitat

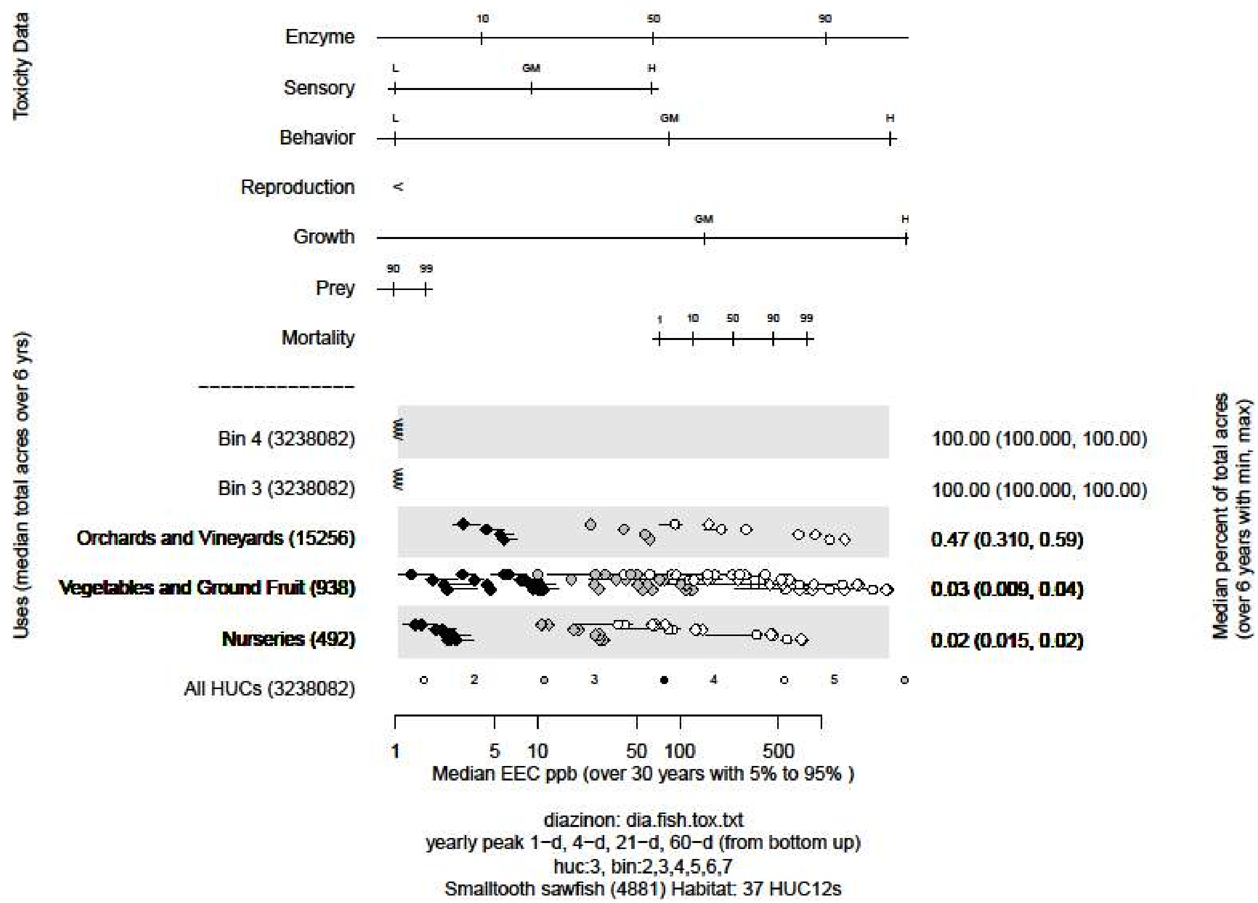


Figure 40. Effects analysis R-plot; Smalltooth Sawfish designated critical habitat.

Table 136. Prey (fish) risk hypothesis; Smalltooth sawfish, US DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Orchards and Vineyards	0.47	High	Low
Vegetables and Ground Fruit	0.03	High	Low

Nurseries	0.02	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey (fish).			
Risk	**Confidence**		
Low	**High**		

Table 137. Prey (inverts) risk hypothesis; Smalltooth sawfish, US DPS; designated critical habitat.

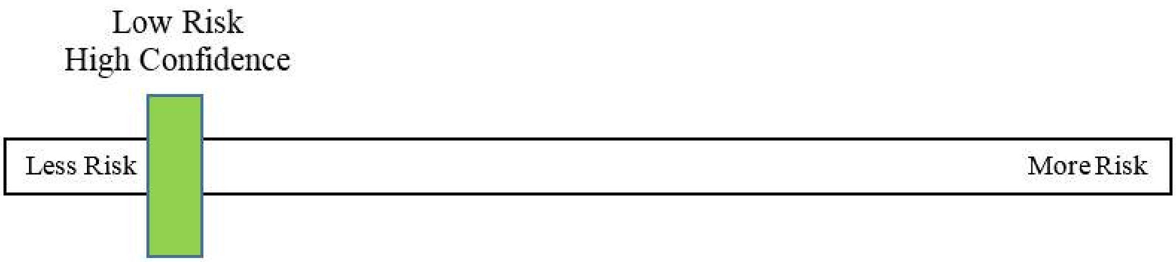
Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Medium	High
Bin 4	100.00	Medium	High
Orchards and Vineyards	0.47	High	Low
Vegetables and Ground Fruit	0.03	High	Low
Nurseries	0.02	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey (inverts).			
Risk	**Confidence**		
Low	**High**		

Table 138. Effects analysis summary table; Smalltooth sawfish, US DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in shallow euryhaline habitats.	Low	High	No

Designated Critical Habitat Effects Analysis Summary:

We do not anticipate that the stressors of the action will negatively affect physical and biological features (PBFs). Neither reductions in prey, nor degradation of water quality are likely throughout designated critical habitat of Smalltooth Sawfish. The magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses the overall conservation value of designated critical habitat is not anticipated to decrease. We have greater confidence in the risk determinations associated with the freshwater habitats than we do in the estuarine and nearshore habitats. Overall the risk is low and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.



16.41 Black Abalone Designated Critical Habitat

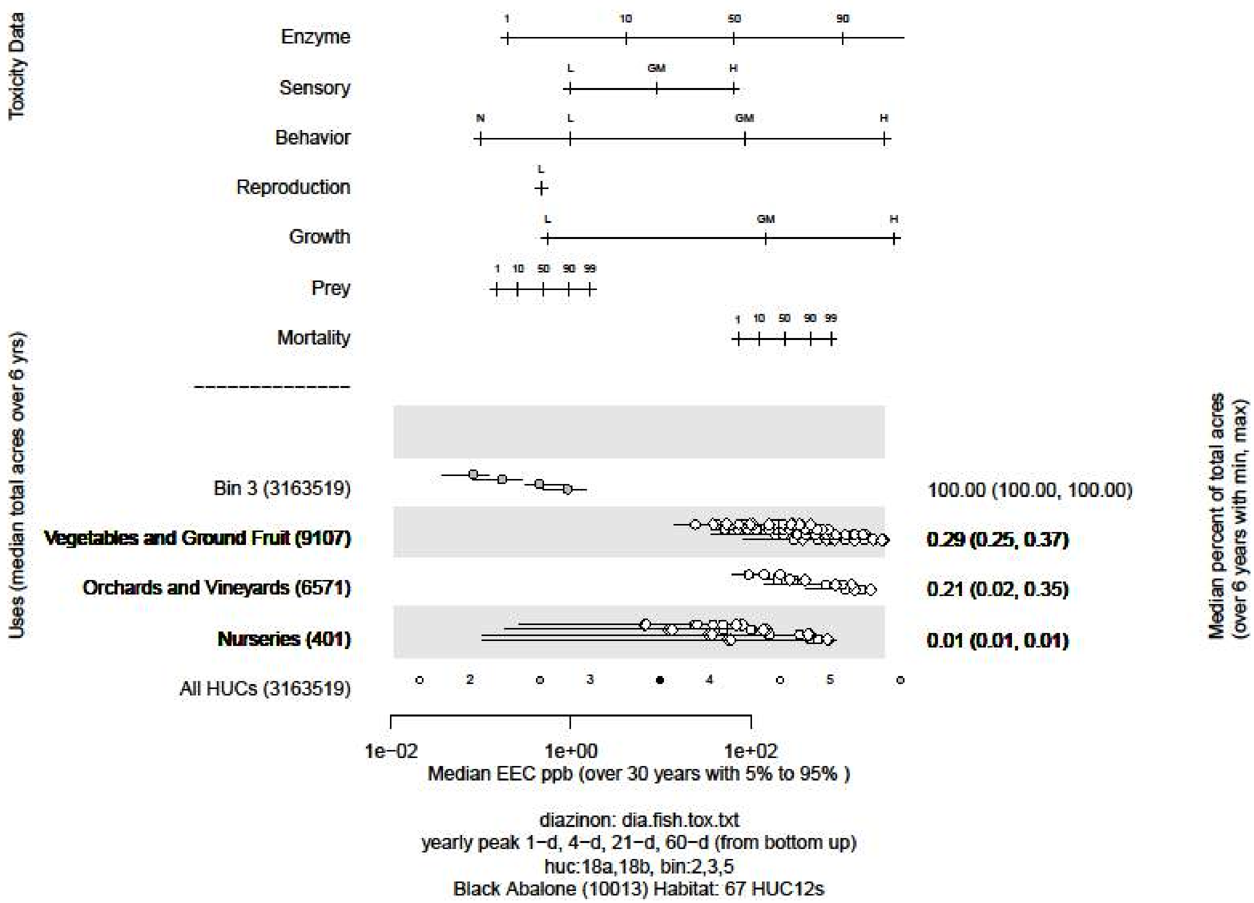


Figure 41. Effects analysis R-plot; Black Abalone designated critical habitat.

Table 139. Prey (inverts) risk hypothesis; Black abalone; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	High	High
Vegetables and Ground Fruit	0.29	High	Low
Orchards and Vineyards	0.21	High	Low
Nurseries	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey (inverts).			

Risk	Confidence	
Low	**High**	

Table 140. Water quality risk hypothesis; Black abalone; designated critical habitat.

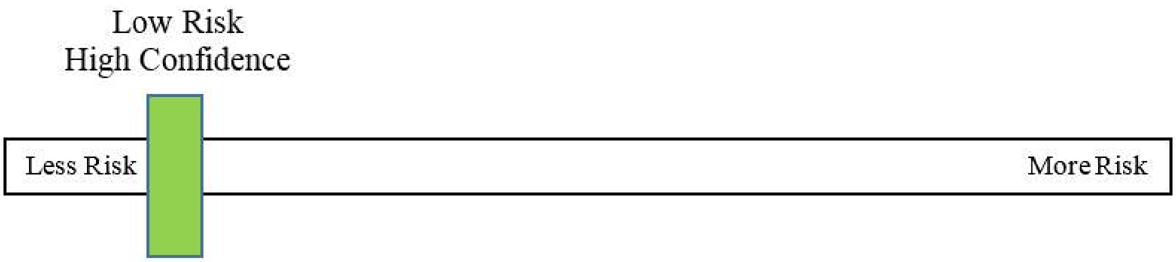
Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. The anticipated diazinon levels in designated critical habitat may be sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth may occur. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, diazinon and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates. Toxic concentrations may occur, however, authorized uses of diazinon-containing products occur minimally within black abalone designated critical habitat. Three use site categories, totaling approximately 16,079 acres (less than one percent of acres) are currently present.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Low	**High**	

Table 141. Effects analysis summary table; Black abalone; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality.	Low	High	No
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey.	Low	High	No

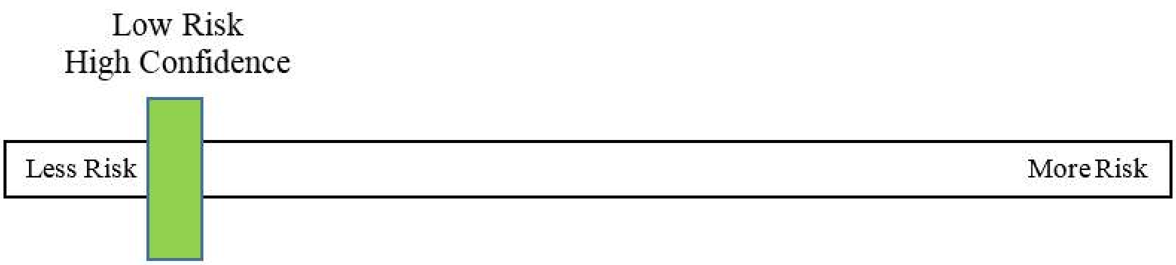
Designated Critical Habitat Effects Analysis Summary:

We do not anticipate that the stressors of the action will negatively affect physical and biological features (PBFs). Neither reductions in prey, nor degradation of water quality are likely throughout designated critical habitat of Black Abalone. The magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses the overall conservation value of designated critical habitat is not anticipated to decrease. We have greater confidence in the risk determinations associated with the freshwater habitats than we do in the estuarine and nearshore habitats. Overall the risk is low and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.



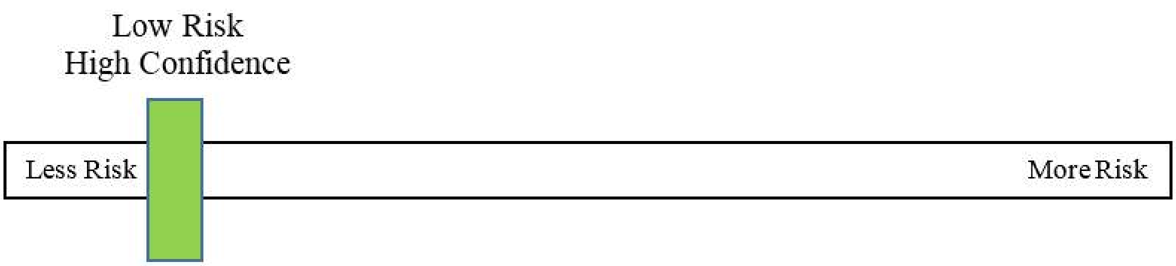
16.42 Staghorn Coral Designated Critical Habitat

There are no physical and biological features identified in Staghorn Coral designated critical habitat that could be affected by the proposed action. We find that the overall risk is low and the confidence associated with that risk is high over the 15-year duration of the action.



16.43 Elkhorn Coral Designated Critical Habitat

There are no physical and biological features identified in Elkhorn Coral designated critical habitat that could be affected by the proposed action. We find that the overall risk is low and the confidence associated with that risk is high over the 15-year duration of the action.



16.44 Green Sea Turtle (North Atlantic DPS) Designated Critical Habitat

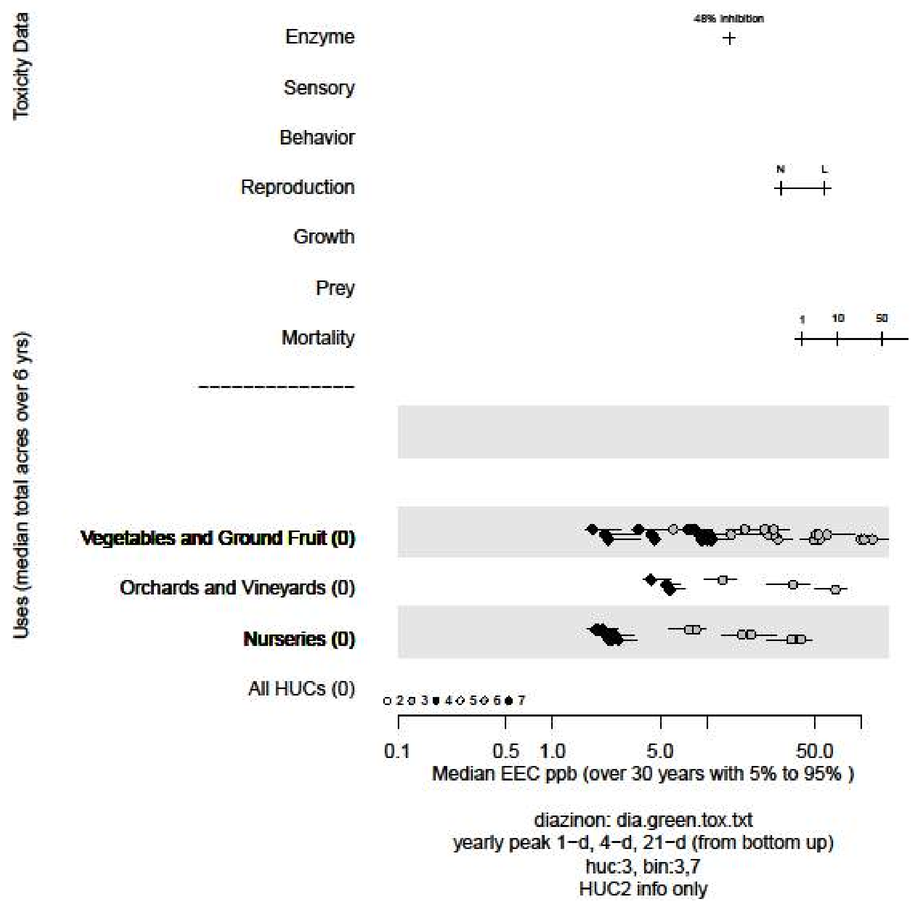


Figure 42. Effects analysis R-plot; Green Sea Turtle, North Atlantic DPS designated critical habitat.

Table 142. Water quality risk hypothesis; Green sea turtle, North Atlantic DPS; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of diazinon-containing products may occur within the designated critical habitat of Green sea turtle, North Atlantic DPS. The anticipated diazinon levels in designated critical habitat may be sufficient to cause adverse effects to sea turtles. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	

High	**Low**	

Table 143. Effects analysis summary table; Green sea turtle, North Atlantic DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

The stressors of the action may negatively affect a relevant physical and biological feature within nearshore designated critical habitat of Green Sea Turtle (North Atlantic DPS). However, we have low confidence in the EECs predicted for the marine nearshore habitats. The likelihood and magnitude of toxic effects are not likely to reduce the overall conservation value of designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.

16.45 Hawksbill Sea Turtle Designated Critical Habitat

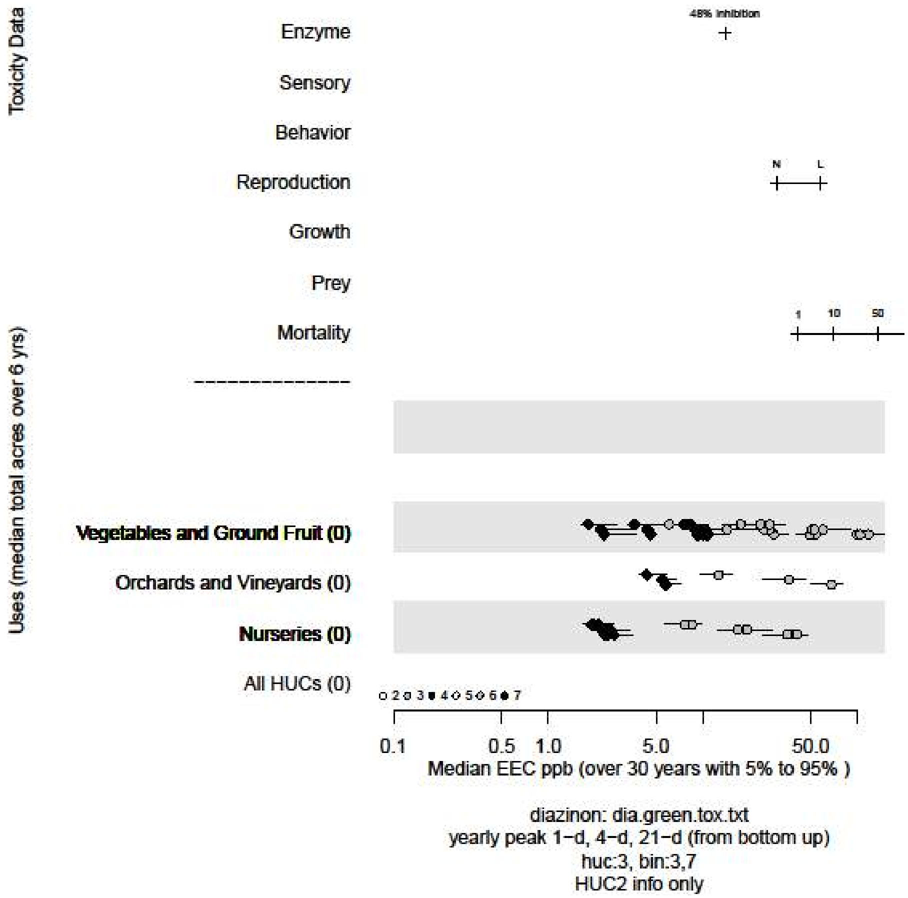


Figure 43. Effects analysis R-plot; Hawksbill sea turtle DPS designated critical habitat.

Table 144. Water quality risk hypothesis; Hawksbill sea turtle designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of diazinon-containing products may occur within the designated critical habitat of the Hawksbill sea turtle. The anticipated diazinon levels in designated critical habitat may be sufficient to cause adverse effects to sea turtles. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	

High	**Low**	

Table 145. Effects analysis summary table; Hawksbill sea turtle; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported? Yes/No
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

The stressors of the action may negatively affect a relevant physical and biological feature within nearshore designated critical habitat. However, we have low confidence in the EECs predicted for the marine nearshore habitats of Hawksbill Sea Turtle. The likelihood and magnitude of toxic effects are not likely to reduce the overall conservation value of designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.

16.46 Leatherback Sea Turtle Designated Critical Habitat

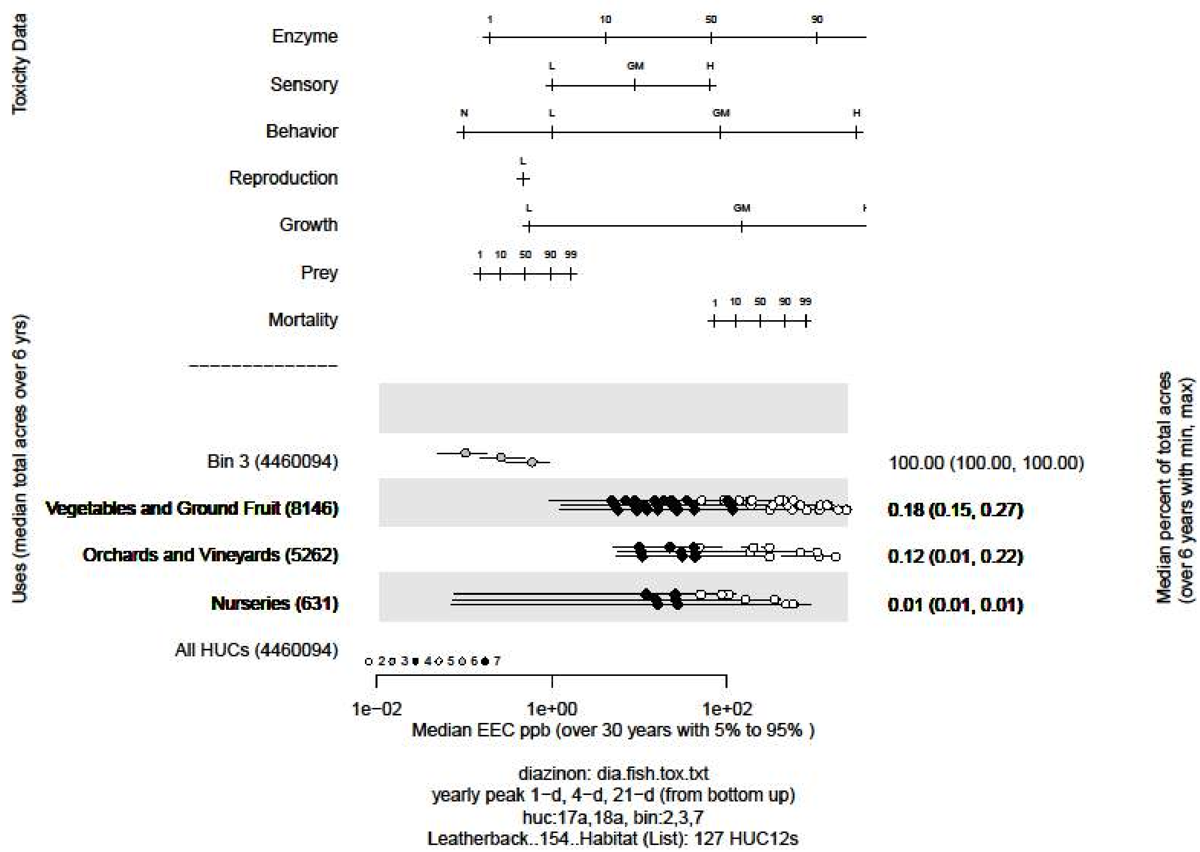


Figure 44. Effects analysis R-plot; Leatherback sea turtle, U.S. West Coast designated critical habitat.

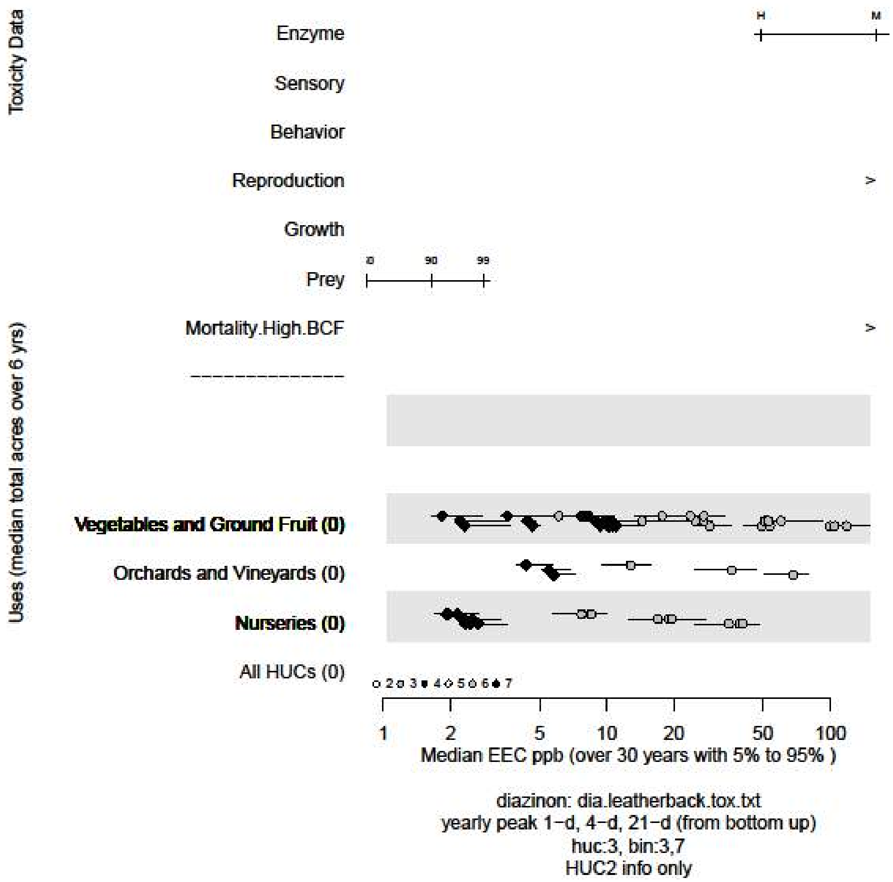


Figure 45. Effects analysis R-plot; Leatherback sea turtle, U.S. Virgin Islands designated critical habitat.

Table 146. Prey (inverts) risk hypothesis; Leatherback sea turtle; designated critical habitat.

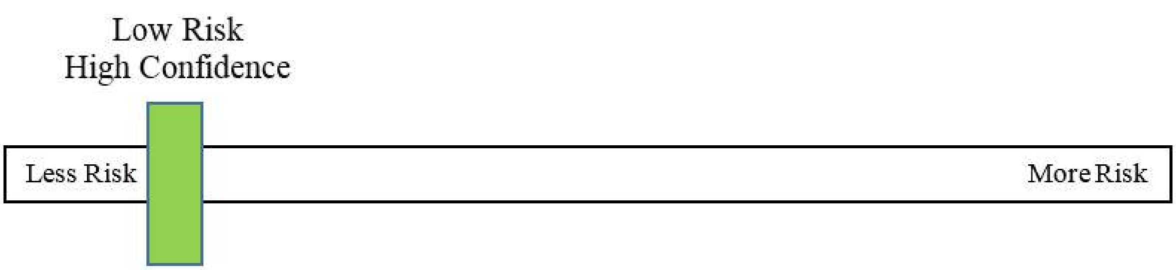
Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	High	High
Vegetables and Ground Fruit	0.18	High	Low
Orchards and Vineyards	0.12	High	Low
Nurseries	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey (inverts).			
Risk	**Confidence**		
Low	**High**		

Table 147. Effects analysis summary table; Leatherback sea turtle; designated critical habitat.

Designated Critical Habitat; Risk Hypotheses	R-plot Derived		Risk Hypothesis Supported? Yes/No
	Risk	Confidence	
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey.	Low	High	No

Designated Critical Habitat Effects Analysis Summary:

The stressors of the action may negatively affect a relevant physical and biological feature within the nearshore of each of the designated critical habitat areas of Leatherback Sea Turtle. However, we have low confidence in the EECs predicted for the marine nearshore habitats. The likelihood and magnitude of toxic effects are not likely to reduce the overall conservation value of designated critical habitat. We find that the overall risk is low and the confidence associated with that risk is high over the 15-year duration of the action.



16.47 Loggerhead Sea Turtle (NW Atlantic Ocean DPS) Designated Critical Habitat

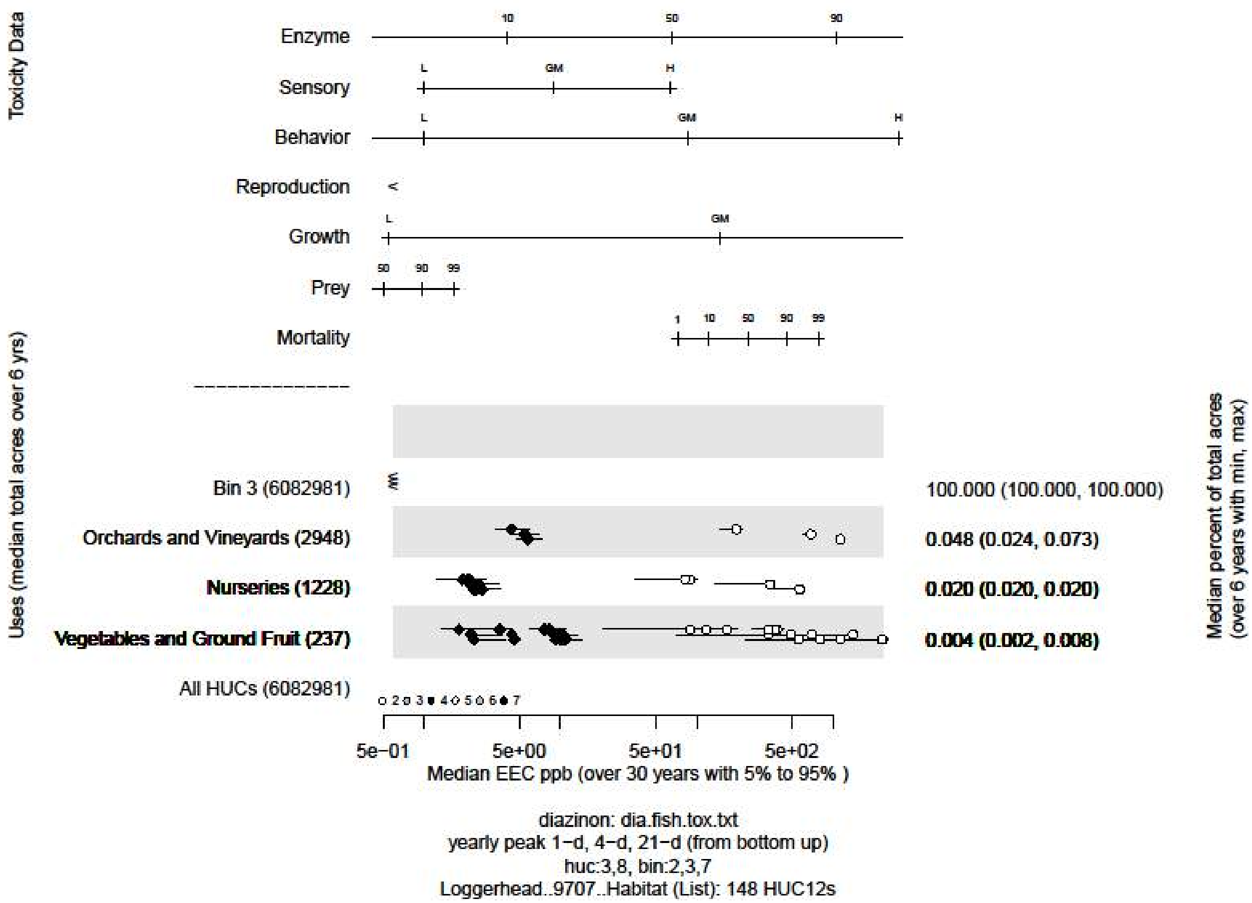


Figure 46. Effects analysis R-plot; Loggerhead sea turtle, NW Atlantic DPS designated critical habitat.

Table 148. Prey (inverts) risk hypothesis; Loggerhead sea turtle; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Orchards and Vineyards	0.05	High	Low
Nurseries	0.02	High	Low
Vegetables and Ground Fruit	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey (inverts).			
Risk	**Confidence**		

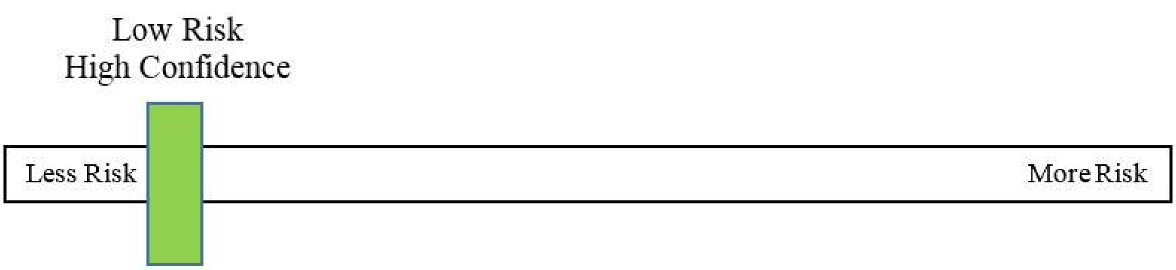
Low	**High**	

Table 149. Effects analysis summary table; Loggerhead sea turtle; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey.	Low	High	No

Designated Critical Habitat Effects Analysis Summary:

The stressors of the action may negatively affect a relevant physical and biological feature within nearshore designated critical habitat of Loggerhead Sea Turtle (NW Atlantic Ocean DPS). However, we have low confidence in the EECs predicted for the marine nearshore habitats. The likelihood and magnitude of toxic effects are not likely to reduce the overall conservation value of designated critical habitat. We find that the overall risk is low and the confidence associated with that risk is high over the 15-year duration of the action.



16.48 Southern Resident Killer Whale Designated Critical Habitat

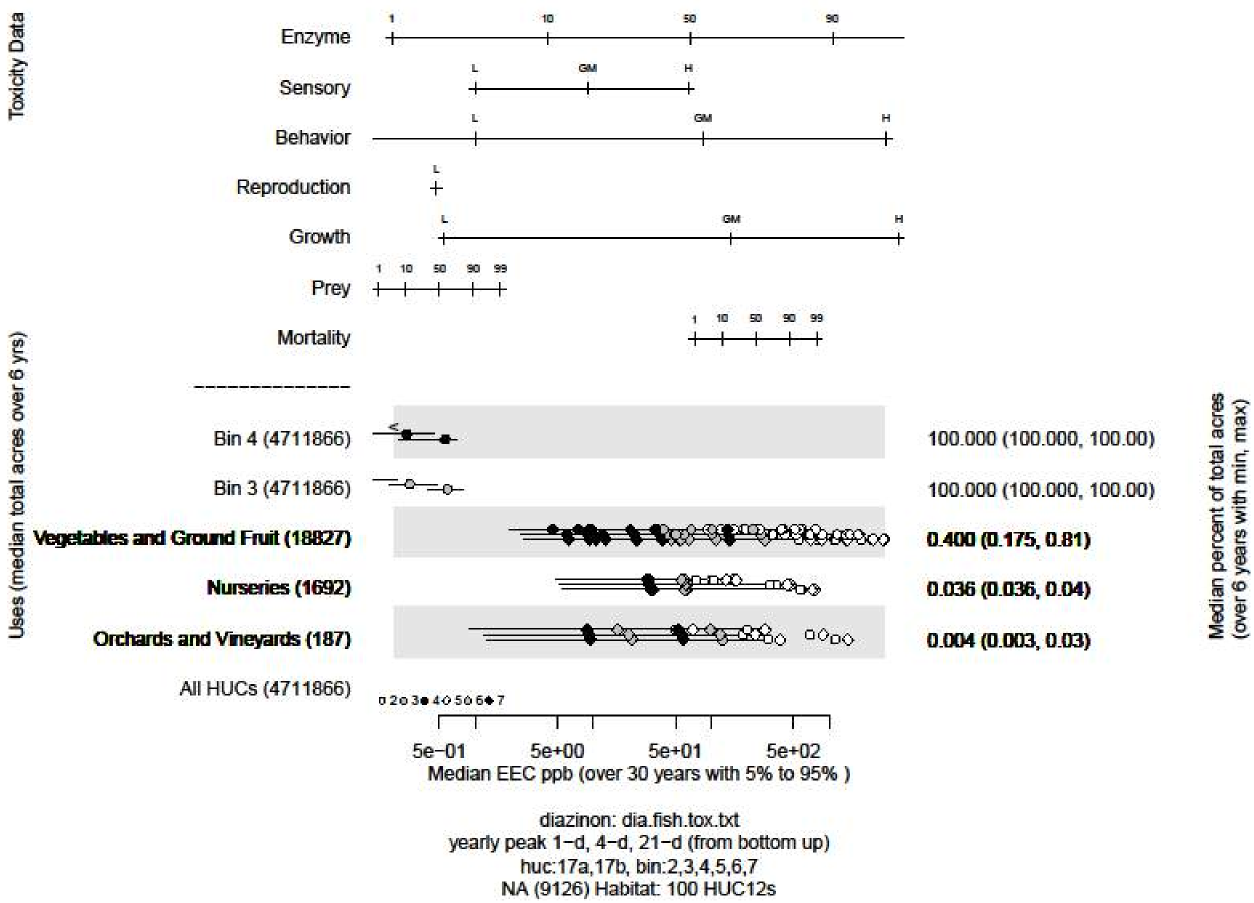


Figure 47. Effects analysis R-plot; Southern Resident Killer Whale designated critical habitat.

Table 150. Direct and in-direct prey (fish) risk hypotheses; Killer whale, Southern resident DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Vegetables and Ground Fruit	0.40	High	Low
Nurseries	0.04	High	Low

Orchards and Vineyards	<0.01	High	Low
Risk Hypothesis: Direct exposure to the stressors of the action within designated critical habitat is sufficient to reduce prey (fish).			
Risk	**Confidence**		
Low	**High**		
Risk Hypothesis: Exposure to the stressors of the action outside of designated critical habitat is sufficient to in-directly reduce prey availability (Chinook salmon).			
Risk	**Confidence**	**Affecting the availability of prey species of sufficient quantity and quality. Jeopardy determinations were made for all ESU's of Chinook salmon with regard to the proposed action.**	
High	**High**		

Table 151. Water quality risk hypothesis; Killer whale, Southern resident DPS; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of diazinon-containing products are minimal within proximity to the designated critical habitat of Killer whale, Southern resident DPS. Three use site categories, totaling more than 20,706 acres (less than one percent of acres) are currently present. The anticipated diazinon levels in designated critical habitat are not sufficient to cause adverse effects to killer whales.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Low	**High**	

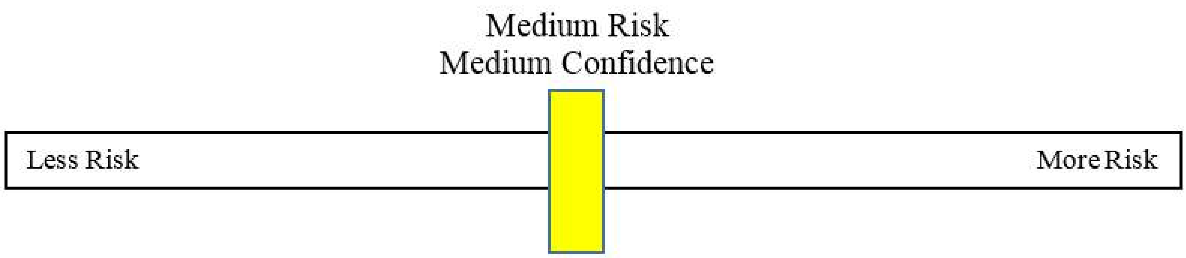
Table 152. Effects analysis summary table; Killer whale, Southern resident DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Direct exposure to the stressors of the action within designated critical habitat is sufficient to reduce the conservation value via reductions in prey (fish).	Low	High	No
Exposure to the stressors of the action outside of designated critical habitat is sufficient to in-directly reduce the conservation value via reductions in prey availability (Chinook salmon).	High	High	Yes

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality.	Low	High	No

Designated Critical Habitat Effects Analysis Summary:

We do not anticipate stressors of the action will directly affect physical and biological features (PBFs). Reductions in suitable prey (within designated critical habitat) and degradation of water quality are unlikely throughout designated critical habitat of Southern Resident Killer Whale. However, indirectly, prey species (salmon) will be adversely affected by exposures anticipated in their freshwater habitats. The likelihood and magnitude of toxic effects will reduce the overall conservation value of designated critical habitat by reducing the availability of these important prey. We find that the overall risk is medium and the confidence associated with that risk is medium over the 15-year duration of the action.



16.49 Stellar Sea Lion (Western DPS) Designated Critical Habitat

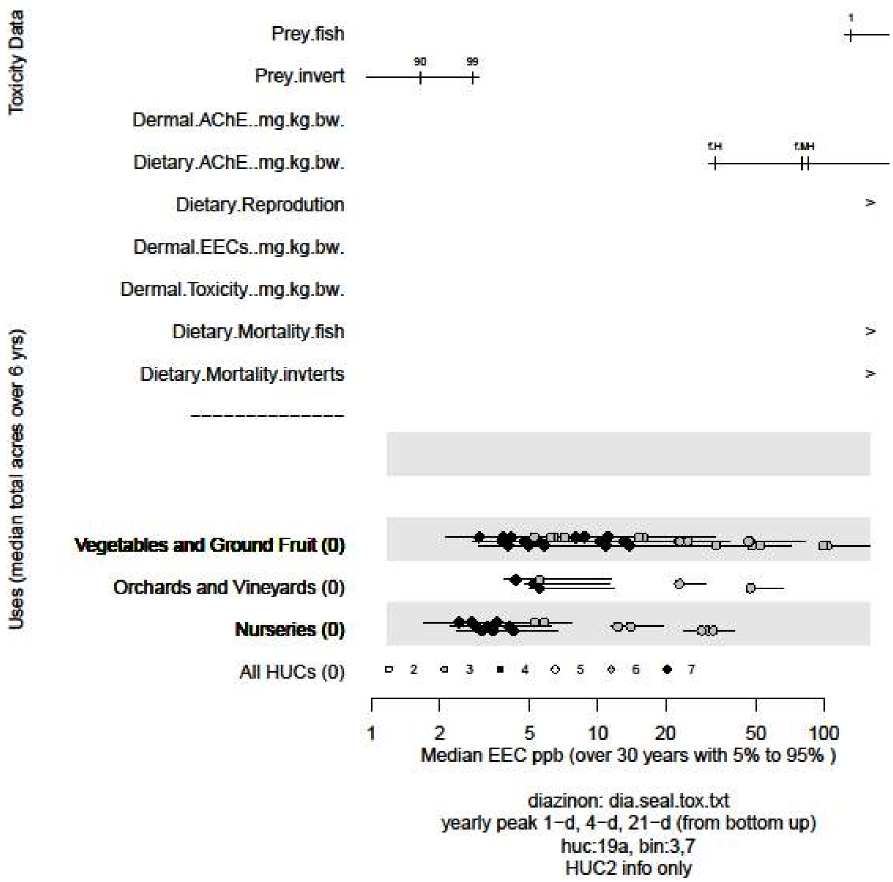


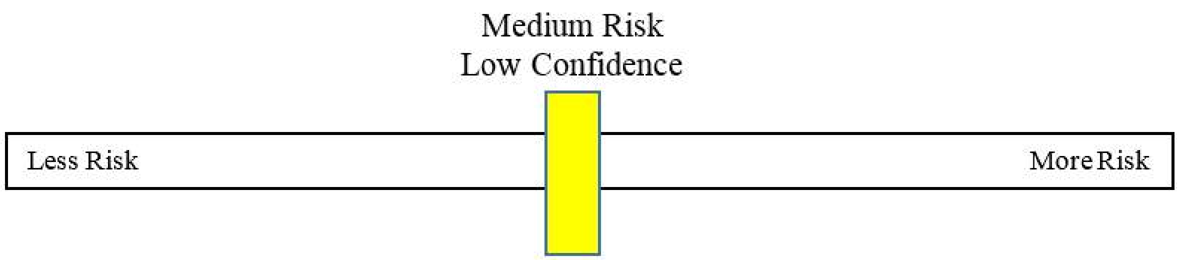
Figure 48. Effects analysis R-plot; Steller sealion, Western DPS designated critical habitat.

Table 153. Effects analysis summary table; Steller sealion, Western DPS; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported?
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce prey.	Medium	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

The stressors of the action may negatively affect a relevant physical and biological feature within nearshore designated critical habitat. However, we have low confidence in the EECs predicted for the marine nearshore habitats of Stellar Sea Lion (Western DPS). The likelihood and magnitude of toxic effects are not likely to reduce the overall conservation value of designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.



16.50 Hawaiin Monk Seal Designated Critical Habitat

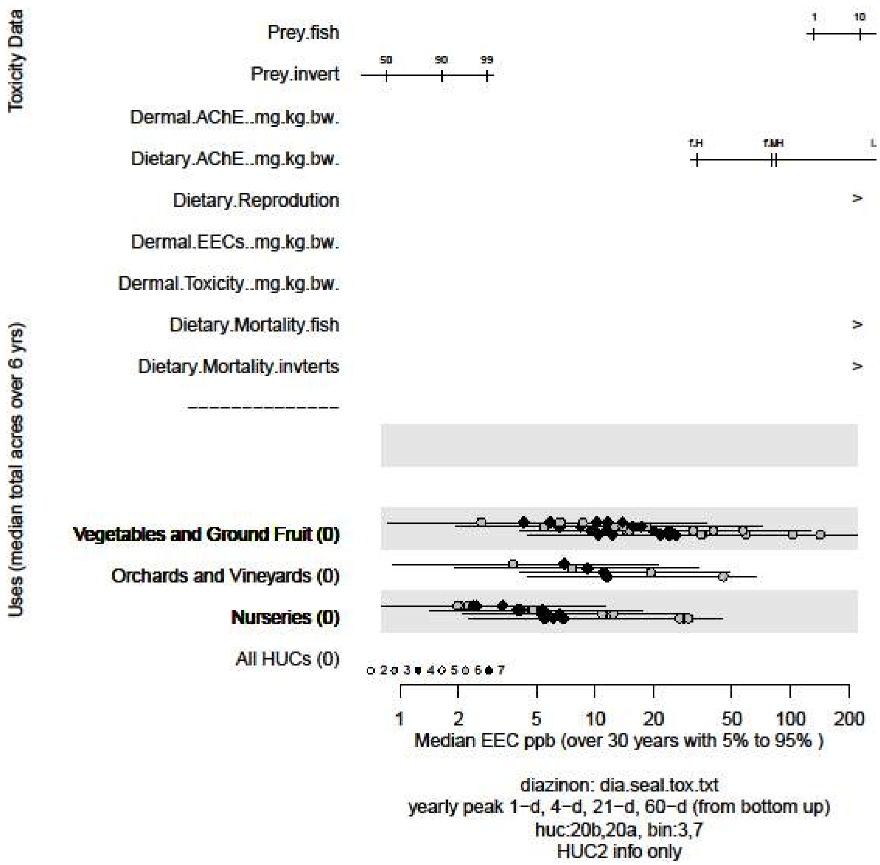


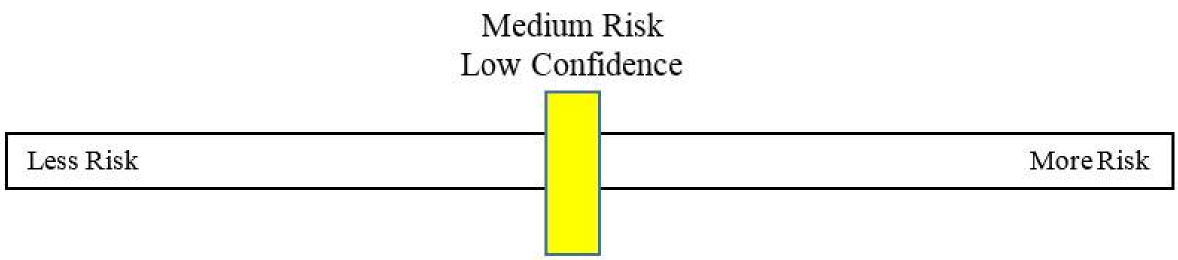
Figure 49. Effects analysis R-plot; Hawaiian Monk Seal designated critical habitat.

Table 154. Effects analysis summary table; Hawaiian Monk Seal designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce prey.	Medium	Low	Yes

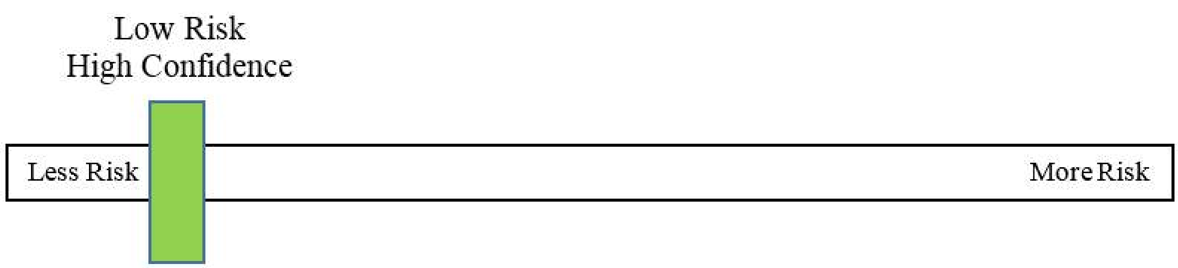
Designated Critical Habitat Effects Analysis Summary:

The stressors of the action may negatively affect a relevant physical and biological feature within nearshore designated critical habitat. However, we have low confidence in the EECs predicted for the marine nearshore habitats of Hawaiin Monk Seal. The likelihood and magnitude of toxic effects are not likely to reduce the overall conservation value of designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.



16.51 Johnson's Seagrass Designated Critical Habitat

Water quality is a physical and biological features identified in Johnson's seagrass designated critical habitat. However, we do not anticipate exposures from the stressors of the action to be sufficient to reduce conservation values of this PBF. We find that the overall risk is low and the confidence associated with that risk is high over the 15-year duration of the action.



16.52 Summary of the Effects of the Action on Physical or Biological Features:

We conclude that the available information on exposure and response of aquatic habitats to the stressors of the action supports risk hypotheses for many of the species. Table 155 summarizes for diazinon and for the species habitats where risk hypotheses are supported. We expect water quality and prey abundance to be reduced in spawning, rearing, migratory, estuarine, or nearshore marine habitats for many of the species'designated critical habitats. Next, within the *Integration and Synthesis for Designated Critical Habitat* section, we evaluate whether these adverse changes to PBFs affect the conservation value of designated critical habitat.

Table 155. Summary of species critical habitat risk assessments to key physical and biological features – diazinon.

Species Designated Critical Habitat	Water Quality and/or Prey Risk Hypotheses Supported (Diazinon)
Chum salmon , Columbia River ESU	No
Chum salmon, Hood Canal summer-run ESU	No
Chinook salmon, California coastal ESU	Yes
Chinook salmon, Central Valley spring-run ESU	Yes
Chinook salmon, Lower Columbia River ESU	No
Chinook salmon, Puget Sound ESU	No
Chinook salmon, Sacramento River winter-run ESU	Yes
Chinook salmon, Snake River fall-run ESU	Yes
Chinook salmon, Snake River spring/summer run ESU	No
Chinook salmon, Upper Columbia River spring-run ESU	Yes
Chinook salmon, Upper Willamette River ESU	Yes
Coho salmon, Central California coast ESU	Yes
Coho salmon, Lower Columbia River ESU	No
Coho salmon, Oregon coast ESU	No
Coho salmon, S. Oregon and N. California coasts ESU	No

Sockeye, Ozette Lake ESU	No
Sockeye, Snake River ESU	Yes
Steelhead, California Central Valley ESU	Yes
Steelhead, Central California coast ESU	Yes
Steelhead, Lower Columbia River ESU	No
Steelhead, Middle Columbia River ESU	Yes
Steelhead, Northern California ESU	No
Steelhead, Puget Sound ESU	No
Steelhead, Snake River Basin ESU	Yes
Steelhead, South-Central California coast ESU	Yes
Steelhead, Southern California ESU	Yes
Steelhead, Upper Columbia River ESU	Yes
Steelhead, Upper Willamette River ESU	Yes
Eulachon, Pacific smelt, Southern DPS	No
Green sturgeon, Southern DPS	Yes
Gulf sturgeon	No
Atlantic sturgeon, Carolina DPS	No
Atlantic sturgeon, Chesapeake Bay DPS	No
Atlantic sturgeon, Gulf of Maine DPS	No
Atlantic sturgeon, New York Bight DPS	No
Atlantic sturgeon, South Atlantic DPS	No
Yelloweye rockfish	No
Bocaccio, Puget Sound/Georgia Basin	No
Smalltooth sawfish, U.S. DPS	No
Black abalone	No
Staghorn coral	No
Elkhorn coral	No
Green sea turtle, North Atlantic DPS	No

Hawksbill sea turtle	No
Leatherback sea turtle	No
Loggerhead sea turtle, Northwest Atlantic Ocean DPS	No
Killer whale, Southern Resident DPS	Yes
Steller sea lion, Western	No
Hawaiian monk seal	No
Johnson’s seagrass	No

CHAPTER 17

DESIGNATED CRITICAL HABITAT EFFECTS ANALYSIS

MALATHION

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17.1 Introduction

The National Marine Fisheries Services (NMFS') critical habitat analysis determines whether the proposed action is likely to destroy or adversely modify critical habitat for Endangered Species Act (ESA)-listed species by examining potential reductions in the conservation value of the essential features of designated critical habitat. "Destruction or adverse modification" means a direct or indirect alteration that appreciably diminishes the value of designated critical habitat for the conservation of an ESA-listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features (PBFs) essential to the conservation of a species or that preclude or significantly delay development of such features (50 C.F.R. §402.02).

In this section, NMFS evaluates the potential consequences to designated critical habitat from exposure to the stressors of the proposed action. A diagram of our analysis framework is shown in ***Figure 1***. It is similar in structure to the jeopardy analysis, but focuses on whether the proposed action is likely to destroy or adversely modify designated critical habitat for listed species. NMFS reviews the status of designated and proposed critical habitat affected by the proposed action separate from species effects by examining the condition and trends of the designated essential physical or biological features (PBFs) of critical habitat throughout the action area. We first determine whether critical habitat is likely to be exposed to the stressors of the proposed action (exposure profile). To conduct this analysis, we relied on R-plots showing expected pesticide concentrations in the species' designated critical habitat. If we find that critical habitat is likely to be exposed, we determined the relevant PBFs for each species' designated critical habitat that would be at risk from this proposed action and assess the consequences of that exposure on the quality, quantity, or availability of those PBFs (response profile) (Appendix C). We relied heavily on EPA provided Crop Land Data Layers of crop uses and conducted an overlap of critical habitat analysis to determine exposure potential to designated critical habitat.

In all of the critical habitat designations that are exposed to the stressors of this action, water quality and forage (prey availability) are key attributes that are either designated as PBFs of the critical habitat, or are relevant to the PBFs. Water quality encompasses a range of typically measured parameters, including dissolved oxygen, temperature, turbidity, and presence of contaminants. Here, we use the presence of chemical contaminants as an indicator of degraded water quality. The proposed action would degrade water quality by introducing chlorpyrifos, diazinon, malathion, and other associated chemicals into designated critical habitats. Therefore, we use the pesticide concentrations likely to adversely affect listed species or prey (e.g. invertebrates and juvenile fish) as measures of degraded water quality. We also note that the PBF's for most of the critical habitats at issue include availability and quality of prey. The three a.i.s are expected to affect prey at concentrations within the range predicted to occur in most freshwater and estuarine habitats by exposure models. This analysis is conducted by comparing toxicity information (e.g., aquatic invertebrate LC_{50} values) provided in EPA's "Effects Characterization" in their BE, with expected pesticide concentrations derived from R-plots using data from EPA's MagTool.

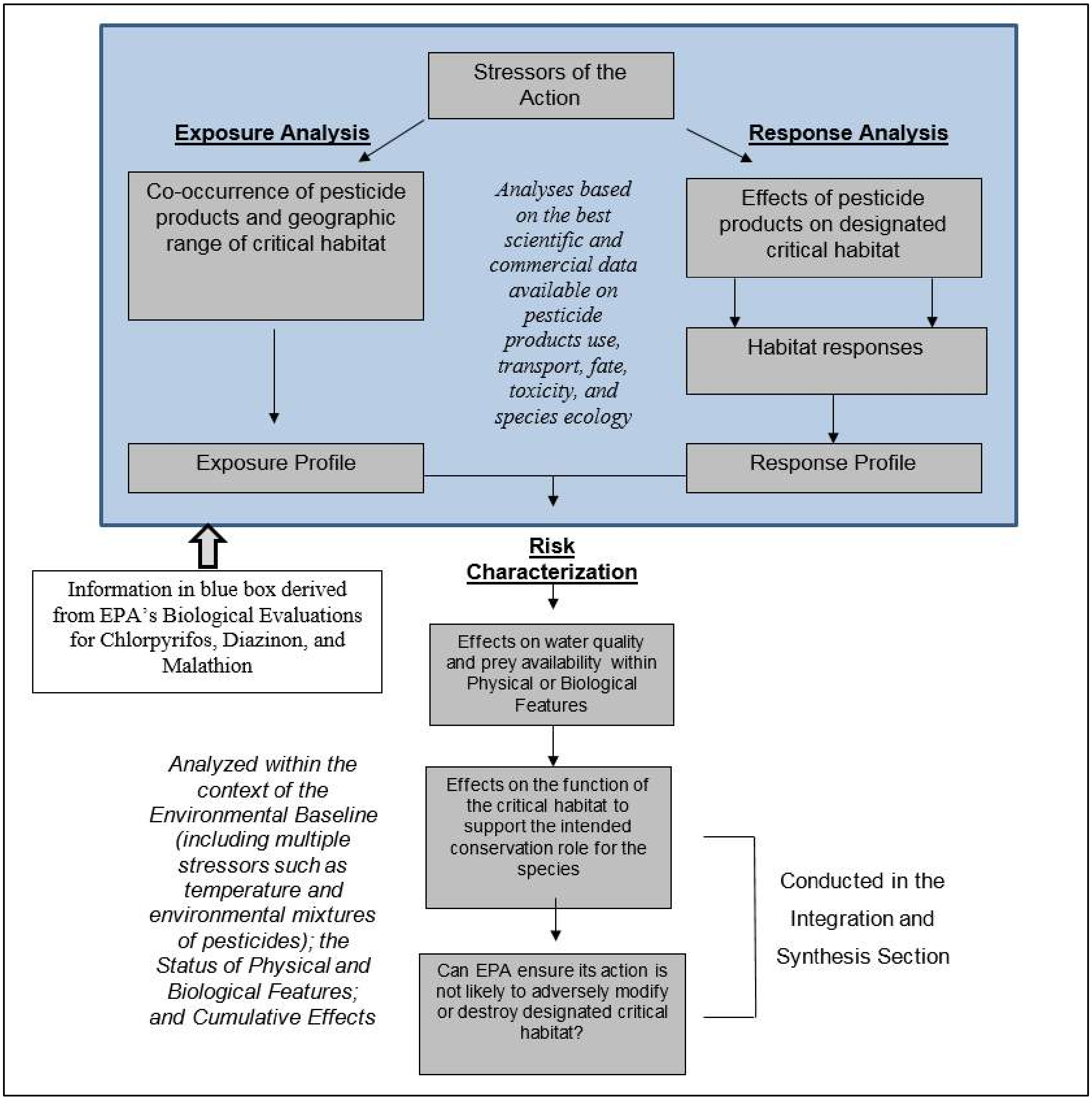


Figure 1. Assessment Framework for Designated Critical Habitat

We translated each PBF into a risk hypothesis to assess potential impacts on designated critical habitat. The analysis of risk hypotheses is based on: 1) the likely concentrations of the three pesticides that would be observed in critical habitat; and 2) the response of PBFs to those anticipated concentrations.

The action area for this Opinion encompasses all designated critical habitat for listed species within the continental U.S., Hawaii, Alaska, and U.S. Protectorates. These species include Pacific salmonids in Washington, Oregon, California and Idaho. As the species of salmonids addressed in this Opinion have similar life history characteristics, they share many of the same PBFs. These PBFs include sites that support one or more life stages and contain physical or biological features essential to the conservation of the Evolutionarily Significant Unit (ESU)/Distinct Population Segment (DPS). PBFs include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, estuarine areas, nearshore marine areas, and offshore marine areas. Other species include two Puget Sound rockfish species, eulachon, two sturgeon species, two species of corals, black abalone, several species of sea turtles, Southern Resident Killer Whale, two pinniped species, Johnson's seagrass, and Smalltooth sawfish. For each of these species we determined the relevant PBFs that would be affected by the proposed action. Descriptions of species' designated critical habitats and associated PBFs are provided in Appendix C.

Water quality and prey availability in freshwater and estuarine areas may be susceptible to pesticide effects where critical habitat overlaps with or is adjacent to use sites. Effects to water quality and prey availability will be evaluated to determine the likelihood of reducing the quality of freshwater, estuarine, and nearshore marine areas. Given the use and environmental fate profile of the pesticide formulations containing these active ingredients, we do not expect offshore marine areas to be directly affected. Therefore, a risk hypothesis was not developed for this area and further evaluation of this PBF is not warranted.

Sufficient water quality is a necessary attribute of many aquatic PBFs to support the conservation role of designated critical habitat, and water quality unimpaired by toxins is necessary to the PBFs of the critical habitats affected by the stressors of this action. For example, all species of juvenile salmon need clean cold water. Clean and cold water is essential support for producing abundant prey for salmonid growth and development. This is also true for green sturgeon. Eggs and larvae develop in freshwater. Development of early life stages is affectd by water flow and temperature. Juvenile sturgeon rear and feed in fresh and estuarine waters from one to 4 years prior to dispersing into marine waters as subadults. During this time, their growth and development relies on adequate water quality to support abundant prey production. Water quality is clearly degraded when pesticides and other stressors of the action reach levels in habitat that are sufficient to adversely affect aquatic organisms and reduce individual fitness of exposed ESA-listed species. Impacts to species fitness were evaluated earlier in the document and these impacts are used as indicators of degraded water quality. We evaluate exposure and effect concentrations presented in the Environmental Protection Agency's (EPA's) BEs to determine whether PBFs are impacted.

We also evaluate effects on prey because forage is an essential attribute of many PBFs. Freshwater juvenile rearing and migratory habitats as well as estuarine and nearshore marine areas must provide sufficient forage to support growth and development of the listed species. Reductions in the abundance of prey items can decrease the quality of rearing, migration, and estuarine PBFs, as less available food will support fewer individuals. Reductions in prey can reduce a PBF's potential to support species (juvenile development, growth, maturation, survival), thereby reducing the carrying capacity of critical habitat. We evaluated the toxicity assessment endpoints including prey and fish survival (EC_{50}/LC_{50}) to determine whether expected concentrations of the stressors of the action are sufficient to affect PBFs of species critical habitats.

Designated critical habitat is located within the action area. Many freshwater areas overlap with the allowable uses of the three a.i.'s. The stressors of the action contaminate these habitats via drift and runoff (including from irrigation returns), and to a lesser extent from atmospheric deposition. Once in species habitats, the three active ingredients persist for varying periods of time, depending in part on the chemical, biological, and physical environment of the contaminated aquatic habitats. The most persistent of the three, chlorpyrifos (soil half-life 171 days),[1] may accumulate in soils and contribute to aquatic loading via runoff months later affecting organisms beyond those exposed initially from application events. Expected concentrations of other/inert ingredients and adjuvants added to formulations prior to application remain unknown, and are an identified data gap.

We use the toxicity information provided in the BEs and presented earlier in the Effects Analysis Chapters (Chapters 12, 13, and 14) to evaluate the scientific lines of evidence that support or refute risk hypotheses developed for designated and proposed critical habitats. Freshwater spawning and rearing sites, migration corridors, estuarine areas, and nearshore marine areas within designated critical habitats are likely to be exposed to the stressors of the action over the 15-year registration duration. We estimate expected concentrations and durations of exposure for these habitats based on pesticide use information, surface water monitoring data, EPA modeling estimates, and NMFS modeling estimates.

For each risk hypothesis in ***Table 1*** (also refer to Appendix E for specific risk hypotheses for each species PBFs relevant to this analysis) we qualitatively weigh the evidence to determine whether the PBF attributes of water quality and prey availability are affected for each species designated critical habitat. Water quality is degraded when pesticides and other stressors of the action reach levels in habitat that are sufficient to adversely affect aquatic organisms and reduce individual fitness of exposed ESA-listed species (this was evaluated earlier in the document). We ultimately determine whether the degradation of water quality and reduction in prey availability within freshwater spawning and rearing sites, migration corridors, estuarine areas, and nearshore marine areas will rise to the level expected to reduce the intended conservation role of designated critical habitats. This analysis is conducted by evaluating toxicity information (e.g., aquatic invertebrate LC50 values), as well as by characterizing the likelihood of exposure within the designated critical habitat. Likelihood of exposure for critical habitat considers three factors: 1) percent overlap; 2) chemical persistence, and; 3) number of repeated applications allowed. See Chapter 3 for a description of how these factors are considered to determine the overall likelihood of exposure.

See Chapters 22 – 24 (Integration and Synthesis for Designated Critical Habitat) for the final conclusion of whether EPA's proposed action with end-use products containing chlorpyrifos, diazinon, or malathion are likely to adversely modify or destroy a species' designated or proposed critical habitat.

Table 1. Generalized risk hypotheses for relevant PBF's.

Risk hypothesis for relevant physical or biological features
1. Exposure to the stressors of the action is sufficient to degrade water quality and/or reduce prey resources in freshwater spawning sites.
2. Exposure to the stressors of the action is sufficient to degrade water quality and/or reduce prey resources in freshwater rearing sites.

[1] Diazinon soil half-life is 34 days, malathion soil half-life is 1 day.

3. Exposure to the stressors of the action is sufficient to degrade water quality, and/or reduce prey resources in freshwater migratory corridors.
4. Exposure to the stressors of the action is sufficient to degrade water quality and/or reduce prey resources in estuarine areas.
5. Exposure to the stressors of the action is sufficient to degrade water quality and/or reduce prey resources in nearshore marine areas.

The following sections provide the chemical-specific assessments of risk hypotheses for each designated critical habitats involved in this consultation (defined by the action area).

17.2 Columbia River Chum Salmon (O. keta) Designated Critical Habitat

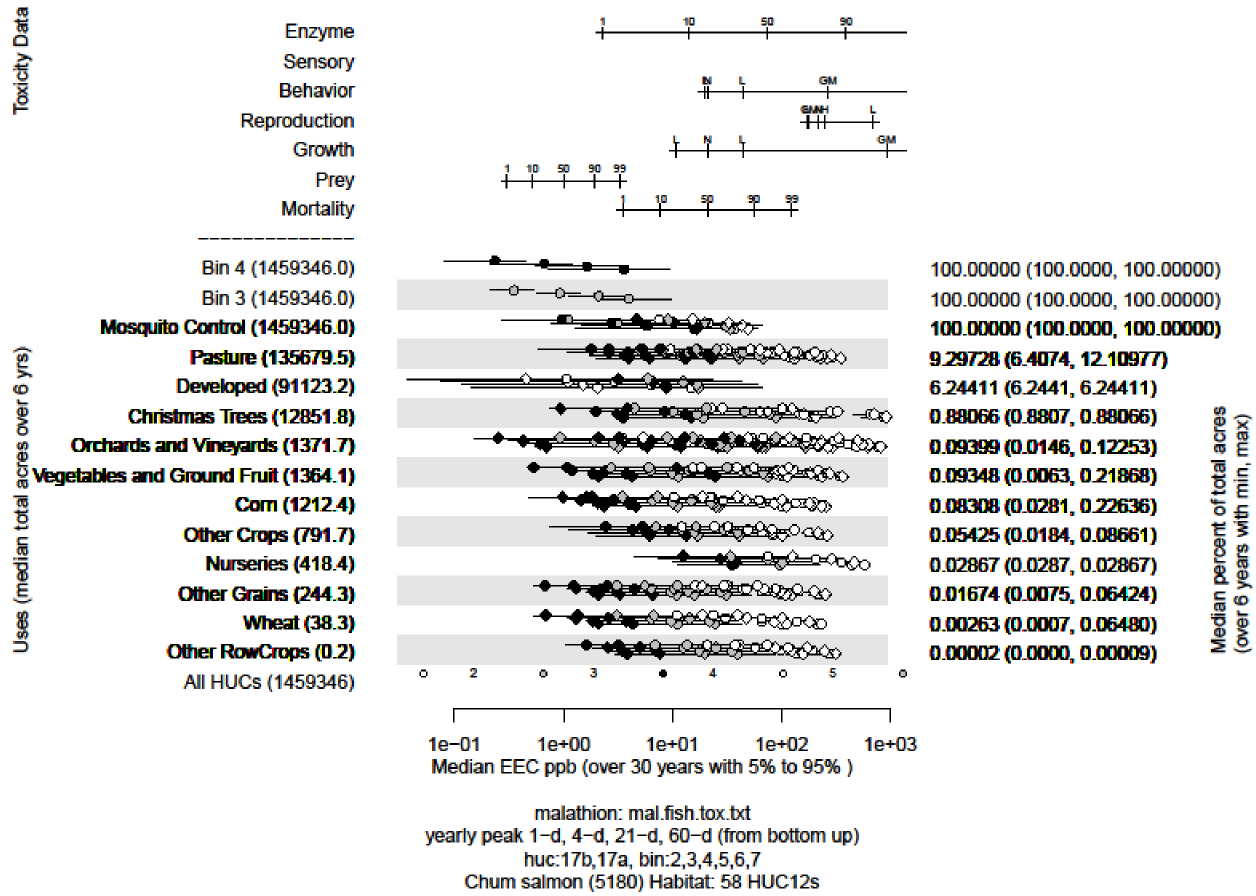


Figure 2. Effects analysis R-plot; chum salmon, Columbia River ESU designated critical habitat.

Table 2. Prey risk hypothesis; chum salmon, Columbia River ESU designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	9.30	High	High
Developed	6.24	High	High
Christmas Trees	0.88	High	Low
Orchards and Vineyards	0.09	High	Low
Vegetables and Ground Fruit	0.09	High	Low
Corn	0.08	High	Low
Other Crops	0.05	High	Low

Nurseries	0.03	High	Low
Other Grains	0.02	High	Low
Wheat	<0.01	High	Low
Other RowCrops	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 3. Water quality risk hypothesis; chum salmon, Columbia River ESU designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within Chum salmon, Columbia River ESU designated critical habitat. Twelve use site categories, totaling more than 245,091 acres (over 8% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

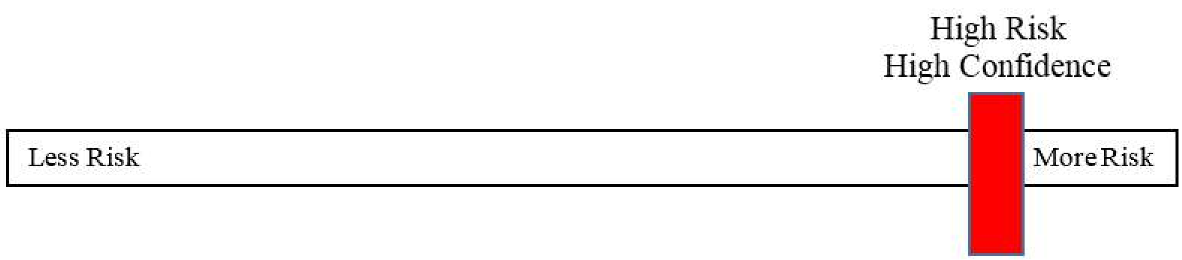
Table 4. Effects analysis summary table; chum salmon, Columbia River ESU designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Columbia River chum salmon. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We have greater confidence in the risk determinations associated with the freshwater habitats than we do in the estuarine and nearshore habitats. Overall the risk is high and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.



17.3 Hood Canal Summer-run Chum (O. keta) Designated Critical Habitat

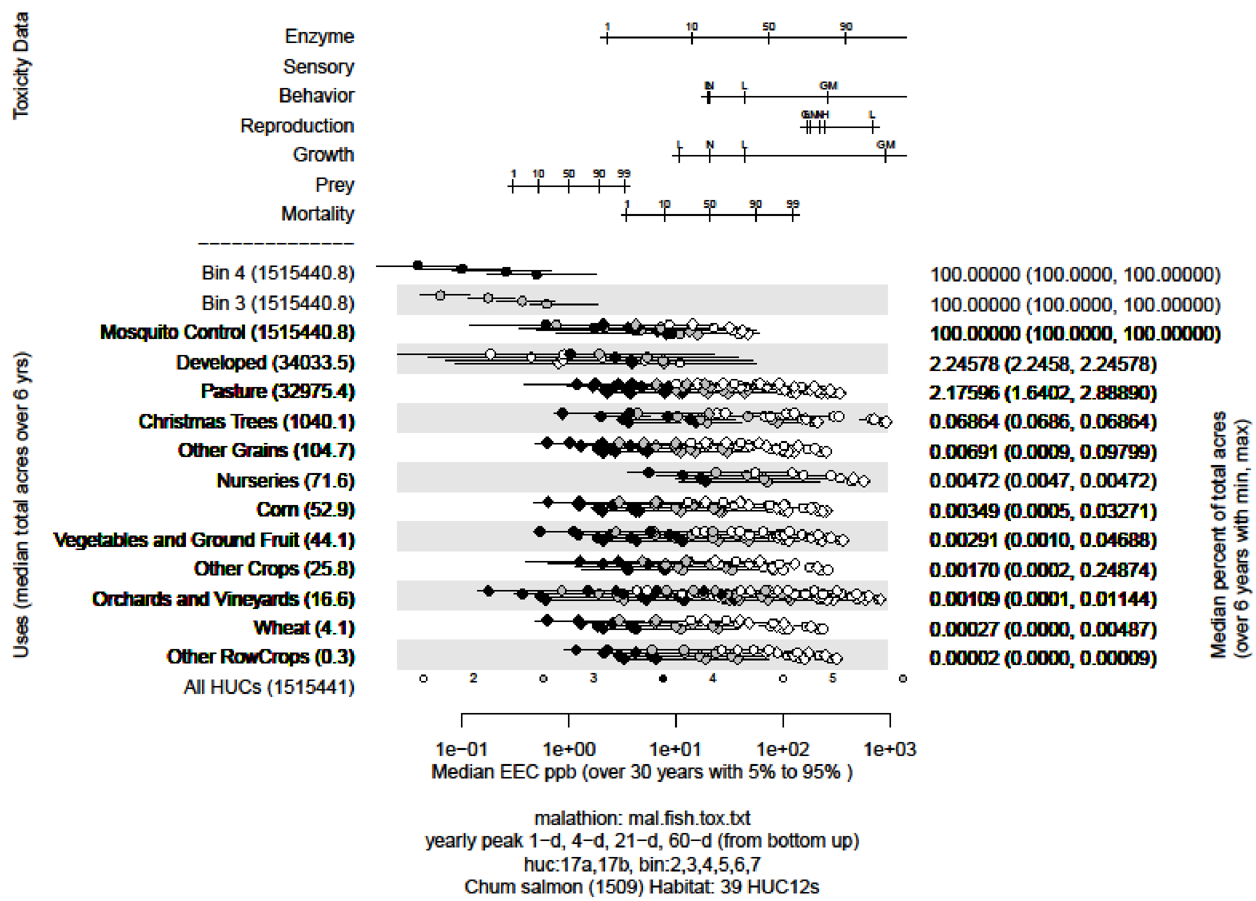


Figure 3. Effects analysis R-plot; chum salmon, Hood Canal summer-run ESU designated critical habitat.

Table 5. Prey Risk Hypothesis; Chum salmon, Hood Canal summer-run ESU designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Developed	2.25	High	Medium
Pasture	2.18	High	Medium
Christmas Trees	0.07	High	Low
Other Grains	0.01	High	Low
Nurseries	<0.01	High	Low
Corn	<0.01	High	Low
Vegetables and Ground Fruit	<0.01	High	Low

Other Crops	<0.01	High	Low
Orchards and Vineyards	<0.01	High	Low
Wheat	<0.01	High	Low
Other RowCrops	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 6. Water quality risk hypothesis; chum salmon, hood canal summer-run ESU; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Chum salmon, Hood Canal summer-run ESU. Twelve use site categories, totaling more than 68,260 acres (over 3% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

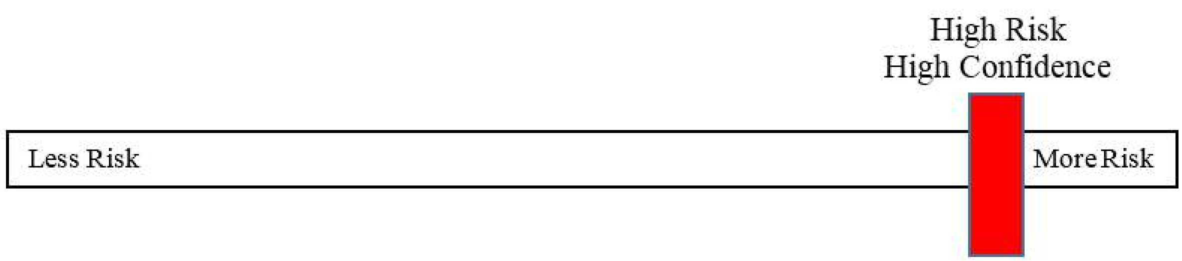
Table 7. Effects analysis summary table; chum salmon, hood canal summer-run ESU; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water	High	High	Yes

quality and/or reductions in prey in freshwater rearing sites.			
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Hood Canal summer-run chum salmon. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



17.4 California Coastal Chinook (O. tshawytscha) Designated Critical Habitat

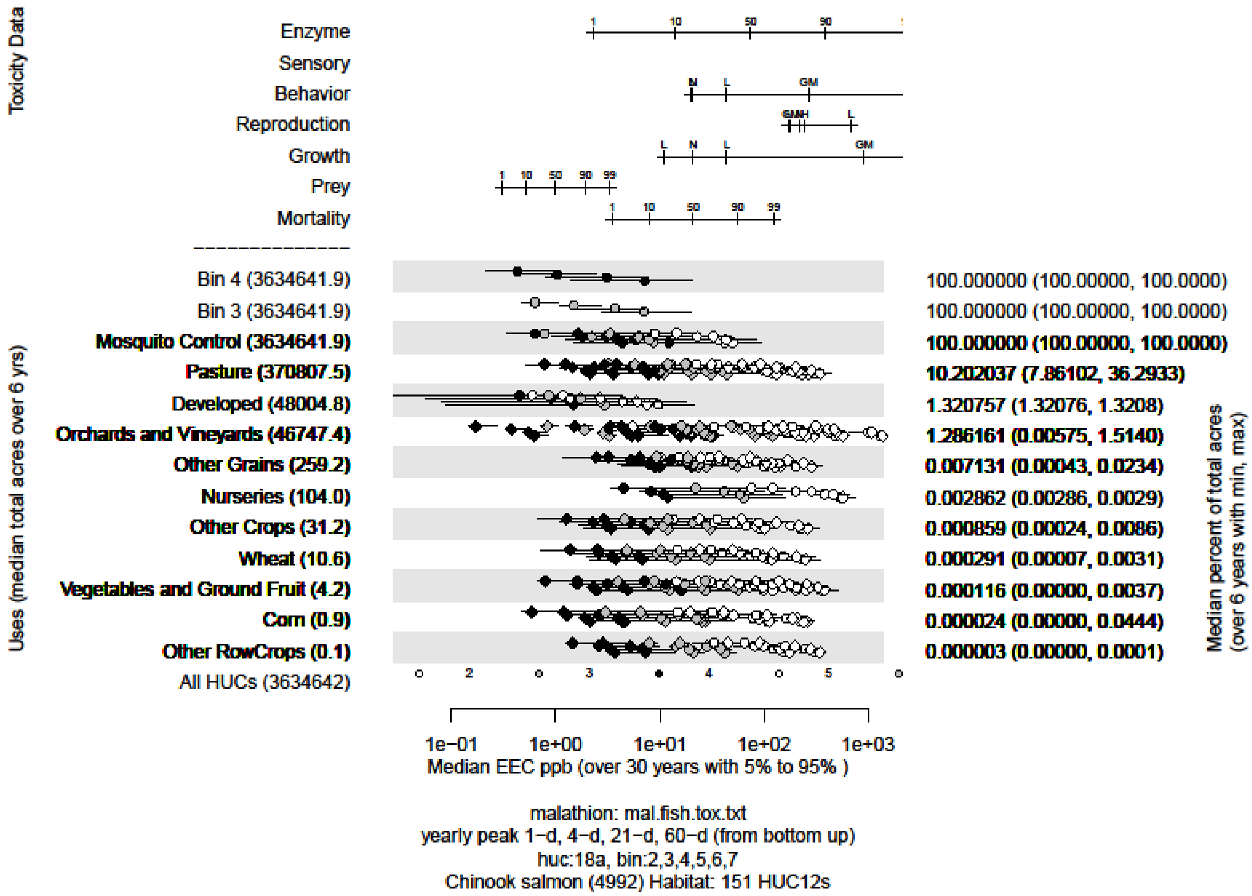


Figure 4. Effects analysis R-plot; Chinook salmon, California Coastal ESU designated critical habitat.

Table 8. Prey Risk Hypothesis; Chinook salmon, California Coastal ESU designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	10.20	High	High
Developed	1.32	High	Medium
Orchards and Vineyards	1.29	High	Medium
Other Grains	0.01	High	Low
Nurseries	<0.01	High	Low
Other Crops	<0.01	High	Low
Wheat	<0.01	High	Low

Vegetables and Ground Fruit	<0.01	High	Low
Corn	<0.01	High	Low
Other RowCrops	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 9. Water quality risk hypothesis; Chinook, California coastal ESU; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Chinook, California coastal ESU. Eleven use site categories, totaling more than 465,967 acres (over 13% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

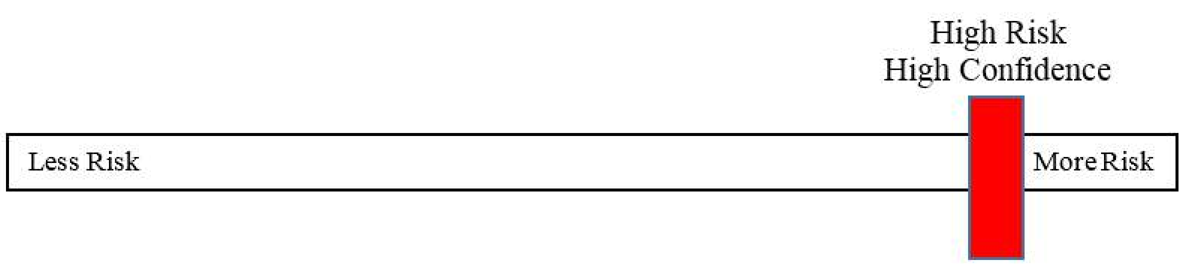
Table 10. Effects analysis summary table; Chinook, California coastal ESU; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of California Coastal Chinook salmon. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



17.5 Central Valley Spring-run Chinook Designated Critical Habitat

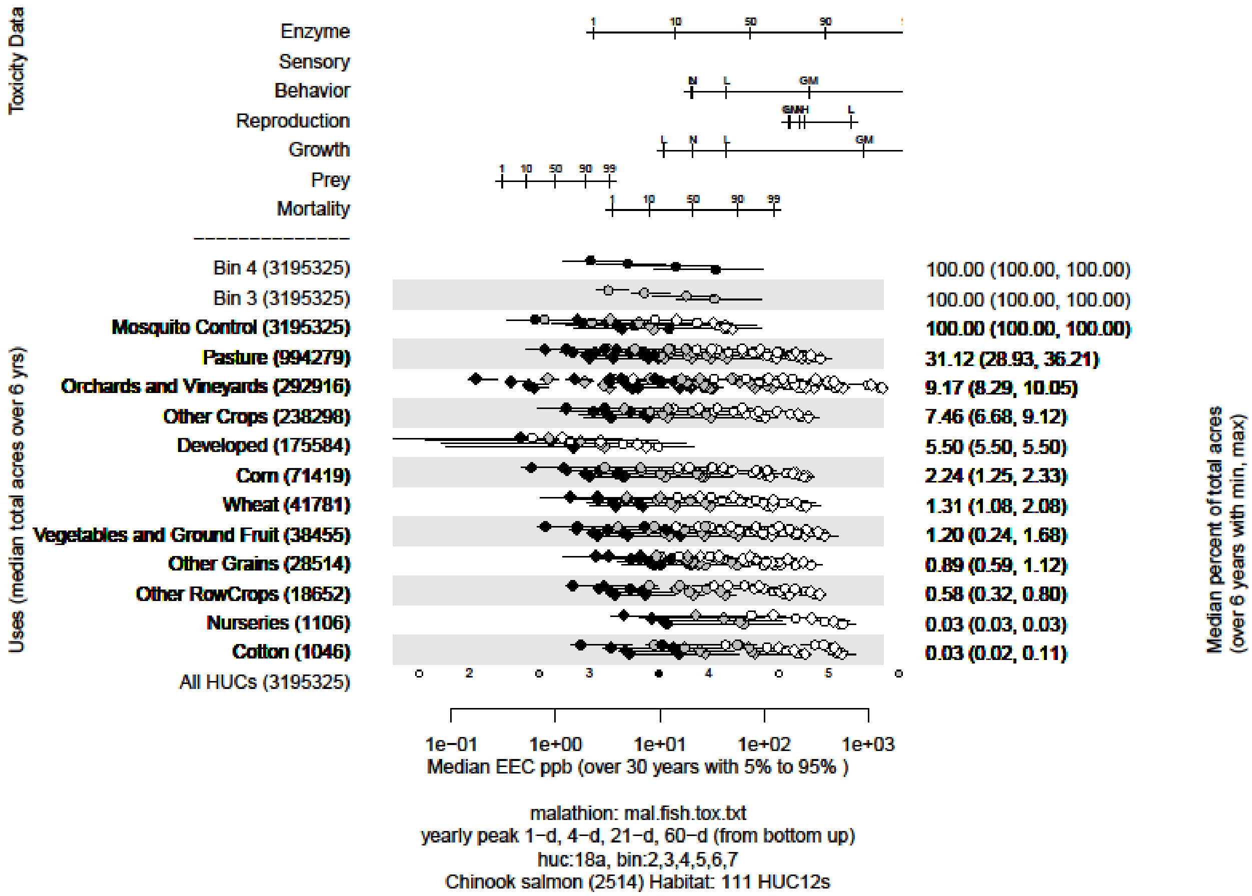


Figure 5. Effects analysis R-plot; Chinook salmon, Central Valley spring-run ESU designated critical habitat.

Table 11. Prey risk hypothesis; Chinook, Central Valley spring-run ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	31.12	High	High
Orchards and Vineyards	9.17	High	High

Other Crops	7.46	High	High
Developed	5.50	High	High
Corn	2.24	High	Medium
Wheat	1.31	High	Medium
Vegetables and Ground Fruit	1.20	High	Medium
Other Grains	0.89	High	Low
Other RowCrops	0.58	High	Low
Nurseries	0.03	High	Low
Cotton	0.03	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 12. Water quality risk hypothesis; Chinook, Central Valley spring-run ESU; designated critical habitat.

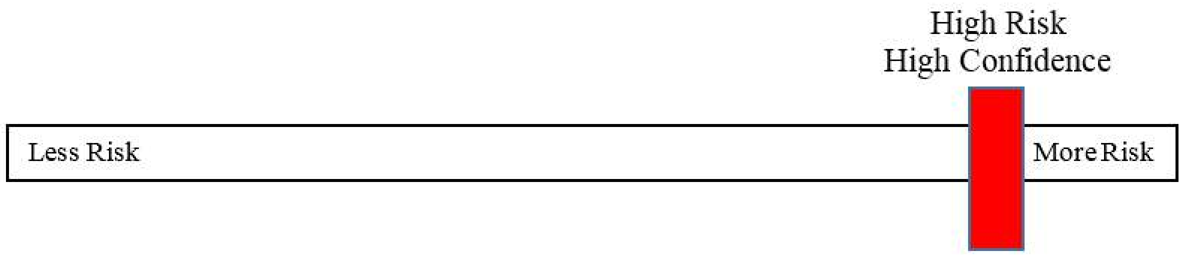
Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Chinook, California Central Valley spring-run ESU. Twelve use site categories, totaling more than 1,902,050 acres (over 58% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

Table 13. Effects analysis summary table; Chinook, Central Valley spring-run ESU; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported? Yes/No
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Califronia Central Valley spring-run Chinook salmon. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.


High Risk
High Confidence
Less Risk
More Risk

17.6 Lower Columbia River Chinook Designated Critical Habitat

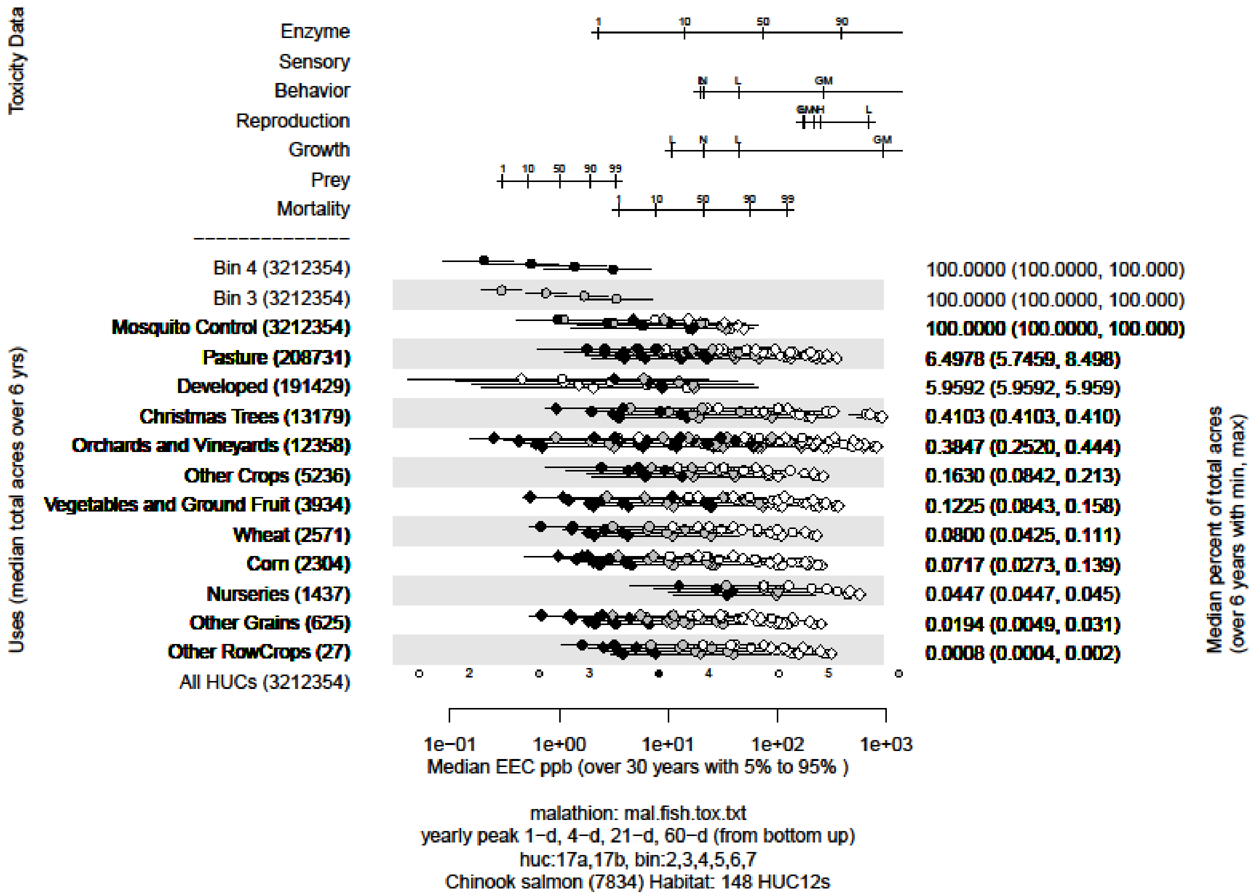


Figure 6. Effects analysis R-plot; Chinook salmon, Lower Columbia River ESU designated critical habitat.

Table 14. Prey risk hypothesis; Chinook, Lower Columbia River ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	6.50	High	High
Developed	5.96	High	High
Christmas Trees	0.41	High	Low

Orchards and Vineyards	0.38	High	Low
Other Crops	0.16	High	Low
Vegetables and Ground Fruit	0.12	High	Low
Wheat	0.08	High	Low
Corn	0.07	High	Low
Nurseries	0.04	High	Low
Other Grains	0.02	High	Low
Other Row Crops	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 15. Water quality risk hypothesis; Chinook, Lower Columbia River ESU; designated critical habitat.

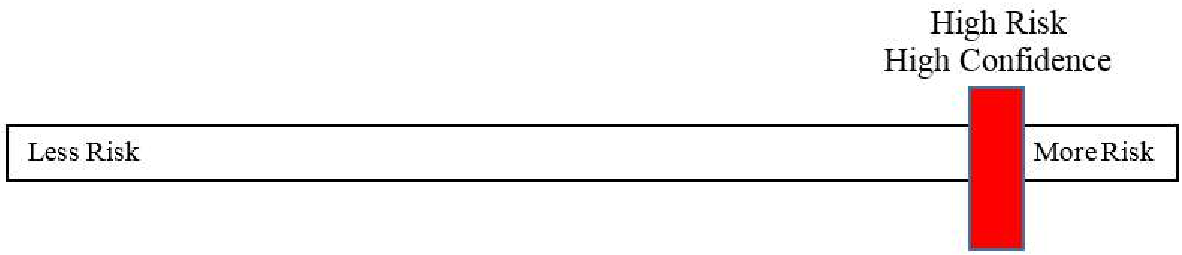
Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Chinook, Lower Columbia River ESU. Twelve use site categories, totaling more than 441,831 acres (over 13% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

Table 16. Effects analysis summary table; Chinook, Lower Columbia River ESU; designated critical habitat.

Designated Critical Habitat; Risk Hypotheses	R-plot Derived		Risk Hypothesis Supported? Yes/No
	Risk	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Lower Columbia River Chinook salmon. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.


High Risk
High Confidence
Less Risk
More Risk

17.7 Puget Sound Chinook Designated Critical Habitat

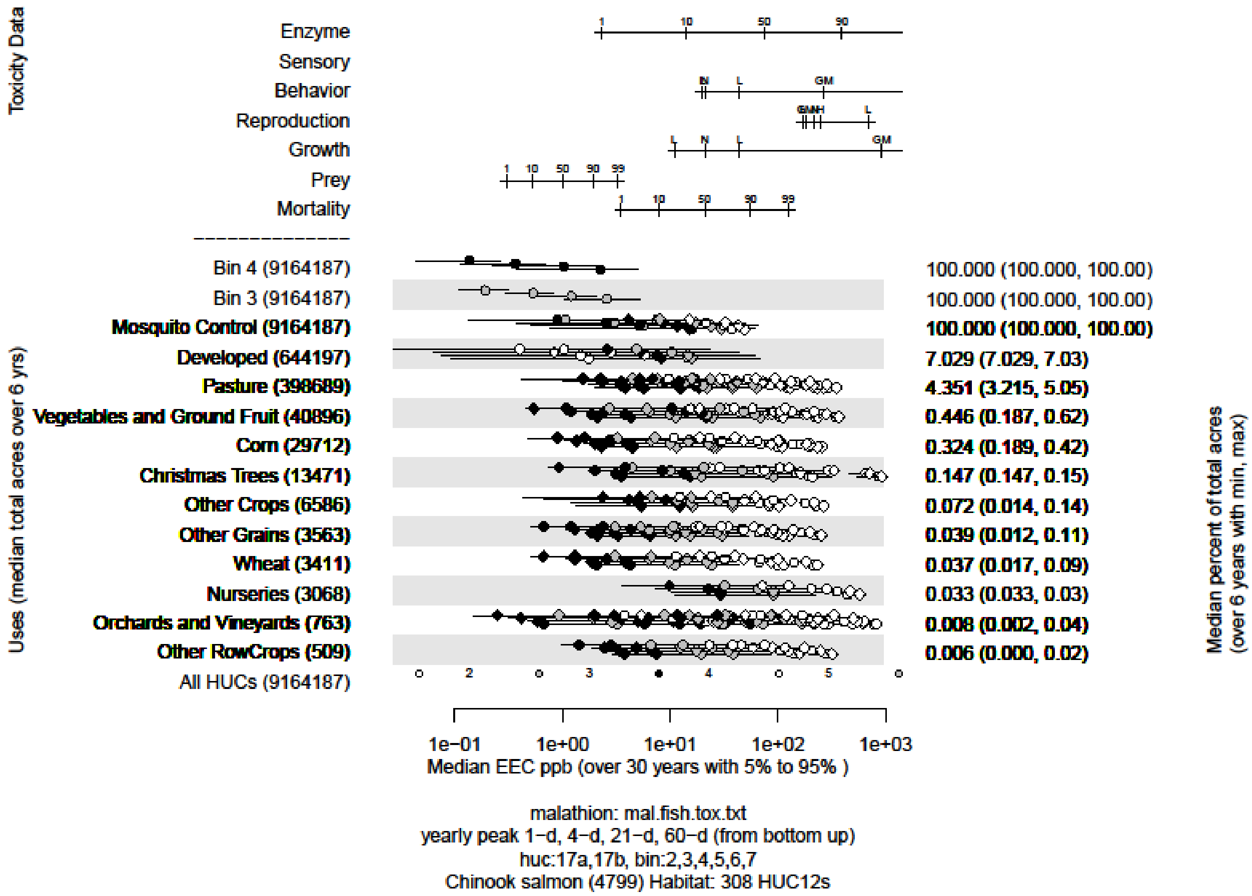


Figure 7. Effects naalysis R-plot; Chinook salmon, Puget Sound ESU designated critical habitat.

Table 17. Prey risk hypothesis; Chinook, Puget Sound ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Developed	7.03	High	High
Pasture	4.35	High	Medium

Vegetables and Ground Fruit	0.45	High	Low
Corn	0.32	High	Low
Christmas Trees	0.15	High	Low
Other Crops	0.07	High	Low
Other Grains	0.04	High	Low
Wheat	0.04	High	Low
Nurseries	0.03	High	Low
Orchards and Vineyards	0.01	High	Low
Other Row Crops	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 18. Water quality risk hypothesis; Chinook, Puget Sound ESU; designated critical habitat.

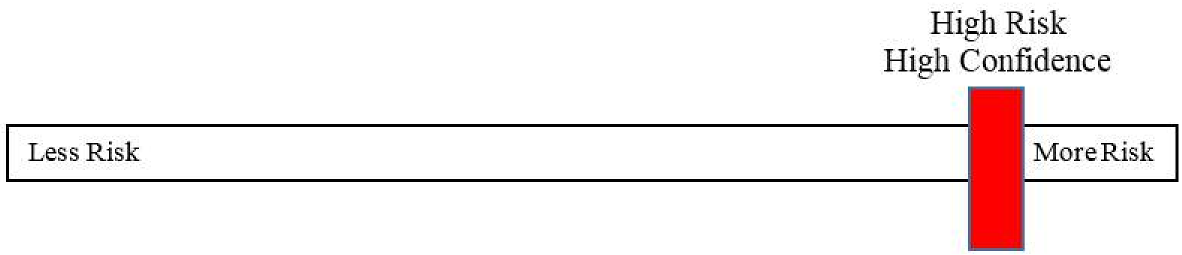
Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Chinook, Puget Sound ESU. Twelve use site categories, totaling more than 1,144,865 acres (over 12% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

Table 19. Effects analysis summary table; Chinook, Puget Sound ESU; designated critical habitat.

Designated Critical Habitat; Risk Hypotheses	R-plot Derived: Risk	R-plot Derived: Confidence	Risk Hypothesis Supported? Yes/No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Puget Sound Chinook salmon. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.


High Risk
High Confidence
Less Risk
More Risk

17.8 Sacramento River Winter-run Chinook Salmon Designated Critical Habitat

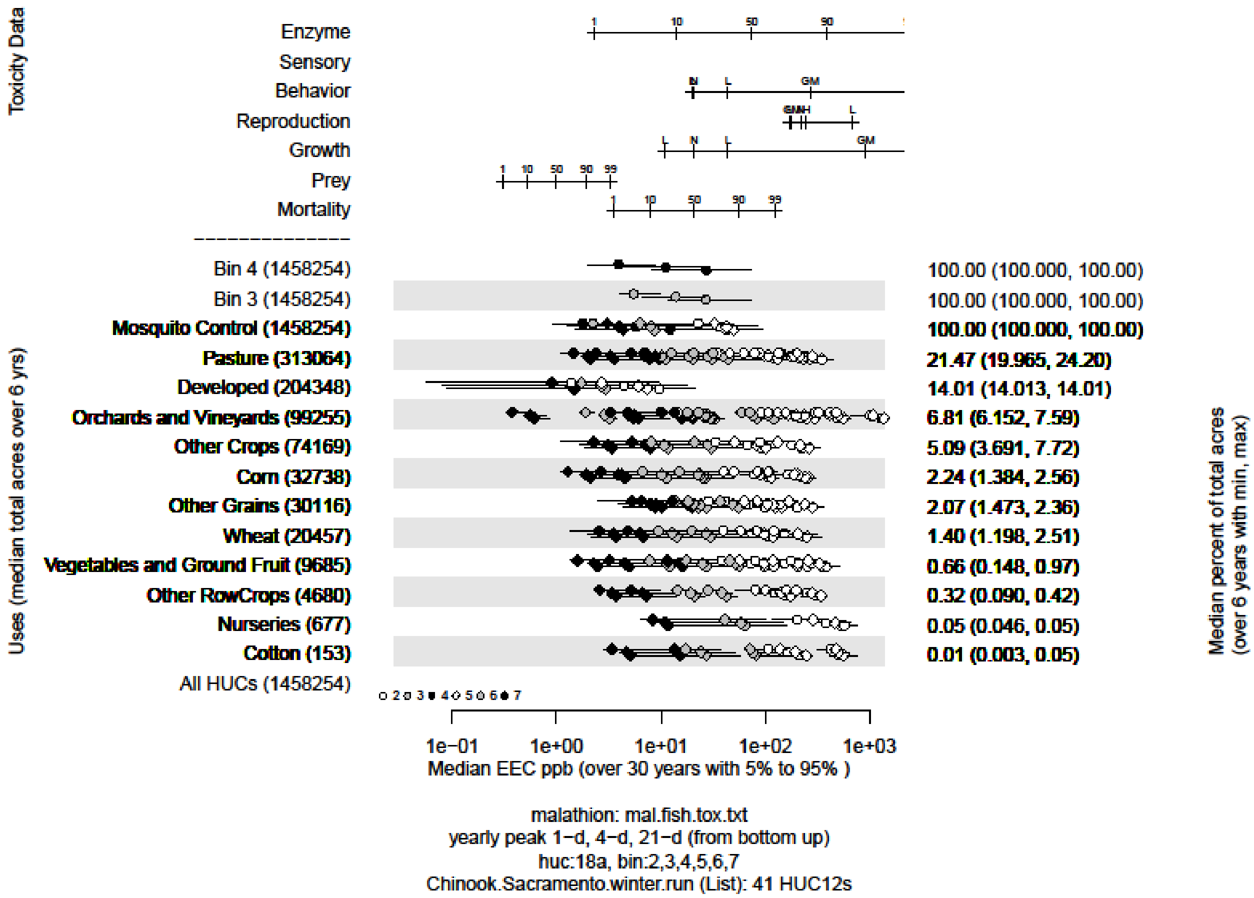


Figure 8. Effects analysis R-plot; Chinook salmon, Sacramento River winter-run ESU designated critical habitat.

Table 20. Prey risk hypothesis; Chinook, Sacramento River winter-run ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	21.47	High	High
Developed	14.01	High	High
Orchards and Vineyards	6.81	High	High

Other Crops	5.09	High	High
Corn	2.24	High	Medium
Other Grains	2.07	High	Medium
Wheat	1.40	High	Medium
Vegetables and Ground Fruit	0.66	High	Low
Other RowCrops	0.32	High	Low
Nurseries	0.05	High	Low
Cotton	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 21. Water quality risk hypothesis; Chinook, Sacramento River winter-run ESU; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Chinook, Sacramento River winter-run ESU. Twelve use site categories, totaling more than 789,342 acres (over 53% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

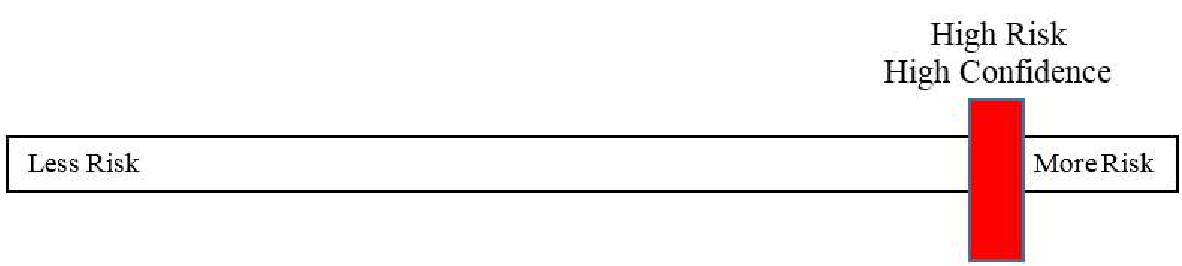
Table 22. Effects analysis summary table; Chinook, Sacramento River winter-run ESU; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat Sacramento River winter-run Chinook salmon. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



17.9 Snake River Fall-run Chinook Salmon Designated Critical Habitat

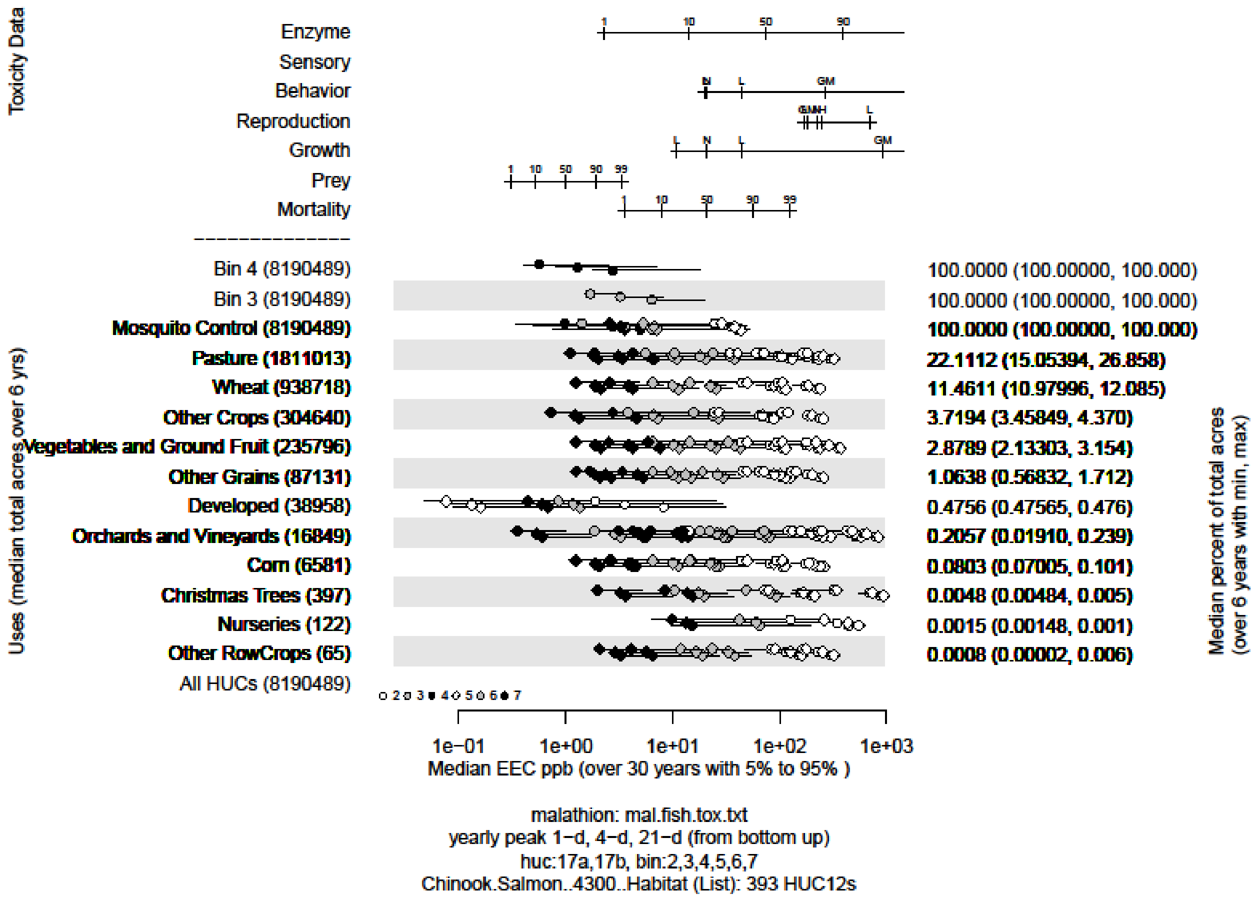


Figure 9. Effects analysis R-plot; Chinook salmon, Snake River fall-run ESU designated critical habitat.

Table 23. Prey risk hypothesis; Chinook, Snake River fall-run ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	22.11	High	High
Wheat	11.46	High	High
Other Crops	3.72	High	Medium
Vegetables and Ground Fruit	2.88	High	Medium
Other Grains	1.06	High	Medium
Developed	0.48	High	Low

Orchards and Vineyards	0.21	High	Low
Corn	0.08	High	Low
Christmas Trees	<0.01	High	Low
Nurseries	<0.01	High	Low
Other RowCrops	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 24. Water quality risk hypothesis; Chinook, Snake River fall-run ESU; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Chinook, Snake River fall-run. Twelve use site categories, totaling more than 3,440,270 acres (over 42% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

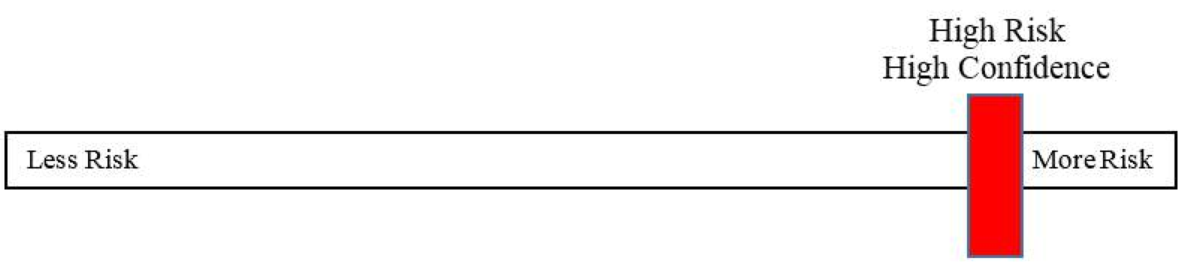
Table 25. Effects analysis summary table; Chinook, Snake River fall-run ESU; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Snake River fall-run Chinook salmon. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



17.10 Snake River Spring/Summer-run Chinook Salmon Designated Critical Habitat

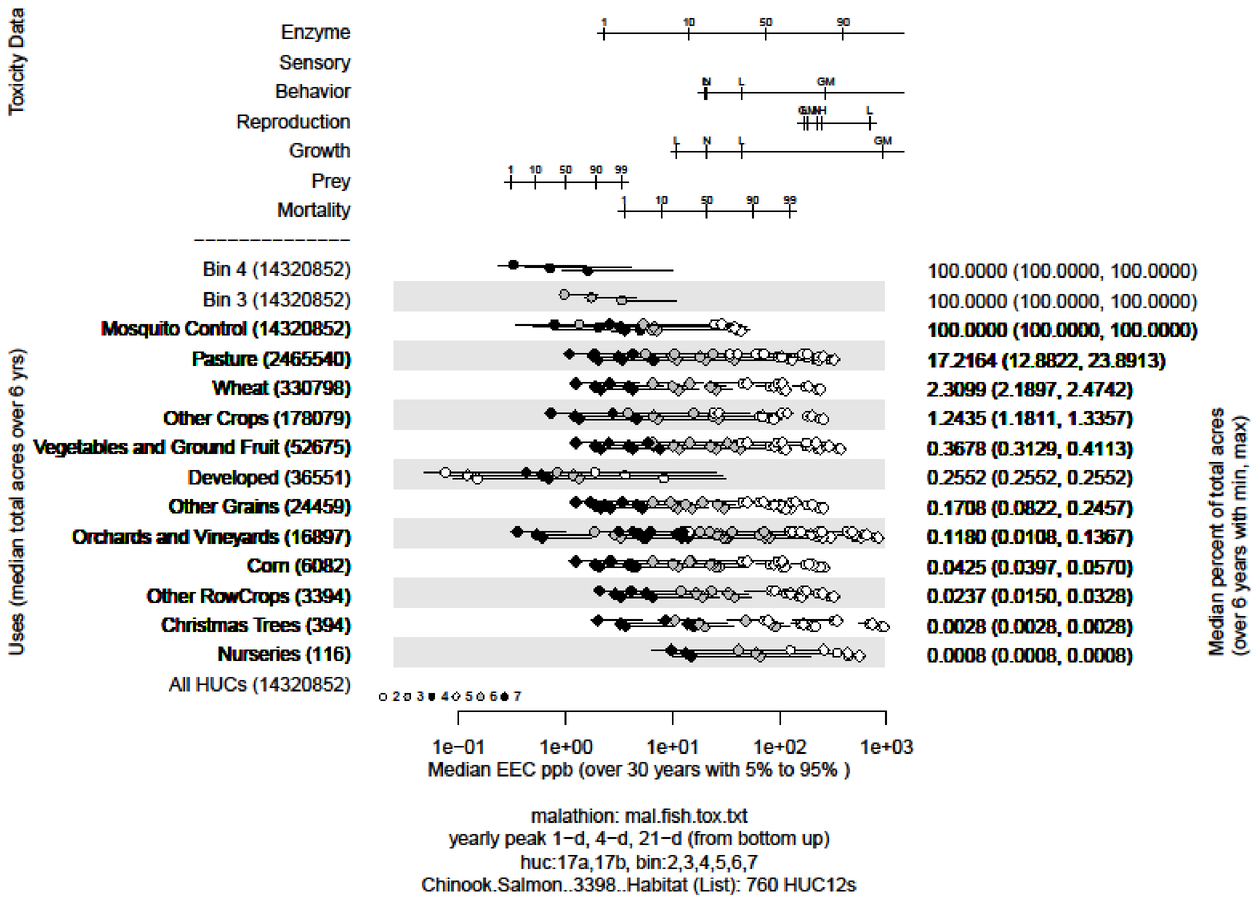


Figure 10. Effects analysis R-plot; Chinook salmon, Snake River spring/summer-run ESU designated critical habitat.

Table 26. Prey risk hypothesis; Chinook, Snake River spring/summer-run ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	17.22	High	High
Wheat	2.31	High	Medium
Other Crops	1.24	High	Medium

Vegetables and Ground Fruit	0.37	High	Low
Developed	0.26	High	Low
Other Grains	0.17	High	Low
Orchards and Vineyards	0.12	High	Low
Corn	0.04	High	Low
Other RowCrops	0.02	High	Low
Christmas Trees	<0.01	High	Low
Nurseries	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 27. Water quality risk hypothesis; Chinook, Snake River spring/summer-run ESU; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Chinook, Snake River spring/summer ESU. Twelve use site categories, totaling more than 17,435,837 acres (over 23% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

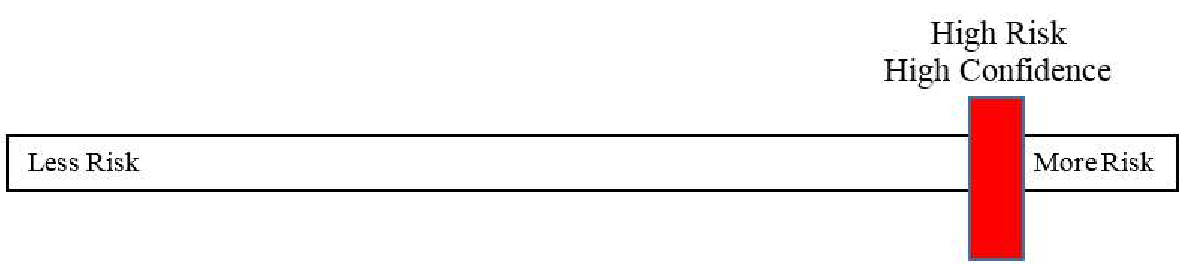
Table 28. Effects analysis summary table; Chinook, Snake River spring/summer-run ESU; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	

			Yes/No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Snake River spring/summer-run Chinook salmon. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



17.11 Upper Columbia River Spring-run Chinook Salmon Designated Critical Habitat

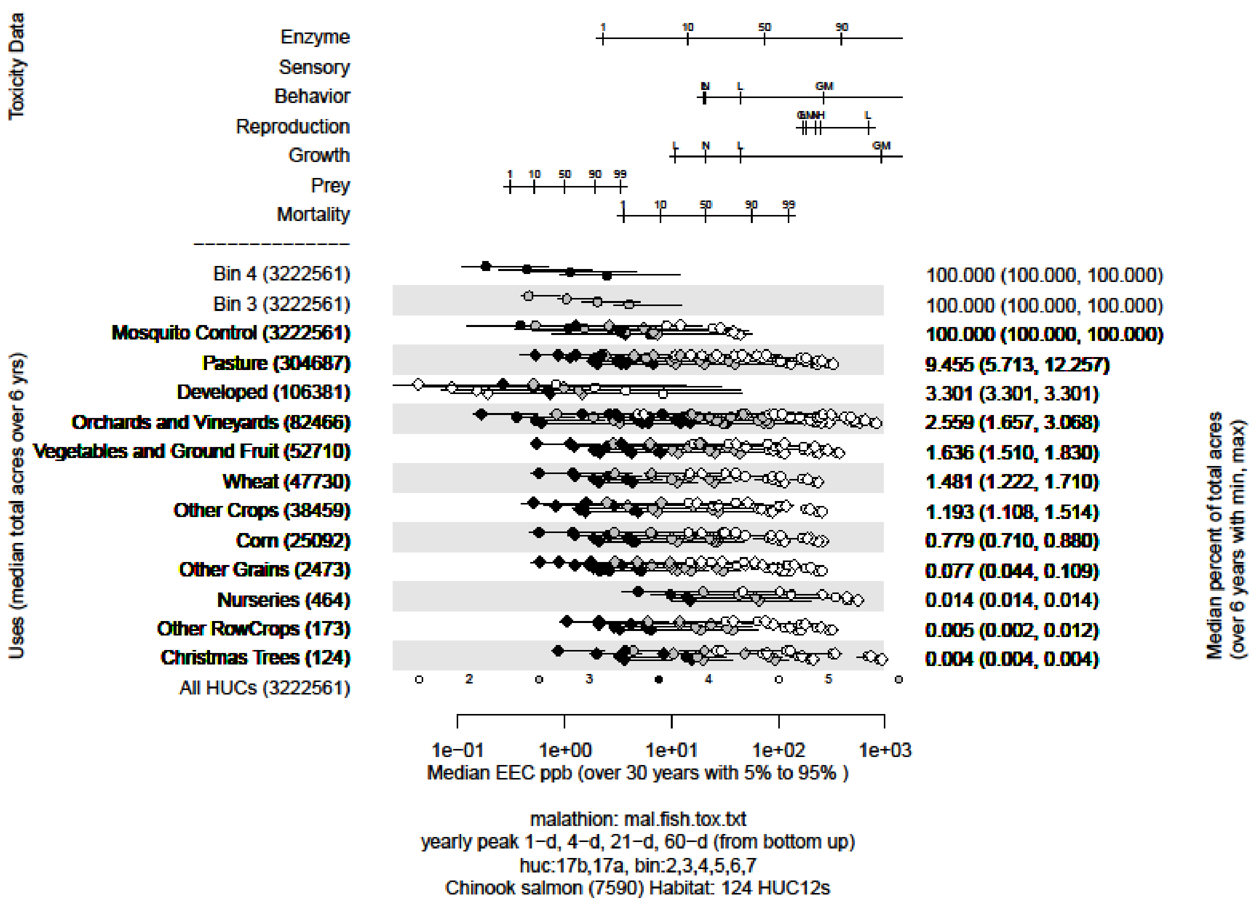


Figure 11. Effects Analysis R-plot; Chinook salmon, Upper Columbia River Spring-run ESU designated critical habitat.

Table 29. Prey risk hypothesis; Chinook salmon, upper Columbia River spring-run ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High

Pasture	9.45	High	High
Developed	3.30	High	Medium
Orchards and Vineyards	2.56	High	Medium
Vegetables and Ground Fruit	1.64	High	Medium
Wheat	1.48	High	Medium
Other Crops	1.19	High	Medium
Corn	0.78	High	Low
Other Grains	0.08	High	Low
Nurseries	0.01	High	Low
Other RowCrops	0.01	High	Low
Christmas Trees	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 30. Water quality risk hypothesis; Chinook salmon, upper Columbia River spring-run ESU; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Chinook salmon, upper Columbia River spring-run ESU. Twelve use site categories, totaling more than 660,759 acres (over 18% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.

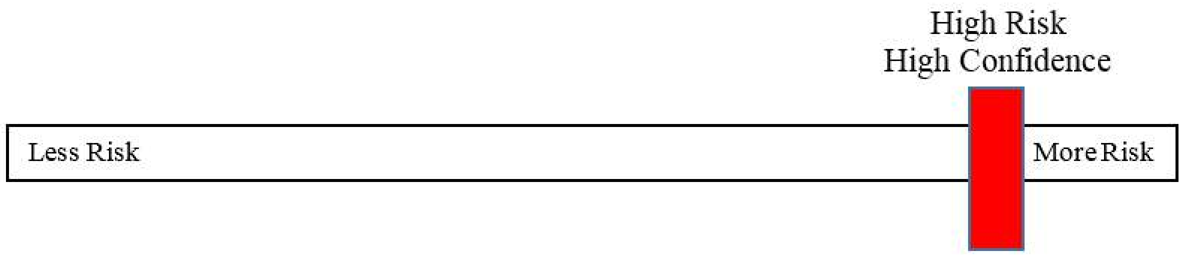
Risk	Confidence	
High	High	

Table 31. Effects analysis summary table; Chinook salmon, upper Columbia River spring-run ESU; designated critical habitat

Designated Critical Habitat; Risk Hypotheses	R-plot Derived		Risk Hypothesis Supported? Yes/No
	Risk	Confidence	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of upper Columbia River spring-run Chinook salmon. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.


High Risk
High Confidence
Less Risk
More Risk

17.12 Upper Willamette River Chinook Salmon Designated Critical Habitat

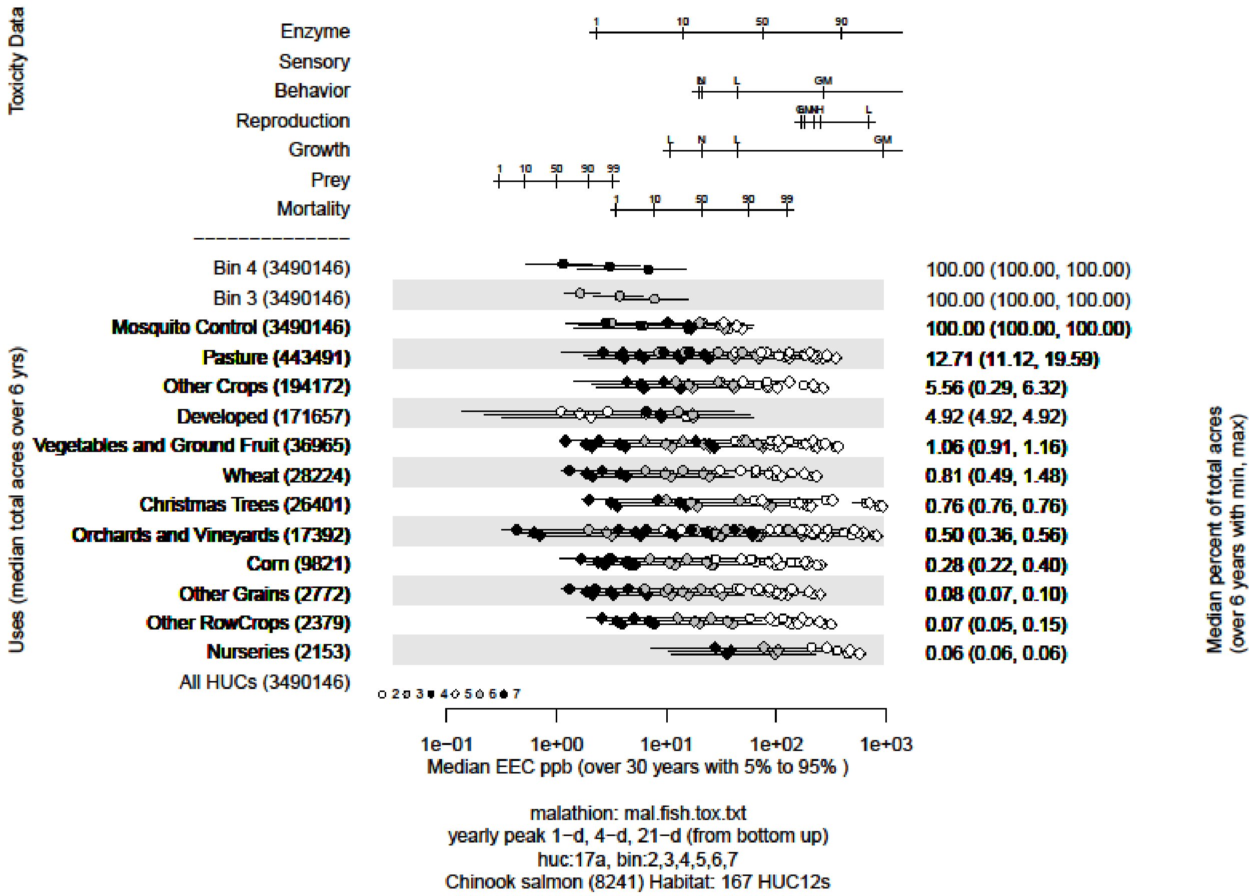


Figure 12. Effects analysis R-plot; Chinook salmon, Upper Willamette River ESU designated critical habitat.

Table 32. Prey risk hypothesis; Chinook, upper Willamette River ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	12.71	High	High
Other Crops	5.56	High	High
Developed	4.92	High	Medium

Vegetables and Ground Fruit	1.06	High	Medium
Wheat	0.81	High	Low
Christmas Trees	0.76	High	Low
Orchards and Vineyards	0.50	High	Low
Corn	0.28	High	Low
Other Grains	0.08	High	Low
Other RowCrops	0.07	High	Low
Nurseries	0.06	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 33. Water quality risk hypothesis; Chinook, upper Willamette River ESU; designated critical habitat.

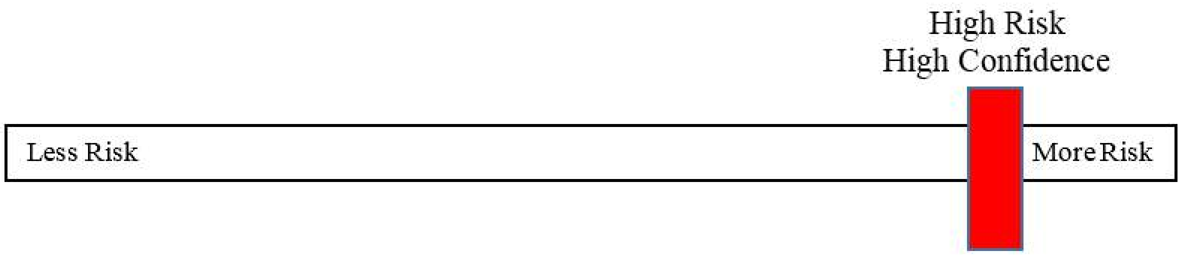
Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Chinook, upper Willamette River ESU. Twelve use site categories, totaling more than 935,427 acres (over 28% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

Table 34. Effects analysis summary table; Chinook, upper Willamette River ESU; designated critical habitat.

Designated Critical Habitat; Risk Hypotheses	R-plot Derived Risk	R-plot Derived Confidence	Risk Hypothesis Supported? Yes/No
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of upper Willamette River Chinook salmon. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.


High Risk
High Confidence
Less Risk
More Risk

17.13 Central California Coast Coho Salmon Designated Critical Habitat

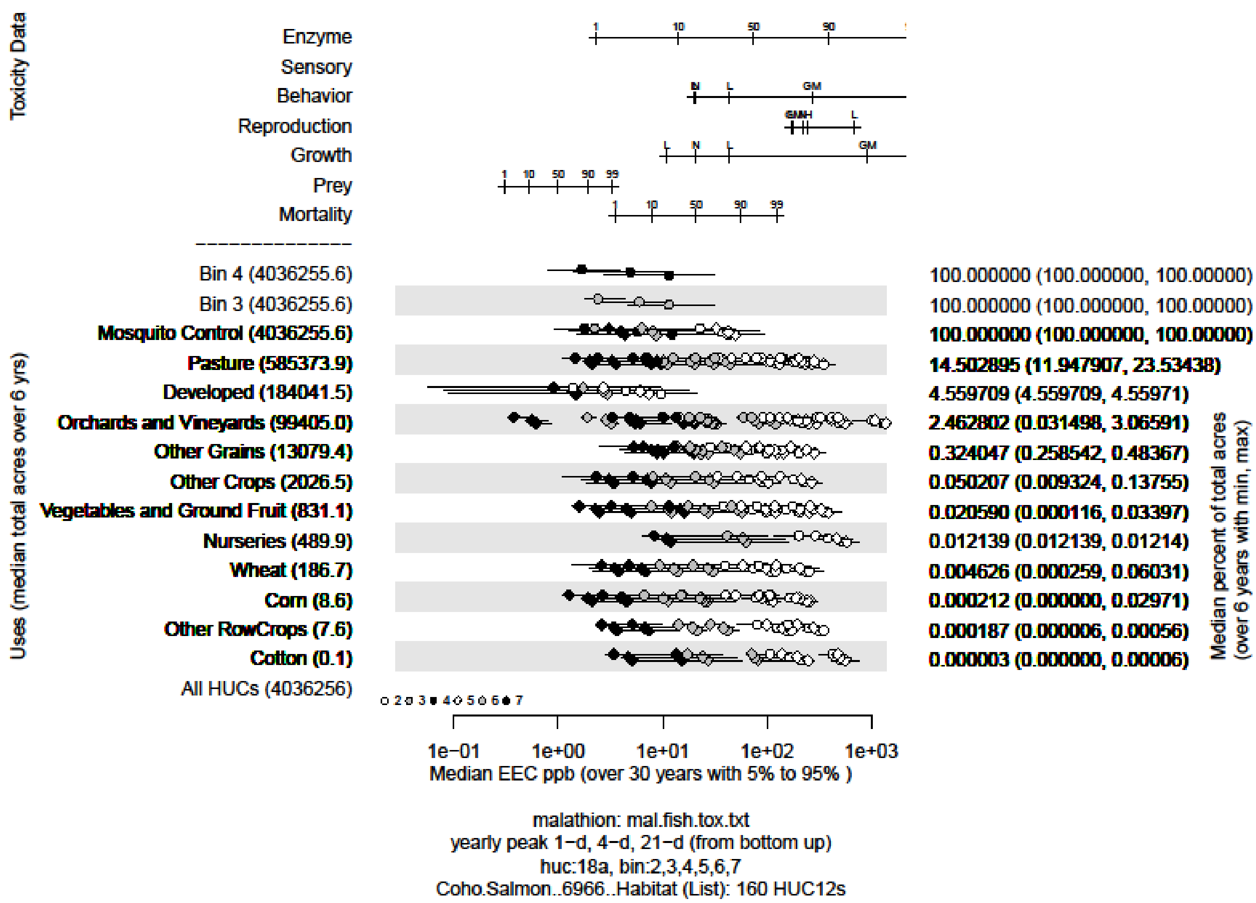


Figure 13. Effects analysis R-plot; Coho, Central California Coast ESU designated critical habitat.

Table 35. Prey risk hypothesis; Coho, Central California Coast ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	14.50	High	High
Developed	4.56	High	Medium
Orchards and Vineyards	2.46	High	Medium
Other Grains	0.32	High	Low
Other Crops	0.05	High	Low

Vegetables and Ground Fruit	0.02	High	Low
Nurseries	0.01	High	Low
Wheat	<0.01	High	Low
Corn	<0.01	High	Low
Other RowCrops	<0.01	High	Low
Cotton	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 36. Water quality risk hypothesis; Coho, Central California Coast ESU; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Central California Coast Coho ESU. Twelve use site categories, totaling more than 885,452 acres (over 23% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

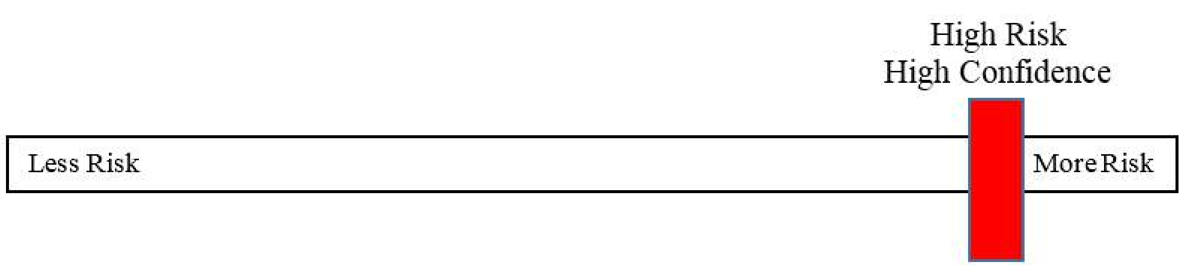
Table 37. Effects analysis summary table; Coho, Central California Coast ESU; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Central California Coast coho salmon. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



17.14 Lower Columbia River Coho Salmon Designated Critical Habitat

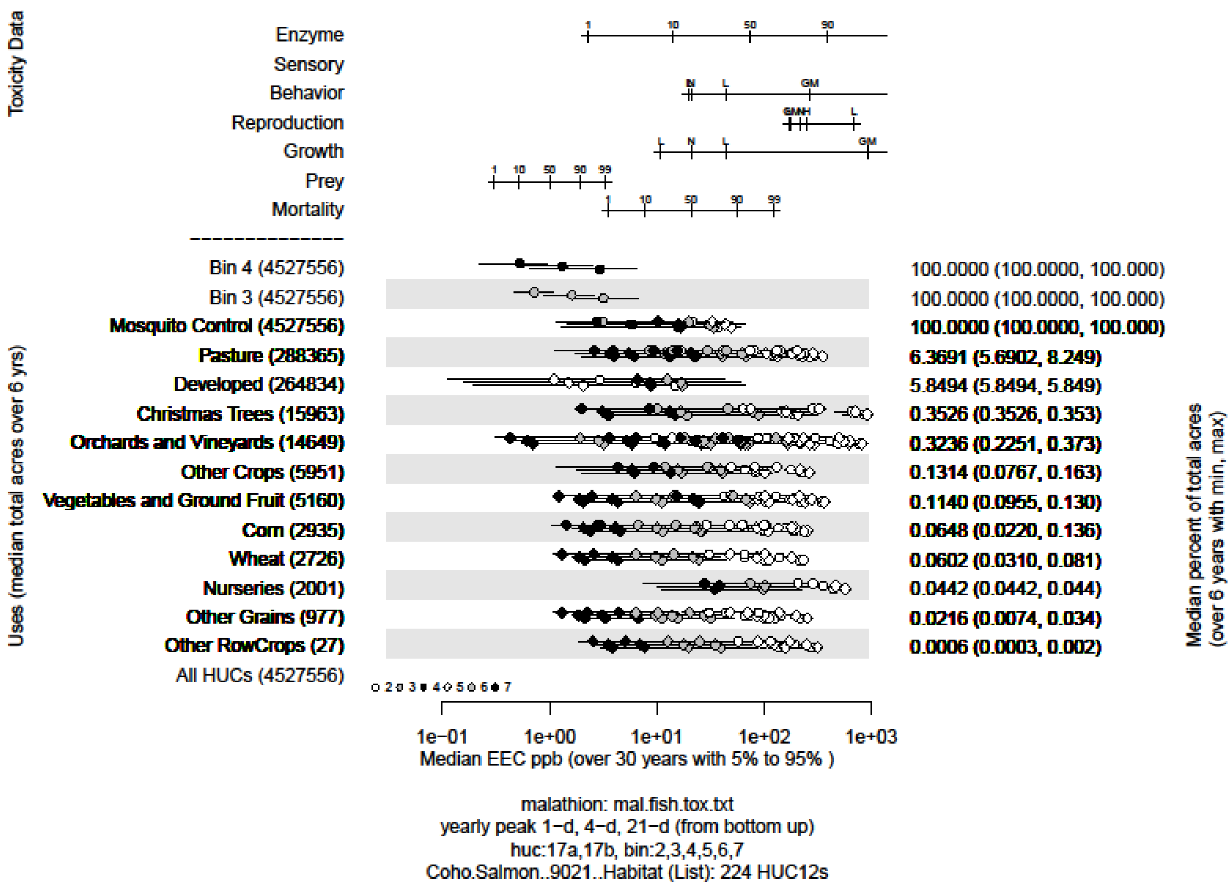


Figure 14. Effects analysis R-plot; Coho, Lower Columbia River ESU designated critical habitat.

Table 38. Prey risk hypothesis; Coho, Lower Columbia River ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	6.37	High	High
Developed	5.85	High	High
Christmas Trees	0.35	High	Low
Orchards and Vineyards	0.32	High	Low
Other Crops	0.13	High	Low

Vegetables and Ground Fruit	0.11	High	Low
Corn	0.06	High	Low
Wheat	0.06	High	Low
Nurseries	0.04	High	Low
Other Grains	0.02	High	Low
Other RowCrops	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 39. Water quality risk hypothesis; Coho, Lower Columbia River ESU; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Lower Columbia River Coho ESU. Twelve use site categories, totaling more than 603,588 acres (over 15% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

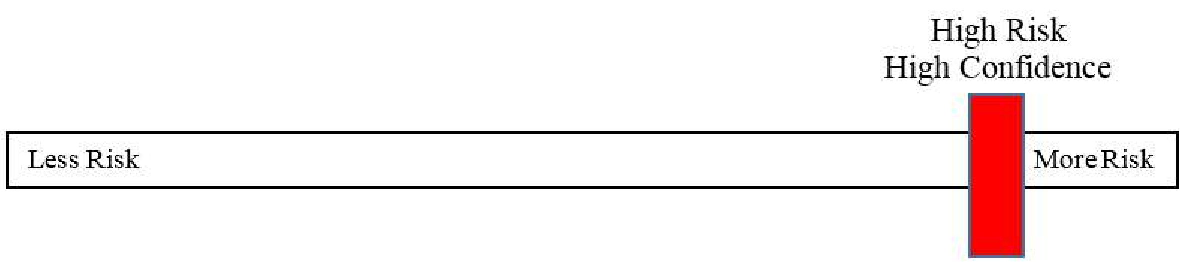
Table 40. Effects analysis summary table; Coho, Lower Columbia River ESU; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Lower Columbia River coho salmon. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



17.15 Oregon Coast Coho Salmon Designated Critical Habitat

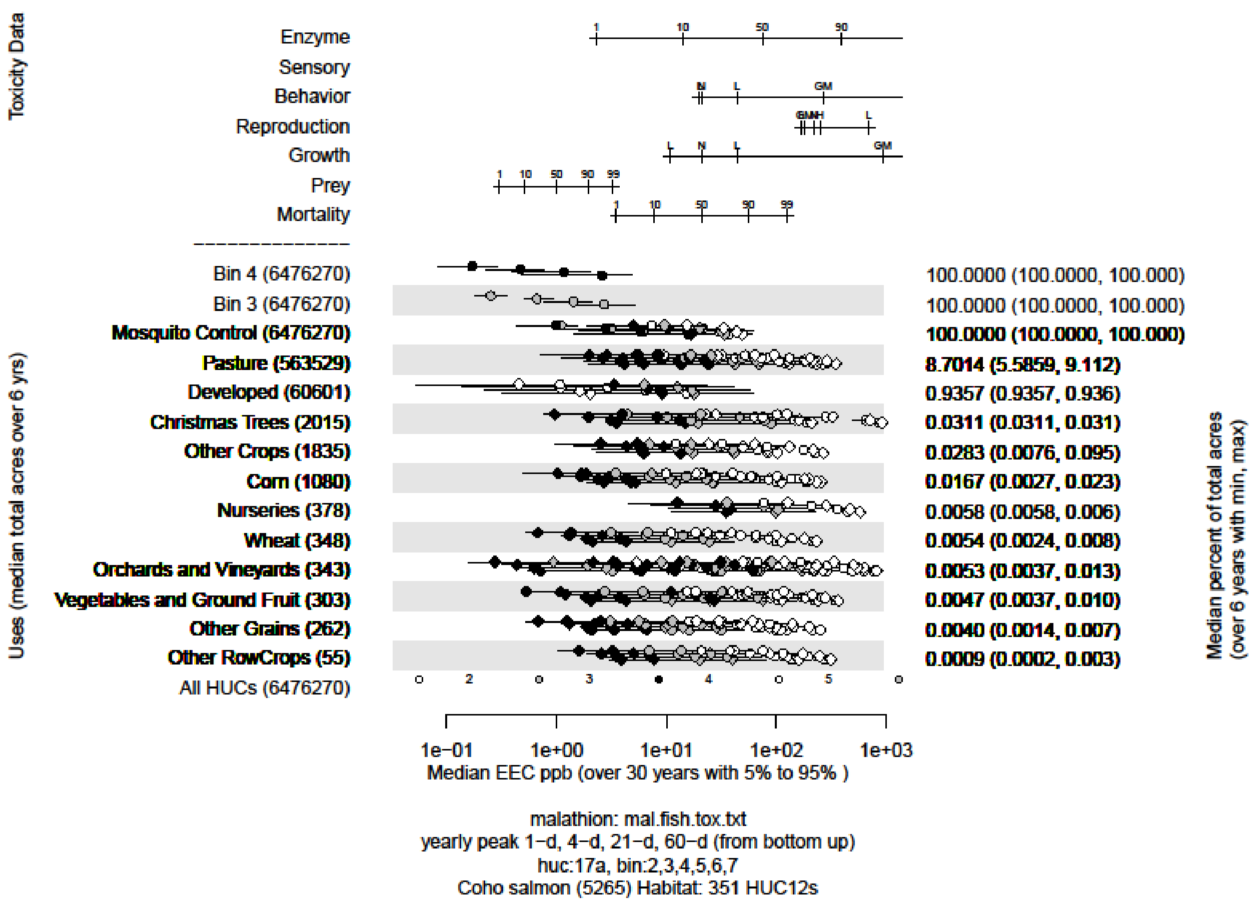


Figure 15. Effects analysis R-plot; Coho salmon, Oregon Coast ESU designated critical habitat.

Table 41. Prey risk hypothesis; Coho, Oregon coast ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Managed Forests	48.83	High	High

Pasture	8.70	High	High
Right of Way	5.80	High	High
Developed	0.94	High	Low
Golfcourses	0.05	High	Low
Christmas Trees	0.03	High	Low
Other Crops	0.03	High	Low
Corn	0.02	High	Low
Nurseries	0.01	High	Low
Wheat	0.01	High	Low
Orchards and Vineyards	0.01	High	Low
Vegetables and Ground Fruit	<0.01	High	Low
Other Grains	<0.01	High	Low
Other RowCrops	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 42. Water quality risk hypothesis; Coho, Oregon coast ESU; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Coho, Oregon coast ESU. Twleve use site categories, totaling more than 630,749 acres (over 11% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.

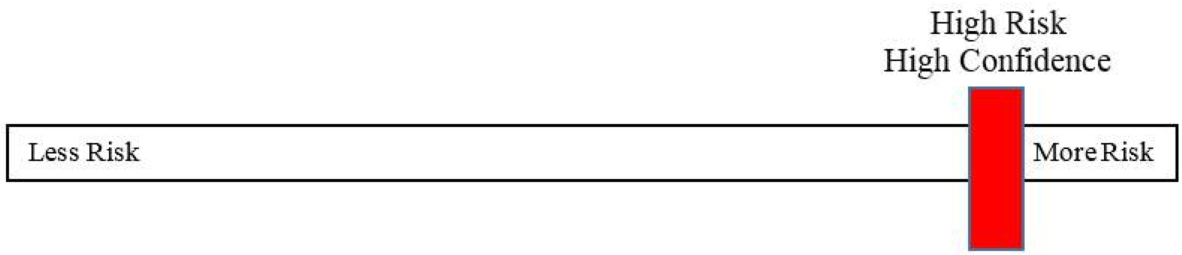
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

Table 43. Effects analysis summary table; Coho, Oregon coast ESU; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported? Yes/No
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Oregon Coast coho salmon. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.


High Risk
High Confidence
Less Risk
More Risk

17.16 Southern Oregon Northern California (SONC) Coho Salmon Designated Critical Habitat

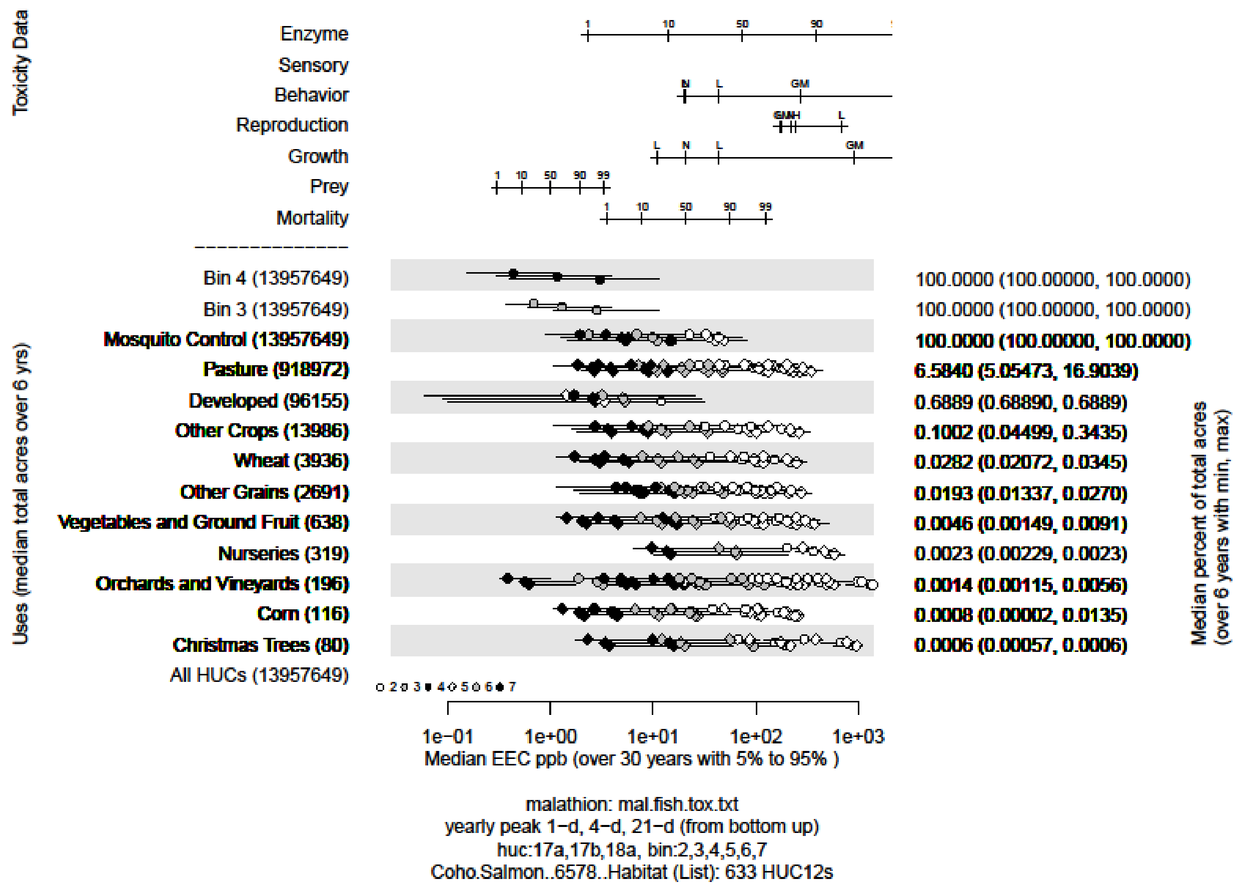


Figure 16. Effects analysis R-plot; Coho salmon, SONC ESU designated critical habitat.

Table 44. Prey risk hypothesis; Coho, SONC ESU; designated critical habitat.

17.16.1.1 Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	6.37	High	High
Developed	5.85	High	High
Christmas Trees	0.35	High	Low
Orchards and Vineyards	0.32	High	Low

Other Crops	0.13	High	Low
Vegetables and Ground Fruit	0.11	High	Low
Corn	0.06	High	Low
Wheat	0.06	High	Low
Nurseries	0.04	High	Low
Other Grains	0.02	High	Low
Other RowCrops	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 45. Water quality risk hypothesis; Coho, SONC ESU; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Coho, SONC ESU. Eleven use site categories, totaling more than 1,037,089 acres (over eight percent of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

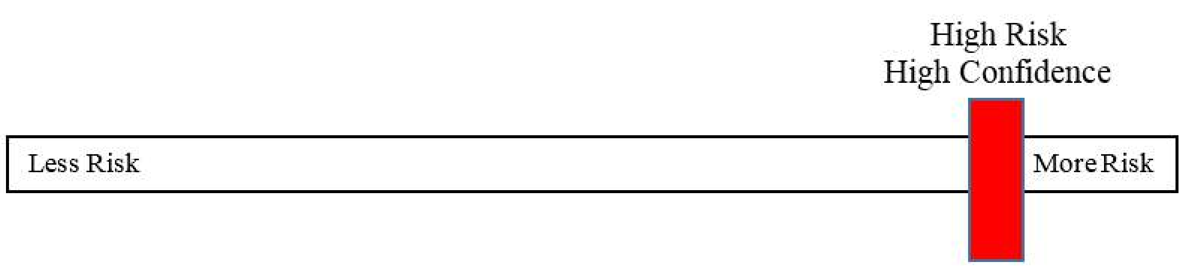
Table 46. Effects analysis summary table; Coho, SONC ESU; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Southern Oregon Northern California coho salmon. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



17.17 Ozette Lake Sockeye Designated Critical Habitat

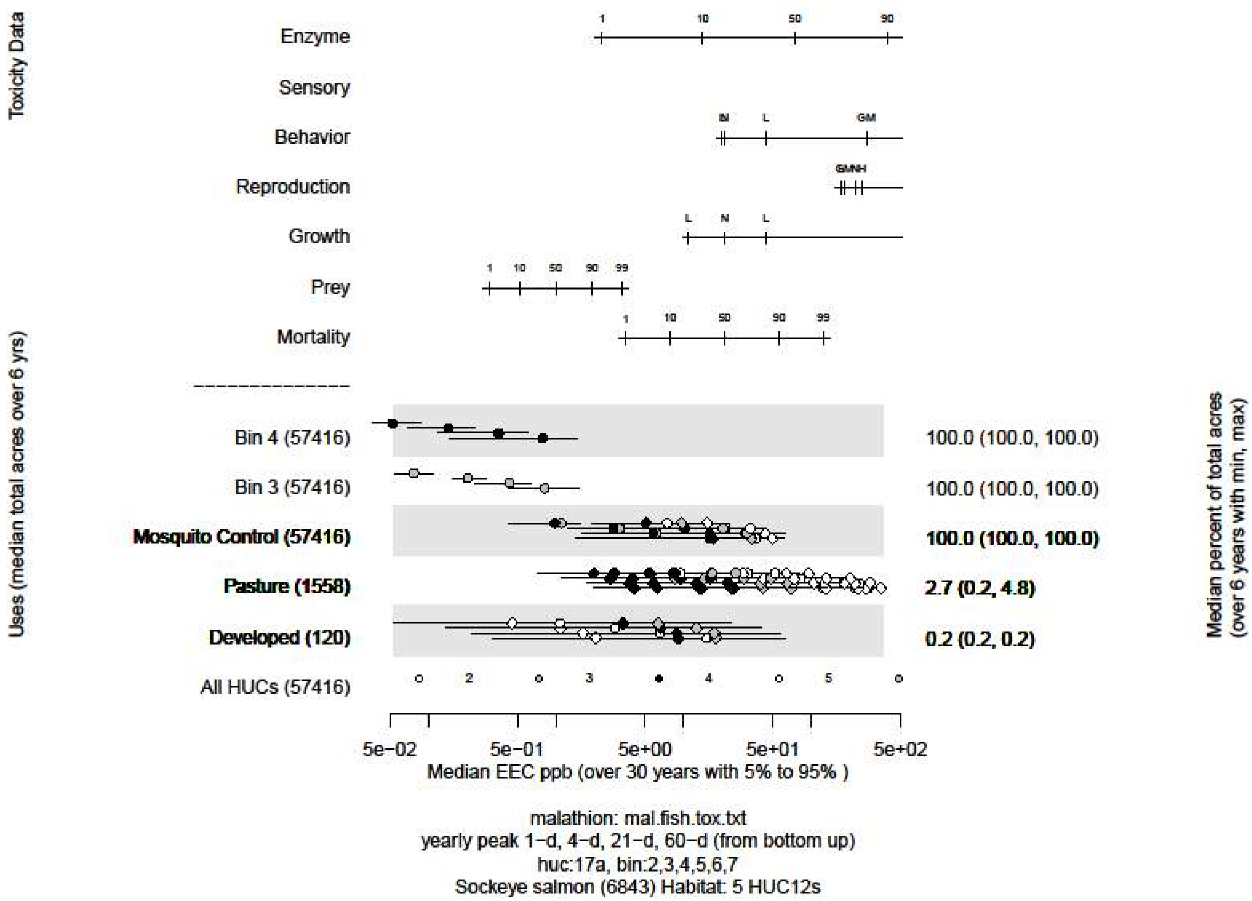


Figure 17. Effects analysis R-plot; Sockeye salmon, Ozette Lake ESU designated critical habitat.

Table 47. Prey risk hypothesis; Sockeye, Ozette Lake ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	Medium	High
Bin 4	100.00	Medium	High
Pasture	2.71	High	Medium
Developed	0.21	High	Low

Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*		
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**
High	**High**	

Table 48. Water quality risk hypothesis; Sockeye, Ozette Lake ESU; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Sockeye, Ozette Lake ESU. Three use site categories, totaling more than 1,678 acres (over 3% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

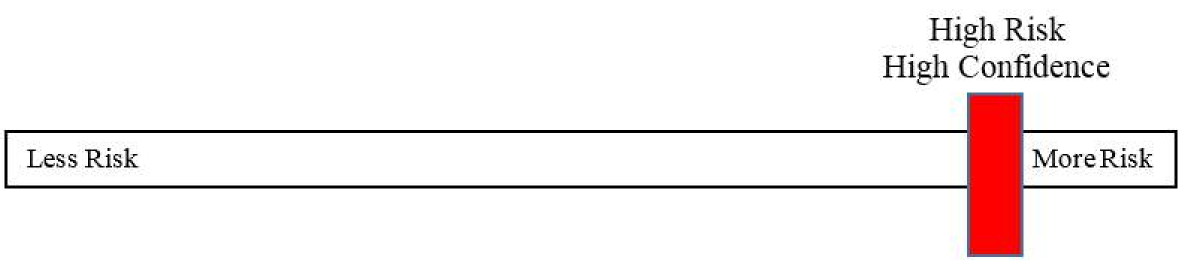
Table 49. Effects analysis summary table; Sockeye, Ozette Lake ESU; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported? Yes/No
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water	High	High	Yes

quality, natural cover, and/or reductions in prey in freshwater migratory corridors.			
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Ozette Lake sockeye salmon. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



17.18 Snake River Sockeye Salmon Designated Critical Habitat

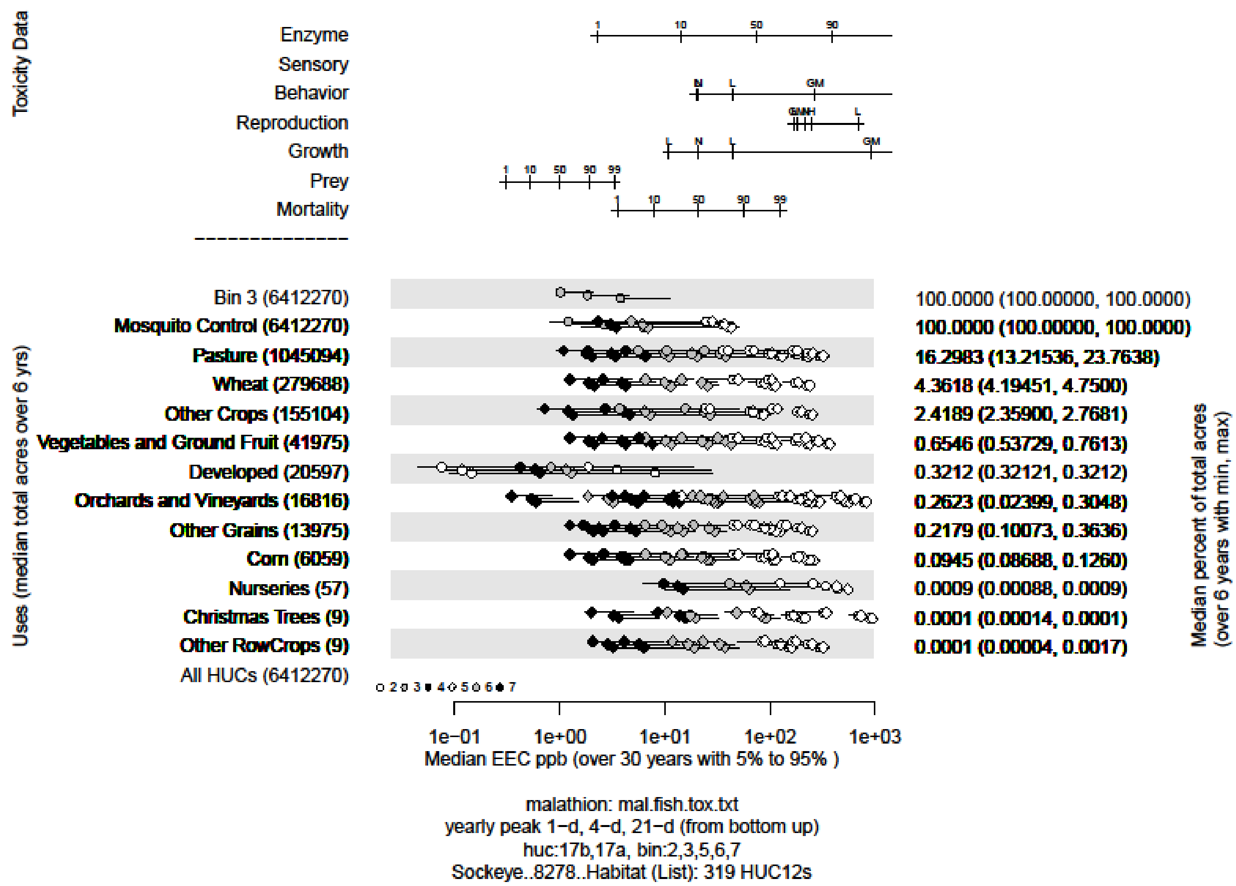


Figure 18. Effects analysis R-plot; Sockeye salmon, Snake River ESU designated critical habitat.

Table 50. Prey risk hypothesis; Sockeye, Snake River ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Pasture	16.30	High	High
Wheat	4.36	High	Medium
Other Crops	2.42	High	Medium
Vegetables and Ground Fruit	0.65	High	Low
Developed	0.32	High	Low
Orchards and Vineyards	0.26	High	Low

Other Grains	0.22	High	Low
Corn	0.09	High	Low
Nurseries	<0.01	High	Low
Christmas Trees	<0.01	High	Low
Other RowCrops	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 51. Water quality risk hypothesis; Sockeye, Snake River ESU; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Snake River Sockeye ESU. Twelve use site categories, totaling more than 7,991,653 acres (over 24% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

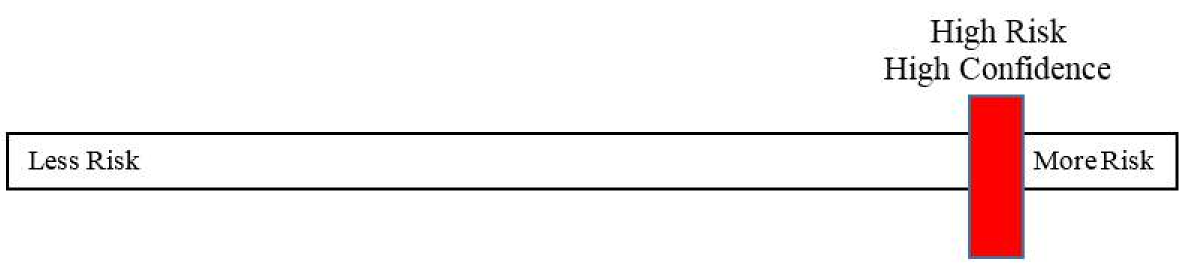
Table 52. Effects analysis summary table; Sockeye, Snake River ESU; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water	High	High	Yes

quality and/or reductions in prey in freshwater rearing sites.			
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Snake River sockeye salmon. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



17.19 California Central Valley Steelhead Designated Critical Habitat

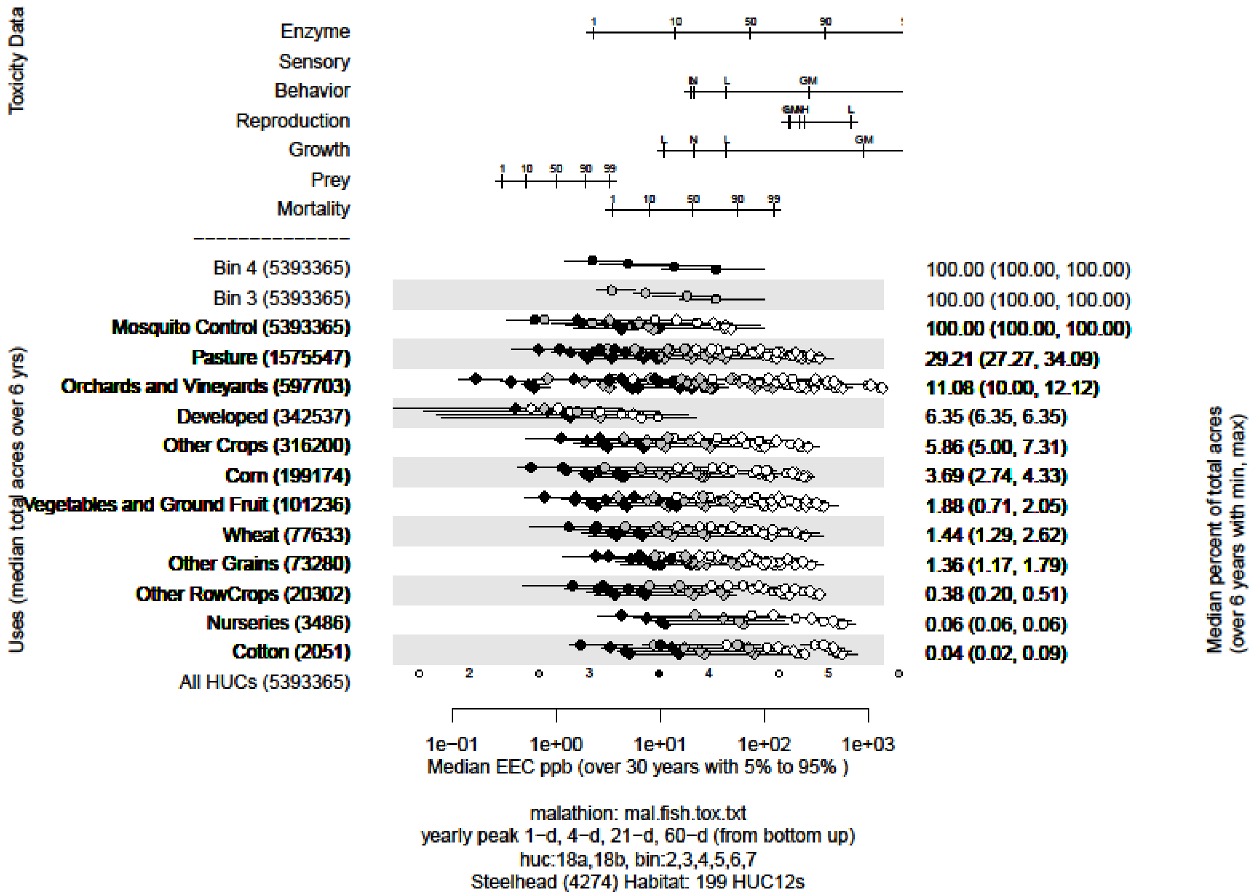


Figure 19. Effects analysis R-plot; Steelhead California Central Valley DPS designated critical habitat.

Table 53. Prey (fish) risk hypothesis; Steelhead, California Central Valley DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	29.21	High	High
Orchards and Vineyards	11.08	High	High

Developed	6.35	Medium	High
Other Crops	5.86	High	High
Corn	3.69	High	Medium
Vegetables and Ground Fruit	1.88	High	Medium
Wheat	1.44	High	Medium
Other Grains	1.36	High	Medium
Other RowCrops	0.38	High	Low
Nurseries	0.06	High	Low
Cotton	0.04	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 54. Prey (inverts) risk hypothesis; Steelhead, California Central Valley DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	29.21	High	High
Orchards and Vineyards	11.08	High	High
Developed	6.35	High	High
Other Crops	5.86	High	High
Corn	3.69	High	Medium
Vegetables and Ground Fruit	1.88	High	Medium
Wheat	1.44	High	Medium

Other Grains	1.36	High	Medium
Other RowCrops	0.38	High	Low
Nurseries	0.06	High	Low
Cotton	0.04	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 55. Water quality risk hypothesis; Steelhead, California Central Valley DPS; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Steelhead, California Central Valley DPS. Twelve use site categories, totaling more than 3,306,149 acres (over 61% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

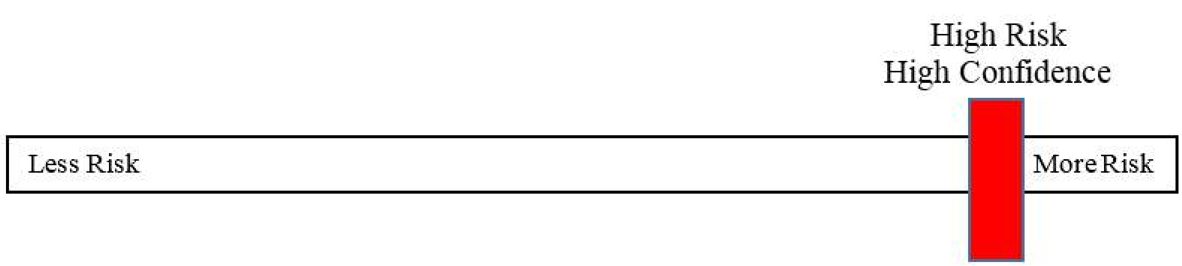
Table 56. Effects analysis summary table; Steelhead, California Central Valley DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of California Central Valley steelhead. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



17.20 Central California Coast Steelhead Designated Critical Habitat

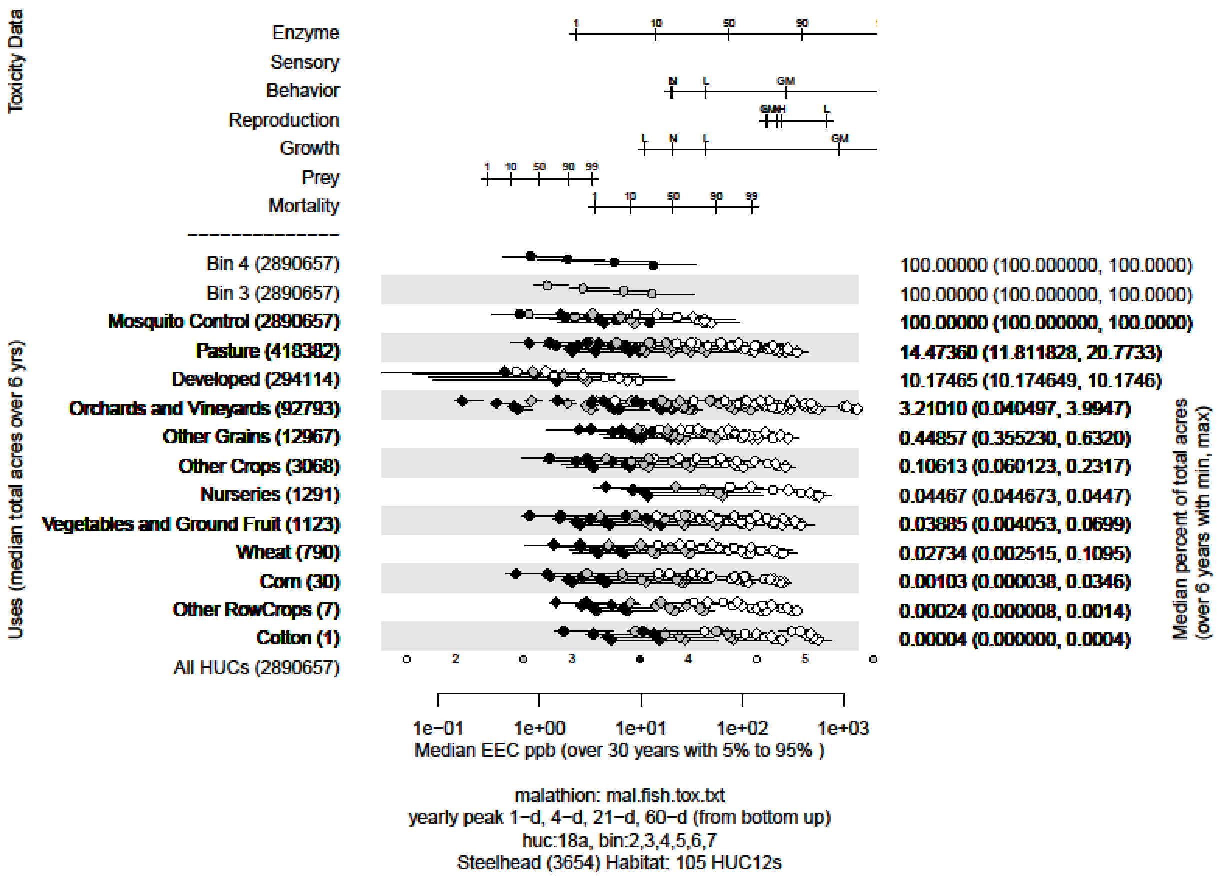


Figure 20. Effects analysis R-plot; Steelhead, Central California Coast DPS designated critical habitat.

Table 57. Prey (fish) risk hypothesis; Steelhead, Central California coast DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	14.47	High	High
Developed	10.17	Medium	High
Orchards and Vineyards	3.21	High	Medium

Other Grains	0.45	High	Low
Other Crops	0.11	High	Low
Nurseries	0.04	High	Low
Vegetables and Ground Fruit	0.04	High	Low
Wheat	0.03	High	Low
Corn	<0.01	High	Low
Other RowCrops	<0.01	High	Low
Cotton	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 58. Prey (inverts) risk hypothesis; Steelhead, Central California coast DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	14.47	High	High
Developed	10.17	High	High
Orchards and Vineyards	3.21	High	Medium
Other Grains	0.45	High	Low
Other Crops	0.11	High	Low
Nurseries	0.04	High	Low
Vegetables and Ground Fruit	0.04	High	Low
Wheat	0.03	High	Low
Corn	<0.01	High	Low

Other RowCrops	<0.01	High	Low
Cotton	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 59. Water quality risk hypothesis; Steelhead, Central California coast DPS; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Steelhead, Central California coast DPS. Twelve use site categories, totaling more than 824,556 acres (over 28% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

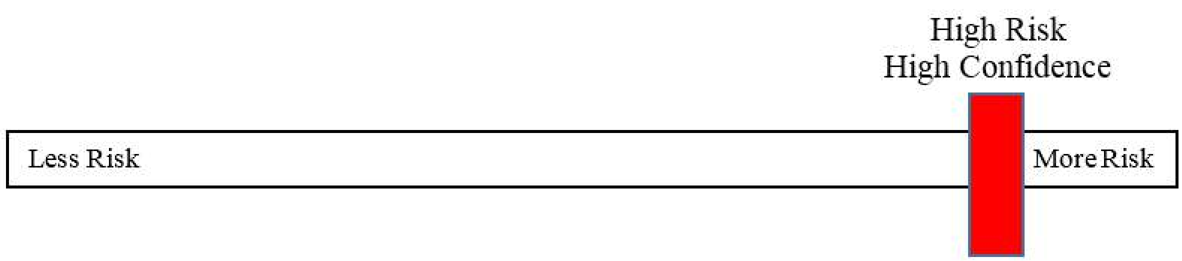
Table 60. Effects analysis summary table; Steelhead, Central California coast DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water	High	High	Yes

quality and/or reductions in prey in freshwater rearing sites.			
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Central California Coast steelhead. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



17.21 Lower Columbia River Steelhead Designated Critical Habitat

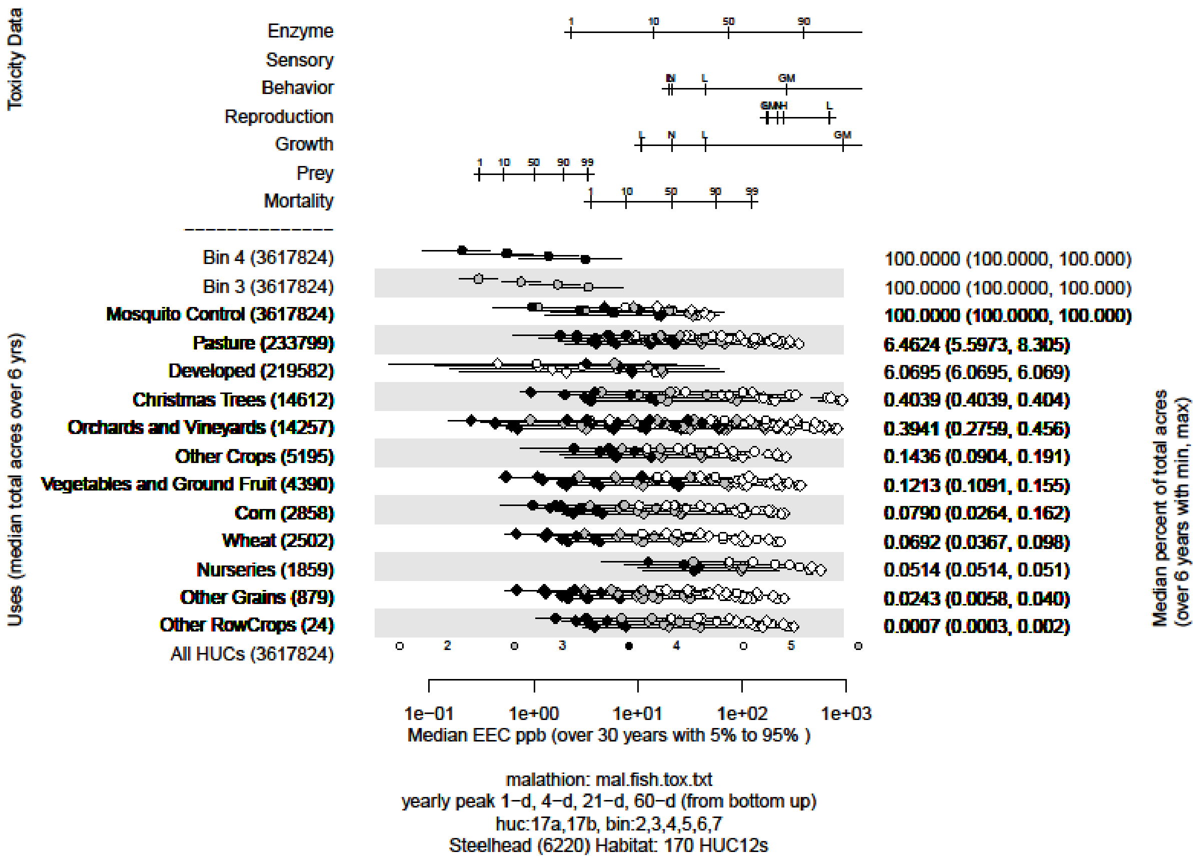


Figure 21. Effects analysis R-plot; Steelhead Lower Columbia River DPS designated critical habitat.

Table 61. Prey (fish) risk hypothesis; Steelhead, lower Columbia River DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Pasture	6.46	High	High
Developed	6.07	High	High
Christmas Trees	0.40	High	Low

Orchards and Vineyards	0.39	High	Low
Other Crops	0.14	High	Low
Vegetables and Ground Fruit	0.12	High	Low
Corn	0.08	High	Low
Wheat	0.07	High	Low
Nurseries	0.05	High	Low
Other Grains	0.02	High	Low
Other RowCrops	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 62. Prey (inverts) risk hypothesis; Steelhead, lower Columbia River DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	6.46	High	High
Developed	6.07	High	High
Christmas Trees	0.40	High	Low
Orchards and Vineyards	0.39	High	Low
Other Crops	0.14	High	Low
Vegetables and Ground Fruit	0.12	High	Low
Corn	0.08	High	Low
Wheat	0.07	High	Low

Nurseries	0.05	High	Low
Other Grains	0.02	High	Low
Other RowCrops	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 63. Water quality risk hypothesis; Steelhead, lower Columbia River DPS; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Steelhead, lower Columbia River DPS. Twelve use site categories, totaling more than 499,957 acres (over 8% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

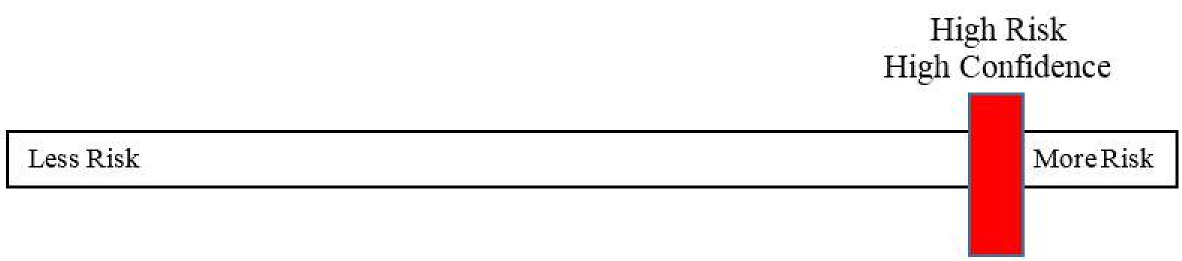
Table 64. Effects analysis summary table; Steelhead, lower Columbia River DPS; designated critical habitat.

Designated Critical Habitat; Risk Hypotheses	**R-plot Derived**		**Risk Hypothesis Supported? Yes/No**
	Risk	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water	High	High	Yes

quality and/or reductions in prey in freshwater rearing sites.			
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat Lower Columbia River steelhead. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



17.22 Middle Columbia River Steelhead Designated Critical Habitat

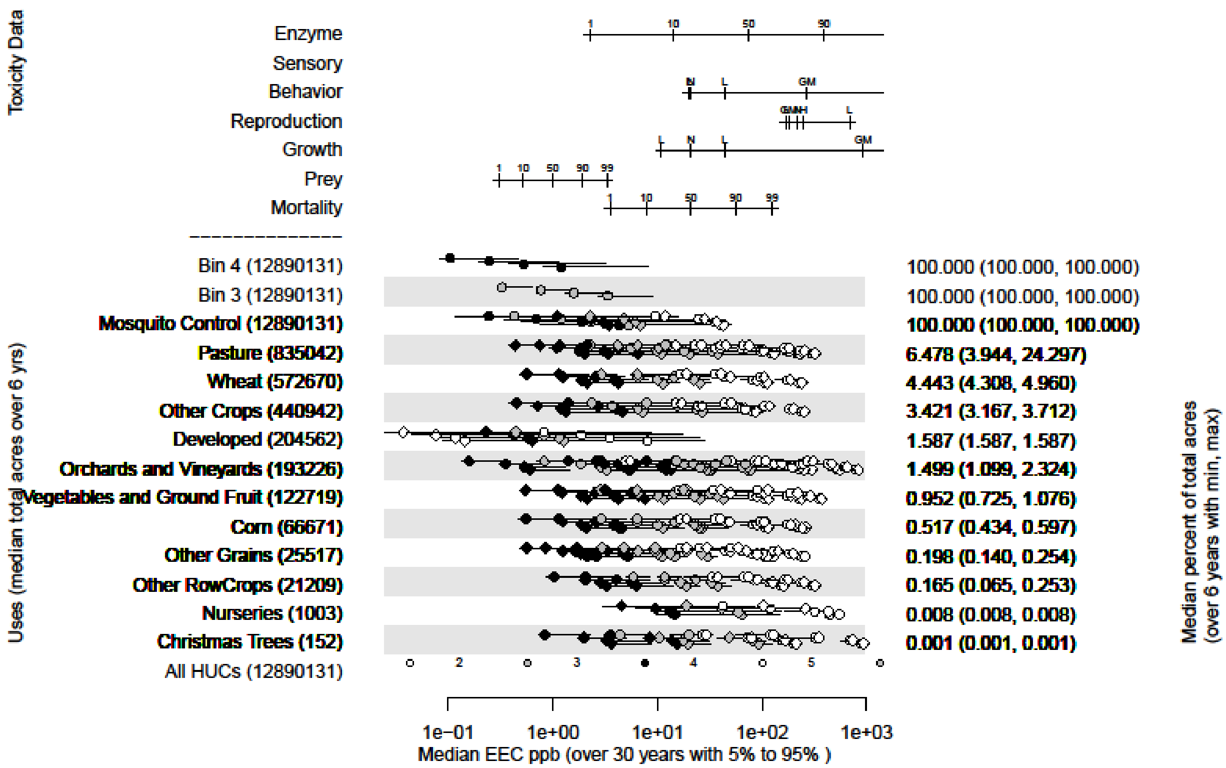


Figure 22. Effects analysis R-plot; Steelhead, Middle Columbia River DPS designated critical habitat.

Table 65. Prey (fish) risk hypothesis; Steelhead, middle Columbia River DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Pasture	6.48	High	High
Wheat	4.44	High	Medium
Other Crops	3.42	High	Medium
Developed	1.59	Medium	Medium

Orchards and Vineyards	1.50	High	Medium
Vegetables and Ground Fruit	0.95	High	Low
Corn	0.52	High	Low
Other Grains	0.20	High	Low
Other RowCrops	0.16	High	Low
Nurseries	0.01	High	Low
Christmas Trees	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 66. Prey (inverts) risk hypothesis; Steelhead, middle Columbia River DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	6.48	High	High
Wheat	4.44	High	Medium
Other Crops	3.42	High	Medium
Developed	1.59	High	Medium
Orchards and Vineyards	1.50	High	Medium
Vegetables and Ground Fruit	0.95	High	Low
Corn	0.52	High	Low
Other Grains	0.20	High	Low
Other RowCrops	0.16	High	Low

Nurseries	0.01	High	Low
Christmas Trees	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 67. Water quality risk hypothesis; Steelhead, middle Columbia River DPS; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Steelhead, middle Columbia River DPS. Twelve use site categories, totaling more than 2,483,713 acres (over 19% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

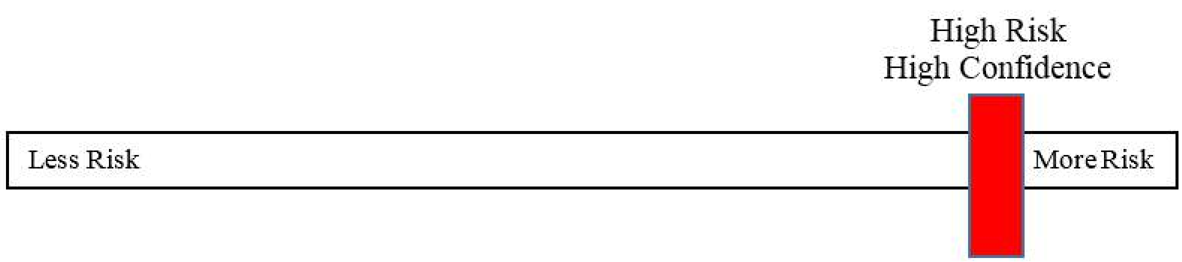
Table 68. Effects analysis summary table; Steelhead, middle Columbia River DPS; designated critical habitat.

Designated Critical Habitat; Risk Hypotheses	**R-plot Derived** **Risk**	**Confidence**	**Risk Hypothesis Supported?** **Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Middle Columbia River steelhead. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



17.23 Northern California Steelhead Designated Critical Habitat

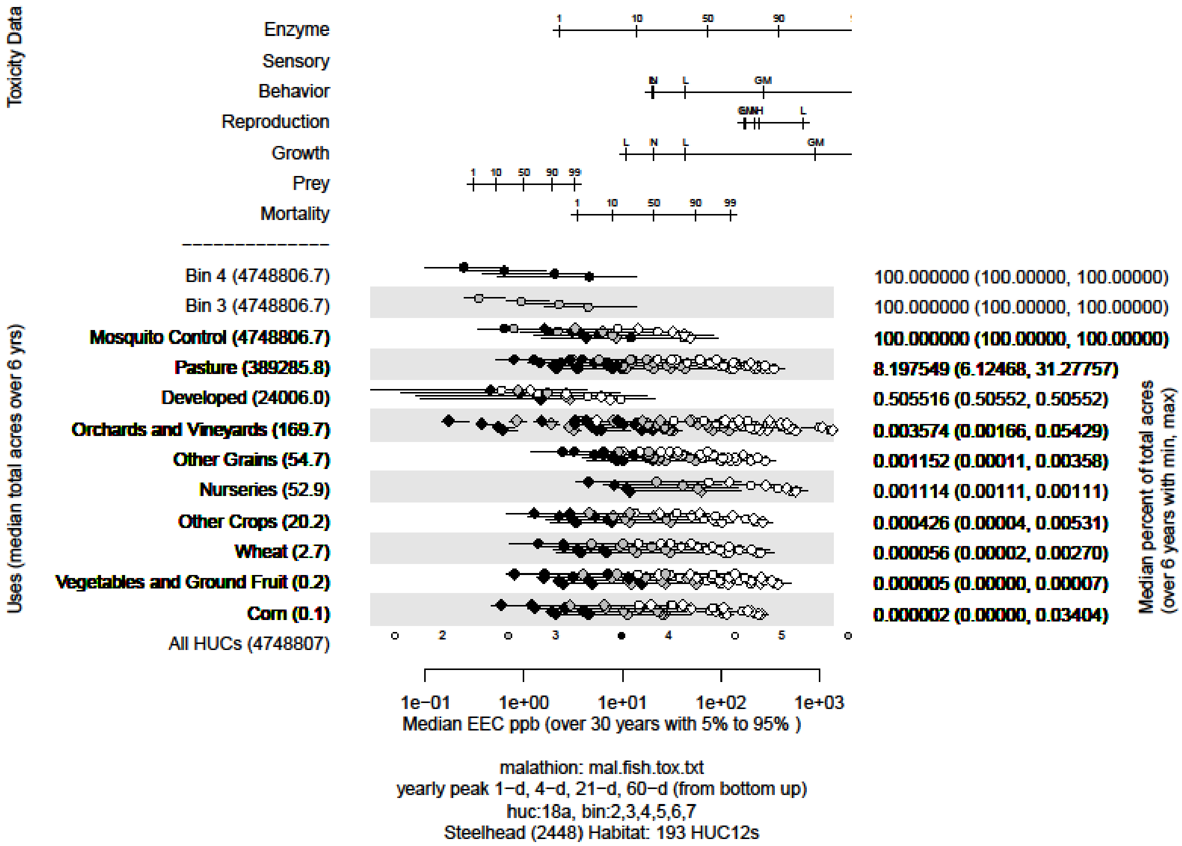


Figure 23. Effects analysis R-plot; Steelhead, Northern California DPS designated critical habitat.

Table 69. Prey (fish) risk hypothesis; Steelhead, Northern California DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	Medium	High
Bin 4	100.00	Medium	High
Pasture	8.20	High	High
Developed	0.51	Medium	Low
Orchards and Vineyards	<0.01	High	Low

Other Grains	<0.01	High	Low
Nurseries	<0.01	High	Low
Other Crops	<0.01	High	Low
Wheat	<0.01	High	Low
Vegetables and Ground Fruit	<0.01	High	Low
Corn	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 70. Prey (inverts) risk hypothesis; Steelhead, Northern California DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	Medium	High
Bin 4	100.00	Medium	High
Pasture	8.20	High	High
Developed	0.51	Medium	Low
Orchards and Vineyards	<0.01	High	Low
Other Grains	<0.01	High	Low
Nurseries	<0.01	High	Low
Other Crops	<0.01	High	Low
Wheat	<0.01	High	Low
Vegetables and Ground Fruit	<0.01	High	Low
Corn	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			

Risk	Confidence	*We have low confidence in EECs associated with marine and estuarine habitats.
High	**High**	

Table 71. Water quality risk hypothesis; Steelhead, Northern California DPS; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Steelhead, Northern California DPS. Ten use site categories, totaling more than 413,593 acres (over 9% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

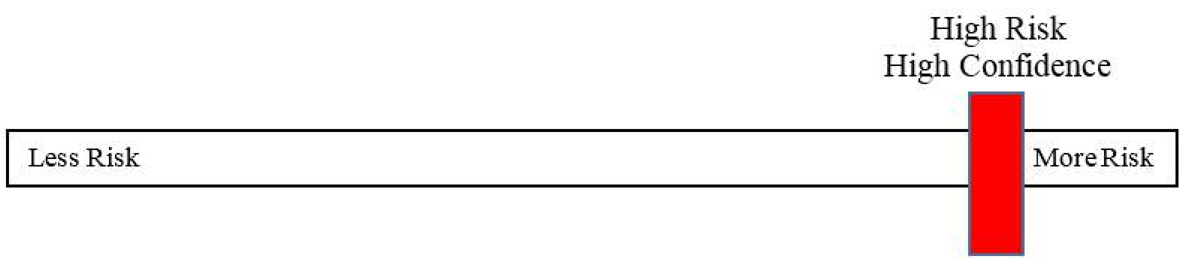
Table 72. Effects analysis summary table; Steelhead, Northern California DPS; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported? Yes/No
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat Northern California steelhead. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



17.24 Puget Sound Steelhead Designated Critical Habitat

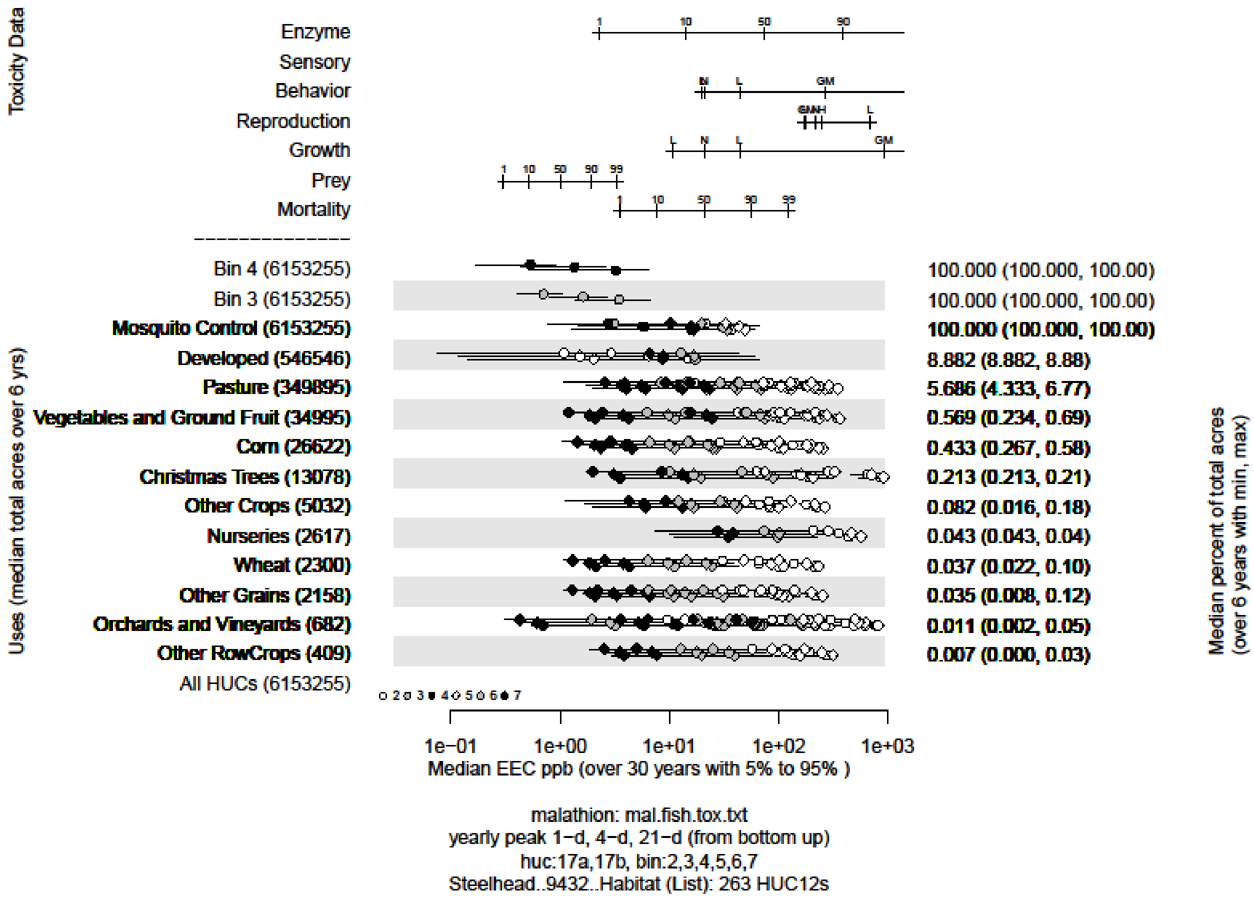


Figure 24. Effects analysis R-plot; Steelhead, Puget Sound DPS designated critical habitat.

Table 73. Prey (fish) risk hypothesis; Steelhead, Puget Sound DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Developed	8.88	High	High
Pasture	5.69	High	High
Vegetables and Ground Fruit	0.57	High	Low
Corn	0.43	High	Low

Christmas Trees	0.21	High	Low
Other Crops	0.08	High	Low
Nurseries	0.04	High	Low
Wheat	0.04	High	Low
Other Grains	0.04	High	Low
Orchards and Vineyards	0.01	High	Low
Other RowCrops	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 74. Prey (inverts) risk hypothesis; Steelhead, Puget Sound DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Developed	8.88	High	High
Pasture	5.69	High	High
Vegetables and Ground Fruit	0.57	High	Low
Corn	0.43	High	Low
Christmas Trees	0.21	High	Low
Other Crops	0.08	High	Low
Nurseries	0.04	High	Low
Wheat	0.04	High	Low
Other Grains	0.04	High	Low
Orchards and Vineyards	0.01	High	Low
Other RowCrops	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 75. Water quality risk hypothesis; Steelhead, Puget Sound DPS; designated critical habitat.

Endpoint: Water Quality

Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of steelhead, Puget Sound DPS. Twelve use site categories, totaling more than 7,137,589 acres (over 17% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

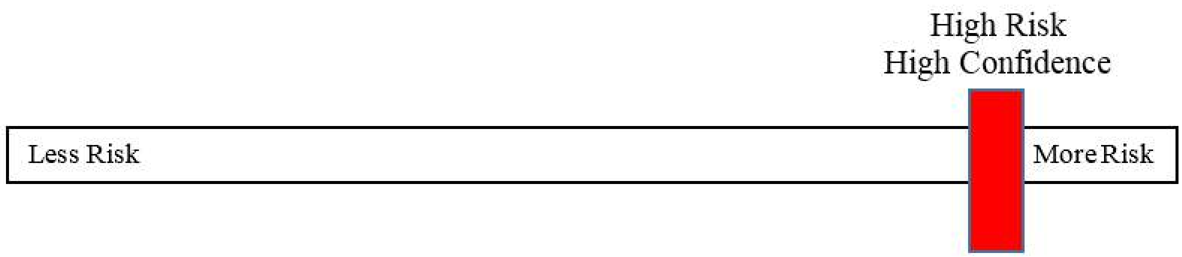
Table 76. Effects analysis summary table; Steelhead, Puget Sound DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water	High	Low	Yes

quality and/or reductions in prey in nearshore marine areas.			

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Puget Sound steelhead. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



17.25 Snake River Basin Steelhead Designated Critical Habitat

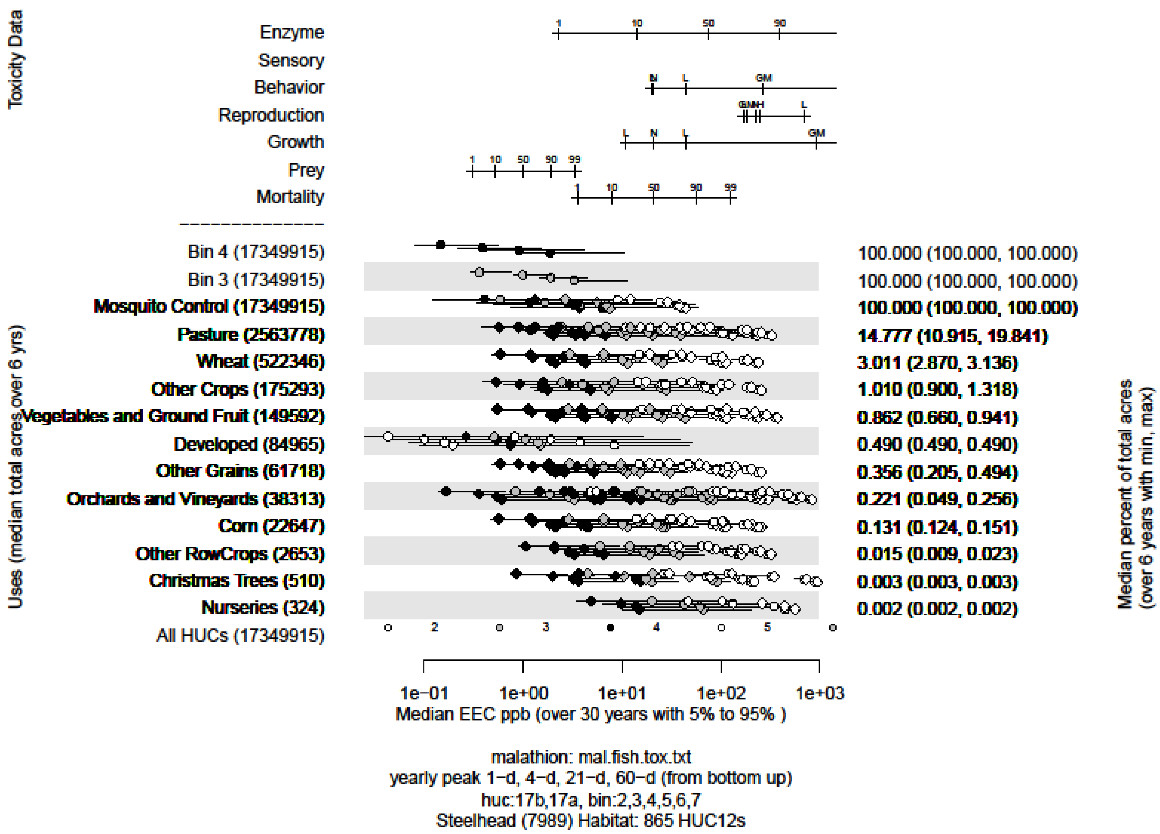


Figure 25. Effects analysis R-plot; Steelhead, Snake River Basin DPS designated critical habitat.

Table 77. Prey (fish) risk hypothesis; Steelhead, Snake River basin DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	Medium	High
Bin 4	100.00	Medium	High
Pasture	14.78	High	High
Wheat	3.01	High	Medium
Other Crops	1.01	High	Medium
Vegetables and Ground Fruit	0.86	High	Low

Developed	0.49	High	Low
Other Grains	0.36	High	Low
Orchards and Vineyards	0.22	High	Low
Corn	0.13	High	Low
Other RowCrops	0.02	High	Low
Christmas Trees	<0.01	High	Low
Nurseries	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 78. Prey (inverts) risk hypothesis; Steelhead, Snake River basin DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	14.78	High	High
Wheat	3.01	High	Medium
Other Crops	1.01	High	Medium
Vegetables and Ground Fruit	0.86	High	Low
Developed	0.49	High	Low
Other Grains	0.36	High	Low
Orchards and Vineyards	0.22	High	Low
Corn	0.13	High	Low
Other RowCrops	0.02	High	Low
Christmas Trees	<0.01	High	Low

Nurseries	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 79. Water quality risk hypothesis; Steelhead, Snake River basin DPS; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Steelhead, Snake River basin DPS. Twelve use site categories, totaling more than 3,622,139 acres (over 21% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

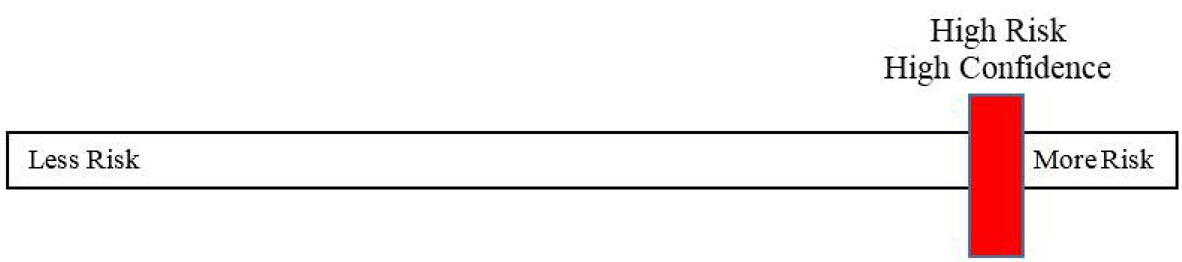
Table 80. Effects analysis summary table; Steelhead, Snake River basin DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat Snake River basin steelhead. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



17.26 South Central California Coast Steelhead Designated Critical Habitat

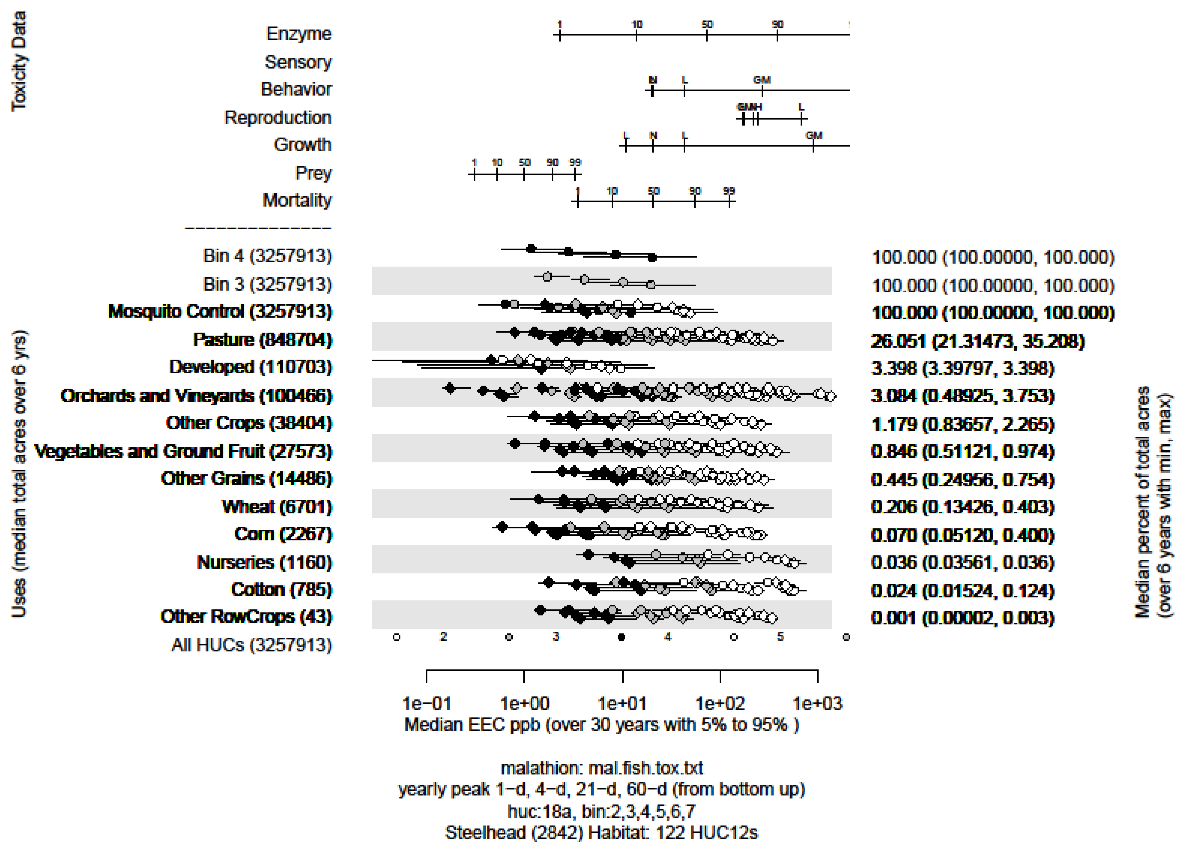


Figure 26. Effects analysis R-plot; Steelhead, South Central California Coast DPS designated critical habitat.

Table 81. Prey (fish) risk hypothesis; Steelhead, South-central California coast DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	26.05	High	High
Developed	3.40	Medium	Medium
Orchards and Vineyards	3.08	High	Medium

Other Crops	1.18	High	Medium
Vegetables and Ground Fruit	0.85	High	Low
Other Grains	0.44	High	Low
Wheat	0.21	High	Low
Corn	0.07	High	Low
Nurseries	0.04	High	Low
Cotton	0.02	High	Low
Other RowCrops	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 82. Prey (inverts) risk hypothesis; Steelhead, South-central California coast DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	26.05	High	High
Developed	3.40	High	Medium
Orchards and Vineyards	3.08	High	Medium
Other Crops	1.18	High	Medium
Vegetables and Ground Fruit	0.85	High	Low
Other Grains	0.44	High	Low
Wheat	0.21	High	Low
Corn	0.07	High	Low

Nurseries	0.04	High	Low
Cotton	0.02	High	Low
Other RowCrops	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 83. Water quality risk hypothesis; Steelhead, South-central California coast DPS; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Steelhead, South-central California Coast DPS. Twelve use site categories, totaling more than 1,149,507 acres (over 35% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

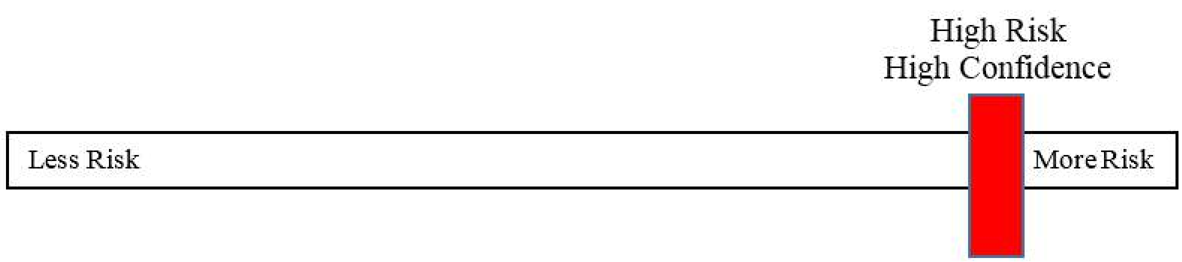
Table 84. Effects analysis summary table; Steelhead, South-central California coast DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of South-central California Coast steelhead. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



17.27 Southern California Steelhead Designated Critical Habitat

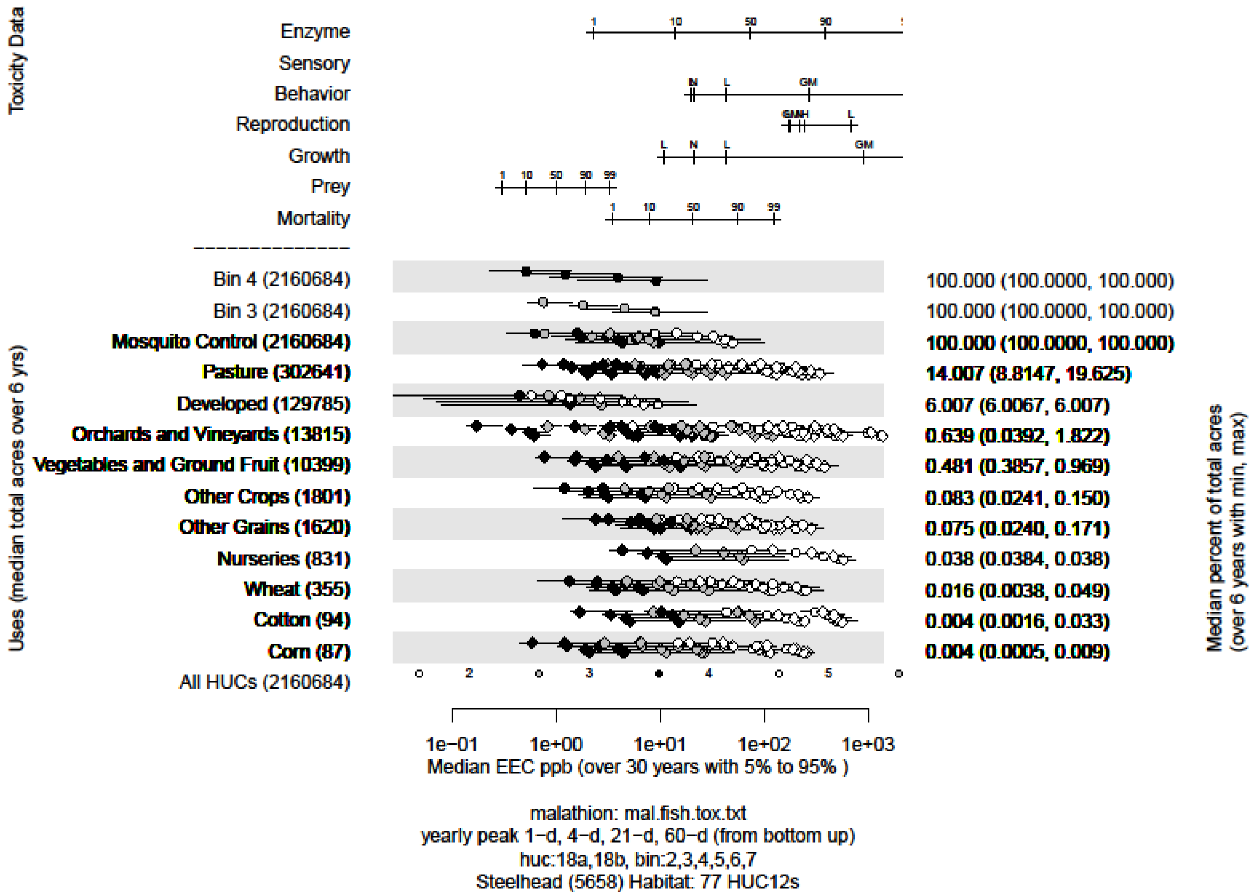


Figure 27. Effects analysis R-plot; Steelhead, Southern California DPS designated critical habitat.

Table 85. Prey (fish) risk hypothesis; Steelhead, Southern California DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	Medium	High
Bin 4	100.00	Medium	High
Pasture	14.01	High	High
Developed	6.01	Medium	High

Orchards and Vineyards	0.64	High	Low
Vegetables and Ground Fruit	0.48	High	Low
Other Crops	0.08	High	Low
Other Grains	0.07	High	Low
Nurseries	0.04	High	Low
Wheat	0.02	High	Low
Cotton	<0.01	High	Low
Corn	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 86. Prey (inverts) risk hypothesis; Steelhead, Southern California ESU; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	14.01	High	High
Developed	6.01	High	High
Orchards and Vineyards	0.64	High	Low
Vegetables and Ground Fruit	0.48	High	Low
Other Crops	0.08	High	Low
Other Grains	0.07	High	Low
Nurseries	0.04	High	Low
Wheat	0.02	High	Low

Cotton	<0.01	High	Low
Corn	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 87. Water quality risk hypothesis; Steelhead, Southern California DPS; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Steelhead, Southern California DPS. Eleven use site categories, totaling more than 461,428 acres (over 22% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

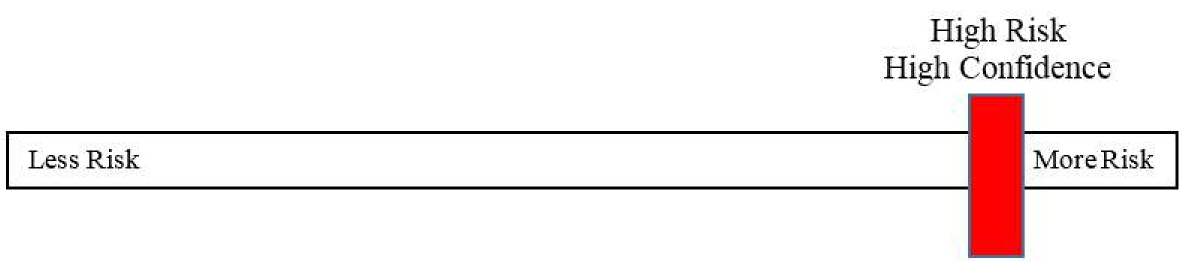
Table 88. Effects analysis summary table; Steelhead, Southern California DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.	High	High	Yes

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat Southern California steelhead. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



17.28 Upper Columbia River Steelhead Designated Critical Habitat

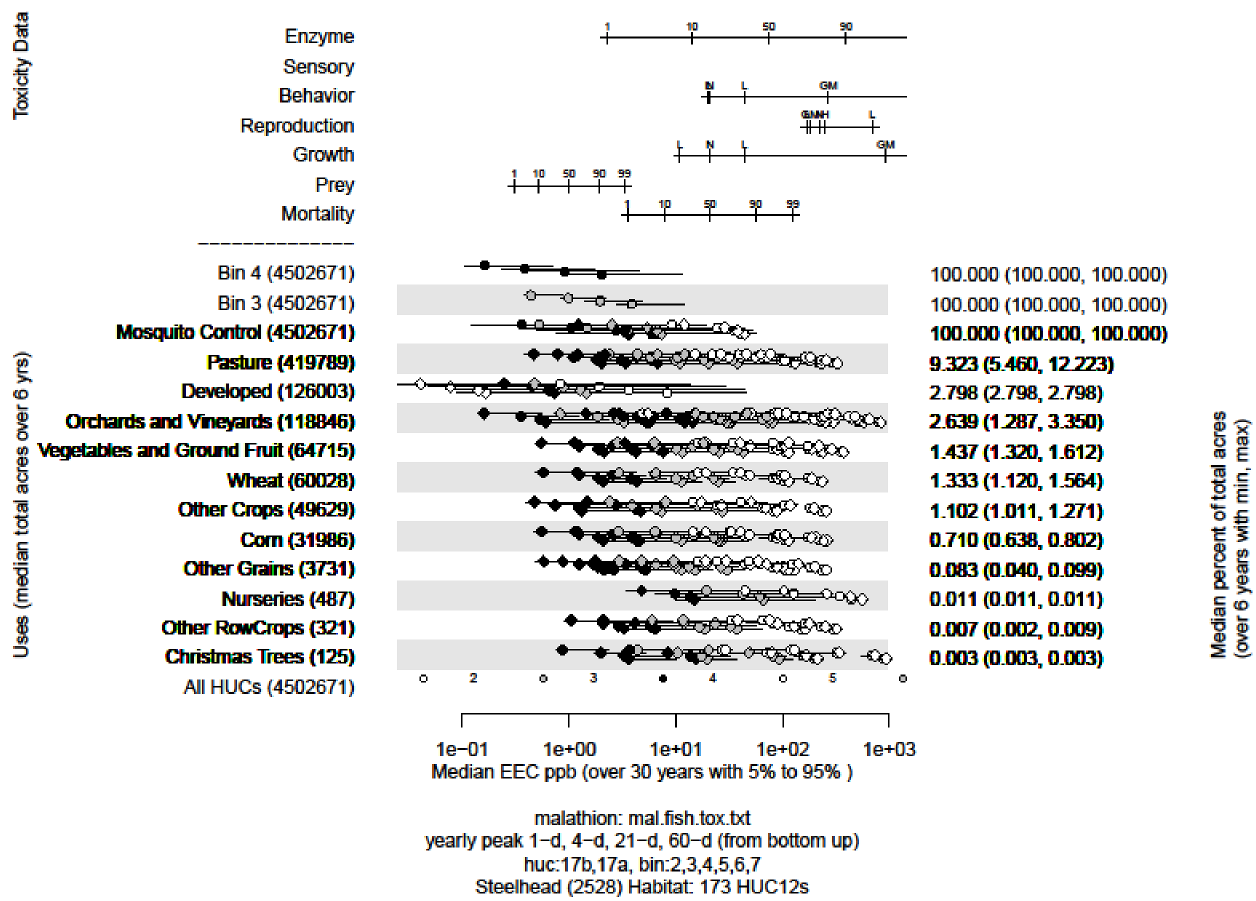


Figure 28. Effects analysis R-plot; Steelhead, Upper Columbia River DPS designated critical habitat.

Table 89. Prey (fish) risk hypothesis; Steelhead, upper Columbia River DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	Medium	High
Bin 4	100.00	Medium	High
Pasture	9.32	High	High
Developed	2.80	High	Medium

Orchards and Vineyards	2.64	High	Medium
Vegetables and Ground Fruit	1.44	High	Medium
Wheat	1.33	High	Medium
Other Crops	1.10	High	Medium
Corn	0.71	High	Low
Other Grains	0.08	High	Low
Nurseries	0.01	High	Low
Other RowCrops	0.01	High	Low
Christmas Trees	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 90. Prey (inverts) risk hypothesis; Steelhead, upper Columbia River DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	9.32	High	High
Developed	2.80	High	Medium
Orchards and Vineyards	2.64	High	Medium
Vegetables and Ground Fruit	1.44	High	Medium
Wheat	1.33	High	Medium
Other Crops	1.10	High	Medium
Corn	0.71	High	Low

Other Grains	0.08	High	Low
Nurseries	0.01	High	Low
Other RowCrops	0.01	High	Low
Christmas Trees	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 91. Water quality risk hypothesis; Steelhead, upper Columbia River DPS; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Steelhead, upper Columbia River DPS. Twelve use site categories, totaling more than 875,660 acres (over 20% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

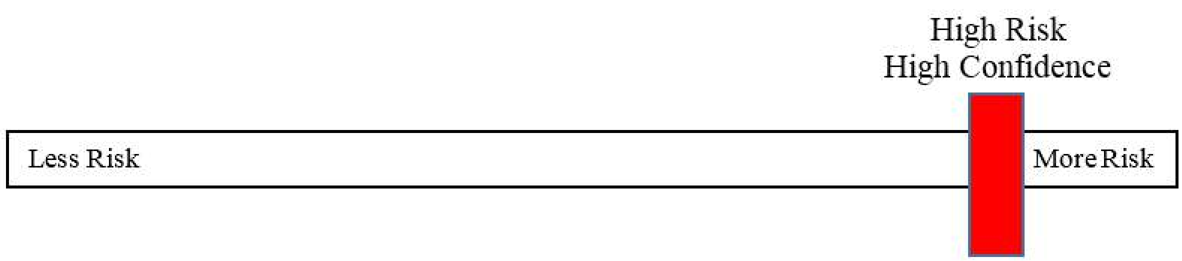
Table 92. Effects analysis summary table; Steelhead, upper Columbia River DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water	High	High	Yes

quality and/or reductions in prey in freshwater rearing sites.			
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of upper Columbia River steelhead. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



17.29 Upper Willamette River Steelhead Designated Critical Habitat

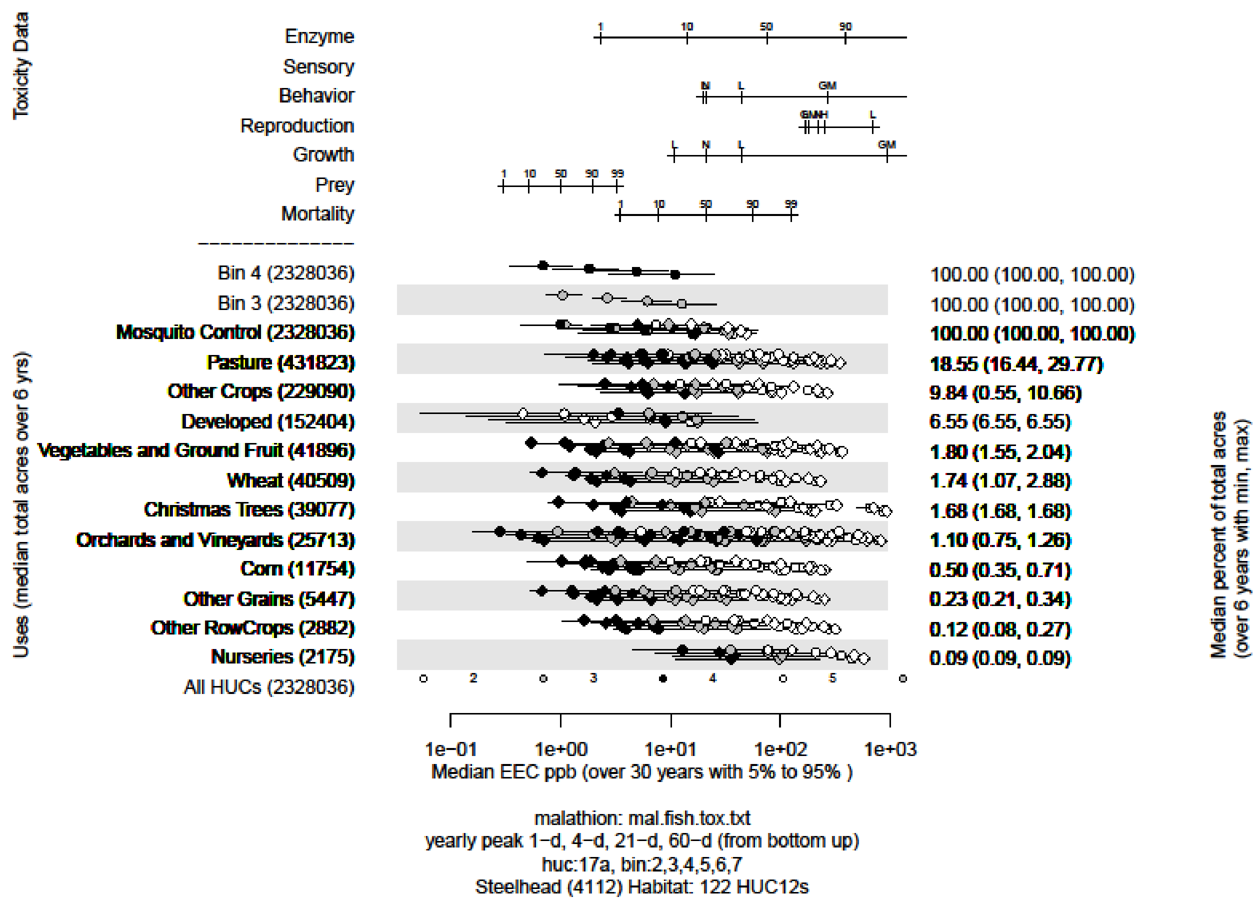


Figure 29. Effects analysis R-plot; Steelhead, Upper Willamette River DPS designated critical habitat.

Table 93. Prey (fish) risk hypothesis; Steelhead, upper Willamette River DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	Medium	High
Bin 4	100.00	Medium	High
Pasture	18.55	High	High
Other Crops	9.84	High	High
Developed	6.55	High	High

Vegetables and Ground Fruit	1.80	High	Medium
Wheat	1.74	High	Medium
Christmas Trees	1.68	High	Medium
Orchards and Vineyards	1.10	High	Medium
Corn	0.50	High	Low
Other Grains	0.23	High	Low
Other RowCrops	0.12	High	Low
Nurseries	0.09	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 94. Prey (inverts) risk hypothesis; Steelhead, upper Willamette River DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	18.55	High	High
Other Crops	9.84	High	High
Developed	6.55	High	High
Vegetables and Ground Fruit	1.80	High	Medium
Wheat	1.74	High	Medium
Christmas Trees	1.68	High	Medium
Orchards and Vineyards	1.10	High	Medium
Corn	0.50	High	Low

Other Grains	0.23	High	Low
Other RowCrops	0.12	High	Low
Nurseries	0.09	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater spawning, rearing, migratory corridors, estuarine, and nearshore marine habitats.*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 95. Water quality risk hypothesis; Steelhead, upper Willamette River DPS; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Steelhead, upper Willamette River DPS. Twelve use site categories, totaling more than 982,770 acres (over 44% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

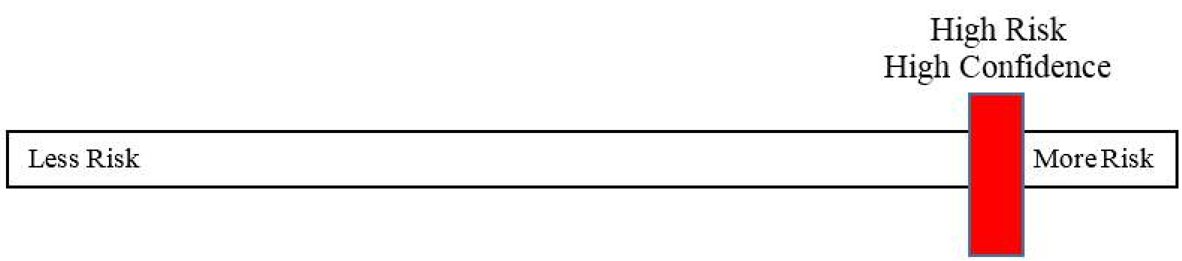
Table 96. Effects analysis summary table; Steelhead, upper Willamette River DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water	High	High	Yes

quality and/or reductions in prey in freshwater rearing sites.			
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat upper Willamette River steelhead. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



17.30 Eulachon (Southern DPS) Designated Critical Habitat

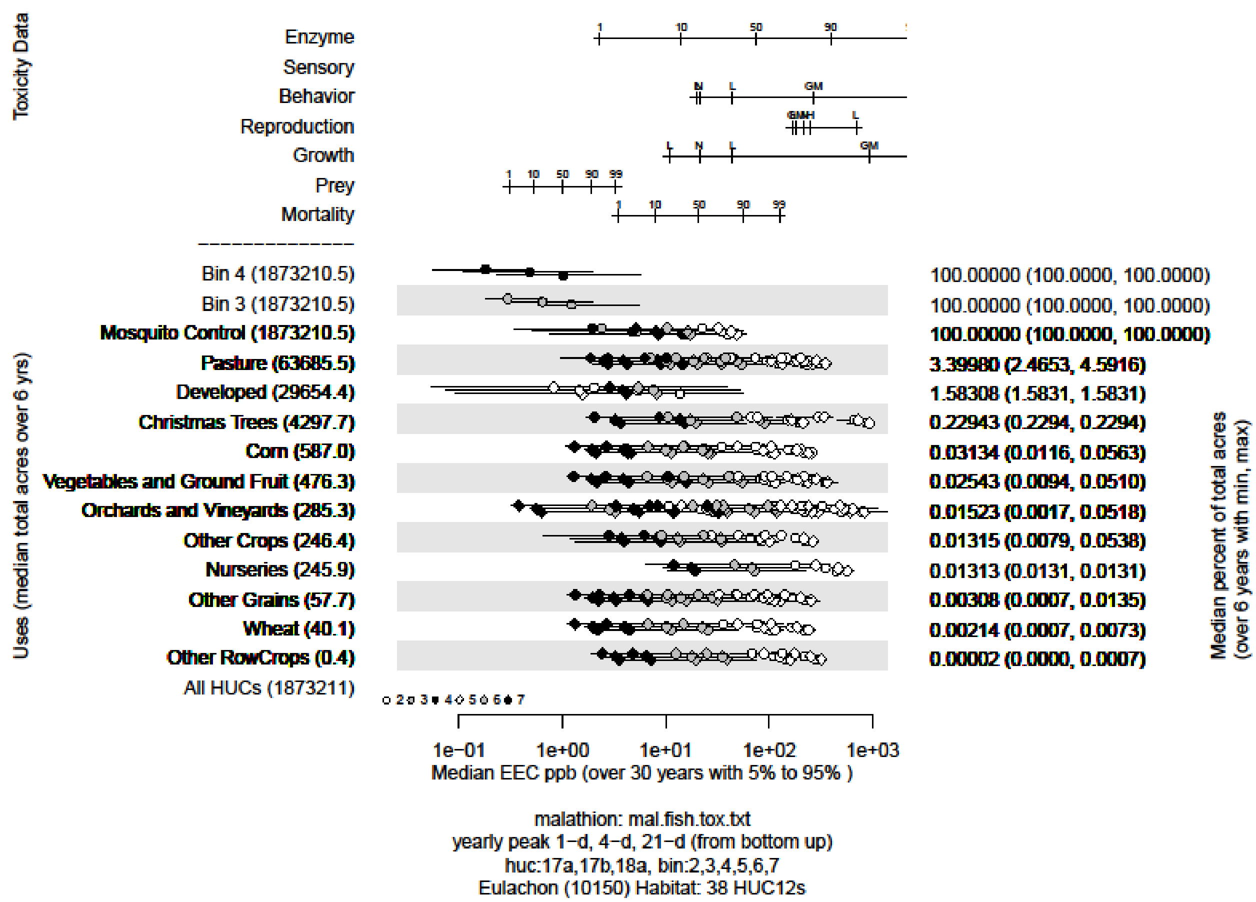


Figure 30. Effects analysis R-plot; Eulachon, Southern DPS designated critical habitat.

Table 97. Prey (inverts) risk hypothesis; Eulachon, southern DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	3.40	High	Medium
Developed	1.58	High	Medium

Christmas Trees	0.23	High	Low
Corn	0.03	High	Low
Vegetables and Ground Fruit	0.03	High	Low
Orchards and Vineyards	0.02	High	Low
Other Crops	0.01	High	Low
Nurseries	0.01	High	Low
Other Grains	<0.001	High	Low
Wheat	<0.001	High	Low
Other RowCrops	<0.001	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey (inverts).			
Risk	**Confidence**		
High	**High**		

Table 98. Water quality risk hypothesis; Eulachon, southern DPS; designated critical habitat.

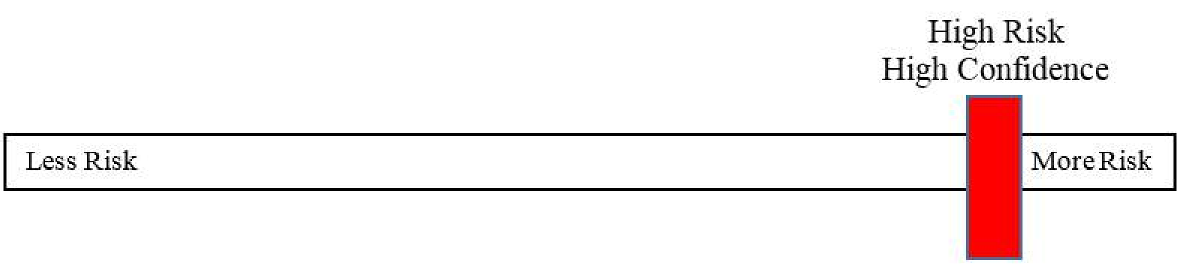
Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Eulachon, southern DPS. Twelve use site categories, totaling more than 99,572 acres (over 6% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

Table 99. Effects analysis summary table; Eulachon, southern DPS; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported? Yes/No
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater and estuarine habitats.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in freshwater and estuarine habitats.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in nearshore and offshore habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in nearshore and offshore habitats.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat eulachon. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



17.31 Green Sturgeon (Southern DPS) Designated Critical Habitat

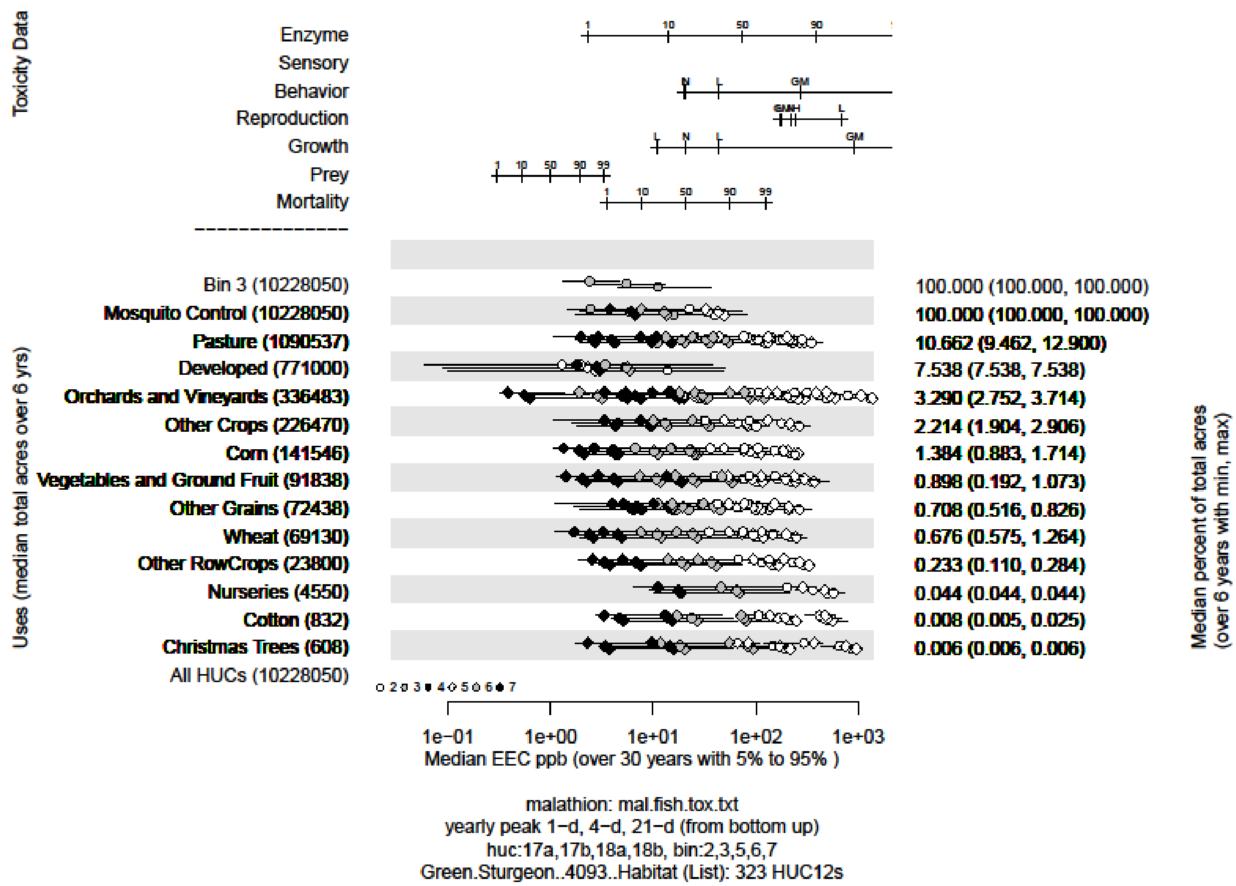


Figure 31. Effects analysis R-plot; Green Sturgeon, Southern DPS designated critical habitat.

Table 100. Prey (fish) risk hypothesis; Green Sturgeon, Southern DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Pasture	10.66	High	High
Developed	7.54	High	High
Orchards and Vineyards	3.29	High	Medium
Other Crops	2.21	High	Medium
Corn	1.38	High	Medium
Vegetables and Ground Fruit	0.90	High	Low
Other Grains	0.71	High	Low

Wheat	0.68	High	Low
Other RowCrops	0.23	High	Low
Nurseries	0.04	High	Low
Cotton	0.01	High	Low
Christmas Trees	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (fish).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 101. Prey (inverts) risk hypothesis; Green Sturgeon, Southern DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Pasture	10.66	High	High
Developed	7.54	High	High
Orchards and Vineyards	3.29	High	Medium
Other Crops	2.21	High	Medium
Corn	1.38	High	Medium
Vegetables and Ground Fruit	0.90	High	Low
Other Grains	0.71	High	Low
Wheat	0.68	High	Low
Other RowCrops	0.23	High	Low
Nurseries	0.04	High	Low
Cotton	0.01	High	Low
Christmas Trees	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (inverts).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 102. Water quality risk hypothesis; Green Sturgeon, Southern DPS; designated critical habitat.

Endpoint: Water Quality

Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of green sturgeon. Thirteen use site categories, totaling more than 2,829,232 acres (over 28% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

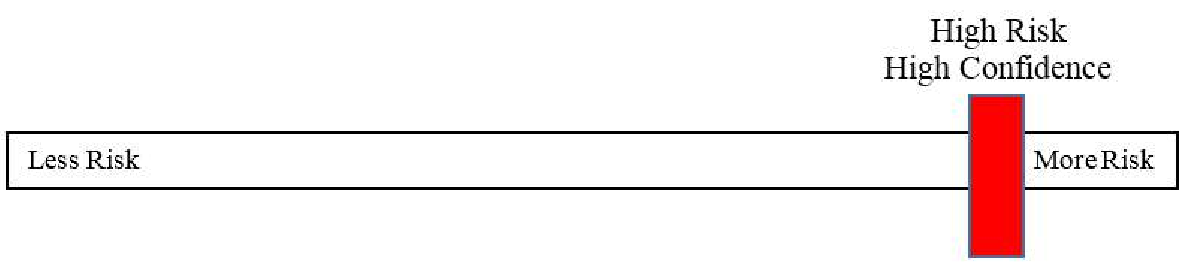
Table 103. Effects analysis summary table; Green Sturgeon, Southern DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater habitats.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of prey in freshwater habitats.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in estuarine habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in estuarine habitats.	High	Low	Yes

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in coastal habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in coastal habitats.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of green sturgeon. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



17.32 Gulf Sturgeon Designated Critical Habitat

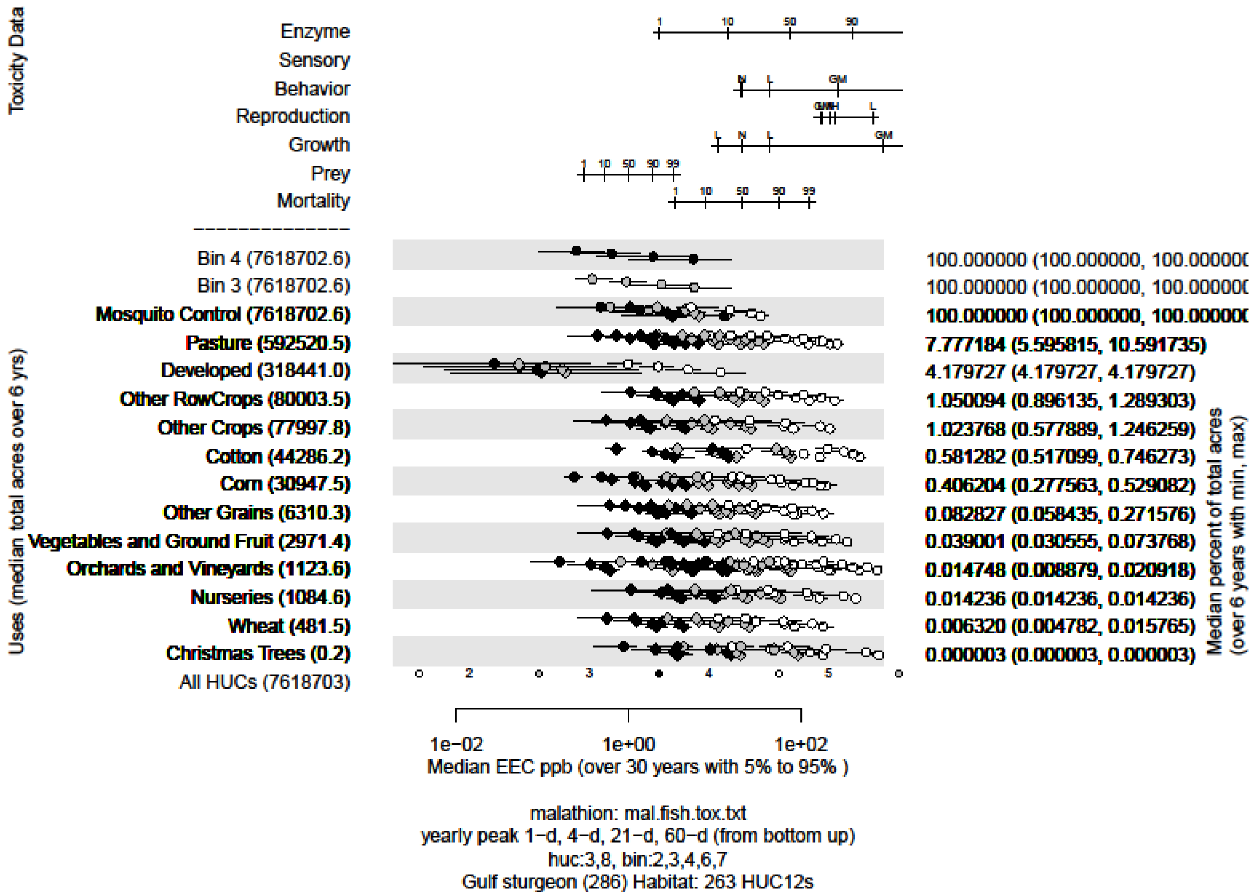


Figure 32. Effects analysis R-plot; Gulf Sturgeon designated critical habitat.

Table 104. Prey (fish) risk hypothesis; Gulf Sturgeon; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	Medium	High
Bin 4	100.00	Medium	High
Pasture	7.78	High	High
Developed	4.18	Medium	Medium
Other RowCrops	1.05	High	Medium

Other Crops	1.02	High	Medium
Cotton	0.58	High	Low
Corn	0.41	High	Low
Other Grains	0.08	High	Low
Vegetables and Ground Fruit	0.04	High	Low
Orchards and Vineyards	0.01	High	Low
Nurseries	0.01	High	Low
Wheat	0.01	High	Low
Christmas Trees	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey (fish) in estuarine and coastal habitats.			
Risk	**Confidence**		
High	**Low**		

Table 105. Prey (inverts) risk hypothesis; Gulf Sturgeon; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	7.78	High	High
Developed	4.18	High	Medium
Other RowCrops	1.05	High	Medium
Other Crops	1.02	High	Medium
Cotton	0.58	High	Low
Corn	0.41	High	Low
Other Grains	0.08	High	Low
Vegetables and Ground Fruit	0.04	High	Low

Orchards and Vineyards	0.01	High	Low
Nurseries	0.01	High	Low
Wheat	0.01	High	Low
Christmas Trees	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey (inverts) in estuarine and coastal habitats.			
Risk	**Confidence**		
High	**Low**		

Table 106. Water quality risk hypothesis; Gulf Sturgeon; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Gulf Sturgeon. Thirteen use site categories, totaling more than 1,156,170 acres (over 16% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The estimated concentrations of malathion in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth can result. Multiple (*perhaps all*) habitat types may experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality.		
Risk	**Confidence**	
High	**Low**	

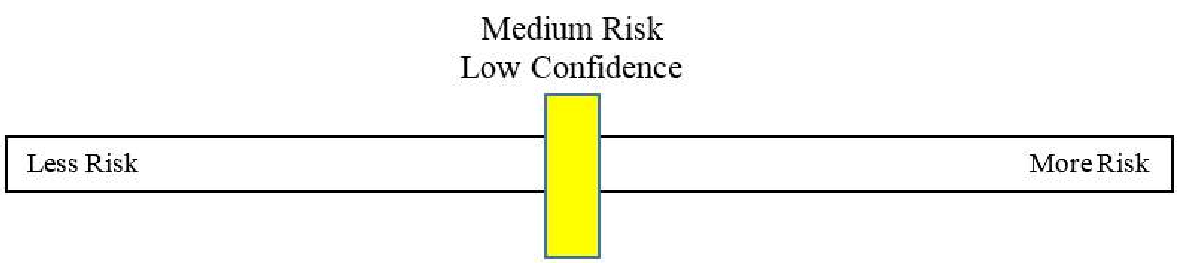
Table 107. Effects analysis summary table; Gulf Sturgeon; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in the estuarine and nearshore habitats.	High	Low	Yes

Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in the estuarine and nearshore habitats.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

The stressors of the action may negatively affect relavent physical or biological features within estuarine and nearshore habitats of gulf sturgeon. However, we have low confidence in the EECs predicted for the nearshore habitats. Within the nearshore and estuarine portions of their range, we do not anticipate that the stressors of the action will reduce the overall conservation value of the designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.



17.33 Atlantic Sturgeon, Gulf of Maine DPS, Designated Critical Habitat

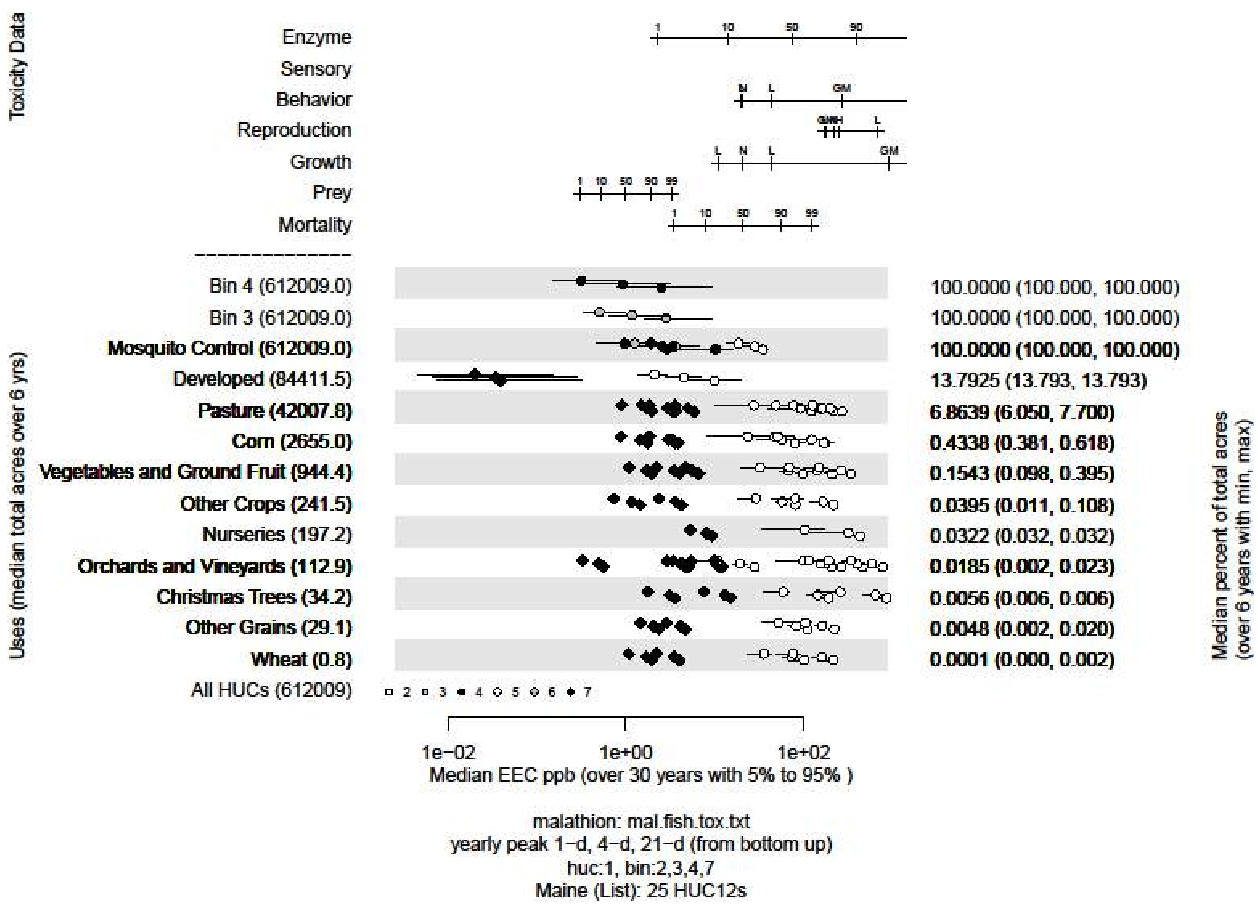


Figure 33. Effects analysis R-plot; Atlantic Sturgeon, Gulf of Maine DPS; designated critical habitat.

Table 108. Prey (fish) risk hypothesis; Atlantic Sturgeon, Gulf of Maine DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	Medium	High
Bin 4	100.00	Medium	High

Developed	13.80	Medium	High
Pasture	6.86	High	High
Corn	0.43	High	Low
Vegetables and Ground Fruit	0.15	High	Low
Other Crops	0.04	High	Low
Nurseries	0.03	High	Low
Orchards and Vineyards	0.02	High	Low
Christmas Trees	<0.01	High	Low
Other Grains	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (fish).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 109. Prey (inverts) risk hypothesis; Atlantic Sturgeon, Gulf of Maine DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Developed	13.80	High	High
Pasture	6.86	High	High
Corn	0.43	High	Low
Vegetables and Ground Fruit	0.15	High	Low
Other Crops	0.04	High	Low
Nurseries	0.03	High	Low

Orchards and Vineyards	0.02	High	Low
Christmas Trees	<0.01	High	Low
Other Grains	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (inverts).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 110. Water quality risk hypothesis; Atlantic Sturgeon, Gulf of Maine DPS; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Atlantic sturgeon, Gulf of Maine DPS. Ten use site categories, totaling more than 130,630 acres (over 21% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

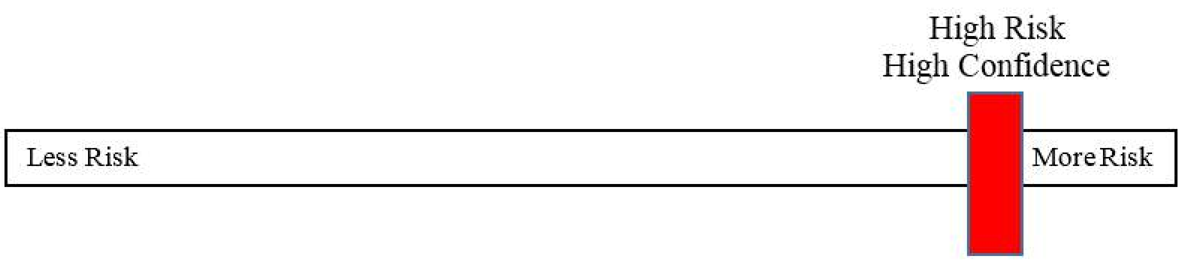
Table 111. Effects analysis summary table; Atlantic Sturgeon, Gulf of Maine DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater habitats.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of prey in freshwater habitats.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in estuarine habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in estuarine habitats.	High	Low	Yes

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in coastal habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in coastal habitats.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Atlantic Sturgeon, Gulf of Maine DPS. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



17.34 Atlantic Sturgeon, New York Bight DPS, Designated Critical Habitat

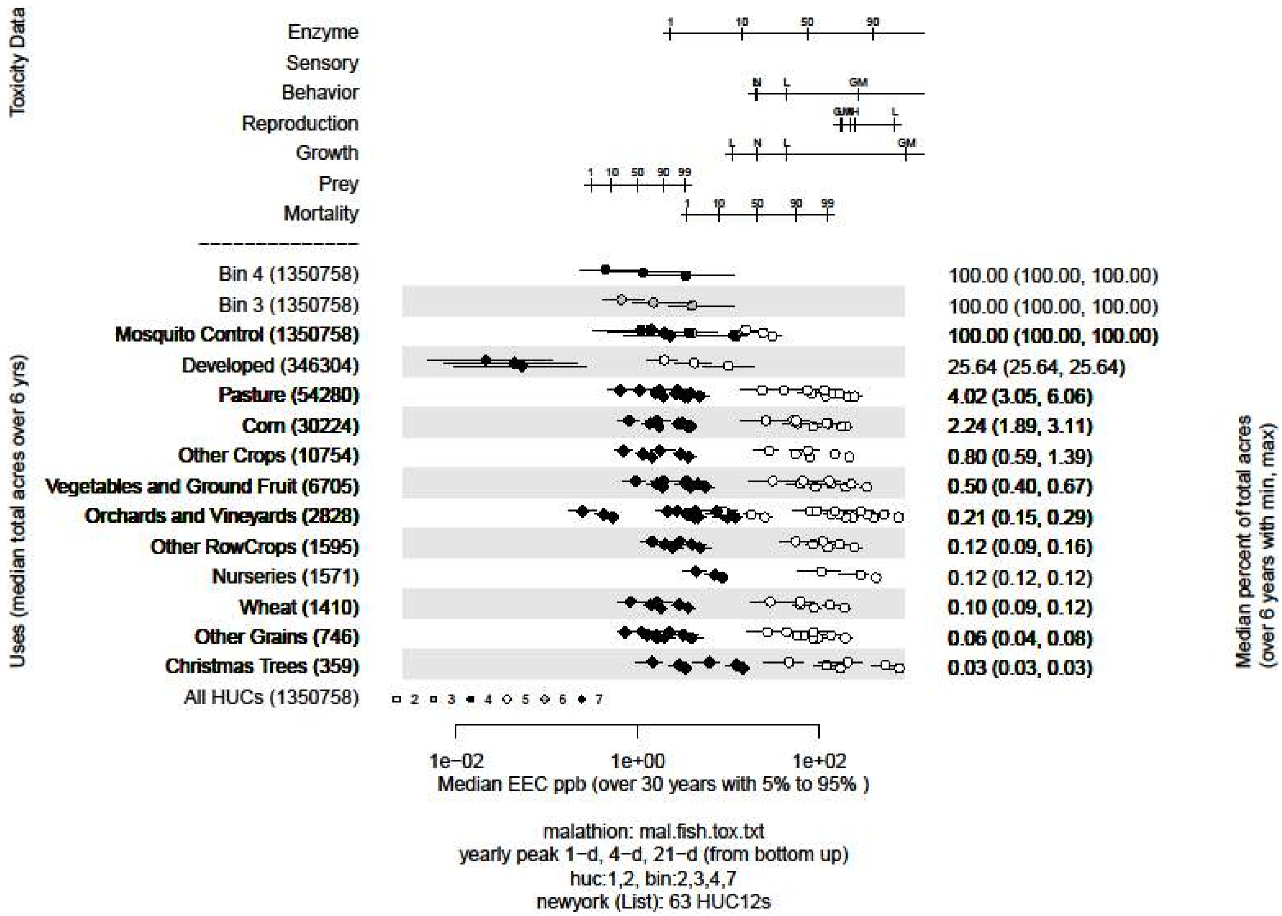


Figure 34. Effects analysis R-plot; Atlantic Sturgeon, New York Bight DPS; designated critical habitat.

Table 112. Prey (fish) risk hypothesis; Atlantic Sturgeon, New York Bight DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	Medium	High

Bin 4	100.00	Medium	High
Developed	25.64	Medium	High
Pasture	4.02	High	Medium
Corn	2.24	High	Medium
Other Crops	0.80	High	Low
Vegetables and Ground Fruit	0.50	High	Low
Orchards and Vineyards	0.21	High	Low
Other Row Crops	0.12	High	Low
Nurseries	0.12	High	Low
Wheat	0.10	High	Low
Other Grains	0.06	High	Low
Christmas Trees	0.03	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (fish).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 113. Prey (inverts) risk hypothesis; Atlantic Sturgeon, New York Bight DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Developed	25.64	High	High
Pasture	4.02	High	Medium
Corn	2.24	High	Medium
Other Crops	0.80	High	Low

Vegetables and Ground Fruit	0.50	High	Low
Orchards and Vineyards	0.21	High	Low
Other Row Crops	0.12	High	Low
Nurseries	0.12	High	Low
Wheat	0.10	High	Low
Other Grains	0.06	High	Low
Christmas Trees	0.03	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (inverts).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 114. Water quality risk hypothesis; Atlantic Sturgeon, New York Bight DPS; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Atlantic sturgeon, New York Bight DPS. Eleven use site categories, totaling more than 456,776 acres (over 33% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

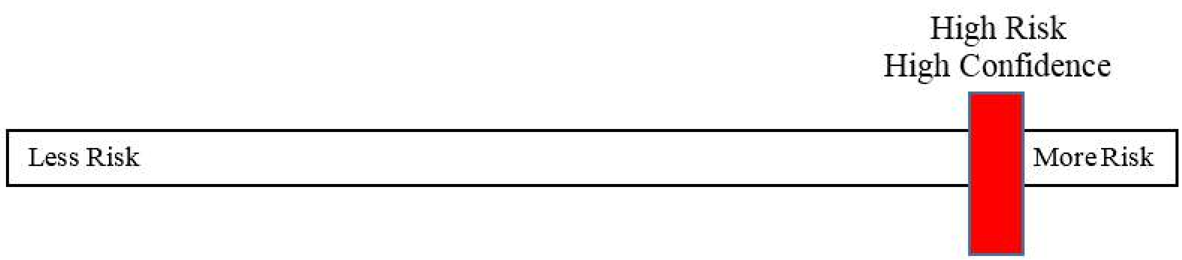
Table 115. Effects analysis summary table; Atlantic Sturgeon, New York Bight DPS; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported? Yes/No
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater habitats.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of prey in freshwater habitats.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in estuarine habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in estuarine habitats.	High	Low	Yes

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in coastal habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in coastal habitats.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Atlantic Sturgeon, New York Bight DPS. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



17.35 Atlantic Sturgeon, Chesapeake Bay DPS, Designated Critical Habitat

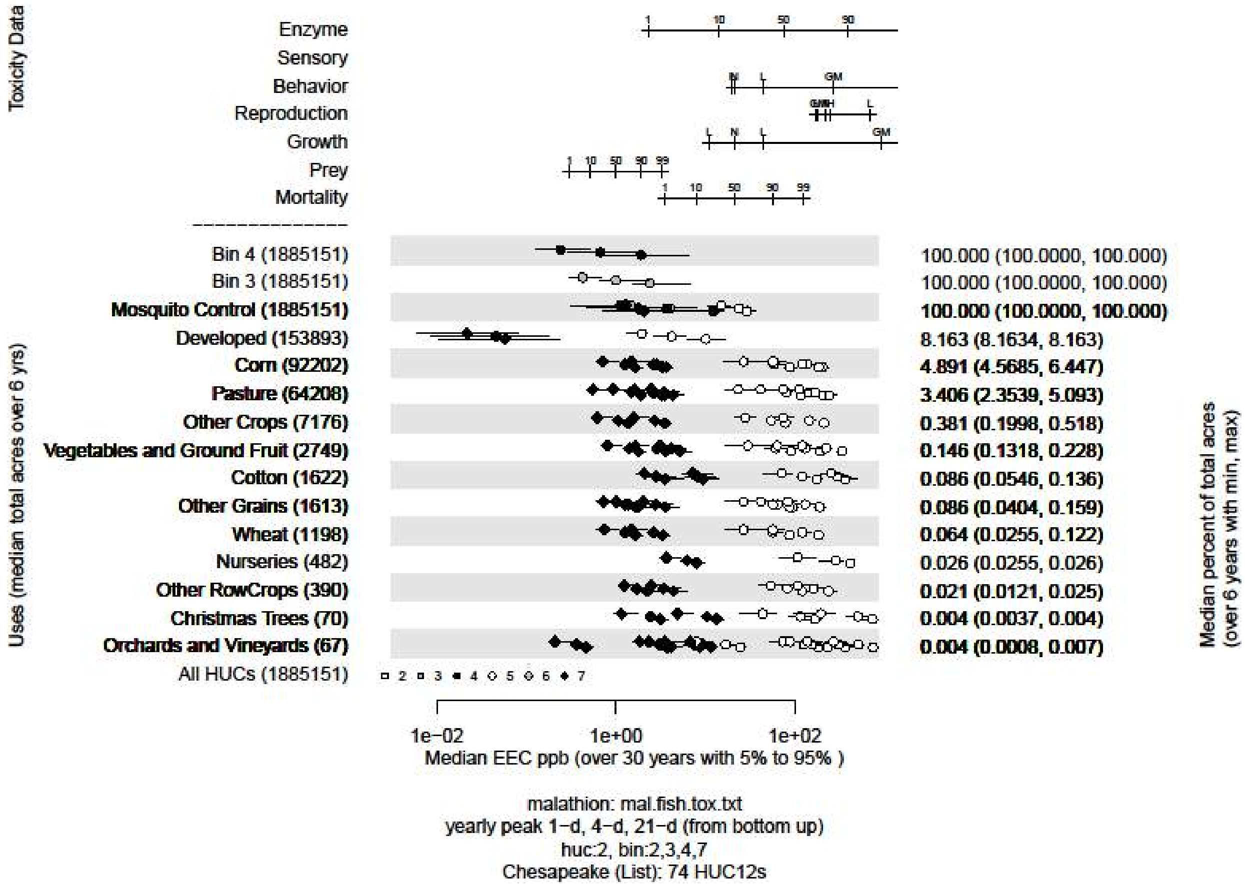


Figure 35. Effects analysis R-plot; Atlantic Sturgeon, Chesapeake Bay DPS; designated critical habitat.

Table 116. Prey (fish) risk hypothesis; Atlantic Sturgeon, Chesapeake Bay DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100.00	High	High
Bin 3	100.00	Medium	High
Bin 4	100.00	Medium	High
Developed	8.13	Medium	High

Corn	4.89	High	Medium
Pasture	3.41	High	Medium
Other Crops	0.38	High	Low
Vegetables and Ground Fruit	0.15	High	Low
Cotton	0.09	High	Low
Other Grains	0.09	High	Low
Wheat	0.06	High	Low
Nurseries	0.03	High	Low
Other Row Crops	0.02	High	Low
Christmas Trees	<0.01	High	Low
Orchards and Vineyards	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (fish).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 117. Prey (inverts) risk hypothesis; Atlantic Sturgeon, Chesapeake Bay DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Wide Area Use	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Developed	8.13	High	High
Corn	4.89	High	Medium
Pasture	3.41	High	Medium
Other Crops	0.38	High	Low

Vegetables and Ground Fruit	0.15	High	Low
Cotton	0.09	High	Low
Other Grains	0.09	High	Low
Wheat	0.06	High	Low
Nurseries	0.03	High	Low
Other Row Crops	0.02	High	Low
Christmas Trees	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (inverts).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 118. Water quality risk hypothesis; Atlantic Sturgeon, Chesapeake Bay DPS; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Atlantic sturgeon, Chesapeake Bay DPS. Twelve use site categories, totaling more than 325,670 acres (over 17% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

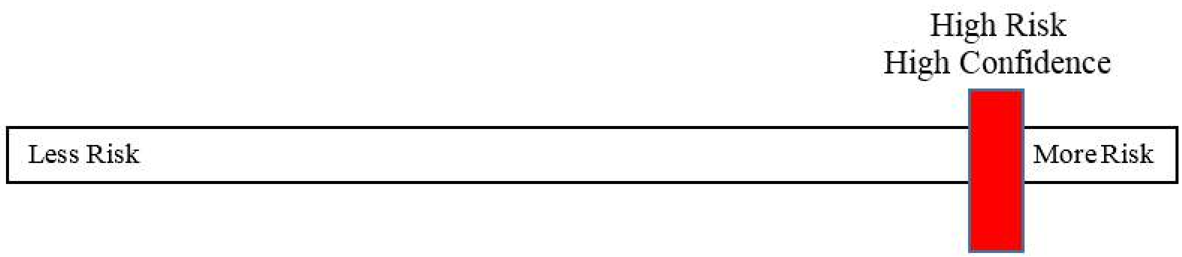
Table 119. Effects analysis summary table; Atlantic Sturgeon, Chesapeake Bay DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater habitats.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of prey in freshwater habitats.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in estuarine habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in estuarine habitats.	High	Low	Yes

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in coastal habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in coastal habitats.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Atlantic Sturgeon, Chesapeake Bay DPS. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



17.36 Atlantic Sturgeon, Carolina DPS, Designated Critical Habitat

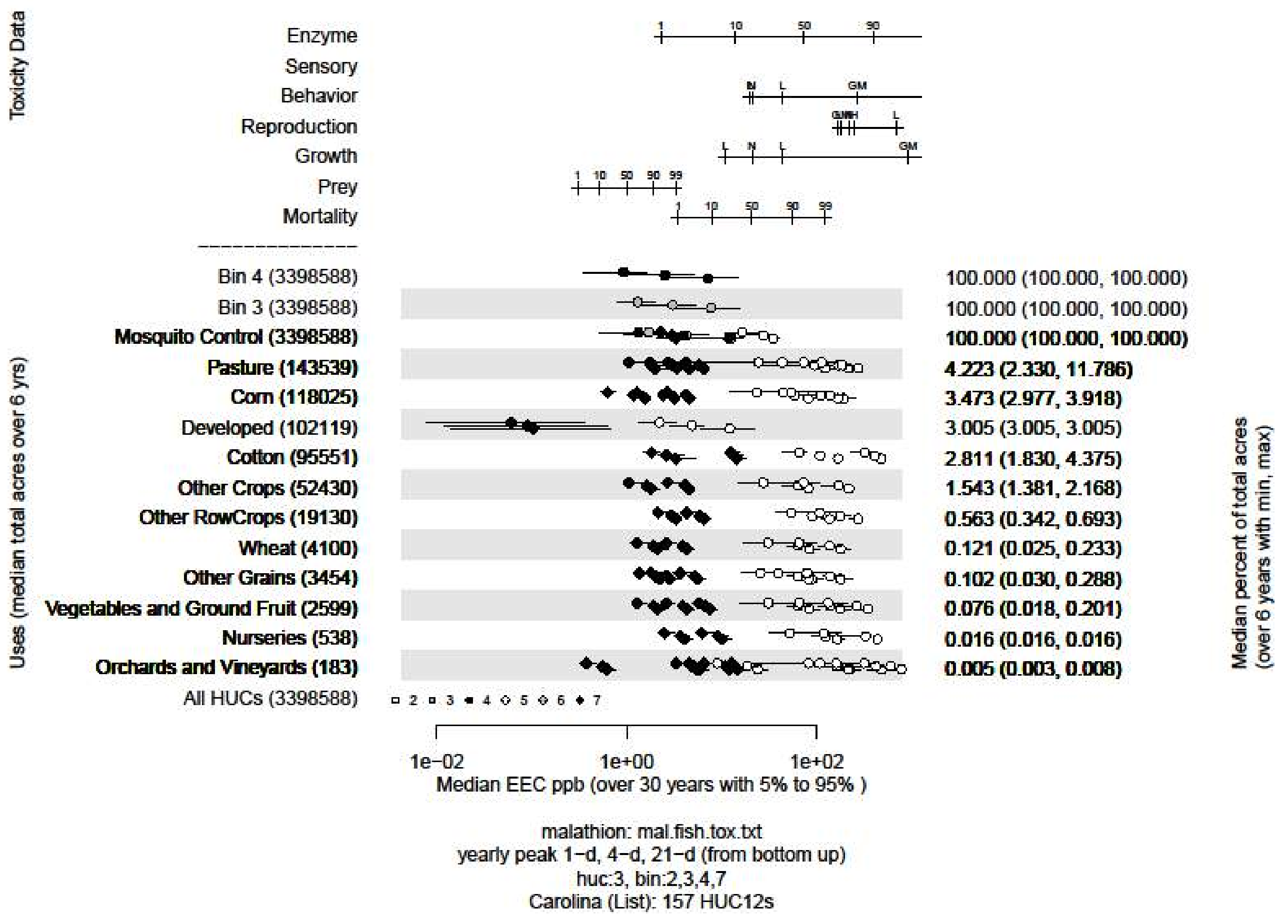


Figure 36. Effects analysis R-plot; Atlantic Sturgeon, Carolina DPS; designated critical habitat.

Table 120. Prey (fish) risk hypothesis; Atlantic Sturgeon, Carolina DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	Medium	High

Bin 4	100.00	Medium	High
Pasture	4.22	High	Medium
Corn	3.47	High	Medium
Developed	3.01	Medium	Medium
Cotton	2.81	High	Medium
Other Crops	1.54	High	Medium
Other Row Crops	0.56	High	Low
Wheat	0.12	High	Low
Other Grains	0.10	High	Low
Vegetables and Ground Fruit	0.08	High	Low
Nurseries	0.02	High	Low
Orchards and Vineyards	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (fish).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 121. Prey (inverts) risk hypothesis; Atlantic Sturgeon, Carolina DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	4.22	High	Medium
Corn	3.47	High	Medium
Developed	3.01	High	Medium
Cotton	2.81	High	Medium

Other Crops	1.54	High	Medium
Other Row Crops	0.56	High	Low
Wheat	0.12	High	Low
Other Grains	0.10	High	Low
Vegetables and Ground Fruit	0.08	High	Low
Nurseries	0.02	High	Low
Orchards and Vineyards	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (inverts).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 122. Water quality risk hypothesis; Atlantic Sturgeon, Carolina DPS; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Atlantic sturgeon, Carolina DPS. Eleven use site categories, totaling more than 541,668 acres (over 15% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

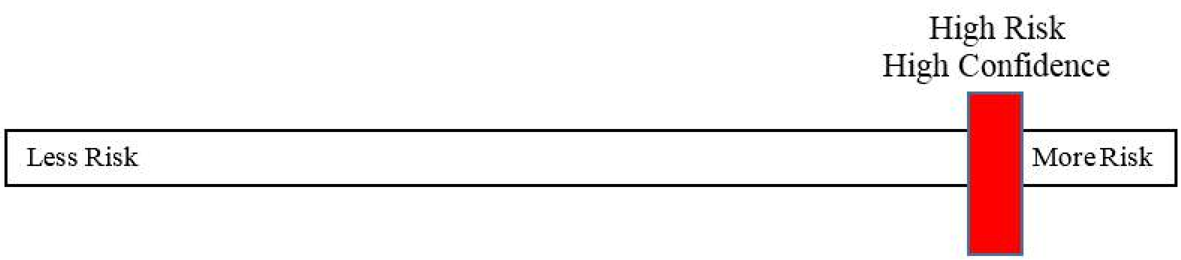
Table 123. Effects analysis summary table; Atlantic Sturgeon, Carolina DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater habitats.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of prey in freshwater habitats.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in estuarine habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in estuarine habitats.	High	Low	Yes

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in coastal habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in coastal habitats.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Atlantic Sturgeon, Carolina DPS. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



17.37 Atlantic Sturgeon, South Atlantic DPS, Designated Critical Habitat

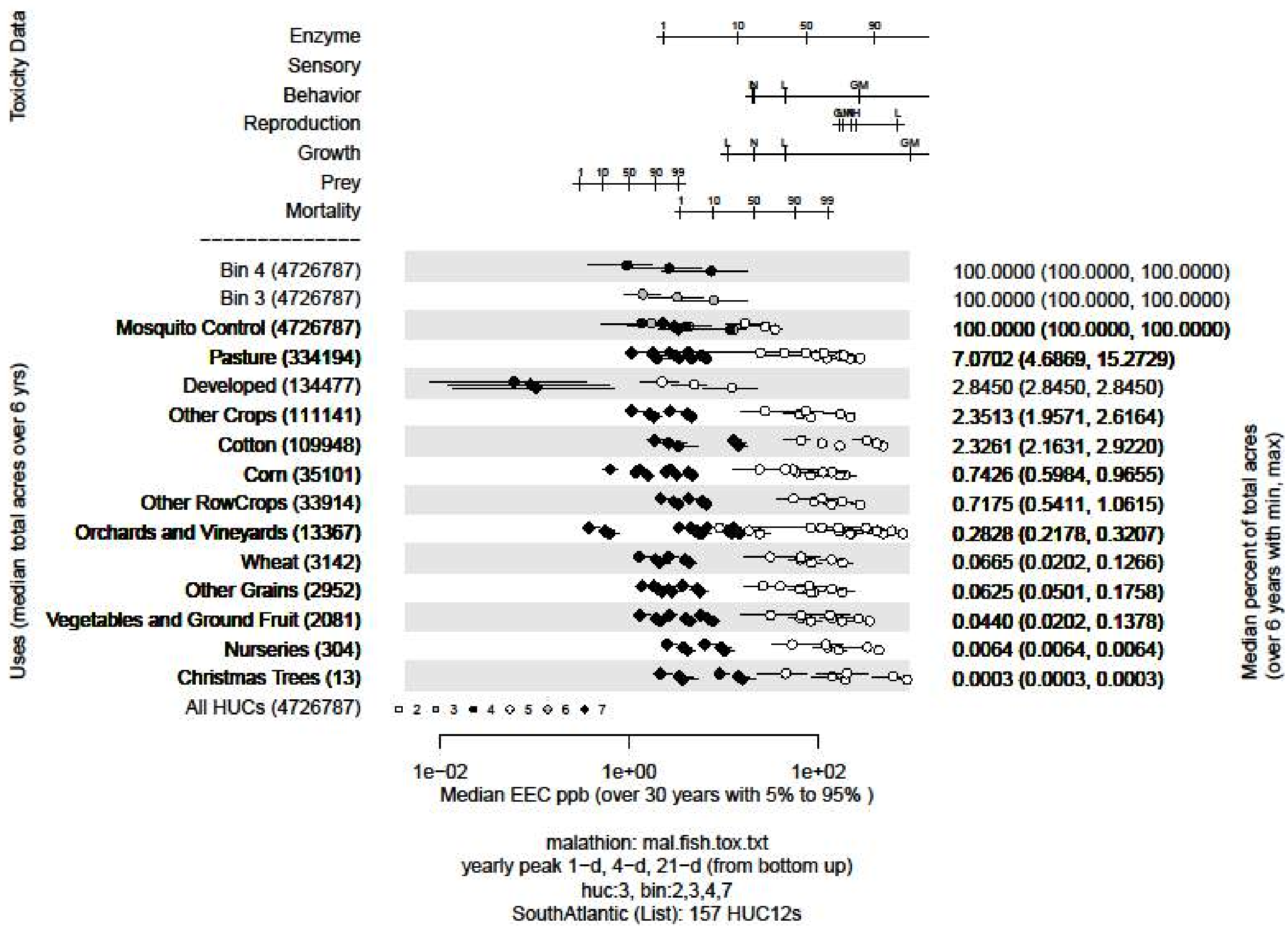


Figure 37. Effects analysis R-plot; Atlantic Sturgeon, South Atlantic DPS; designated critical habitat.

Table 124. Prey (fish) risk hypothesis; Atlantic Sturgeon, South Atlantic DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	Medium	High
Bin 4	100.00	Medium	High

Pasture	7.07	High	High
Developed	2.85	Medium	Medium
Other Crops	2.35	High	Medium
Cotton	2.33	High	Medium
Corn	0.74	High	Low
Other Row Crops	0.72	High	Low
Orchards and Vineyards	0.28	High	Low
Wheat	0.07	High	Low
Other Grains	0.06	High	Low
Vegetables and Ground Fruit	0.04	High	Low
Nurseries	0.01	High	Low
Christmas Trees	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (fish).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 125. Prey (inverts) risk hypothesis; Atlantic Sturgeon, South Atlantic DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Pasture	7.07	High	High
Developed	2.85	High	Medium
Other Crops	2.35	High	Medium
Cotton	2.33	High	Medium

Corn	0.74	High	Low
Other Row Crops	0.72	High	Low
Orchards and Vineyards	0.28	High	Low
Wheat	0.07	High	Low
Other Grains	0.06	High	Low
Vegetables and Ground Fruit	0.04	High	Low
Nurseries	0.01	High	Low
Christmas Trees	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to reduce prey in freshwater, estuarine, and coastal habitats (inverts).*			
Risk	**Confidence**	***We have low confidence in EECs associated with marine and estuarine habitats.**	
High	**High**		

Table 126. Water quality risk hypothesis; Atlantic Sturgeon, South Atlantic DPS; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Atlantic sturgeon, South Atlantic DPS. Twelve use site categories, totaling more than 780,634 acres (over 16% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types will experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**High**	

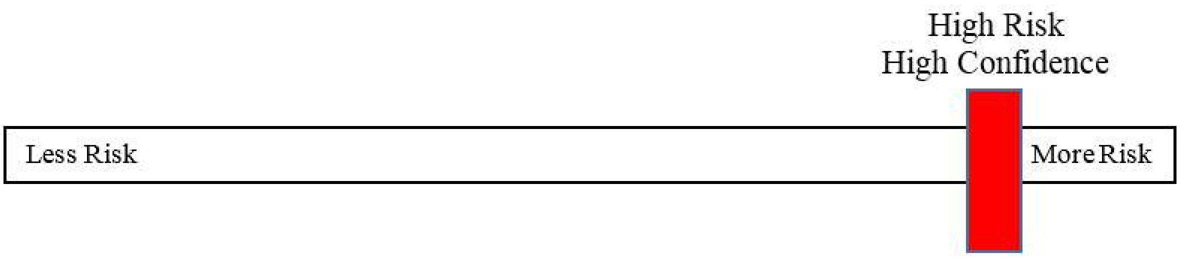
Table 127. Effects analysis summary table; Atlantic Sturgeon, South Atlantic DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater habitats.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of prey in freshwater habitats.	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in estuarine habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in estuarine habitats.	High	Low	Yes

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in coastal habitats.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in coastal habitats.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that the stressors of the action will negatively affect physical or biological features (PBFs). Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of Atlantic Sturgeon, South Atlantic DPS. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



17.38 Yelloweye Rockfish (Puget Sound/Georgia Basin DPS) Designated Critical Habitat

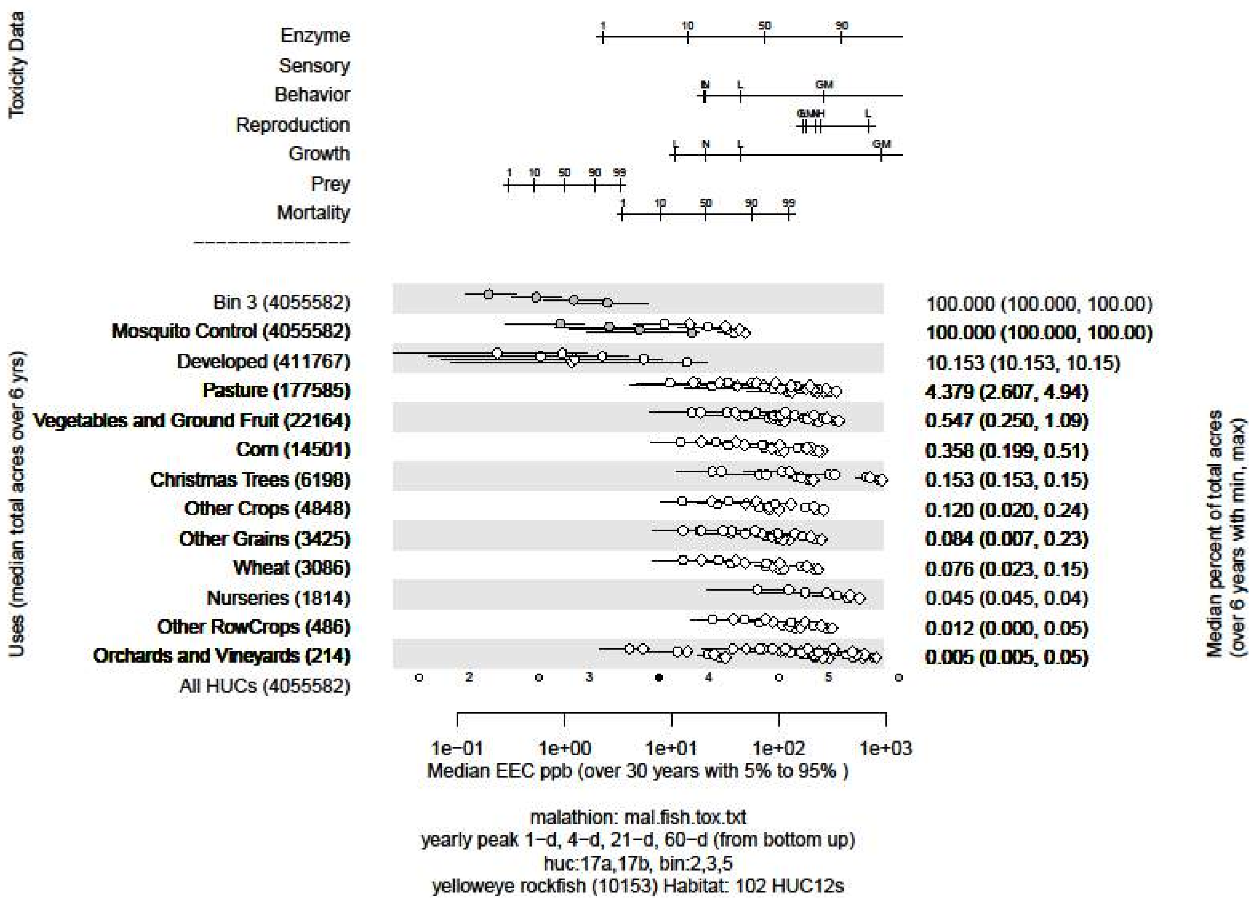


Figure 38. Effects analysis R-plot; Yelloweye rockfish, Puget Sound/Georgia Basin DPS designated critical habitat.

Table 128. Prey (fish) risk hypothesis; Yelloweye rockfish, Puget Sound/Georgia Basin DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	Low	High
Developed	10.15	Medium	High
Pasture	4.38	High	Medium
Vegetables and Ground Fruit	0.55	High	Low

Corn	0.36	High	Low
Christmas Trees	0.15	High	Low
Other Crops	0.12	High	Low
Other Grains	0.08	High	Low
Wheat	0.08	High	Low
Nurseries	0.04	High	Low
Other RowCrops	0.01	High	Low
Orchards and Vineyards	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to cause reductions in prey (fish).			
Risk	**Confidence**		
High	**Low**		

Table 129. Prey (inverts) risk hypothesis; Yelloweye rockfish, Puget Sound/Georgia Basin DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Developed	10.15	High	High
Pasture	4.38	High	Medium
Vegetables and Ground Fruit	0.55	High	Low
Corn	0.36	High	Low
Christmas Trees	0.15	High	Low
Other Crops	0.12	High	Low
Other Grains	0.08	High	Low
Wheat	0.08	High	Low
Nurseries	0.04	High	Low
Other RowCrops	0.01	High	Low

Orchards and Vineyards	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to cause reductions in prey (inverts).			
Risk	**Confidence**		
High	**Low**		

Table 130. Water quality risk hypothesis; Yelloweye rockfish, Puget Sound/Georgia Basin DPS; designated critical habitat.

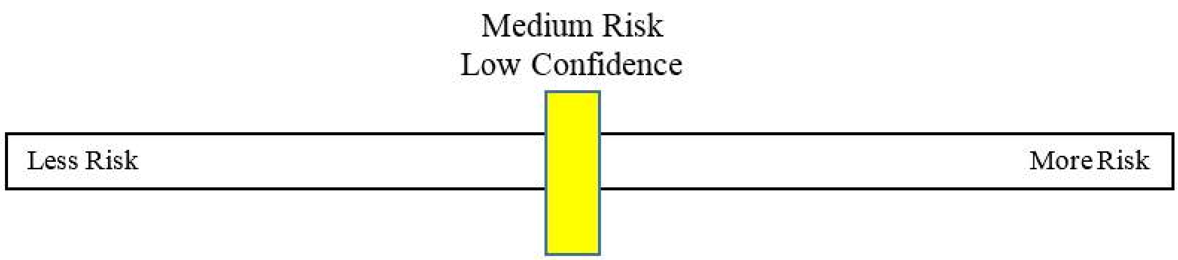
Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of yelloweye rockfish. Twelve use site categories, totaling more than 746,088 acres (over 16% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The estimated concentrations of malathion in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth can result. Multiple (*perhaps all*) habitat types may may experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**Low**	

Table 131. Effects analysis summary table; Yelloweye rockfish, Puget Sound/Georgia Basin DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

The stressors of the action may negatively affect relevant physical or biological features within estuarine and nearshore habitats of yelloweye rockfish. However, we have low confidence in the EECs predicted for the marine nearshore habitats. Within the nearshore and estuarine portions of their range, we do not anticipate that the stressors of the action will reduce the overall conservation value of the designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.



17.39 Bocaccio (Puget Sound/Georgia Basin DPS) Designated Critical Habitat

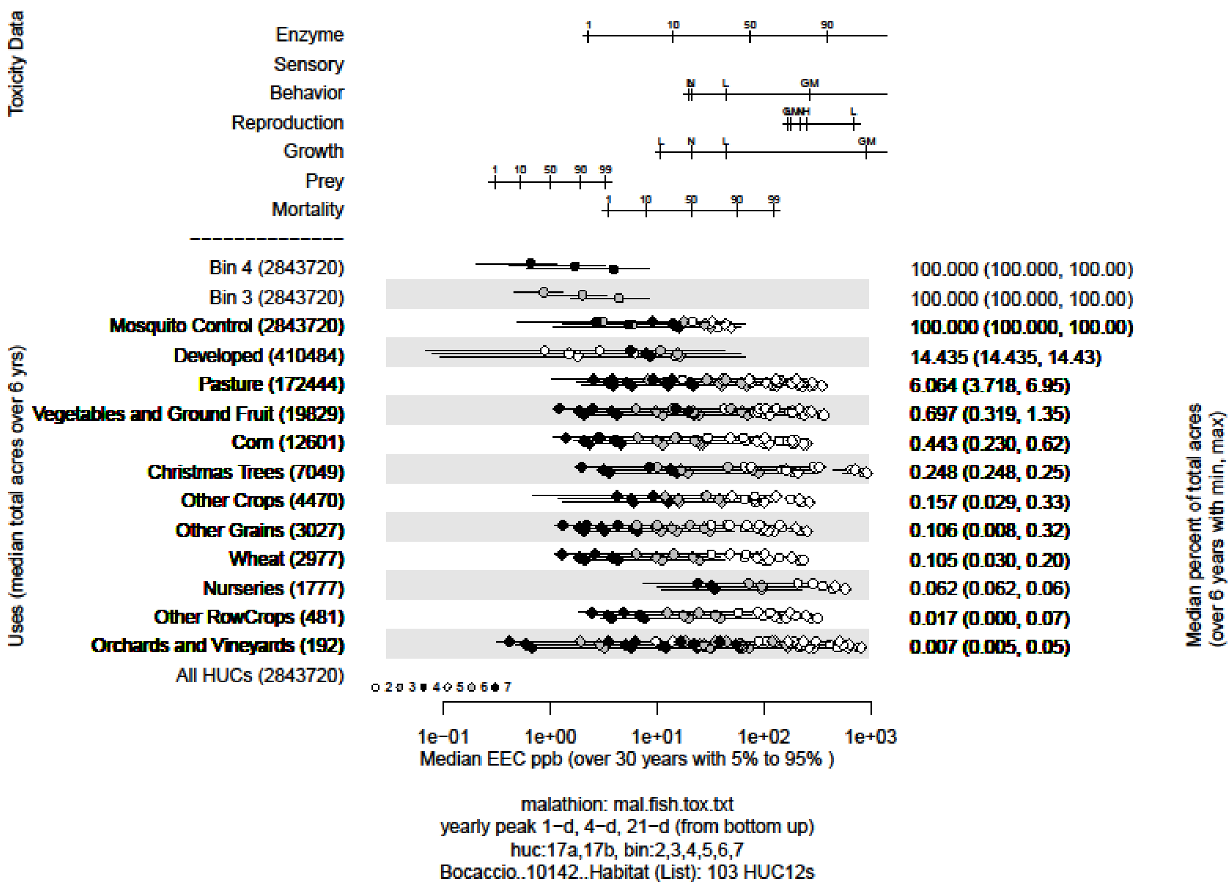


Figure 39. Effects analysis R-plot; Bocaccio rockfish, Puget Sound/Georgia Basin DPS designated critical habitat.

Table 132. Prey (fish) risk hypothesis; Bocaccio rockfish, Puget Sound/Georgia Basin DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Developed	14.43	High	High
Pasture	6.06	High	High

Vegetables and Ground Fruit	0.70	High	Low
Corn	0.44	High	Low
Christmas Trees	0.25	High	Low
Other Crops	0.16	High	Low
Other Grains	0.11	High	Low
Wheat	0.10	High	Low
Nurseries	0.06	High	Low
Other RowCrops	0.02	High	Low
Orchards and Vineyards	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to cause reductions in prey (fish).			
Risk	**Confidence**		
High	**Low**		

Table 133. Prey (inverts) risk hypothesis; Bocaccio rockfish, Puget Sound/Georgia Basin DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Developed	14.43	High	High
Pasture	6.06	High	High
Vegetables and Ground Fruit	0.70	High	Low
Corn	0.44	High	Low
Christmas Trees	0.25	High	Low
Other Crops	0.16	High	Low
Other Grains	0.11	High	Low

Wheat	0.10	High	Low
Nurseries	0.06	High	Low
Other RowCrops	0.02	High	Low
Orchards and Vineyards	0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to cause reductions in prey (inverts).			
Risk	**Confidence**		
High	**Low**		

Table 134. Water quality risk hypothesis; Bocaccio rockfish, Puget Sound/Georgia Basin DPS; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of Bocaccio. Twelve use site categories, totaling more than 635,331 acres (over 22% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill fish and aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. Multiple (*perhaps all*) habitat types may experience levels that degrade water quality. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation. Additionally, where elevated temperatures occur, malathion and other co-occurring organophosphates will exhibit greater toxicity to fish and invertebrates.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**Low**	

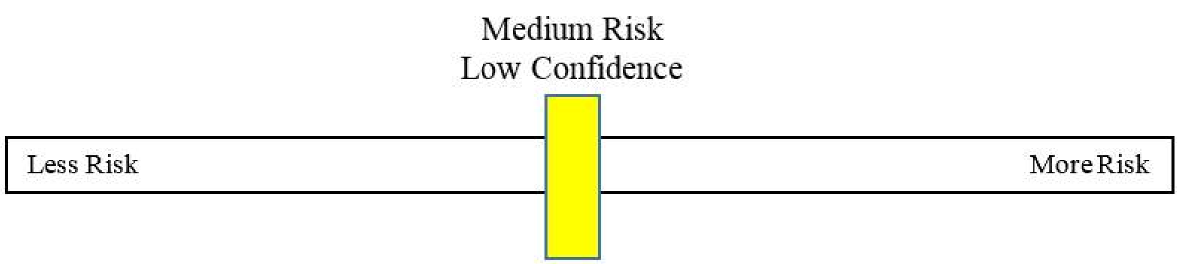
Table 135. Effects analysis summary table; Bocaccio rockfish, Puget Sound/Georgia Basin DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	

Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

The stressors of the action may negatively affect relevant physical or biological features (PBFs) within estuarine and nearshore habitats of bocaccio rockfish. However, we have low confidence in the EECs predicted for the marine nearshore habitats. Within the nearshore and estuarine portions of their range, we do not anticipate that the stressors of the action will reduce the overall conservation value of the designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.



17.40 Smalltooth Sawfish Designated Critical Habitat

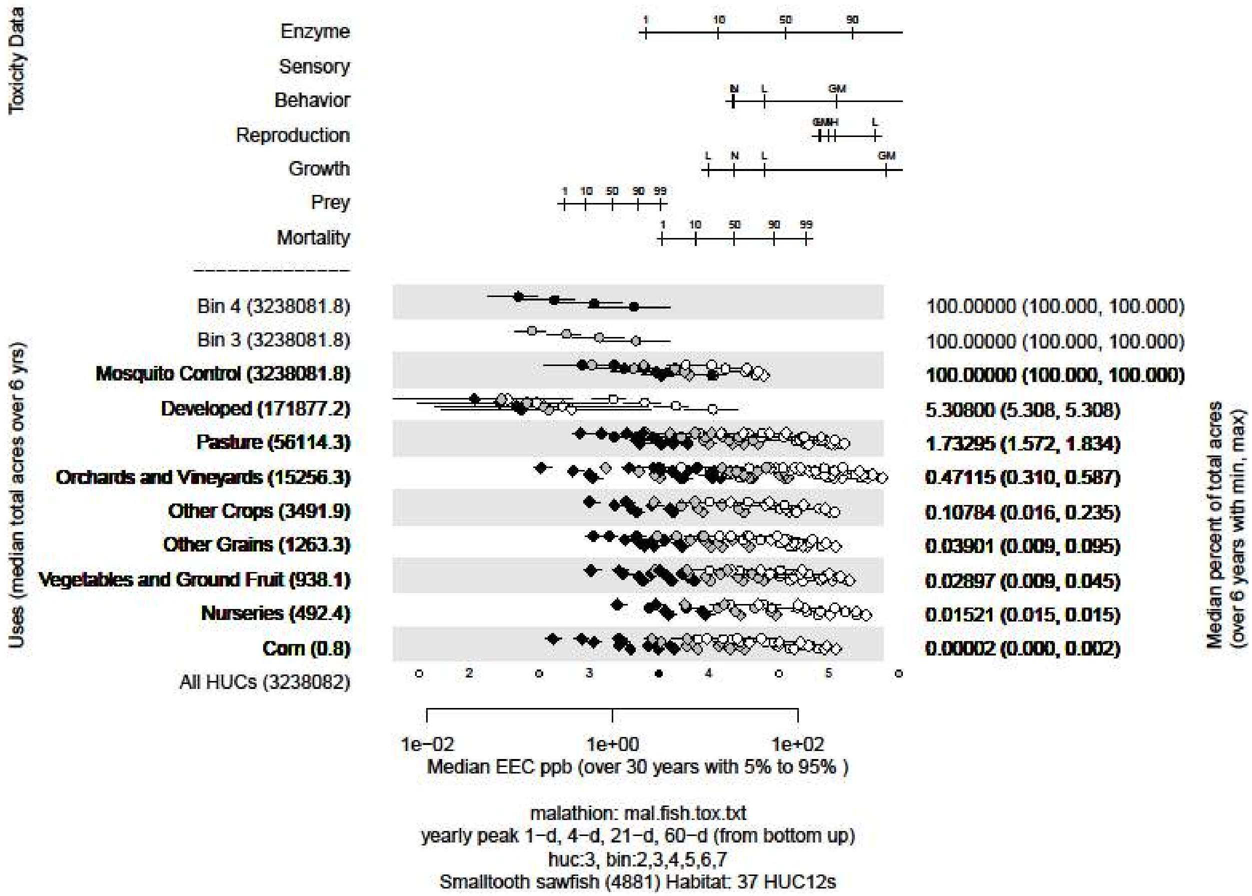


Figure 40. Effects analysis R-plot; Smalltooth Sawfish designated critical habitat.

Table 136. Prey (fish) risk hypothesis; Smalltooth sawfish, US DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Developed	5.31	Medium	High
Pasture	1.73	High	Medium

Orchards and Vineyards	0.47	High	Low
Other Crops	0.11	High	Low
Other Grains	0.04	High	Low
Vegetables and Ground Fruit	0.03	High	Low
Nurseries	0.02	High	Low
Corn	<0.001	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to cause reductions in prey (fish).			
Risk	**Confidence**		
High	**High**		

Table 137. Prey (inverts) risk hypothesis; Smalltooth sawfish, US DPS; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Bin 4	100.00	High	High
Developed	5.31	High	High
Pasture	1.73	High	Medium
Orchards and Vineyards	0.47	High	Low
Other Crops	0.11	High	Low
Other Grains	0.04	High	Low
Vegetables and Ground Fruit	0.03	High	Low
Nurseries	0.02	High	Low
Corn	<0.001	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to cause reductions in prey (inverts).			
Risk	**Confidence**		

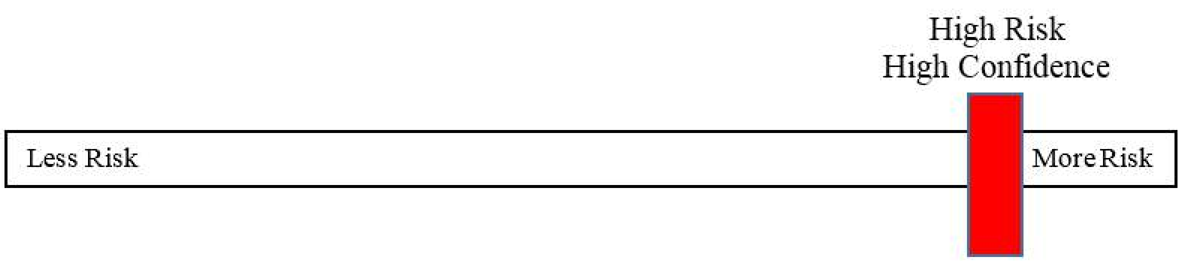
High	**High**	

Table 138. Effects analysis summary table; Smalltooth sawfish, US DPS; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in shallow euryhaline habitats.	High	High	Yes

Designated Critical Habitat Effects Analysis Summary:

We anticipate a high likelihood that that the stressors of the action will negatively affect a key physical and biological feature. Reductions in prey are likely throughout designated critical habitat of the smalltooth sawfish. The likelihood and magnitude of toxic effects may reduce the overall conservation value of designated critical habitat. We find that the overall risk is high and the confidence associated with that risk is high over the 15-year duration of the action.



17.41 Black Abalone Designated Critical Habitat

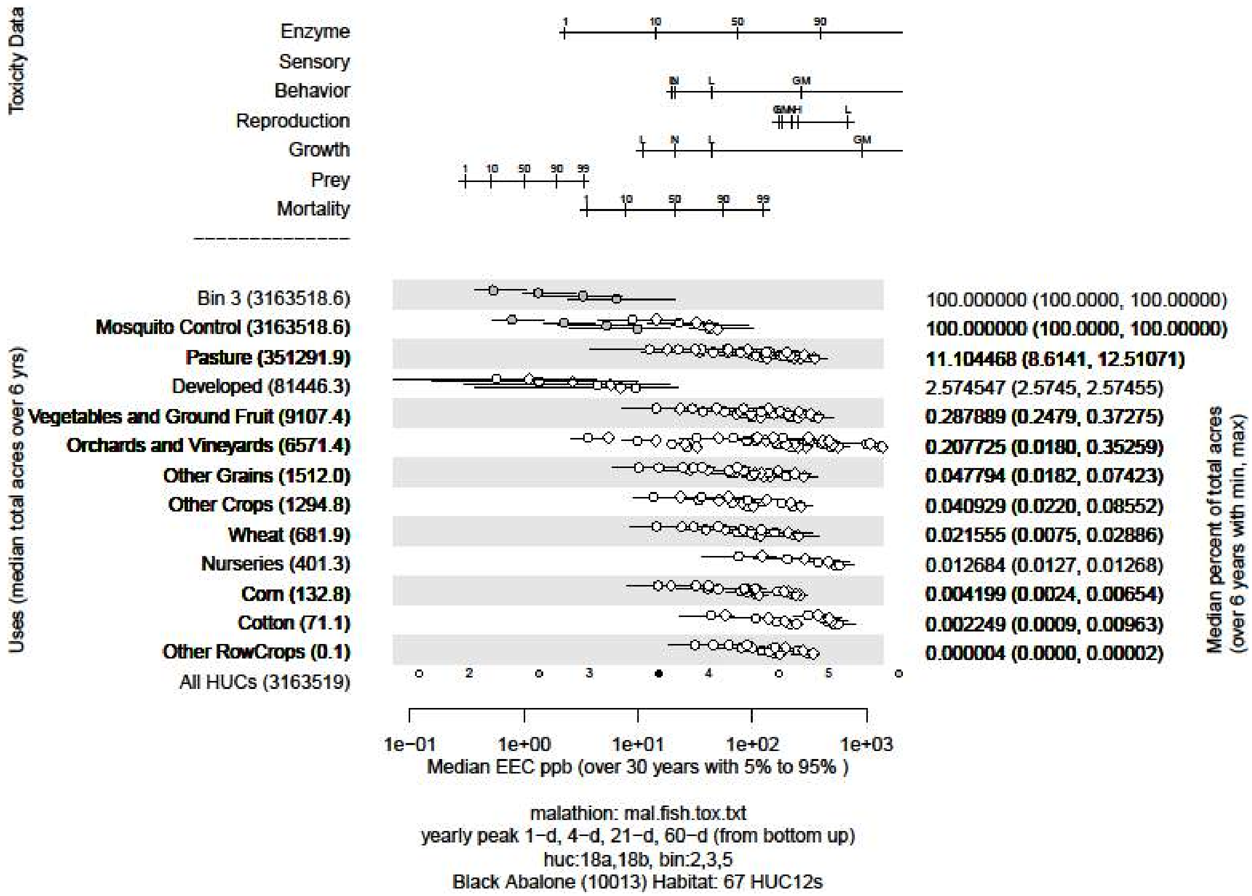


Figure 41. Effects analysis R-plot; Black Abalone designated critical habitat.

Table 139. Prey (inverts) risk hypothesis; Black abalone; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Pasture	11.10	High	High
Developed	2.57	High	Medium
Vegetables and Ground Fruit	0.29	High	Low

Orchards and Vineyards	0.21	High	Low
Other Grains	0.05	High	Low
Other Crops	0.04	High	Low
Wheat	0.02	High	Low
Nurseries	0.01	High	Low
Corn	<0.01	High	Low
Cotton	<0.01	High	Low
Other RowCrops	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to cause reductions in prey (inverts).			
Risk	**Confidence**		
High	**Low**		

Table 140. Water quality risk hypothesis; Black abalone; designated critical habitat.

Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur within the designated critical habitat of black abalone. Twelve use site categories, totaling more than 452,510 acres (over 14% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are sufficient to kill aquatic invertebrates, and for the animals that survive, impaired swimming, reduced reproduction, and reduced growth are anticipated. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
High	**Low**	

Table 141. Effects analysis summary table; Black abalone; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	

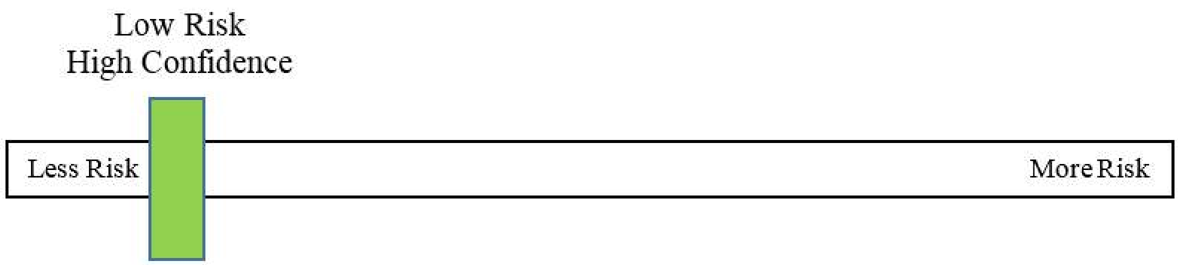
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality.	High	Low	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

The stressors of the action may negatively affect relaventrelevant physical or biological features within nearshore habitats of the black abalone. However, we have low confidence in the EECs predicted for the marine nearshore habitats. We do not anticipate that the stressors of the action will reduce the overall conservation value of the designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.

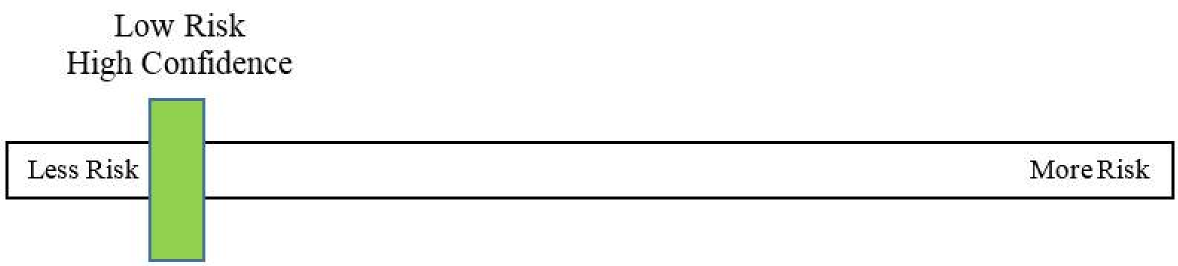
17.42 Staghorn Coral Designated Critical Habitat

There are no physical or biological features identified in Staghorn Coral designated critical habitat that could be affected by the proposed action. We find that the overall risk is low and the confidence associated with that risk is high over the 15-year duration of the action.



17.43 Elkhorn Coral Designated Critical Habitat

There are no physical or biological features identified in Elkhorn Coral designated critical habitat that could be affected by the proposed action. We find that the overall risk is low and the confidence associated with that risk is high over the 15-year duration of the action.



17.44 Green Sea Turtle (North Atlantic DPS) Designated Critical Habitat

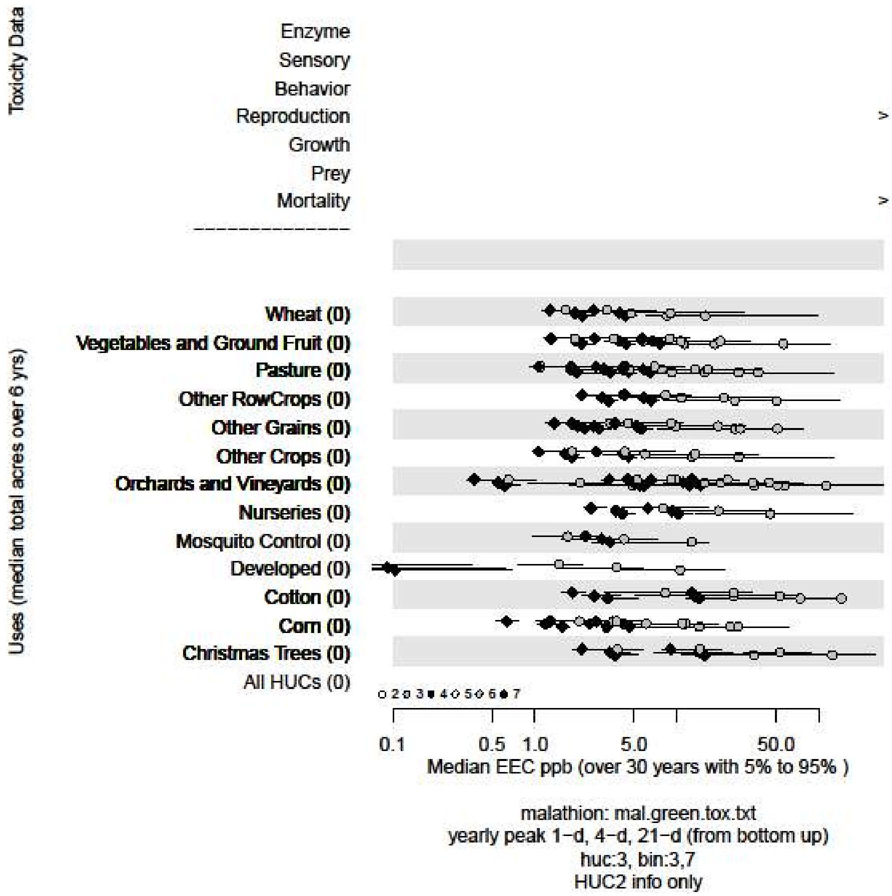


Figure 42. Effects analysis R-plot; Green Sea Turtle, North Atlantic DPS designated critical habitat.

Table 142. Water quality risk hypothesis; Green sea turtle, North Atlantic DPS; designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products may occur within the designated critical habitat of Green sea turtle, North Atlantic DPS. Proposed labels for malathion allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat may be sufficient to cause adverse effects to sea turtles. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation.
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.

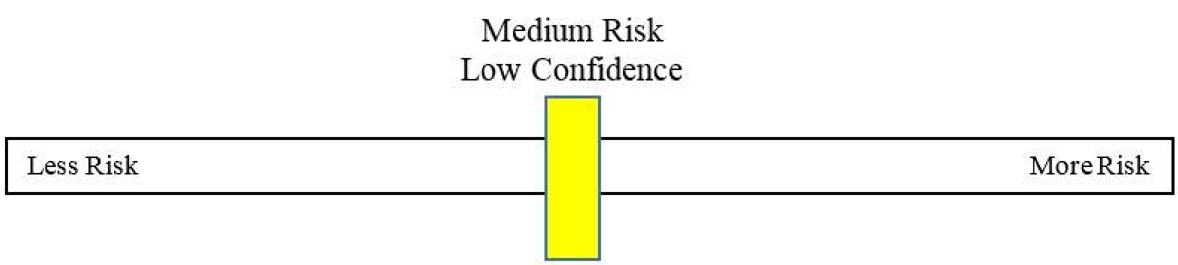
Risk	Confidence	
High	Low	

Table 143. Effects analysis summary table; Green sea turtle, North Atlantic DPS; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported? Yes/No
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

The stressors of the action may negatively affect a relevant physical and biological feature within nearshore designated critical habitat of the green sea turtle. However, we have low confidence in the EECs predicted for the marine nearshore habitats. The likelihood and magnitude of toxic effects are not likely to reduce the overall conservation value of designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.



17.45 Hawksbill Sea Turtle Designated Critical Habitat

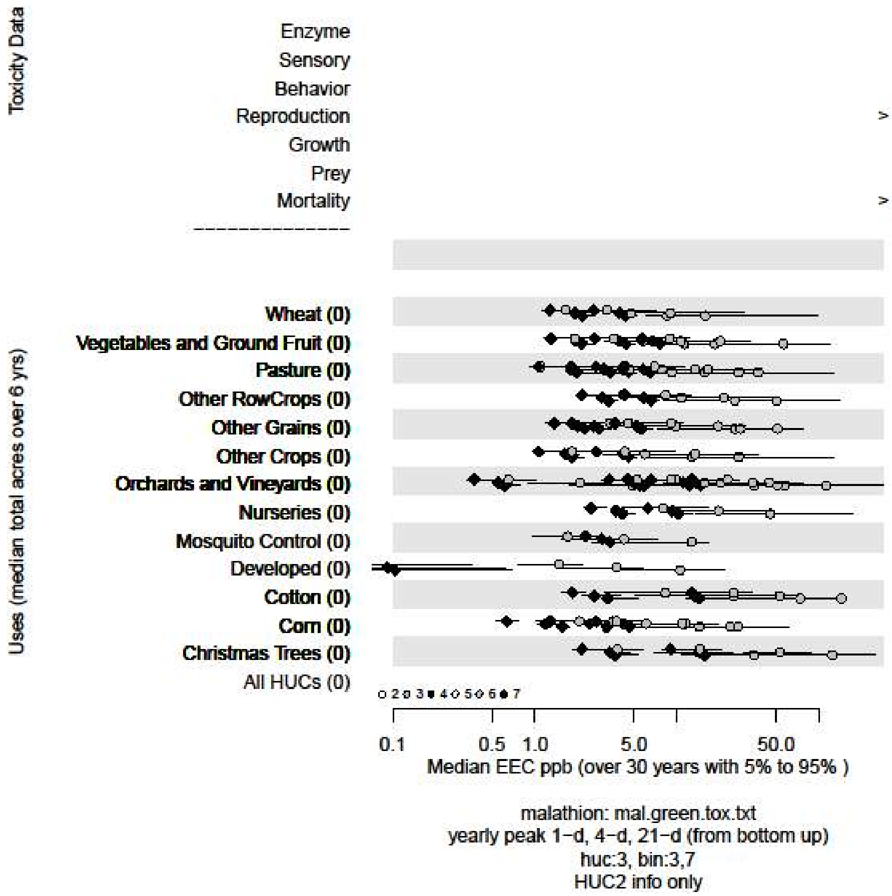


Figure 43. Effects analysis R-plot; Hawksbill sea turtle DPS designated critical habitat.

Table 144. Water quality risk hypothesis; Hawksbill sea turtle designated critical habitat.

Endpoint: Water Quality
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products may occur within the designated critical habitat of the Hawksbill sea turtle. Proposed labels for malathion allow for mosquito control and wide area use, both of which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat may be sufficient to cause adverse effects to sea turtles. The likelihood of attaining these concentrations increases with frequency of application, use of the maximum rates, and the proximity to designated critical habitats. Other chemicals within formulations or added to tank mixes increases the extent of water quality degradation.
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.

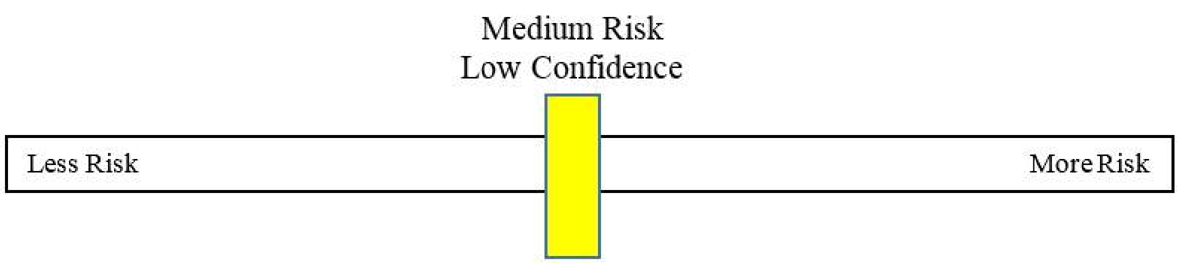
Risk	Confidence	
High	**Low**	

Table 145. Effects analysis summary table; Hawksbill sea turtle; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported? Yes/No
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

The stressors of the action may negatively affect a relevant physical and biological feature within nearshore designated critical habitat of the hawksbill sea turtle. However, we have low confidence in the EECs predicted for the marine nearshore habitats. The likelihood and magnitude of toxic effects are not likely to reduce the overall conservation value of designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.



17.46 Leatherback Sea Turtle Designated Critical Habitat

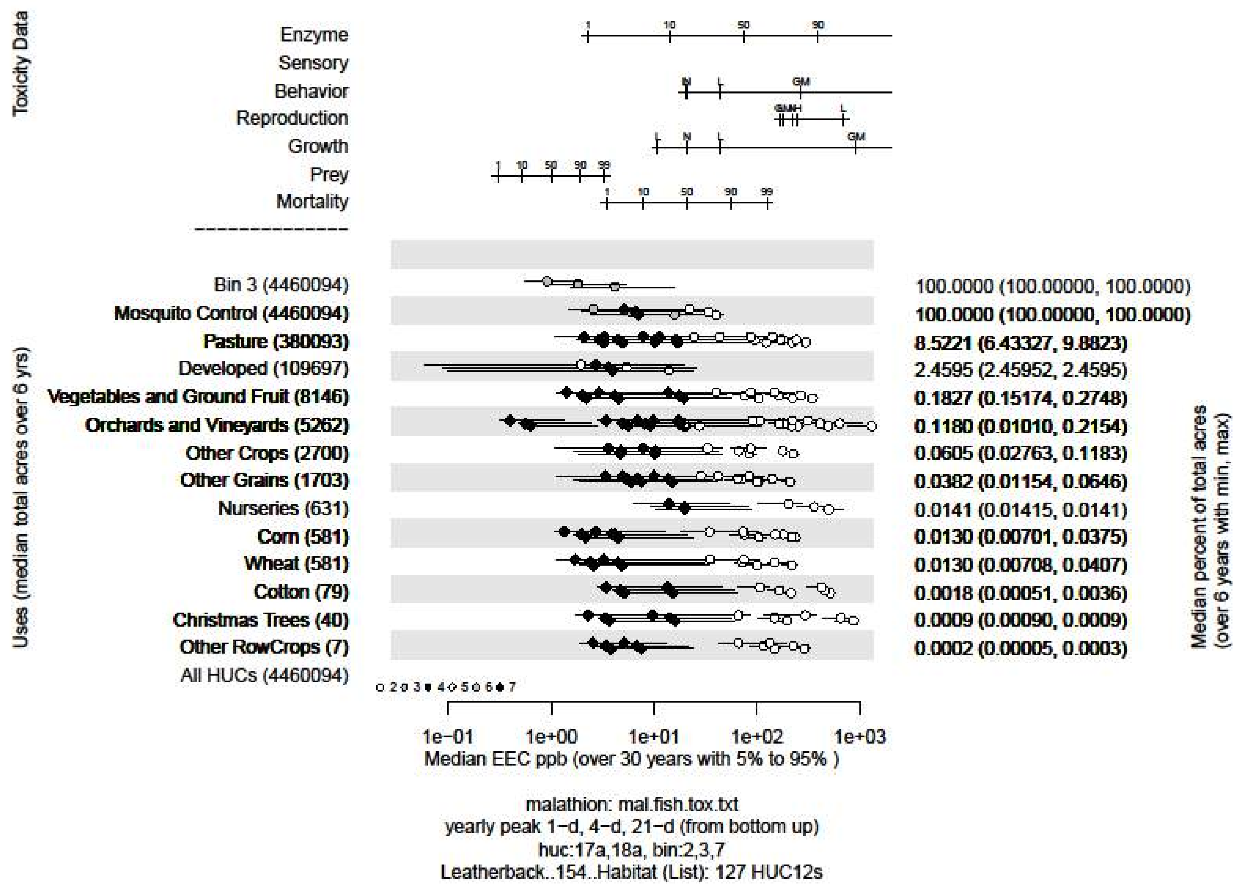


Figure 44. Effects analysis R-plot; Leatherback sea turtle, U.S. West Coast designated critical habitat.

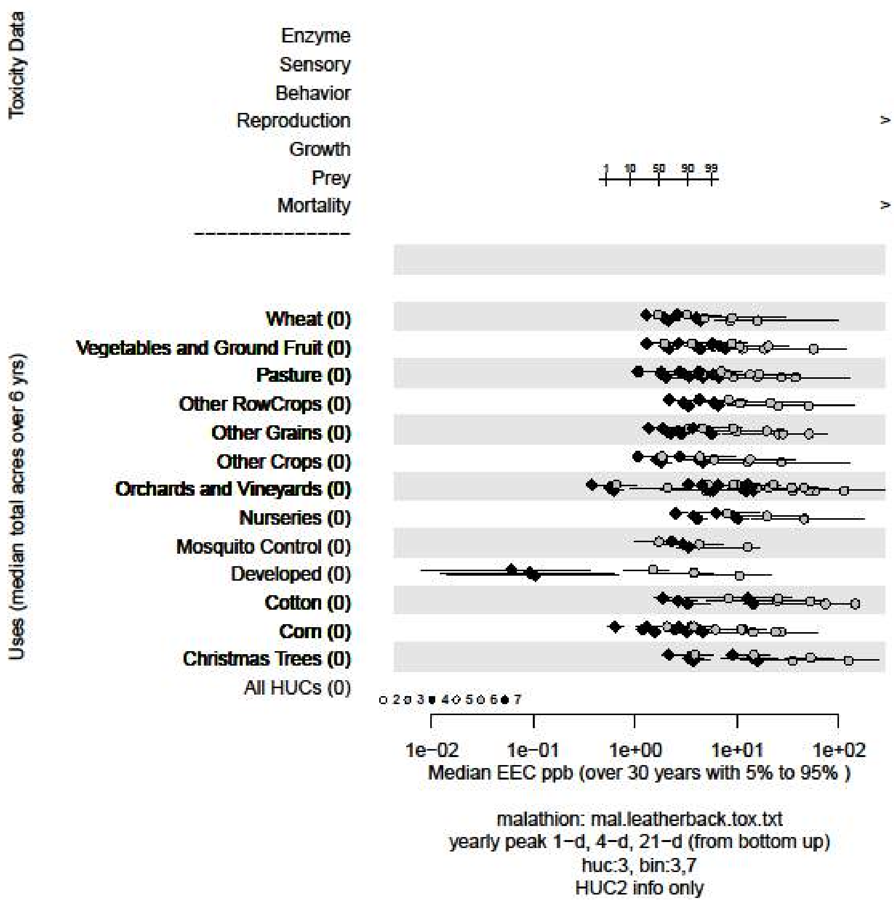


Figure 45. Effects analysis R-plot; Leatherback sea turtle, U.S. Virgin Islands designated critical habitat.

Table 146. Prey (inverts) risk hypothesis; Leatherback sea turtle; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Pasture	8.52	High	High
Developed	2.46	High	Medium
Vegetables and Ground Fruit	0.18	High	Low
Orchards and Vineyards	0.12	High	Low
Other Crops	0.06	High	Low
Other Grains	0.04	High	Low

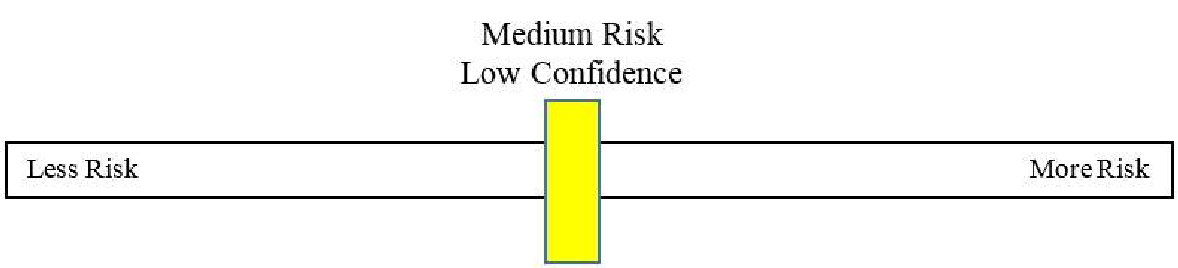
Nurseries	0.01	High	Low
Corn	0.01	High	Low
Wheat	0.01	High	Low
Cotton	<0.01	High	Low
Christmas Trees	<0.01	High	Low
Other RowCrops	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to cause reductions in prey (inverts).			
Risk	**Confidence**		
High	**Low**		

Table 147. Effects analysis summary table; Leatherback sea turtle; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported? Yes/No**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

The stressors of the action may negatively affect a relevant physical and biological feature within the nearshore of each of the designated critical habitat areas if the leatherback sea turtle. However, we have low confidence in the EECs predicted for the marine nearshore habitats. The likelihood and magnitude of toxic effects are not likely to reduce the overall conservation value of designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.



17.47 Loggerhead Sea Turtle (NW Atlantic Ocean DPS) Designated Critical Habitat

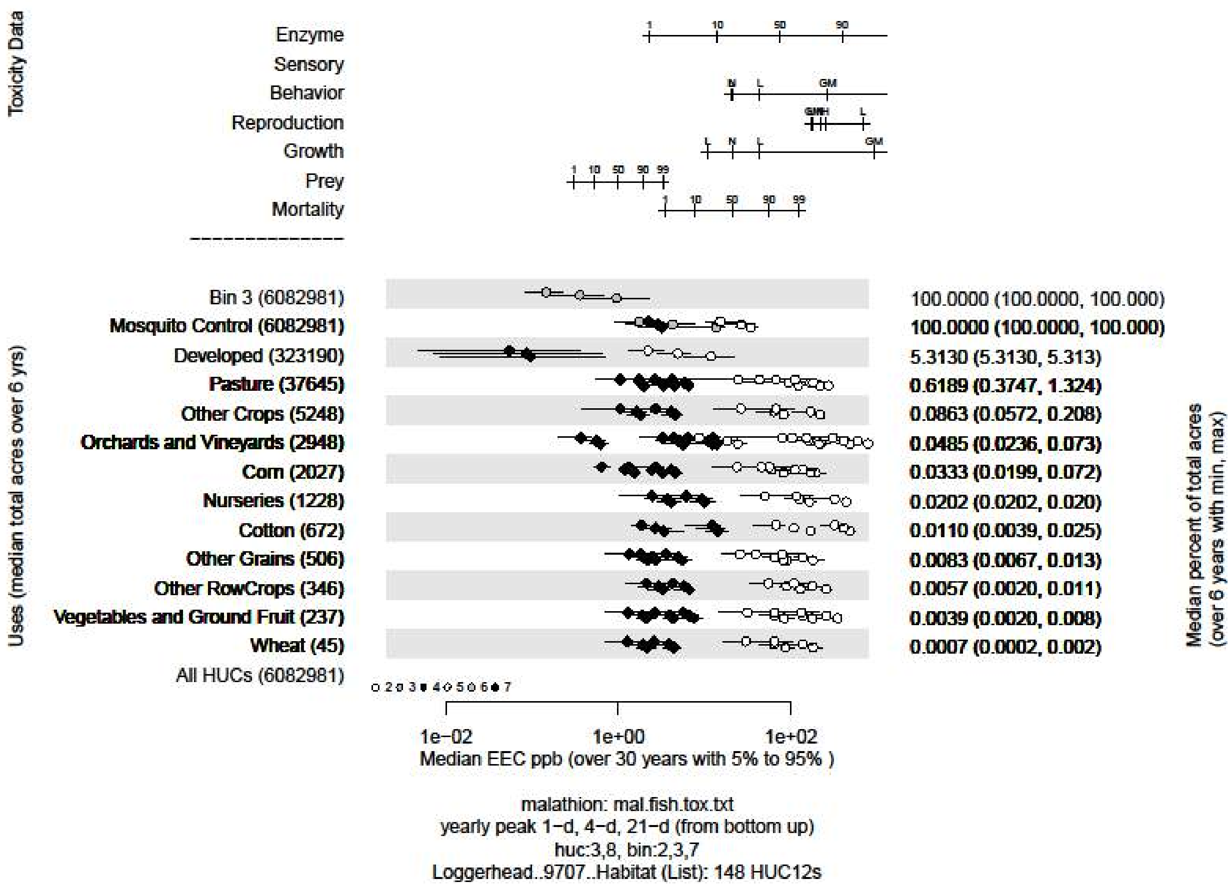


Figure 46. Effects analysis R-plot; Loggerhead sea turtle, NW Atlantic DPS designated critical habitat.

Table 148. Prey (inverts) risk hypothesis; Loggerhead sea turtle; designated critical habitat.

Endpoint: Prey (invertebrates)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	High	High
Developed	5.31	High	High
Pasture	0.62	High	Low
Other Crops	0.09	High	Low
Orchards and Vineyards	0.05	High	Low
Corn	0.03	High	Low
Nurseries	0.02	High	Low
Cotton	0.01	High	Low

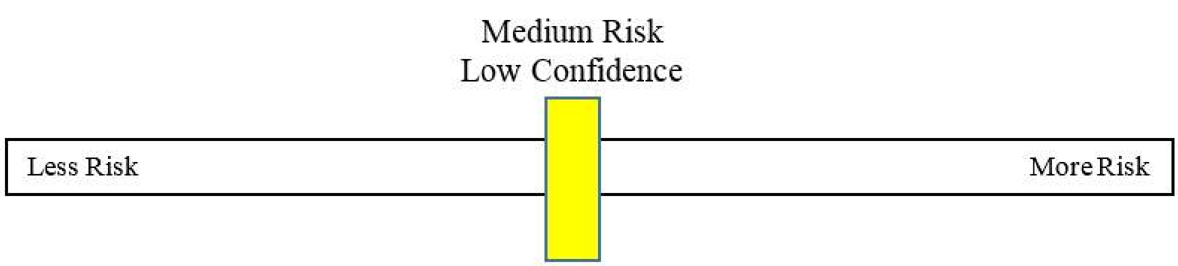
Other Grains	0.01	High	Low
Other RowCrops	0.01	High	Low
Vegetables and Ground Fruit	<0.01	High	Low
Wheat	<0.01	High	Low
Risk Hypothesis: Exposure to the stressors of the action is sufficient to cause reductions in prey (inverts).			
Risk	**Confidence**		
High	**Low**		

Table 149. Effects analysis summary table; Loggerhead sea turtle; designated critical habitat.

	R-plot Derived		**Risk Hypothesis Supported?**
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	**Yes/No**
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey.	High	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

The stressors of the action may negatively affect a relevant physical and biological feature within nearshore designated critical habitat of the loggerhead sea turtle. However, we have low confidence in the EECs predicted for the marine nearshore habitats. The likelihood and magnitude of toxic effects are not likely to reduce the overall conservation value of designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.



17.48 Southern Resident Killer Whale Designated Critical Habitat

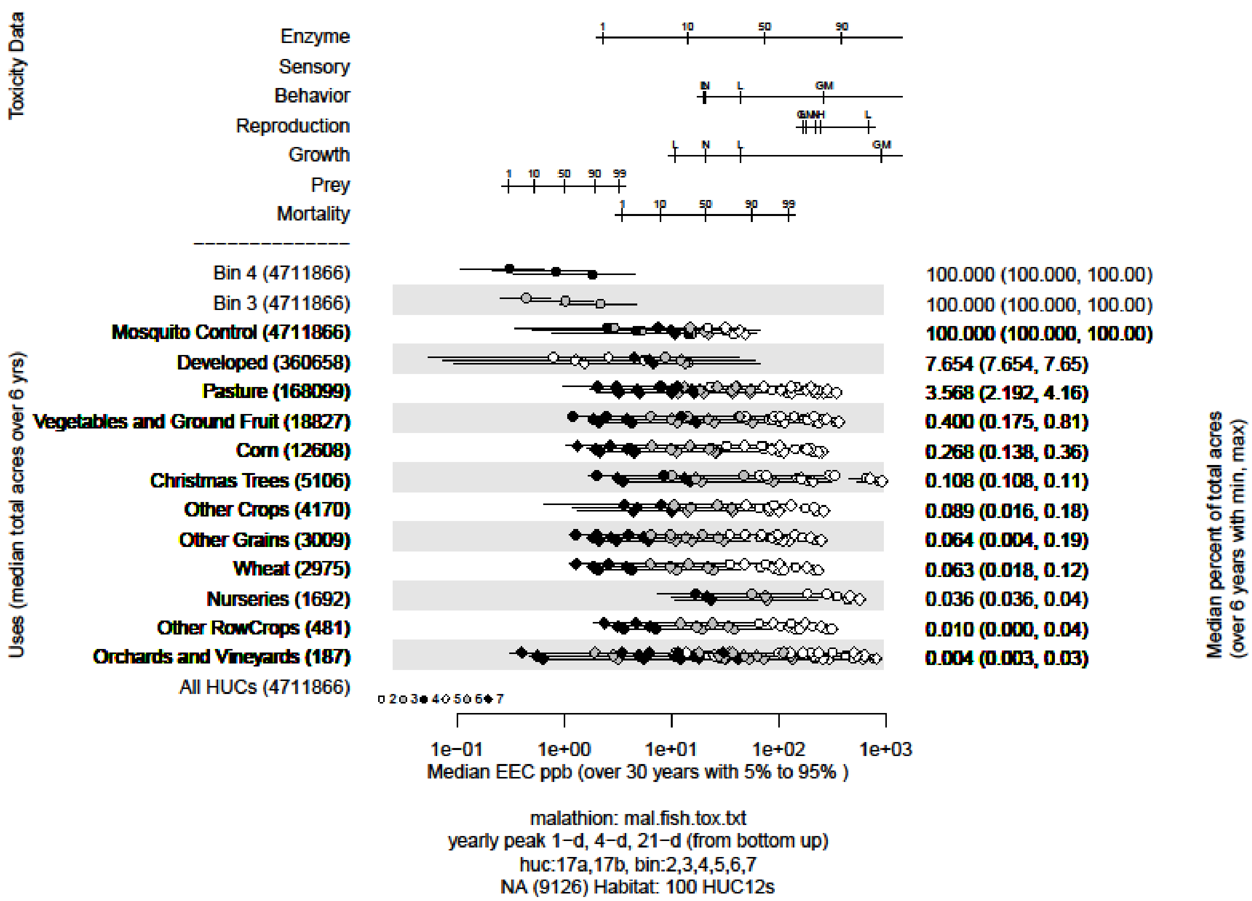


Figure 47. Effects analysis R-plot; Southern Resident Killer Whale designated critical habitat.

Table 150. Prey (fish) risk hypothesis; Killer whale, Southern resident DPS; designated critical habitat.

Endpoint: Prey (fish)			
Use Category	**% Overlap**	**Effect of Exposure**	**Likelihood of Exposure**
Mosquito Control	100.00	High	High
Bin 3	100.00	Low	High
Bin 4	100.00	Low	High
Developed	7.65	High	High
Pasture	3.57	High	Medium

Vegetables and Ground Fruit	0.40	High	Low
Corn	0.27	High	Low
Christmas Trees	0.11	High	Low
Other Crops	0.09	High	Low
Other Grains	0.06	High	Low
Wheat	0.06	High	Low
Nurseries	0.04	High	Low
Other RowCrops	0.01	High	Low
Orchards and Vineyards	<0.01	High	Low
Risk Hypothesis: Direct exposure to the stressors of the action within designated critical habitat is sufficient to reduce prey (fish).			
Risk	**Confidence**		
High	**Low**		
Risk Hypothesis: Exposure to the stressors of the action outside of designated critical habitat is sufficient to in-directly reduce prey availability (Chinook salmon).			
Risk	**Confidence**	**Affecting the availability of prey species of sufficient quantity and quality. Jeopardy determinations were made for all ESU's of Chinook salmon with regard to the proposed action.**	
High	**High**		

Table 151. Water quality risk hypothesis; Killer whale, Southern resident DPS; designated critical habitat.

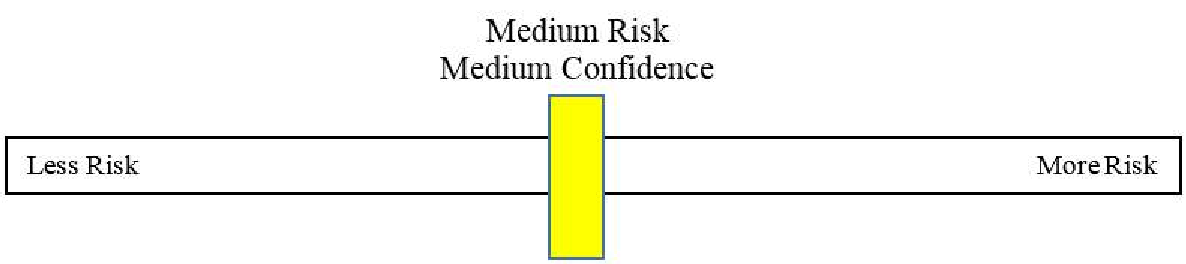
Endpoint: Water Quality		
Compromised water quality occurs when anticipated concentrations of the stressors of the action achieve toxic levels in designated critical habitat. Authorized uses of malathion-containing products occur in proximity to the designated critical habitat of Killer whale, Southern resident DPS. Twelve use site categories, totaling more than 577,812 acres (over 13% of acres) are currently present. In addition, proposed labels for malathion allow for mosquito control which can be applied to 100% of the species designated critical habitat. The anticipated malathion levels in designated critical habitat are not sufficient to cause adverse effects to killer whales.		
Risk Hypothesis: Exposure to the stressors of the action is sufficient to degrade water quality.		
Risk	**Confidence**	
Low	**High**	

Table 152. Effects analysis summary table; Killer whale, Southern resident DPS; designated critical habitat.

	R-plot Derived		Risk Hypothesis Supported? Yes/No
Designated Critical Habitat; Risk Hypotheses	**Risk**	**Confidence**	
Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey.	Low	High	No
Exposure to the stressors of the action outside of designated critical habitat is sufficient to in-directly reduce the conservation value via reductions in prey availability (Chinook salmon).	High	High	Yes
Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality.	Low	High	No

Designated Critical Habitat Effects Analysis Summary:

We do not anticipate stressors of the action will directly affect physical or biological features (PBFs). Reductions in suitable prey (within designated critical habitat) and degradation of water quality are unlikely throughout designated critical habitat of Southern Resident Killer Whale. However, indirectly, prey species (salmon) will be adversely affected by exposures anticipated in their freshwater habitats. The likelihood and magnitude of toxic effects will reduce the overall conservation value of designated critical habitat by reducing the availability of these important prey. We find that the overall risk is medium and the confidence associated with that risk is medium over the 15-year duration of the action.



17.49 Stellar Sea Lion (Western DPS) Designated Critical Habitat

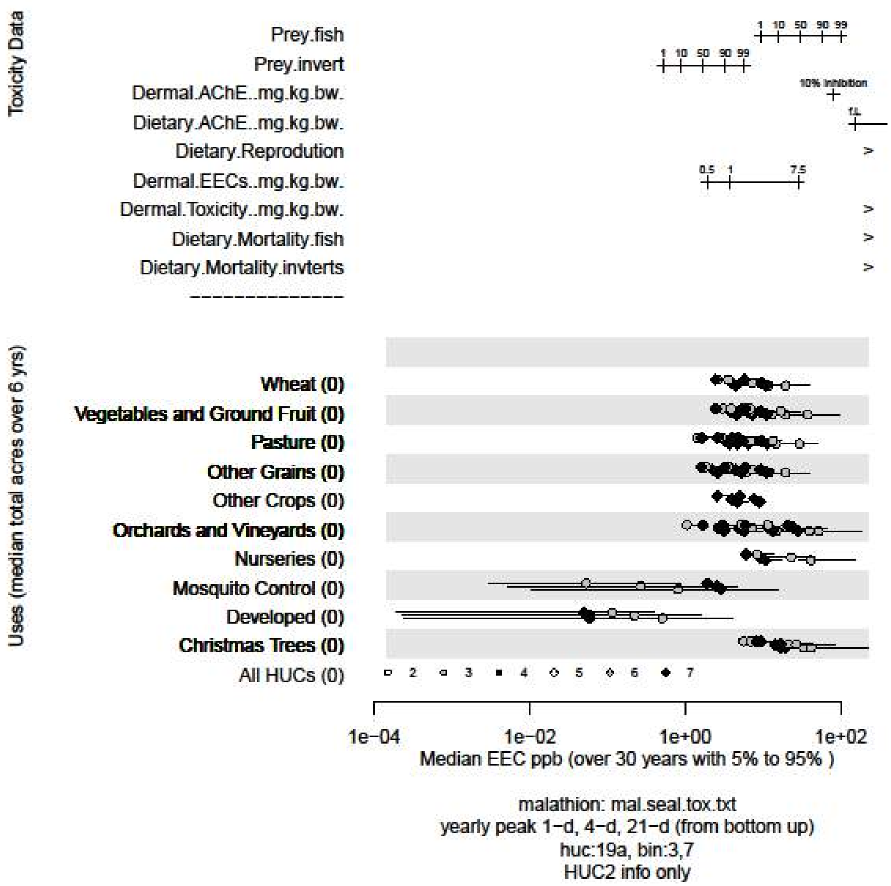


Figure 48. Effects analysis R-plot; Steller sea lion, Western DPS designated critical habitat.

Table 153. Effects analysis summary table; Steller sea lion, Western DPS; designated critical habitat.

Designated Critical Habitat; Risk Hypotheses	R-plot Derived		Risk Hypothesis Supported? Yes/No
	Risk	Confidence	
Exposure to the stressors of the action is sufficient to cause reductions in prey.	Medium	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

The stressors of the action may negatively affect a relevant physical and biological feature within nearshore designated critical habitat of the Steller sealion. However, we have low confidence in the EECs predicted for the marine nearshore habitats. The likelihood and magnitude of toxic effects are not likely to reduce the overall conservation value of designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.

17.50 Hawaiin Monk Seal Designated Critical Habitat

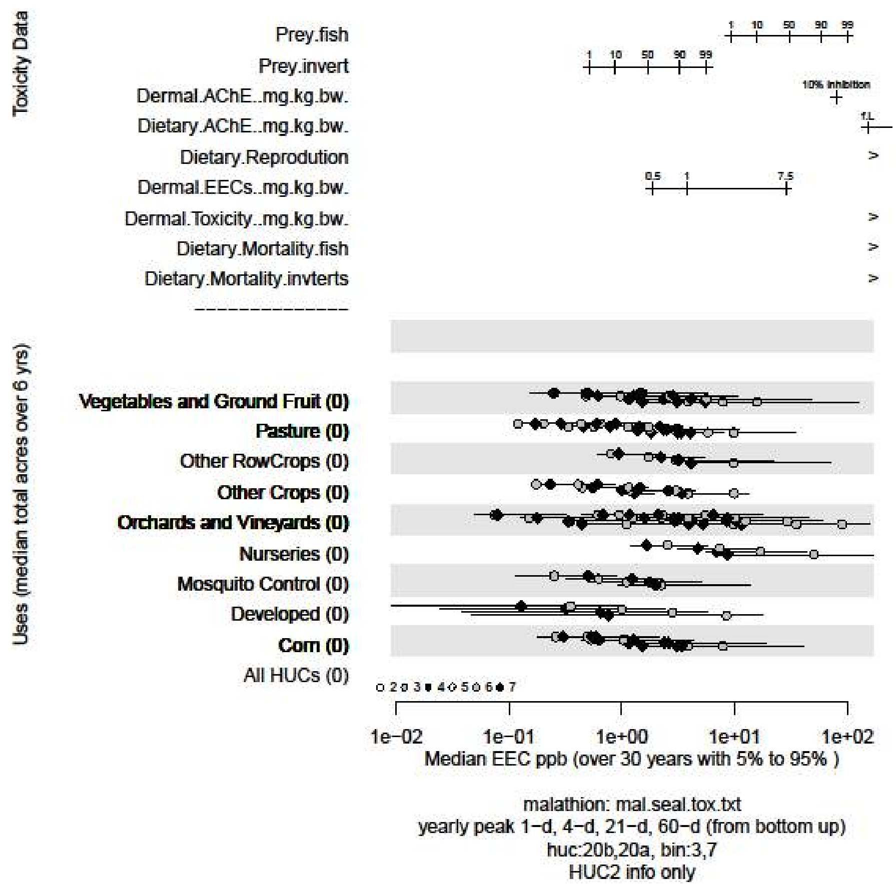


Figure 49. Effects analysis R-plot; Hawaiian Monk Seal designated critical habitat.

Table 154. Effects analysis summary table; Hawaiian Monk Seal designated critical habitat.

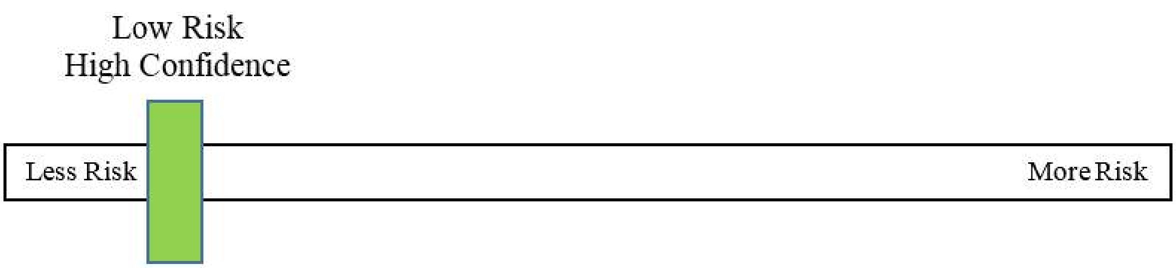
Designated Critical Habitat; Risk Hypotheses	R-plot Derived		Risk Hypothesis Supported? Yes/No
	Risk	**Confidence**	
Exposure to the stressors of the action is sufficient to cause reductions in prey.	Medium	Low	Yes

Designated Critical Habitat Effects Analysis Summary:

The stressors of the action may negatively affect a relevant physical and biological feature within nearshore designated critical habitat of the Hawaiian monk seal. However, we have low confidence in the EECs predicted for the marine nearshore habitats. The likelihood and magnitude of toxic effects are not likely to reduce the overall conservation value of designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.

17.51 Johnson's Seagrass Designated Critical Habitat

Water quality is a physical or biological features identified in Johnson's seagrass designated critical habitat. However, we do not anticipate exposures from the stressors of the action to be sufficient to reduce conservation values of this PBF. We find that the overall risk is low and the confidence associated with that risk is high over the 15-year duration of the action.



17.52 Summary of the Effects of the Action on Physical or Biological Features:

We conclude that the available information on exposure and response of aquatic habitats to the stressors of the action supports risk hypotheses for many of the species. ***Table 155*** summarizes for malathion and for the species habitats where risk hypotheses are supported. We expect water quality and prey abundance to be reduced in spawning, rearing, migratory, estuarine, or nearshore marine habitats for many of the species' designated critical habitats. Next, within the Integration and Synthesis for Designated Critical Habitat section, we evaluate whether these adverse changes to PBFs affect the conservation value of designated critical habitat.

Table 155. Summary of species critical habitat risk assessments to key physical and biological features – malathion.

Species Designated Critical Habitat	Water Quality and/or Prey Risk Hypotheses Supported (Malathion)
Chum salmon , Columbia River ESU	Yes
Chum salmon, Hood Canal summer-run ESU	Yes
Chinook salmon, California coastal ESU	Yes
Chinook salmon, Central Valley spring-run ESU	Yes
Chinook salmon, Lower Columbia River ESU	Yes
Chinook salmon, Puget Sound ESU	Yes
Chinook salmon, Sacramento River winter-run ESU	Yes
Chinook salmon, Snake River fall-run ESU	Yes
Chinook salmon, Snake River spring/summer run ESU	Yes
Chinook salmon, Upper Columbia River spring-run ESU	Yes
Chinook salmon, Upper Willamette River ESU	Yes
Coho salmon, Central California coast ESU	Yes
Coho salmon, Lower Columbia River ESU	Yes
Coho salmon, Oregon coast ESU	Yes
Coho salmon, S. Oregon and N. California coasts ESU	Yes
Sockeye, Ozette Lake ESU	Yes
Sockeye, Snake River ESU	Yes

Steelhead, California Central Valley ESU	Yes
Steelhead, Central California coast ESU	Yes
Steelhead, Lower Columbia River ESU	Yes
Steelhead, Middle Columbia River ESU	Yes
Steelhead, Northern California ESU	Yes
Steelhead, Puget Sound ESU	Yes
Steelhead, Snake River Basin ESU	Yes
Steelhead, South-Central California coast ESU	Yes
Steelhead, Southern California ESU	Yes
Steelhead, Upper Columbia River ESU	Yes
Steelhead, Upper Willamette River ESU	Yes
Eulachon, Pacific smelt, Southern DPS	Yes
Green sturgeon, Southern DPS	Yes
Gulf sturgeon	No
Atlantic sturgeon, Carolina DPS	Yes
Atlantic sturgeon, Chesapeake Bay DPS	Yes
Atlantic sturgeon, Gulf of Maine DPS	Yes
Atlantic sturgeon, New York Bight DPS	Yes
Atlantic sturgeon, South Atlantic DPS	Yes
Yelloweye rockfish	No
Bocaccio, Puget Sound/Georgia Basin	No
Smalltooth sawfish, U.S. DPS	Yes
Black abalone	No
Staghorn coral	No
Elkhorn coral	No
Green sea turtle, North Atlantic DPS	No
Hawksbill sea turtle	No
Leatherback sea turtle	No

Loggerhead sea turtle, Northwest Atlantic Ocean DPS	No
Killer whale, Southern Resident DPS	Yes
Steller sea lion, Western	No
Hawaiian monk seal	No
Johnson’s seagrass	No

CHAPTER 18

CUMULATIVE EFFECTS

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18 CUMULATIVE EFFECTS

18.1 Introduction

Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action area considered by this Opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Endangered Species Act (ESA).

During this consultation, the National Marine Fisheries Service (NMFS) searched for information on future state, tribal, local, or private actions that were reasonably certain to occur in the action area. NMFS conducted electronic searches of business journals, trade journals, and newspapers using Google and other electronic search engines. Those searches produced reports on projected population growth, commercial and industrial growth, and global warming. Trends described below highlight the effects of population growth on existing populations and habitats for all 28 ESUs/DPSs. Changes in the near-term (five-years; 2018) are more likely to occur than longer-term projects (10-years; 2023). Projections are based upon recognized organizations producing best available information and reasonable rough-trend estimates of change stemming from these data. NMFS analysis provides a snapshot of the effects from these future trends on listed ESUs.

Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action area considered by this Opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

The information from the Cumulative Effects section is treated as a “risk modifier” in the Integration and Synthesis section (Chapters 19-24). Factors which have the potential to “modify” the risk are those which are able to interact with the effects of the action. For example, elevated temperatures have been demonstrated to increase the toxicity of certain pesticide mixtures to juvenile coho salmon (Laetz et al. 2014). While many of the factors described in this section have the potential to modify the action, and were thus considered, two of the factors were consistently found to have a high potential to modify the risk. The two factors are: 1) elevated temperatures in marine and freshwater habitats, and 2) hydrologic effects in freshwater habitats. We therefore developed two key questions to guide our synthesis of the information within the Cumulative Effects section:

1. Will future temperatures impair species aquatic habitats?
2. Will future hydrologic flows impair freshwater species habitats?

We divide the species into three groupings: 1) species which are anadromous or that have life history stages within freshwater habitats; 2) marine fish and abalone; and 3) marine mammals, sea turtles, corals, and seagrass. For the first grouping, we used best available information to answer the two questions. For the second and third groupings, we used best available science to answer the first question only as we do not anticipated altered hydrologic flows (due to changes in rainfall and snowmelt) to affect marine environments.

In order to assess potential changes in future aquatic temperatures and future hydrological flows, NMFS searched for information on future state, tribal, local, or private actions that were reasonably certain to occur in the action area. NMFS conducted electronic searches of business journals, trade journals, and newspapers using Google and other electronic search engines. Those searches produced reports on projected population growth, commercial and industrial growth, and climate change (see summaries below). Projections are based upon recognized organizations producing best available information and reasonable rough-trend estimates of change stemming from these data. NMFS analysis provides a snapshot of the effects from these future trends on listed Evolutionarily Significant Units (ESUs)/ Distinct Population Segments (DPS).

In general, NMFS found:

For freshwater and/or anadromous species. Future elevated temperatures and altered hydrologic conditions are likely to affect all freshwater and/or anadromous species. Two species are exceptions to this general rule since NMFS' jurisdiction of both Atlantic salmon and Gulf sturgeon is limited to the marine environment where temperature and hydrologic effects are less likely.

For marine fish and abalone. Neither future elevated temperatures, nor altered hydrologic conditions are likely to affect marine fish and abalone.

For marine mammals, sea turtles, corals, and seagrass. Future elevated temperatures or hydrologic alterations (from rainfall or changes in snowmelt) are not likely to affect these species.

Within the Integration and Synthesis section (Chapters 19-24), we characterize the overall magnitude of influence of the Cumulative Effect as either "low" or "high". This characterization includes directionality (i.e. positive influence or negative influence) as well as confidence. The magnitude, directionality, and confidence of the influence are determined primarily by answers provided to the two key questions outlined above. Confidence is determined by assessing the amount of evidence provided, as well as by further considering the species-specific implications of the two main factors.

18.2 U.S. Population Growth

The U.S. population is growing at a net rate of one person every 14 seconds. Regional data from the U.S. Census Bureau show the South has the highest population at 120 million, followed by the West at 80 million. The Midwest and the Northeast populations are at 75 and 60 million (respectively). ***Figure 1*** depicts the annual rate of growth from the year 2000 to 2015 for each of these regions. Currently the population of the U.S. stands at over 325,032,400 and counting (https://www.census.gov/popclock/). By 2060, the U.S. population is projected to increase to 417 million, reaching 400 million in 2051.

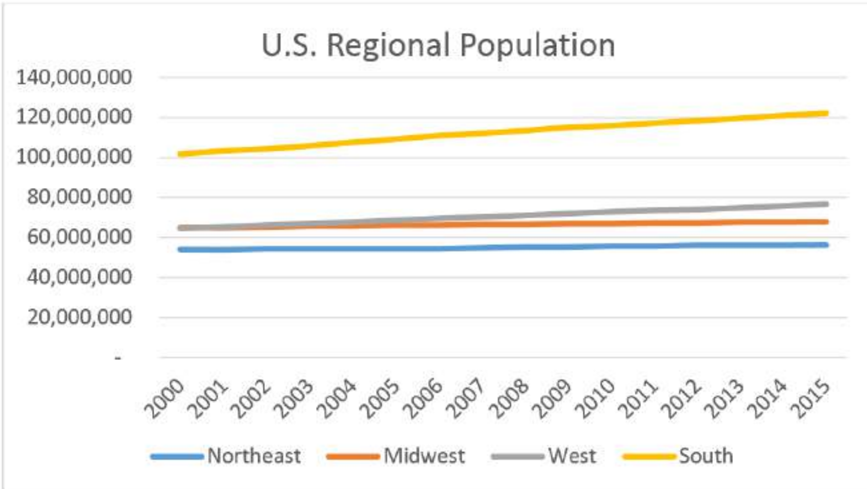

Figure 1. U.S. Population increase by region 2000-2015 (U.S. Census Bureau)

Figure 1 shows the trend in growth over a sixteen-year span. Growth rate in the south was greatest, followed by the West region. The Midwest and Northeast growth rates remained mostly flat taken as a region as a whole. Of particular concern to NMFS' listed species is the population growth within coastal counties. Coastline counties of the U.S., located along the country's saltwater edges, account for just 255 of the nation's 3,142 counties yet contain 29% of its population, 5 of its 10 most populous cities, and 7 of 10 of its most populous counties (Mackun et al, 2011). Between 1960 and 2008, the percentage increase in population along the coastal counties (84%) was greater than that of non-coastal counties (64%). Among the coastal regions, the percentage increase in population in the Gulf of Mexico (150%) and the Pacific (110%) far outpaced the gains for the Atlantic region (56%). Growth in the coastal counties are expected to continue to outpace non-coastal counties.

Population growth will require greater and greater demand on resources, greater demand for food and water, and greater demand for energy. The increase in demand for these essential items are likely to extend pressures on many threatened and endangered species populations and their designated critical habitats. As many cities border coastal or riverine systems, diffuse and extensive growth will increase overall volume of contaminant loading from wastewater treatment plants and sediments from expanding urban and suburban development into riverine, estuarine, and marine habitats. Urban runoff from expanding impervious surfaces and existing and additional roadways may also contain oil, heavy metals, polycyclic aromatic hydrocarbons, and other chemical pollutants and flow into state surface waters. Inputs of these point and non-point pollution sources into numerous rivers and their tributaries will affect water quality in available spawning and rearing habitat for salmon. Based on the increase in human population growth, we expect an associated increase in the number of National Pollution Discharge Elimination System (NPDES) permits issued and the potential listing of more 303(d) waters with high pollutant concentrations in state surface waters. Continued growth into forested and other natural areas will continue the cycle of altering landscapes to the detriment of species habitat. Altered landscapes, such as the loss of riparian vegetation along rivers and increases in impervious surfaces, adversely affect the delivery of sediment and gravel and significantly alter stream hydrology and water quality.

A rise in the population would necessitate a rise in agricultural output, and the potential conversion of forested and other natural lands to agriculture. As most of the coastal states have large tracts of irrigated agriculture, this rise in agricultural output is anticipated to affect coastal areas and aquatic species. Impacts from heightened agricultural production will likely result in two negative impacts on listed species. The first impact may come from a needed reliance and greater use and application of pesticide, fertilizers, and herbicides and their increased concentrations and entry into freshwater systems. Toxics and other pollutants from agricultural runoff may further degrade habitats supporting listed species. Second, increased output and water diversions for agriculture may also place greater demands upon limited water resources. Water diversions will reduce flow rates and alter habitat throughout freshwater systems. Reductions in flows could mean higher water temperatures, and as water is drawn off, contaminants will become more concentrated in these systems, exacerbating toxicity issues in habitats for protected species.

The above issues are likely to pose continuous unquantifiable negative effects on listed species addressed in this Opinion, particularly freshwater and anadromous species, and those species adapted to and requiring nearshore and estuarine habitats. Each activity has negative effects on water quality. They include increases in sedimentation, increased point and non-point pollution discharges, decreased infiltration of rainwater (leading to decreases in shallow groundwater recharge, decreases in hyporrheic flow (e.g., water that spreads laterally beneath river gravels outside the channel where surface flows occur), and decreases in summer base flows). For example, EPA recently released draft *National Rivers and Streams Assessment 2008-2009 – Collaborative Survey* (EPA 2013) revealed only 41.9% of rivers and streams in the west were in good overall biological condition. Biological condition is the most comprehensive indicator of water body health. When the biology of a stream is healthy, the chemical and physical components of the stream are also typically in good condition. The EPA assessment indicated that the overall health of the rivers and streams has declined when compared to past surveys. Nationally, the amount of stream length in good quality for macroinvertebrate condition dropped from 27.4% in 2004 to 20.5%.

18.3 Climate Change

Climate change is an important factor in the long-term survival and recovery of ESA listed species. Salmon and steelhead, sturgeon and eulachon throughout their respective range are likely to be affected by a changing climate both directly and indirectly with increasing water temperatures and reduced instream summer flows. Several studies have revealed that climate change has the potential to affect ecosystems in nearly all tributaries throughout the Northwest and California where abundant cold water flows are essential for the conservation of species habitats (Battin et al. 2007; IPCC 2013; McClure et al. 2013; Crozier and Dechant 2014). While the intensity of effects will vary by region (ISAB 2007), climate change is generally expected to alter aquatic habitat (water yield, peak flows, and stream temperature). As climate change alters the structure and distribution of rainfall, snowpack, and glaciations, each factor will in turn alter riverine hydrographs. Given the increasing certainty that climate change is occurring and is accelerating (Battin et al. 2007), NMFS anticipates salmonid, sturgeon, and eulachon habitats will be affected. Climate and hydrology models project significant reductions in both total snow pack and low-elevation snow pack in the Pacific Northwest over the next 50 years (Mote and Salathe 2009) – changes that will shrink the extent of the snowmelt-dominated habitat available to theses threatened and endangered species. Such changes may restrict our ability to conserve diverse life histories for many of these species.

Hydrologic changes in streamflow may harm the spawning and migration of sturgeon, eulachon, salmon and trout species. Continued warming of stream and lake temperatures may also affect the health of and the extent of suitable habitat for many other aquatic species. Salmonids and other species that currently live in conditions near the upper range of their thermal tolerance are particularly vulnerable to higher stream temperatures, increasing susceptibility to disease and rates of mortality. Upstream migration for thermally-stressed species may be impeded by changes in channel structure from altered low-flow regimes. Reduced glacier area and *volume* over the long-term, which is projected for the future in the North Cascades, may challenge Pacific salmonids in those streams in which glacier melt comprises a significant proportion of streamflow (Dalton, Mote and Snover, 2013).

Altered ocean conditions projected with climate change include sea-level rise and ocean acidification (IPCC 2013). The Intergovernmental Panel on Climate Change (IPCC) reports with virtual certainty that the upper ocean (0-700m) warmed from 1971 to 2010. On the global scale, the ocean warming is largest near the surface, and the upper 75m warmed by 0.11 [0.09-0.13] °C per decade over this 40 year period.

Since the early 1970s, glacier melt and ocean thermal expansion from warming together explain much of the observed global sea-level rise.

The atmospheric concentrations of carbon dioxide, methane, and nitrous oxide have increased to levels unprecedented in at least 800,000 years and these levels are projected to increase further. Carbon dioxide concentrations have increased by 40% since pre-industrial times, primarily from fossil fuel emissions and secondarily from net land use change emissions. The ocean has absorbed about 30% of the emitted carbon dioxide, causing the ocean to acidify (IPCC 2013). The pH of the ocean surface water has decreased by 0.1 since the beginning of the industrial era, corresponding to a 26% increase in hydrogen ion concentration. The IPCC (2013) projects the global ocean will continue to warm during the 21st century. Heat will penetrate from the surface to the deep ocean and affect circulation. Best estimates of ocean warming in the top one hundred meters are as high as 2.0 °C (RCP8.5), and up to 0.6 °C at a depth of 1000 meters by the end of the century.

Projected increases in ocean warming and ocean acidification may have severe effects on corals and other marine invertebrates. Warmer water temperatures can result in coral bleaching Heron et al, 2016). At warmer temperatures, corals expel the symbiotic algae (zooxanthellae) living in their tissues causing the coral to turn completely white. Corals can survive bleaching events, but they are under more stress and are subject to mortality. The U.S. lost half its coral reefs in the Caribbean in 2005. Comparison of satellite data from the previous 20 years confirmed that thermal stress from the 2005 event was greater than the previous 20 years combined (NOAA NOS). Climate models project the percentage of reef locations exposed to bleaching-level thermal stress events to increase. By 2050, more than 98% of reefs are expected to be exposed to bleaching-level thermal stress (Heron et al 2016).

The oceans have absorbed much of the carbon dioxide (CO_2) released from the burning of fossil fuels, and other land-use emissions, resulting in chemical reactions that lower pH (Tans, 2009). This has caused an increase in hydrogen ion (acidity) of about 30% since the start of the industrial age. A process known as “ocean acidification.” A growing number of studies have demonstrated adverse impacts on marine organisms, including: 1) the rate at which reef-building corals produce their skeletons decreases, 2) the ability of marine algae and free-swimming zooplankton to maintain protective shells is reduced, and 3) the survival of larval marine species including commercial fish and shellfish is reduced (e.g. Feely et al, 2009, Kleypas et al. 2009, Cooley et al. 2009, Cohen and Holcomb 2009).

Calcium carbonate, or calcite ($CaCO_3$), and other important carbonate minerals are essential for many marine invertebrates. Benthic calcifiers, such as corals and mollusks are listed species that require uptake of calcite minerals for growth and survival. A variety of evidence indicates that their calcification rates will decrease (see citations above). As the ocean pH continues to dip (i.e. acidify) with the uptake of more CO_2, the saturation states of carbonate minerals calcite, aragonite, and magnesium calcite will lower. Calcification rate will decrease, and carbonate dissolution rates will increase. This will leave less of these minerals available and add stress to organisms that must form supporting skeletal structures for their growth and survival (Kleypas et al. 2006).

CHAPTER 19

INTEGRATION AND SYNTHESIS FOR LISTED SPECIES

CHLORPYRIFOS

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19 CHLORPYRIFOS

19.1 Introduction

The integration and synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Chapter 12) to the environmental baseline (Chapter 10) and the cumulative effects (Chapter 18) to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of Endangered Species Act (ESA)-listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated critical habitat for the conservation of an ESA-listed species. These assessments are made in full consideration of the Status of the Species (Chapter 9).

We treat the information from the status of the species, environmental baseline, and cumulative effects, as "risk modifiers," in that the effects described in the effects analysis section may be modified by the condition of the species; the condition of environmental baseline, and the anticipated cumulative effects. The key questions addressed include:

1) Status of the Species:
    - Are abundance, spatial distribution, and productivity trends increasing, decreasing or stable?
    - Is the species listed as threatened, or as endangered?
    - Have recovery goals been met, or are they on a sustained positive trajectory toward recovery?
2) Environmental Baseline:
    - Are freshwater temperatures elevated?
    - Are pesticide mixtures present, or anticipated based on current land use?
3) Cumulative Effects:
    - Will future temperatures impair species aquatic habitats?
    - Will future hydrologic flows impair freshwater species habitats?

Once each of the above sections is evaluated i.e., questions answered, the effects of the action and the risk modifiers are depicted graphically on a "scorecard." First, we assign a magnitude of influence (low or high) indicated graphically with one of two lengths of arrows. The shorter of the two arrows indicates a low magnitude, while the longer of the two arrows indicates a high magnitude as a risk modifier. The direction an arrow is pointed indicates the directionality of the risk modifier. For example, an environmental baseline arrow pointing towards more risk may indicate that environmental mixtures and elevated temperatures occur in the environmental baseline, which further stresses the species in question. We also assign a level of confidence in our selection of the small and large magnitude, indicated by a bold arrow (high confidence) or an un-bolded arrow (low confidence). The final arrow representing the influence on risk is graphically depicted on each species' scorecard.

Figure 1. Example of arrows to represent direction, magnitude, and confidence of risk modifiers

Conclusion Section:

With full consideration of the status of the species and the designated critical habitat, we construct a description of the effects of the action within the action area on populations or subpopulations, when added to the environmental baseline and the cumulative effects, to determine whether the action could reasonably be expected to:

- Reduce appreciably the likelihood of survival and recovery of ESA-listed species in the wild by reducing its numbers, reproduction, or distribution, and state our conclusion as to whether the action is likely to jeopardize the continued existence of such species; or
- Appreciably diminish the value of designated critical habitat for the conservation of an ESA-listed species, and state our conclusion as to whether the action is likely to destroy or adversely modify designated critical habitat.

A scorecard is generated for each species and designated critical habitat. The effects of the proposed action is considered, as modified by the magnitude and confidence of the three arrows. Next, a no-jeopardy or jeopardy bar is placed on the risk bar i.e., the colored bar beginning with green (less risk) to red (more risk) (***Figure 2***).

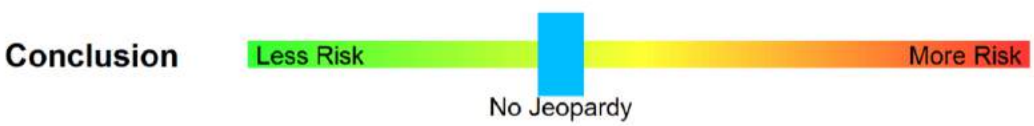

Figure 2: Example conclusion graphic

19.2 Species Scorecards

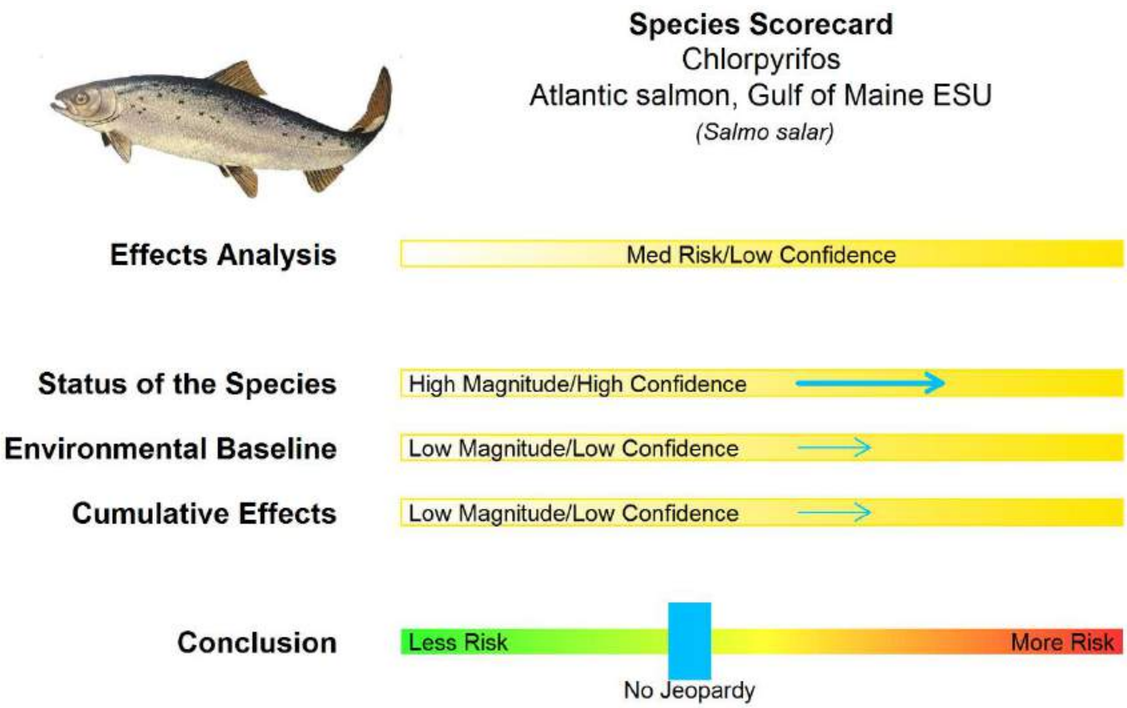

Figure 3. Species Score Card; Atlantic salmon, Gulf of Maine Evolutionarily Significant Unit (ESU); Chlorpyrifos

<u>Effects Analysis: Medium risk/Low confidence</u>

- Salmon occupying coastal, shallow areas may experience reduced abundance.
- Anticipated effects may include death, reduced cholinesterase activity, reduced prey abundance, and impaired swimming.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Abundance is declining, low resilience to disturbance, sustained by hatcheries
- Endangered species population estimated at 0.3% of historical levels
- Proposed action may hinder attainment of recovery goals in coastal areas

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures in marine waters not anticipated to affect species
- Environmental mixtures not anticipated to substantially affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures in marine areas uncertain to affect species
- No anticipated hydrologic effects in marine waters that would affect species

<u>Conclusion:</u> In their marine habitats, we find a low likelihood of exposure and effects to the species as a whole based on low confidence in exposure concentrations predicted for these open water saltwater habitats. The species is most at risk while in coastal, estuarine areas where they spend a small portion of their lives. Potential reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

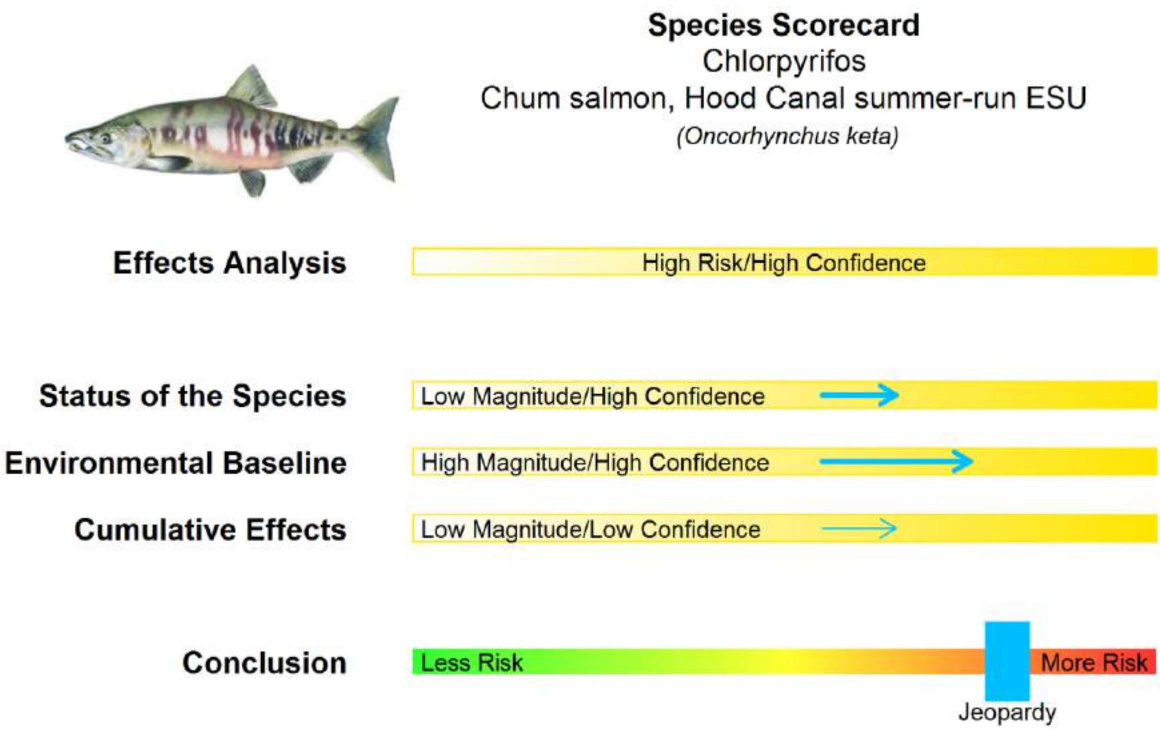

Figure 4. Species Score Card; Chum salmon, Hood Canal summer-run ESU; Chlorpyrifos

<u>Effects Analysis: High risk/High confidence</u>

- Salmon occupying freshwater and nearshore areas likely experience reduced abundance and productivity.
- Anticipated effects include death, reduced cholinesterase activity, reduced prey abundance, impaired swimming, and reduced productivity.

<u>Status of the Species: Increased risk of jeopardy; Low magnitude/ High confidence</u>

- Stable to increasing abundance trend, increasing population productivity
- Threatened species; 6 of 15 populations extirpated or nearly extirpated
- Proposed action may hinder attainment of some recovery goals

<u>Environmental Baseline: Minimal increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures anticipated in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures likely
- Anticipated hydrologic effects in freshwater areas may affect species

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species as a whole based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in freshwater and nearshore areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy</u>

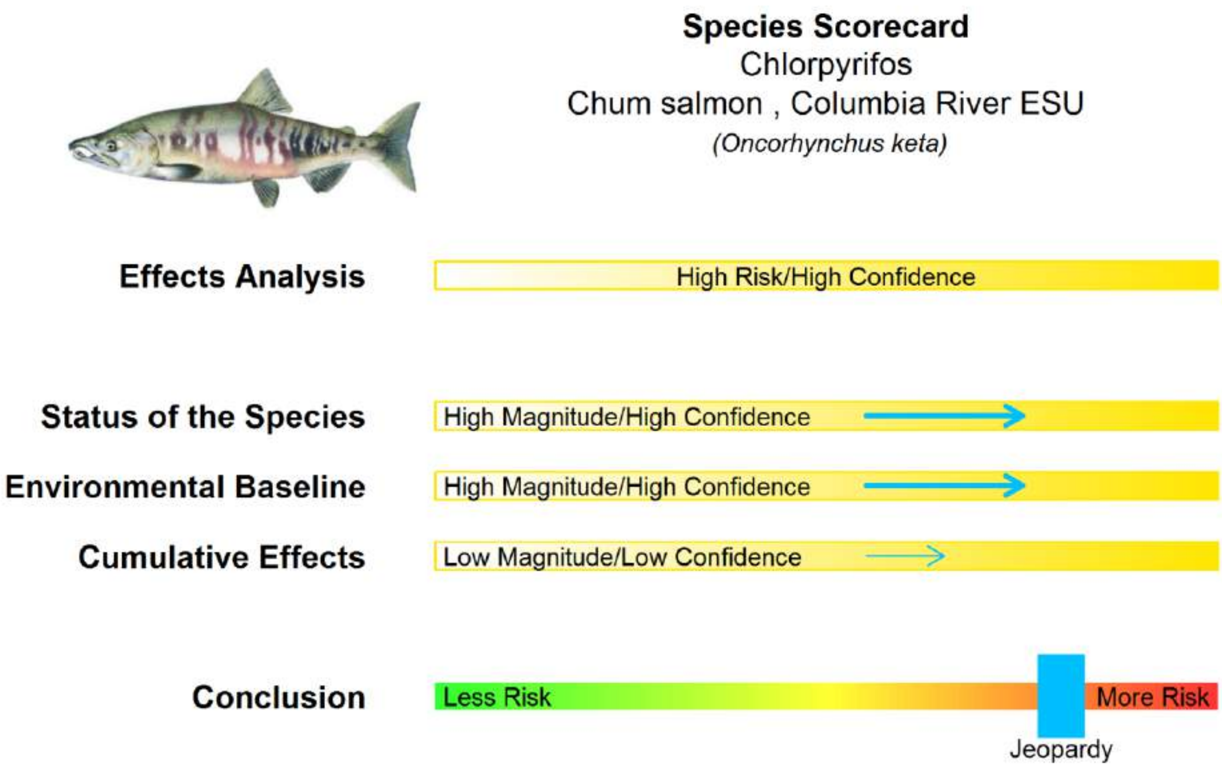

Figure 5. Species Score Card; Chum salmon, Columbia River ESU; Chlorpyrifos

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater and nearshore areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Declining abundance trends, high risk of extinction
- Threatened species; 7 of 16 populations are functionally extinct
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Minimal increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures anticipated in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas that may affect species

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>**Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy**</u>

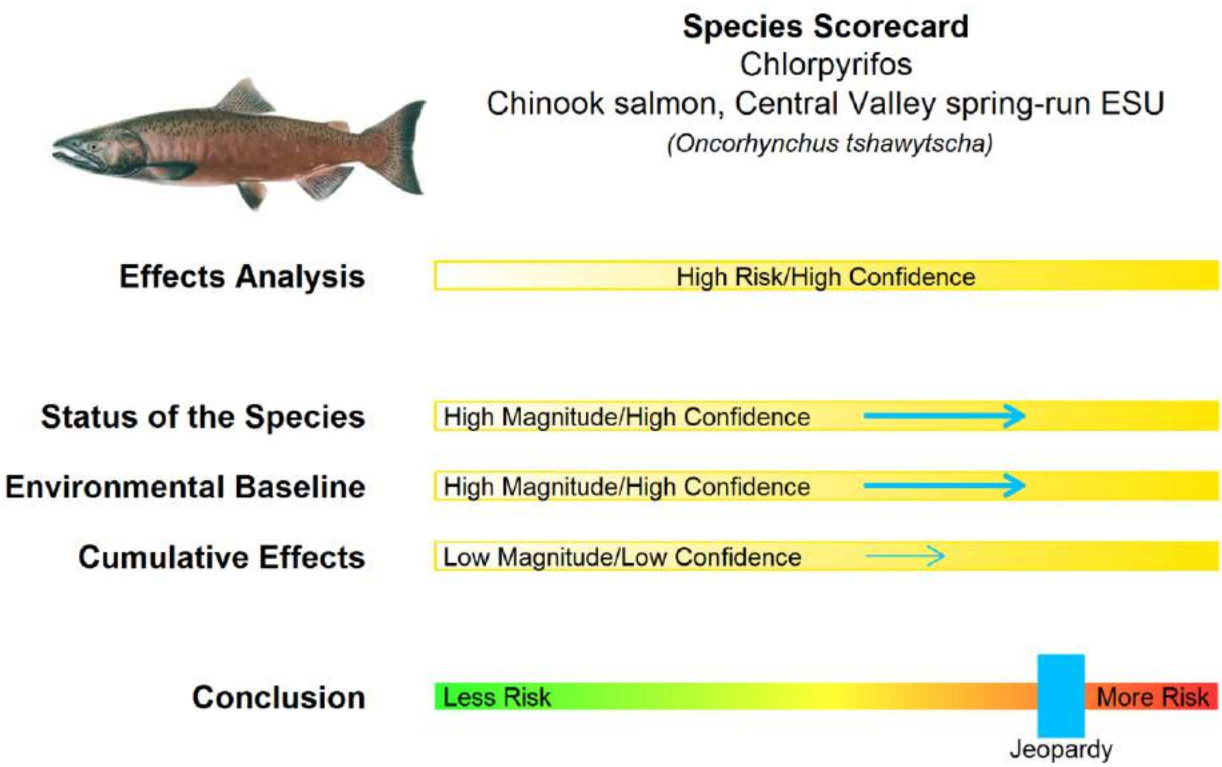

Figure 6. Species Score Card; Chinook salmon, Central Valley spring-run ESU; Chlorpyrifos

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Stable to declining abundance trends, low abundances and fragmented populations
- Threatened species
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>**Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy**</u>

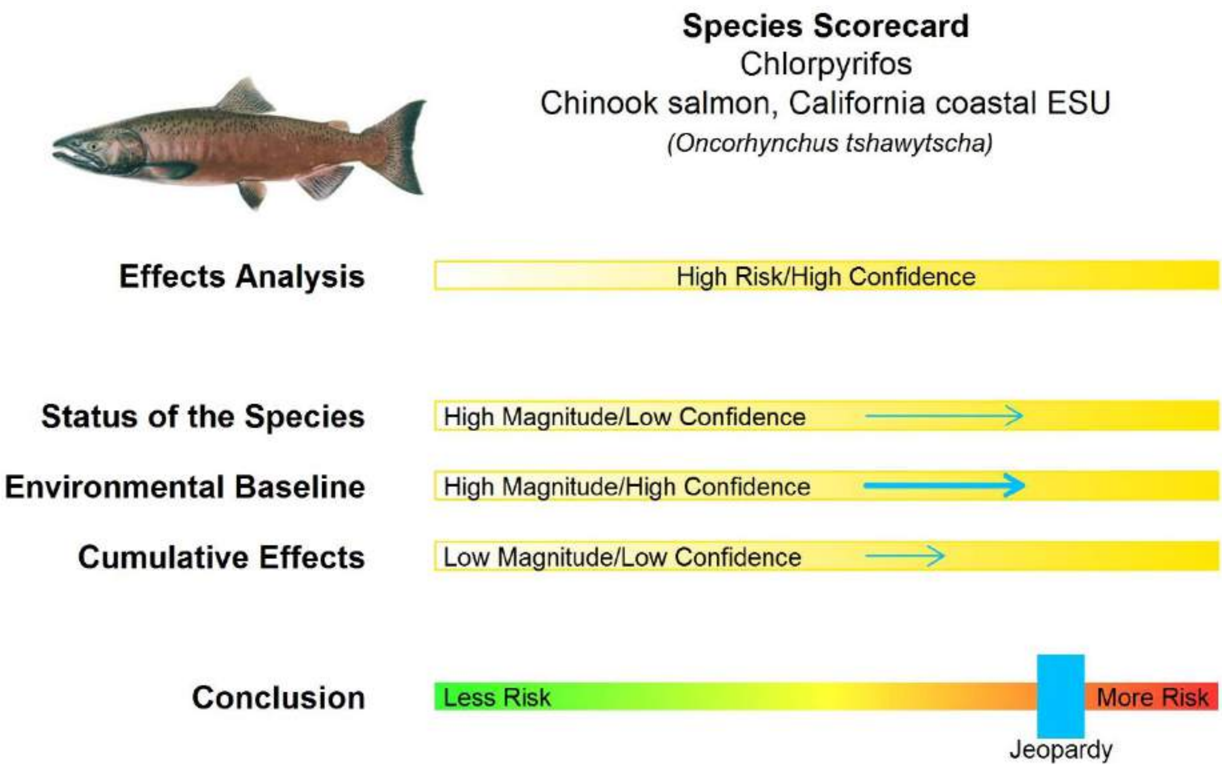

Figure 7. Species Score Card; Chinook salmon, California coastal ESU; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Minimal increased risk of jeopardy; High magnitude/ Low confidence

- One population with greater than 1000 spawners, declining trends in abundance
- Threatened
- Some recovery criteria not met, yet reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy

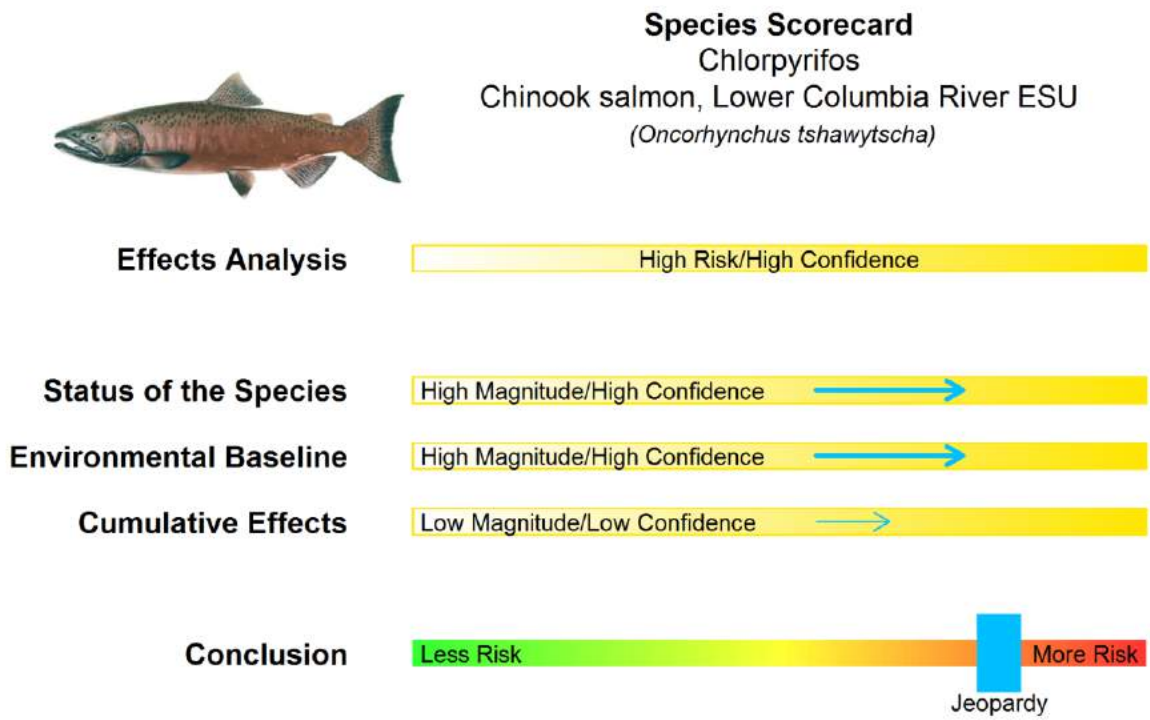

Figure 8. Species Score Card; Chinook salmon, Lower Columbia River ESU; Chlorpyrifos

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Declining trends in abundance, one self-sustaining population, low genetic diversity
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy</u>

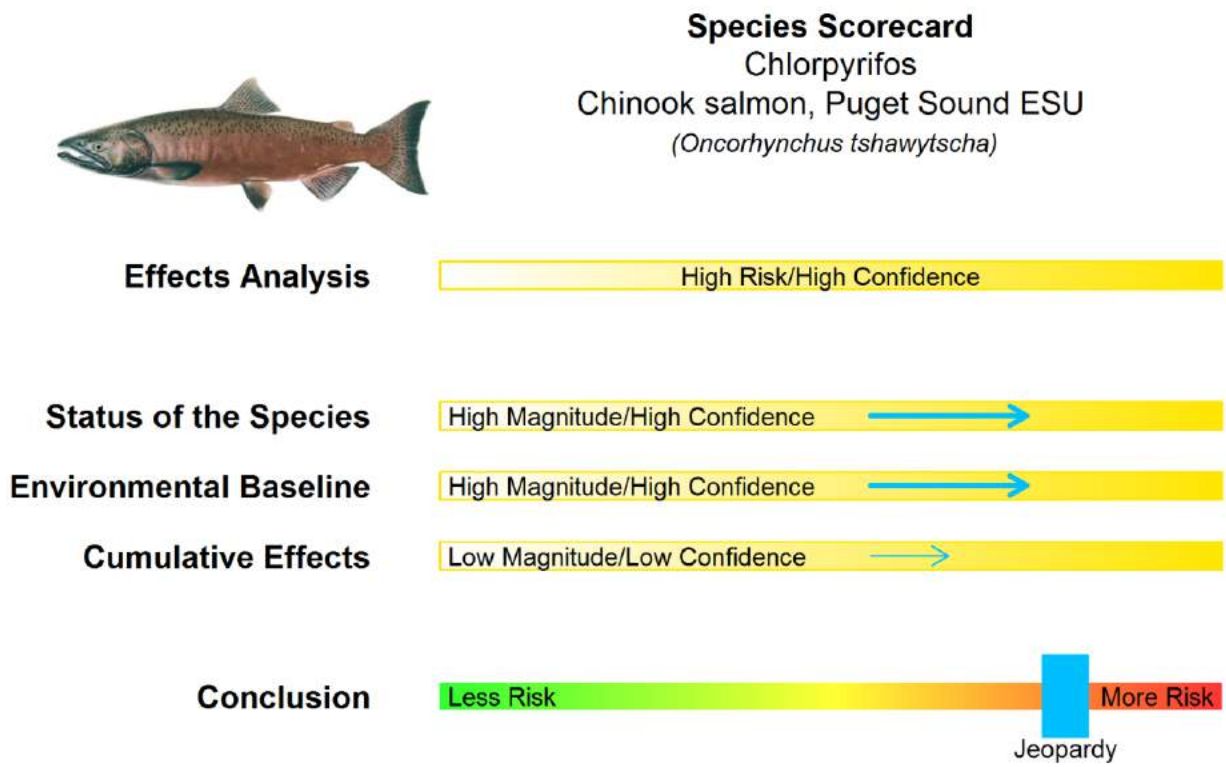

Figure 9. Species Score Card; Chinook salmon, Puget Sound ESU; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence

- Half of the populations declining and half increasing in abundance
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy

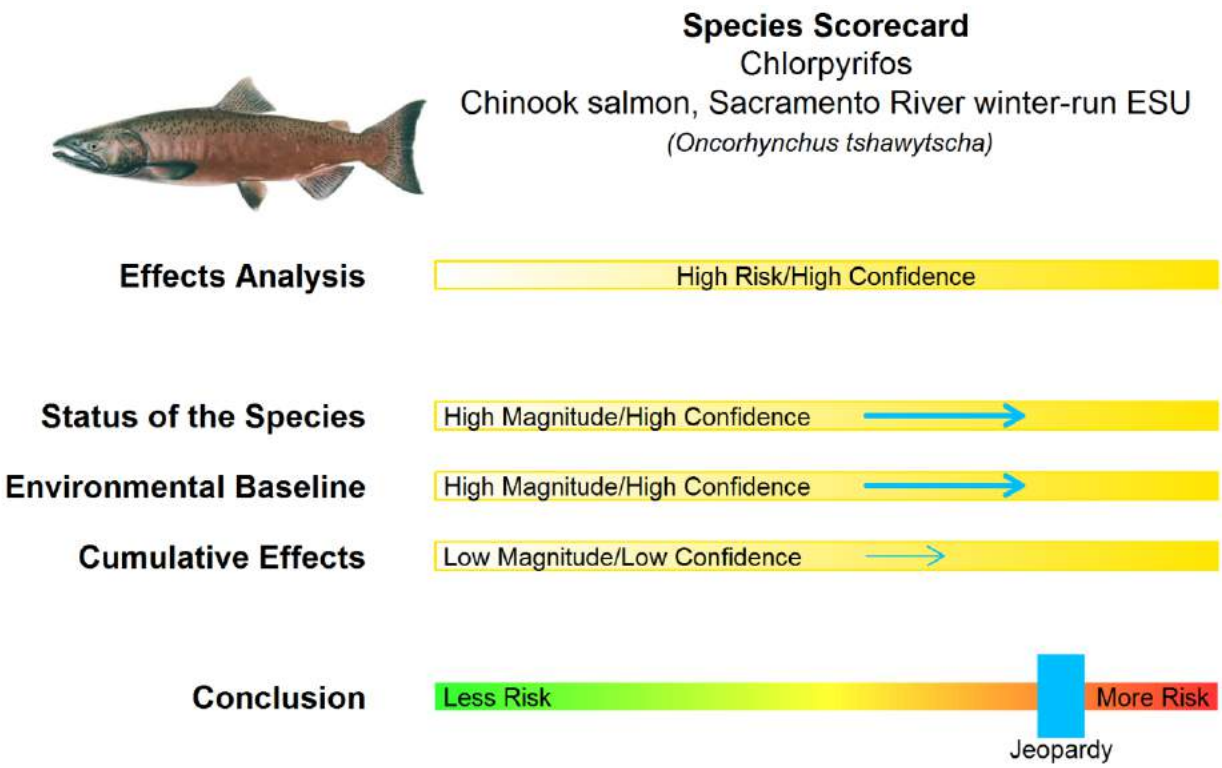

Figure 10. Species Score Card; Chinook salmon, Sacramento River winter-run ESU; Chlorpyrifos

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- One extant population, declining abundance trends, hatchery-supported
- Endangered species
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>**Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy**</u>

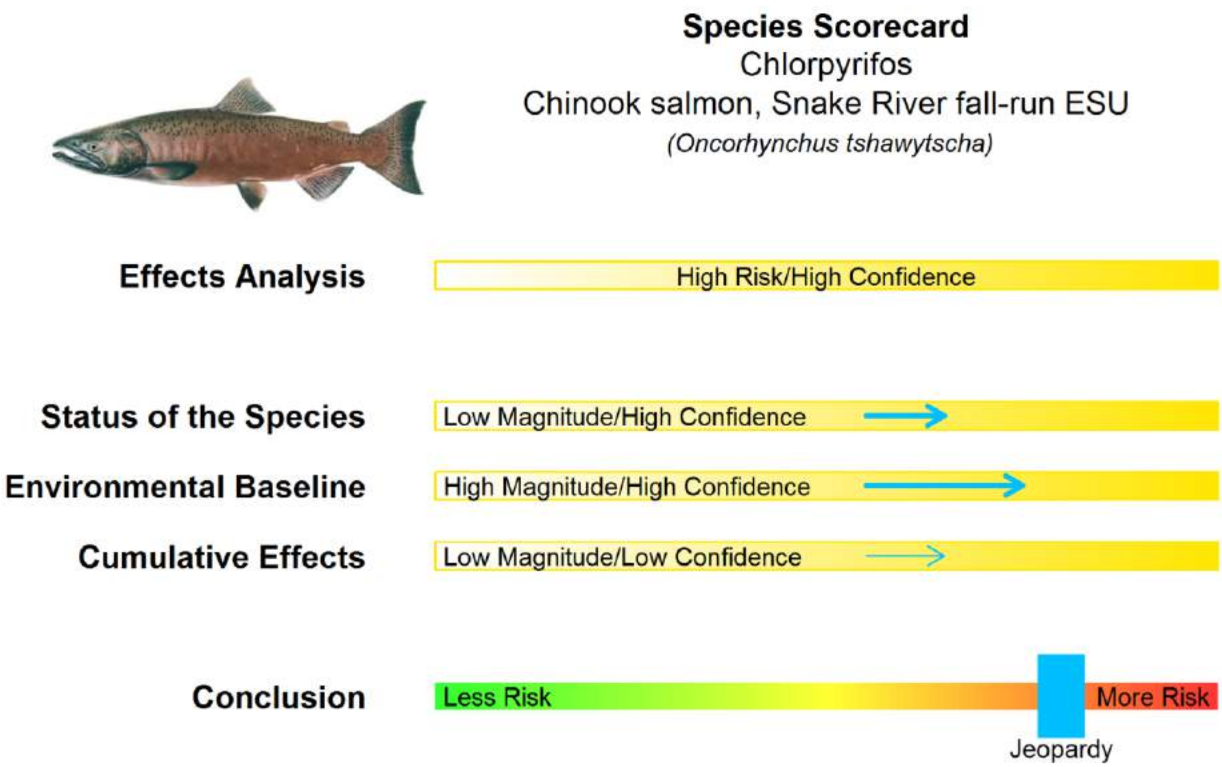

Figure 11. Species Score Card; Chinook salmon, Snake River fall-run ESU; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Increased risk of jeopardy; Low magnitude/ High confidence

- Stable to increasing abundance trends, moderate extinction risk, hatchery supported
- Threatened species
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy

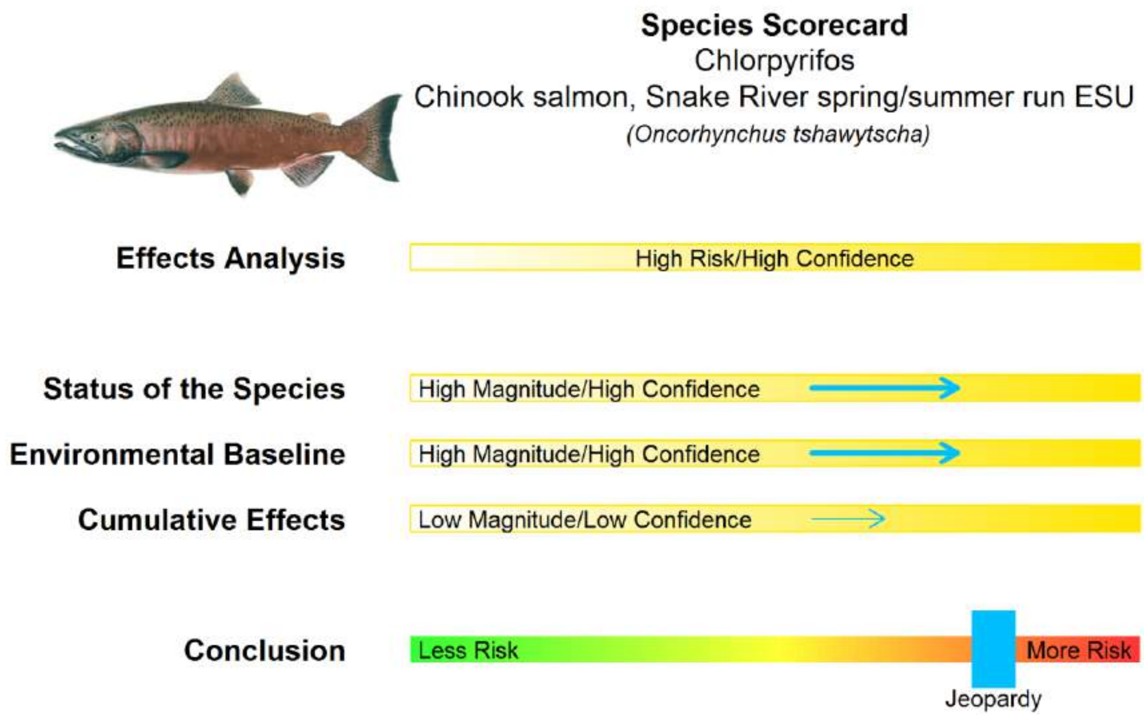

Figure 12. Species Score Card; Chinook salmon, Snake River spring/summer run ESU; Chlorpyrifos

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; Low magnitude/ High confidence</u>

- Decreasing abundance trends, high extinction risk, moderate genetic diversity
- Threatened species
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy</u>

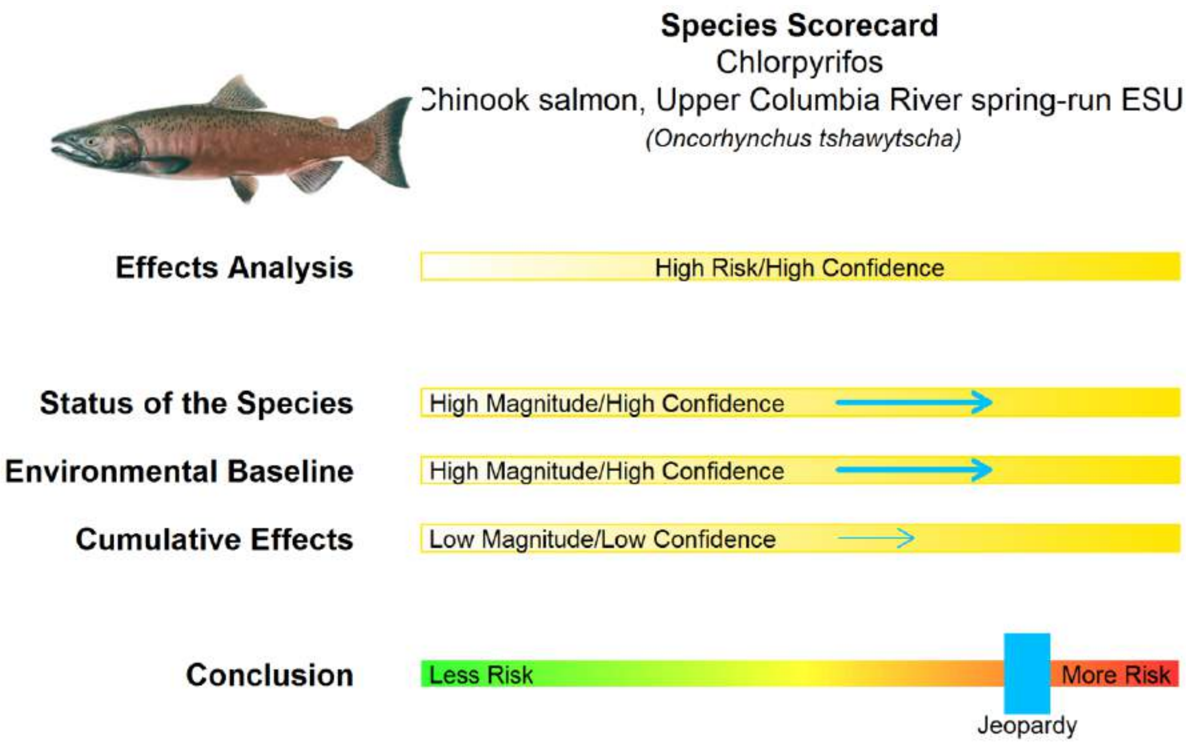

Figure 13. Species Score Card; Chinook salmon, Upper Columbia River spring-run ESU; Chlorpyrifos

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Decreasing abundance trends, independent populations not replacing themselves
- Endangered species (all independent population experiencing low abundance)
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>**Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy**</u>

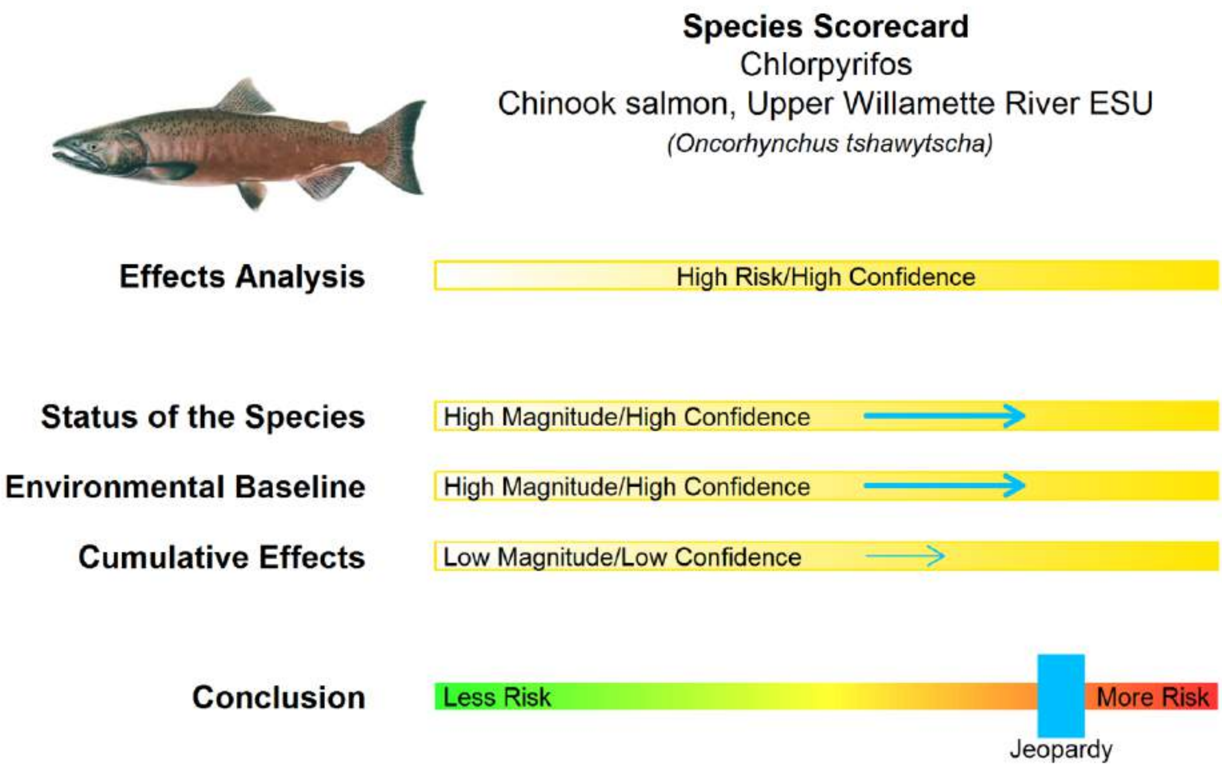

Figure 14. Species Score Card; Chinook salmon, Upper Willamette River ESU; Chlorpyrifos

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; How magnitude/ High confidence</u>

- Decreasing abundance trends, 1 of 7 remaining naturally reproducing populations
- Threatened species
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy</u>

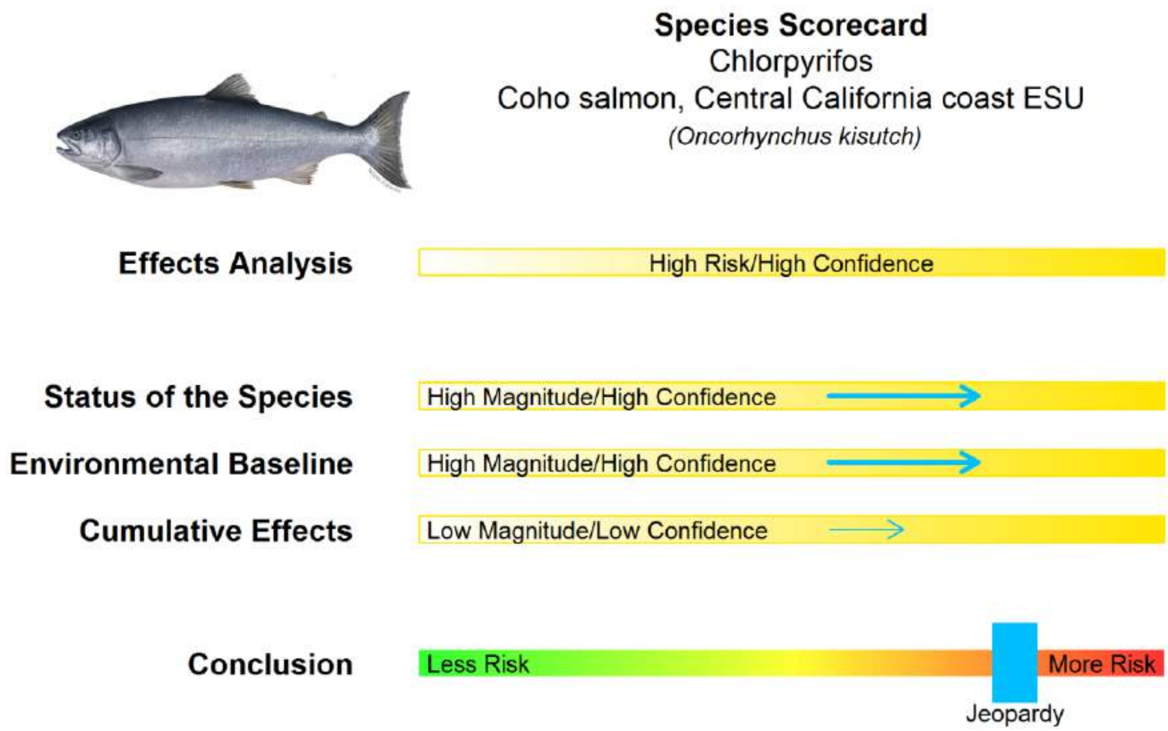

Figure 15. Species Score Card; Coho salmon, Central California coast ESU; Chlorpyrifos

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; How magnitude/ High confidence</u>

- Stable population trend, fragmented populations, supported by hatchery propogation
- Endangered species (low abundances)
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy</u>

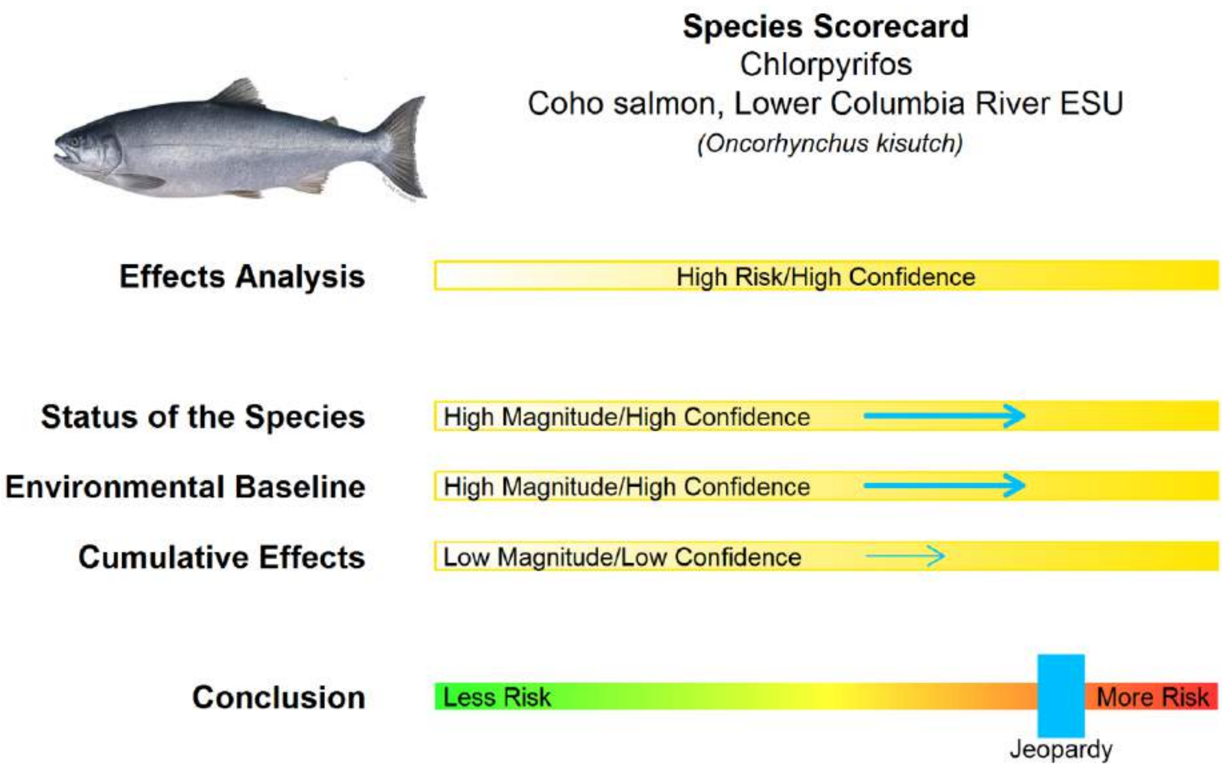

Figure 16. Species Score Card; Coho salmon, Lower Columbia River ESU; Chlorpyrifos

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; How magnitude/ High confidence</u>

- Negative long/short term lambda projections; 2/25 populations exhibit natural production. Diveristy at high risk category.
- Endangered species (90% reduction in abundance of all independent populations)
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy</u>

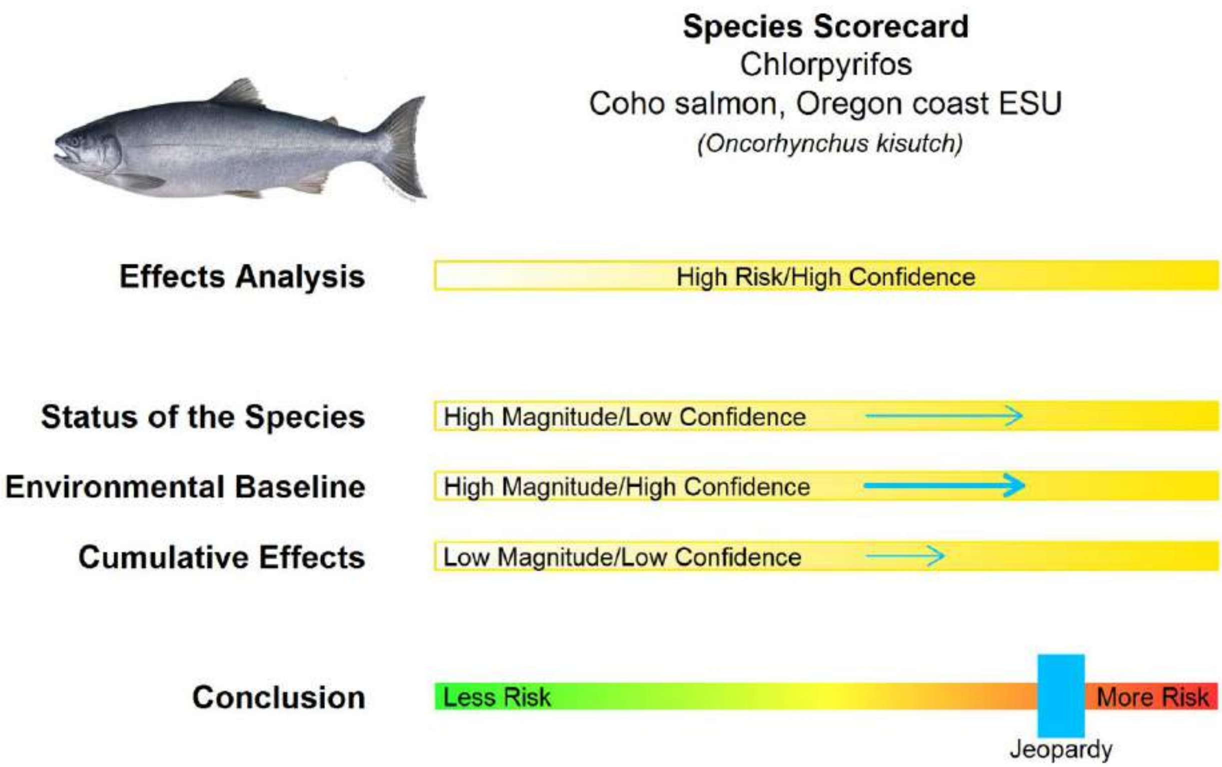

Figure 17. Species Score Card; Coho salmon, Oregon coast ESU; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Increased risk of jeopardy; How magnitude/ Low confidence

- Variable abundances with periods of severe declines. Negative long term trends negative
- Threatened (Severe reductions in ESU abundance compared to historical estimates)
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy

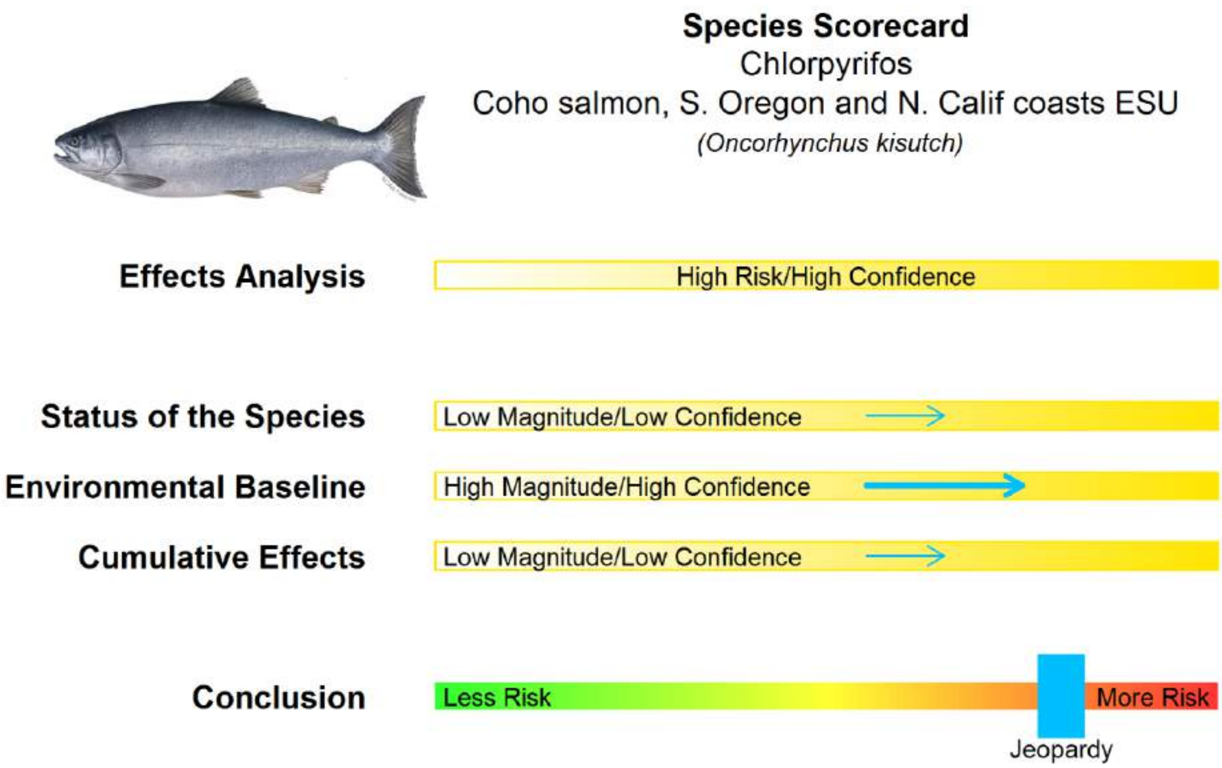

Figure 18. Species Score Card; Coho salmon, S. Oregon and N. Calif coasts ESU; Chlorpyrifos

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Limited data on population abundance, thus trend data unavailable
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy</u>

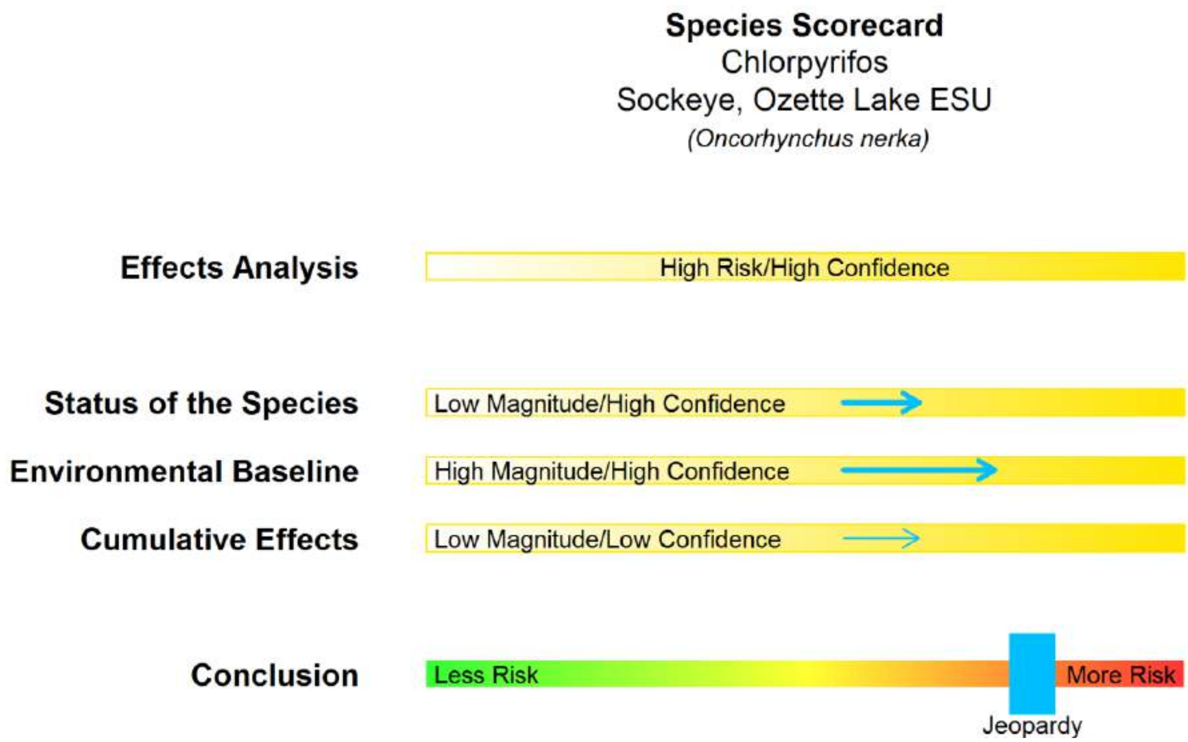

Figure 19. Species Score Card; Sockeye, Ozette Lake ESU; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ High confidence

- Stable productivity rates; low genetic diversity and low resilience to future perturbations
- Threatened (abundance only 1% of historical levels)
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy

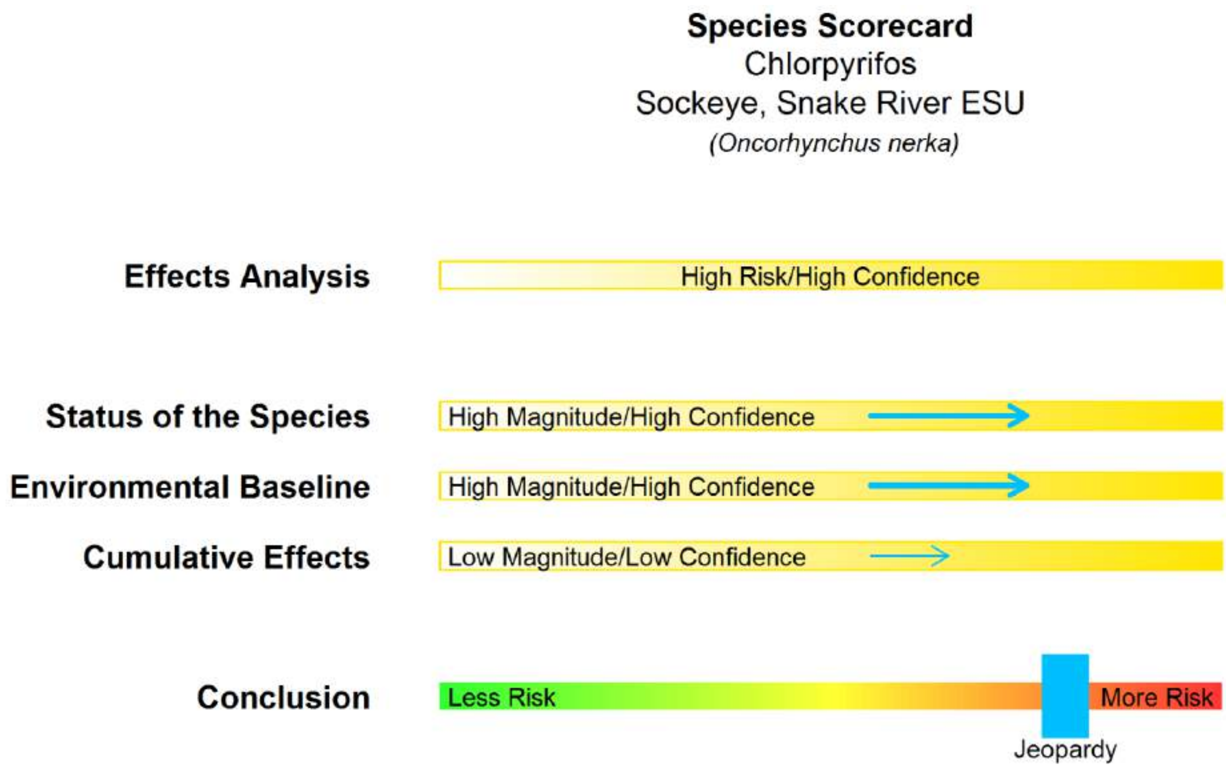

Figure 20. Species Score Card; Sockeye, Snake River ESU; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence

- One population remaining supported by hatchery propagation. Increasing abundance, well below sustainable natural production. Low resilience to perturbations.
- Endangered (abundance only 1% of historical levels)
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy

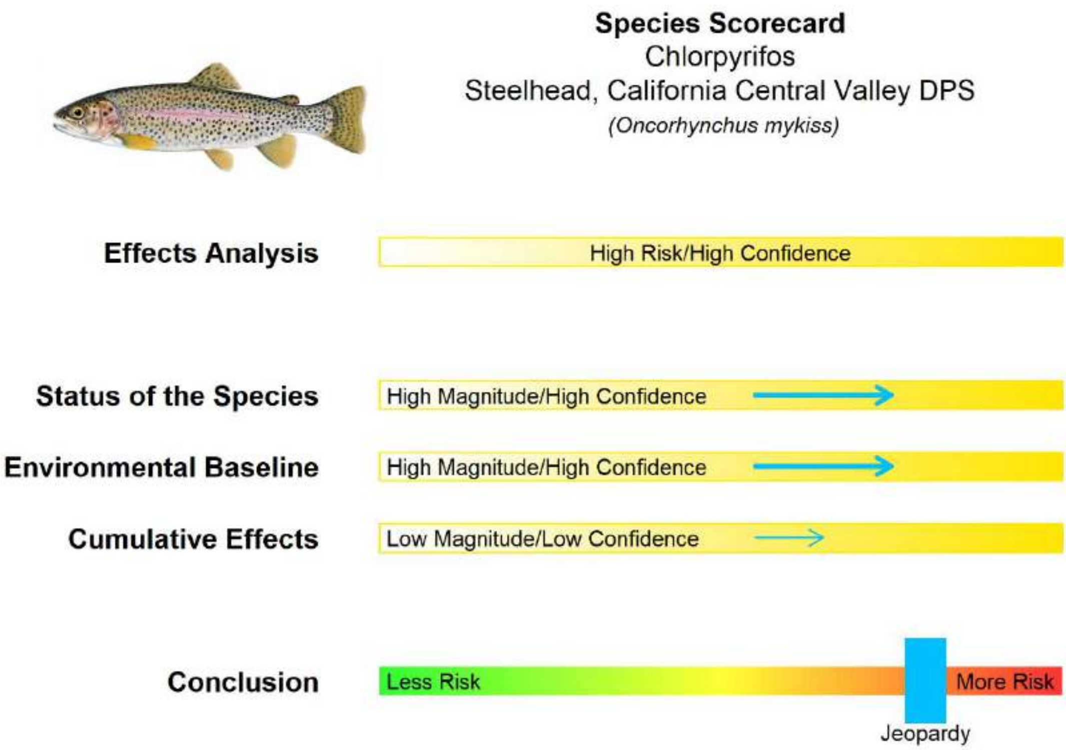

Figure 21. Species Score Card; Steelhead, California Central Valley Distinct Population Segment (DPS); Chlorpyrifos

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Long-term trend of declining abundances and reduced genetic diversity. Populations supplemented by hatchery propogation.
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy</u>

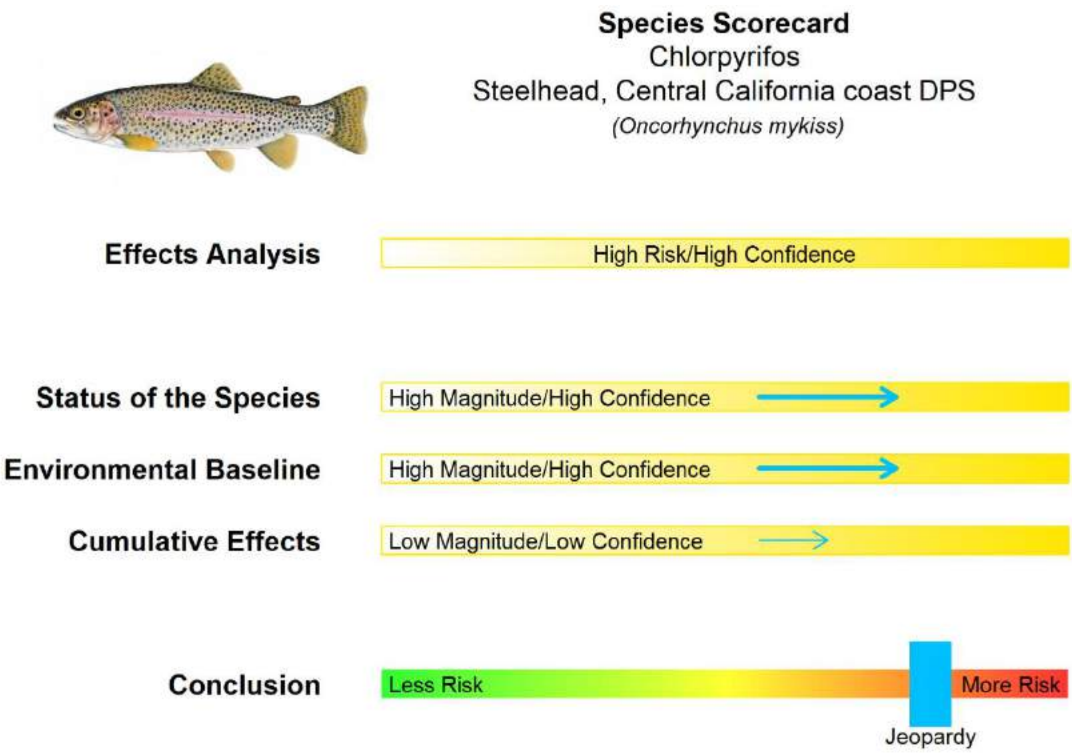

Figure 22. Species Score Card; Steelhead, Central California coast DPS; Chlorpyrifos

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- 5-year population trend uncertain. Population abundance supplemented by hatchery propagation. Populations likely not viable, and have lost spatial structure.
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy</u>

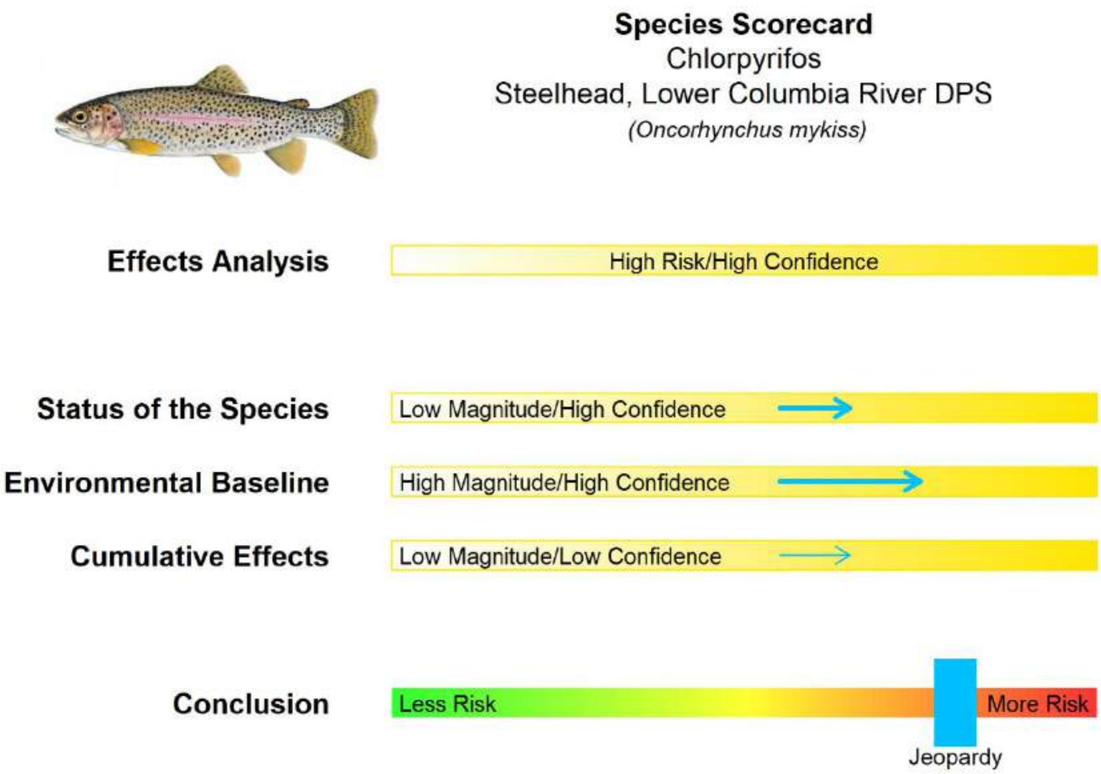

Figure 23. Species Score Card; Steelhead, Lower Columbia River DPS; Chlorpyrifos

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ High confidence</u>

- 5-year population trend stable. Populations exhibit low genetic diversity and impacted by a loss of available habitat.
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>**Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy**</u>

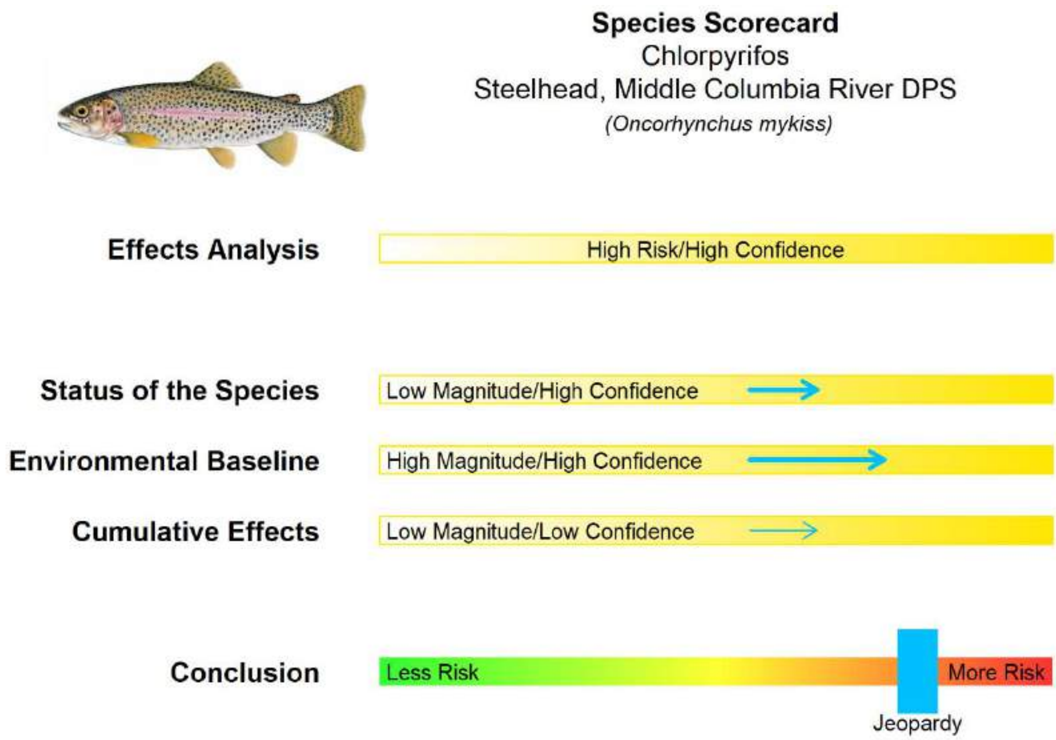

Figure 24. Species Score Card; Steelhead, Middle Columbia River DPS; Chlorpyrifos

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ High confidence</u>

- 5-year population trend stable to improving; abundances remain low compared to historical numbers
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy</u>

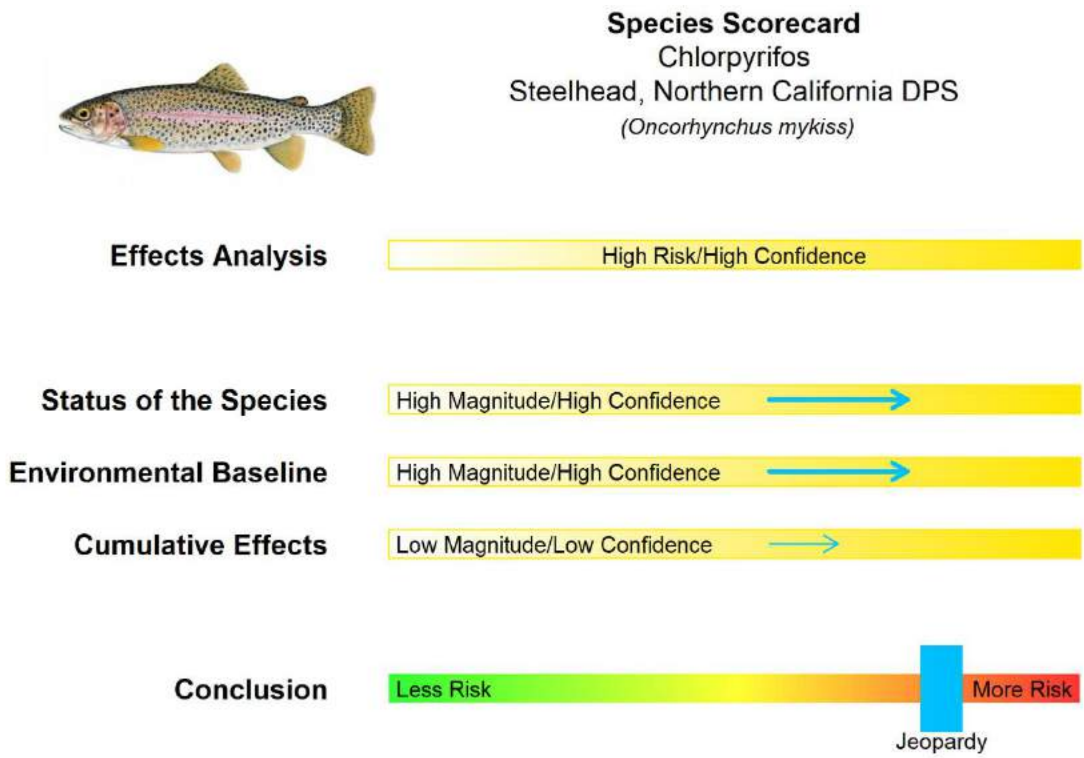

Figure 25. Species Score Card; Steelhead, Northern California DPS; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Icreased risk of jeopardy; High magnitude/ High confidence

- Variable 5-year population abundance trends; Population supplemented by hatchery propagation. Populations exhibit low abundances and productivity.
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy

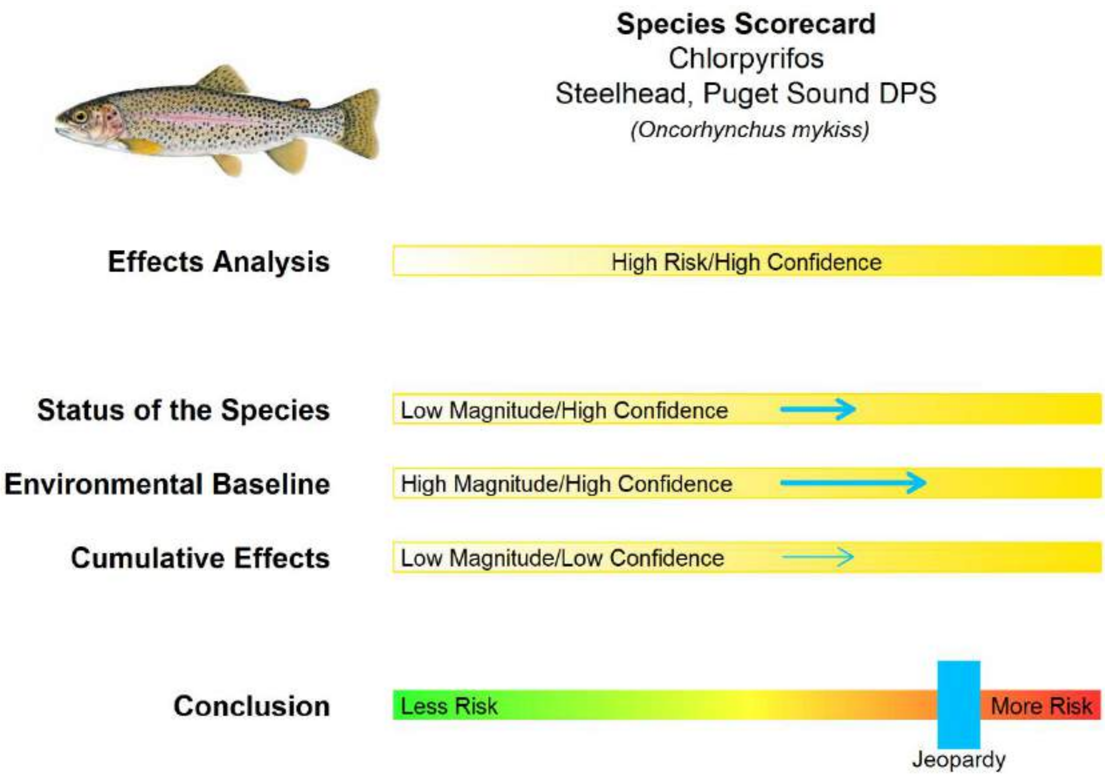

Figure 26. Species Score Card; Steelhead, Puget Sound DPS; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ High confidence

- 5-year population trend stable, but populations have reduced genetic diversity
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy

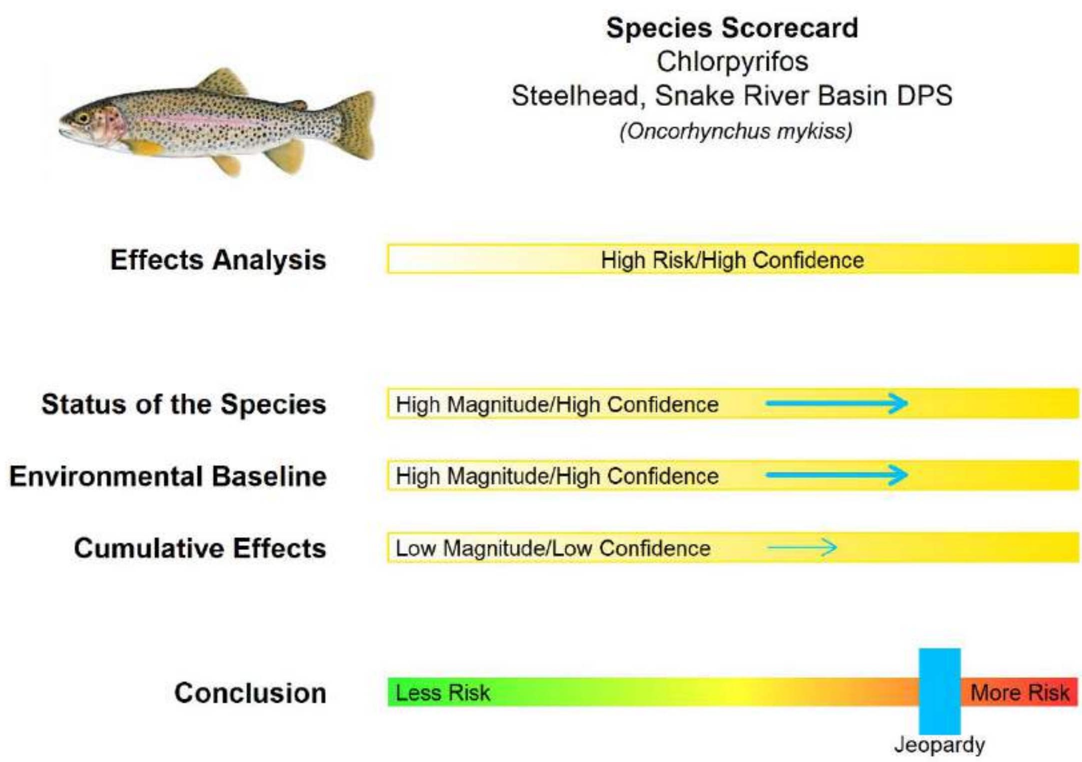

Figure 27. Species Score Card; Steelhead, Snake River Basin DPS; Chlorpyrifos

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- 5-year population trend stable to improving, but still in moderate danger of extinction. Overall abundances remain below thresholds necessary for recovery.
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy</u>

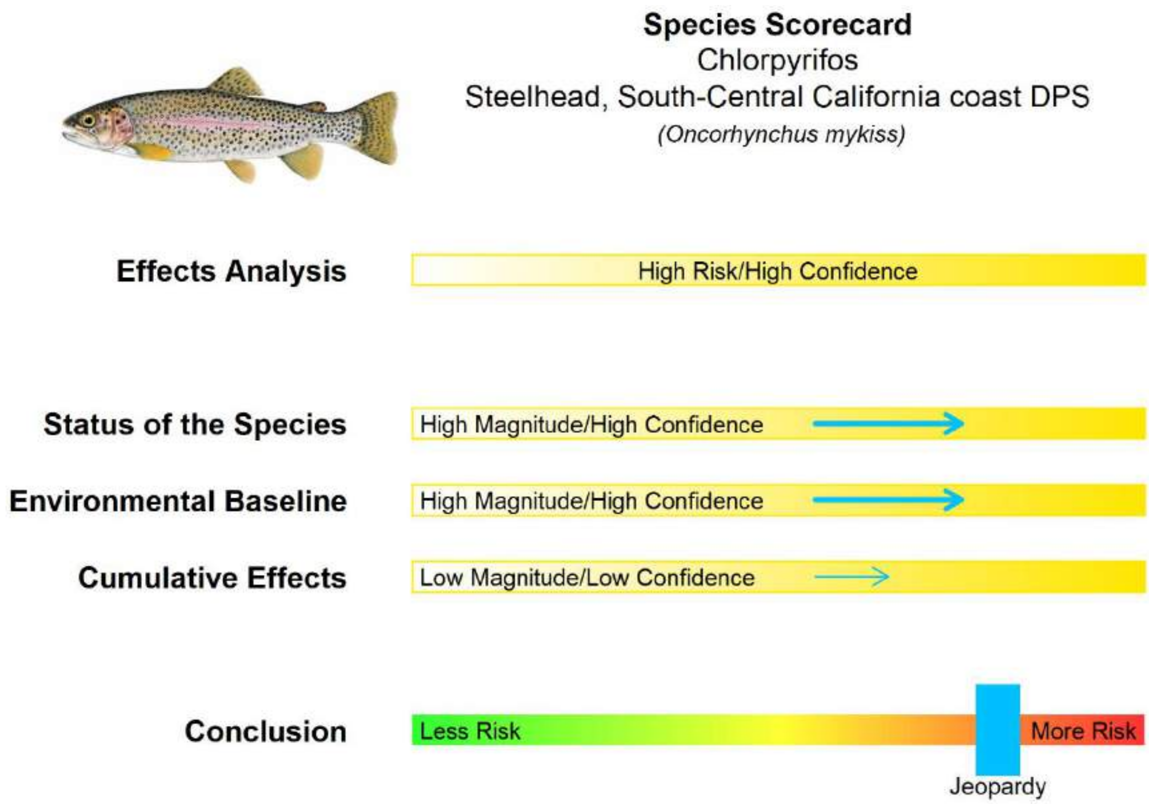

Figure 28. Species Score Card; Steelhead, South-Central California coast DPS; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence

- 5-year population trend declining, depressed abundances.
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy

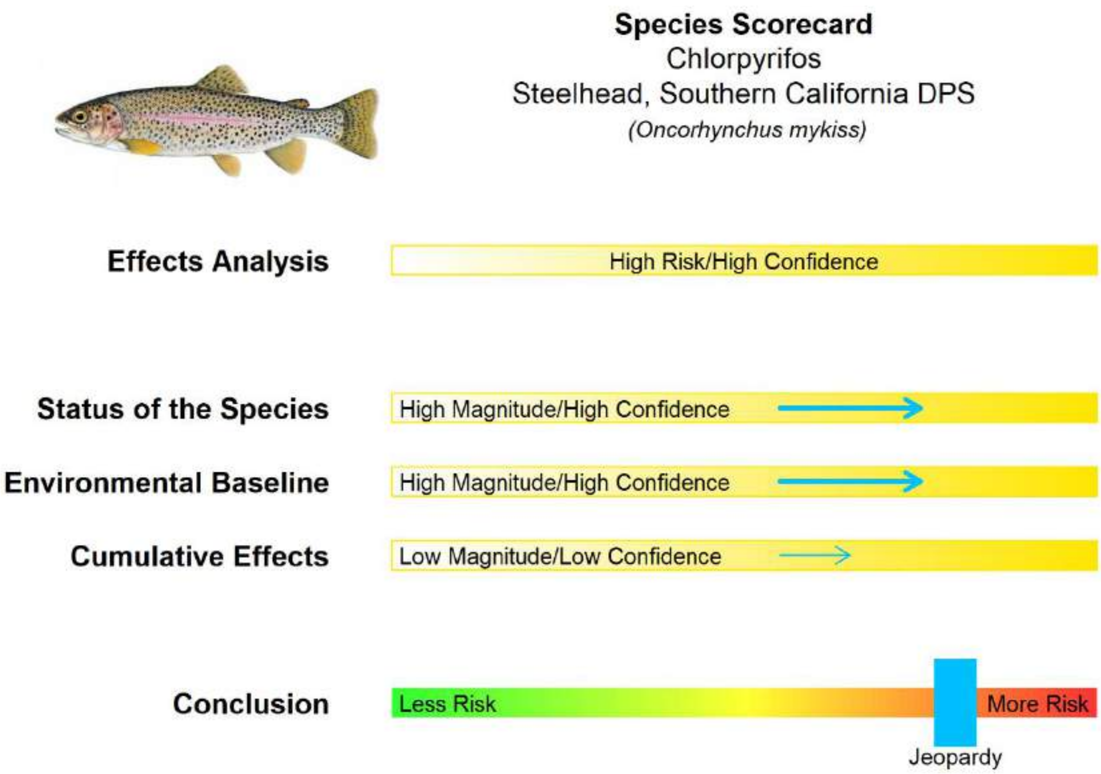

Figure 29. Species Score Card; Steelhead, Southern California DPS; Chlorpyrifos

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- 5-year population trend uncertain (large annual variations); supplemented by hatchery propagation; fragmented distributions.
- Endangered; Populations at extreme southern end of species' range
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy</u>

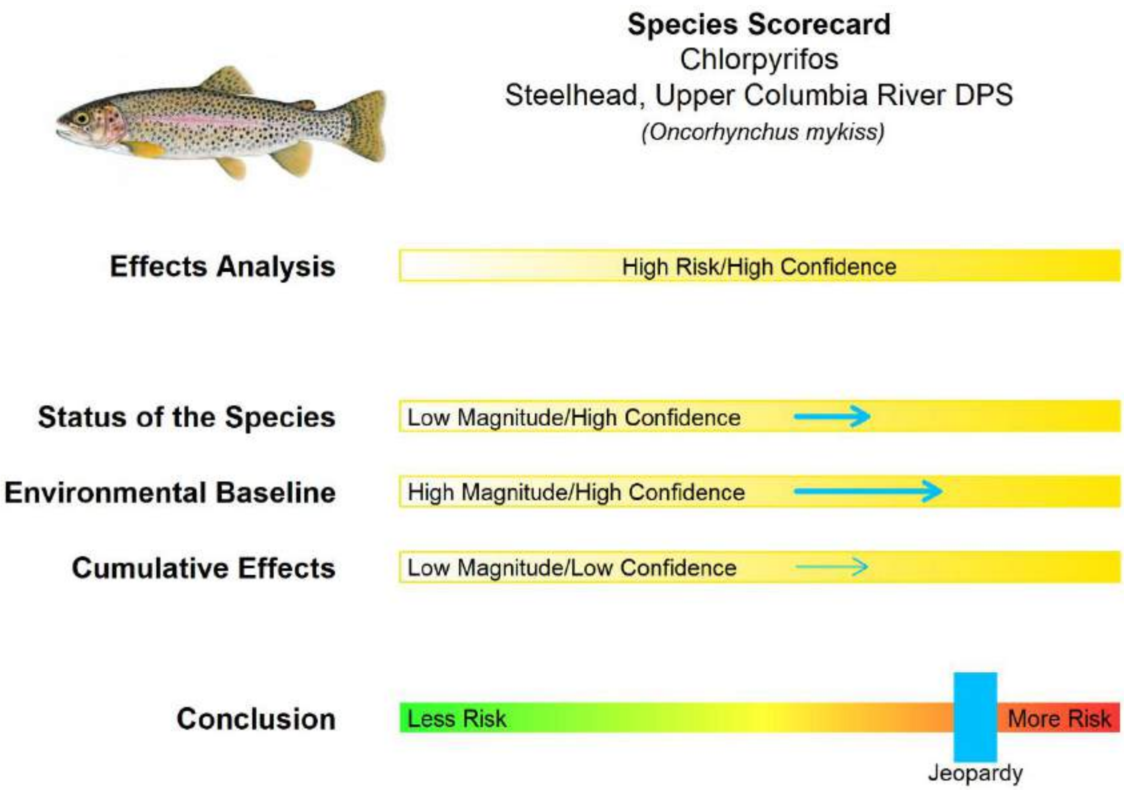

Figure 30. Species Score Card; Steelhead, Upper Columbia River DPS; Chlorpyrifos

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- 5-year population trend improving, but low genetic diversity.
- Threatened;
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy</u>

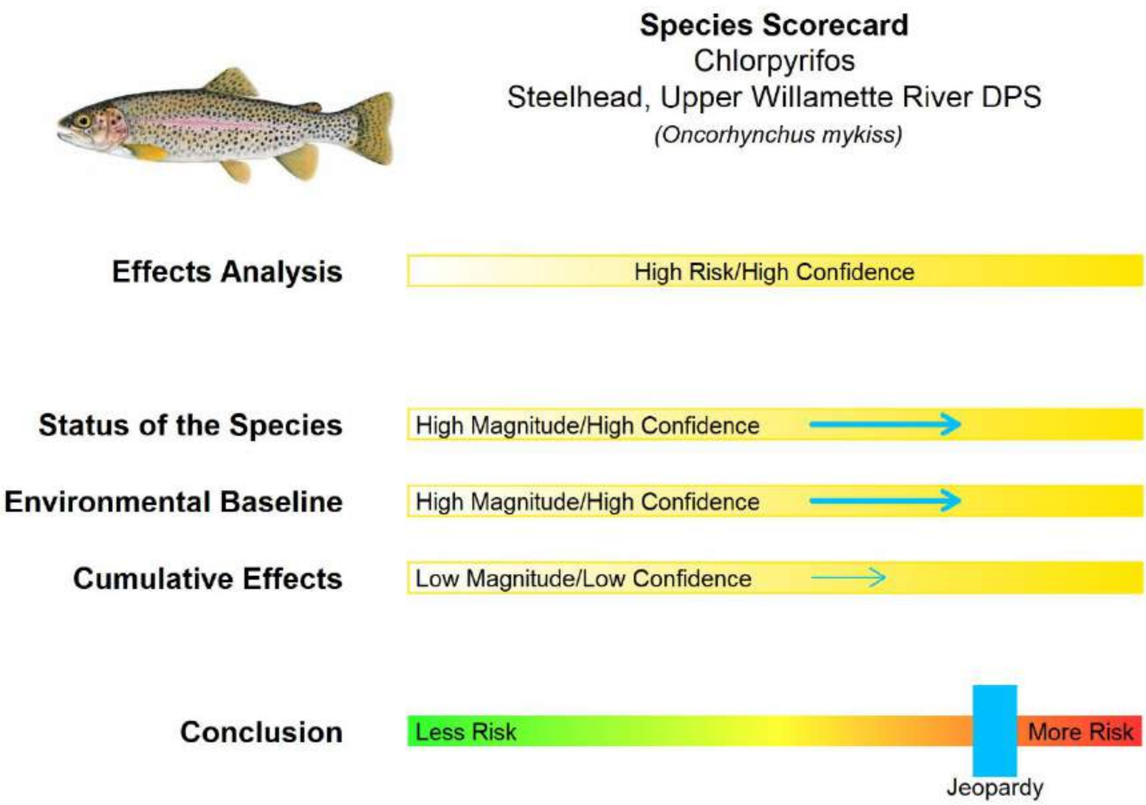

Figure 31. Species Score Card; Steelhead, Upper Willamette River DPS; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence

- 5-year population trend declining, large fluctuations in abundances.
- Threatened;
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy

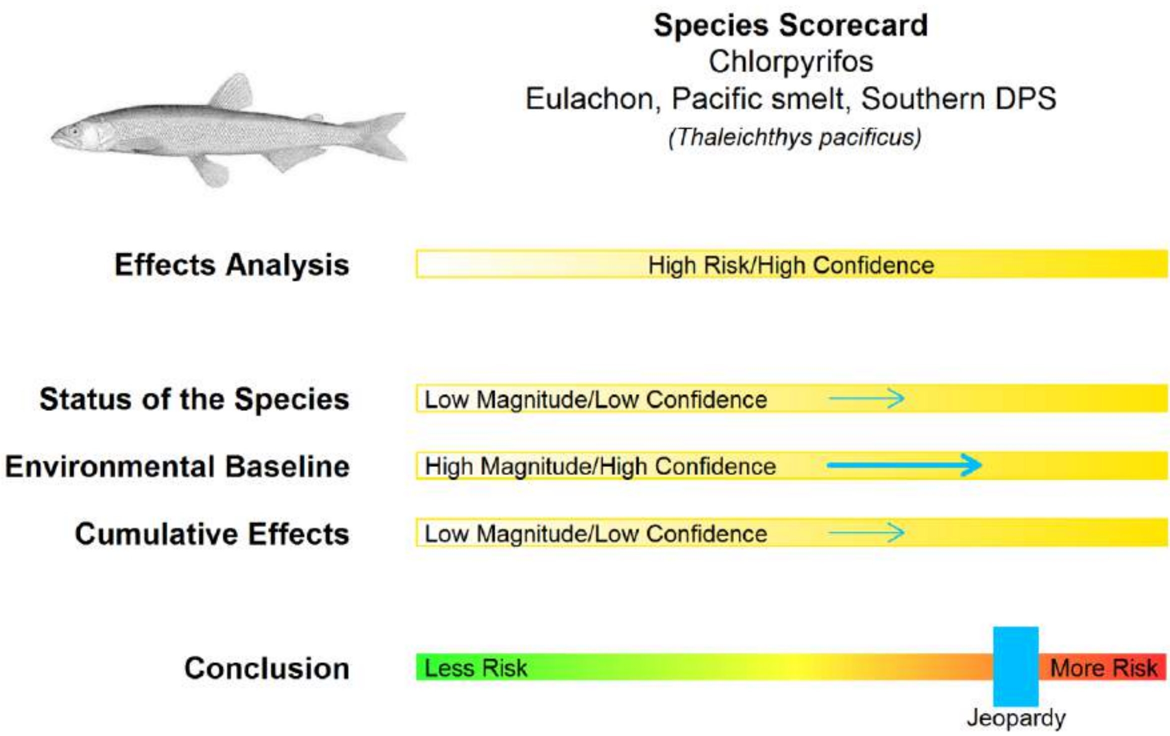

Figure 32. Species Score Card; Eulachon, Pacific smelt, Southern DPS; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Population abundance improving, especially in the 2013–2015 return years; in upcoming return years population declines may be widespread from poor ocean conditions
- Threatened; severely depressed abundance mid-late 1990s to late 2000s;
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy

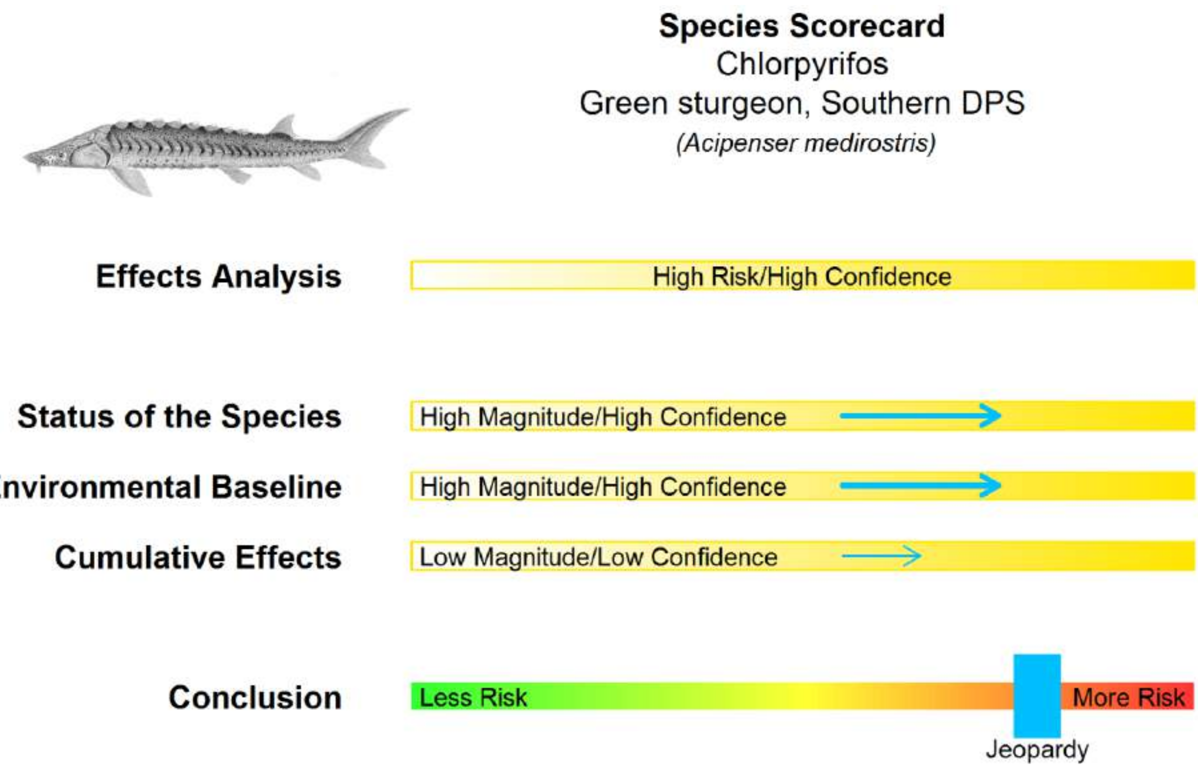

Figure 33. Species Score Card; Green sturgeon, Southern DPS; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence

- Small population size, little population data, few remaining spawning sites
- Threatened;
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy

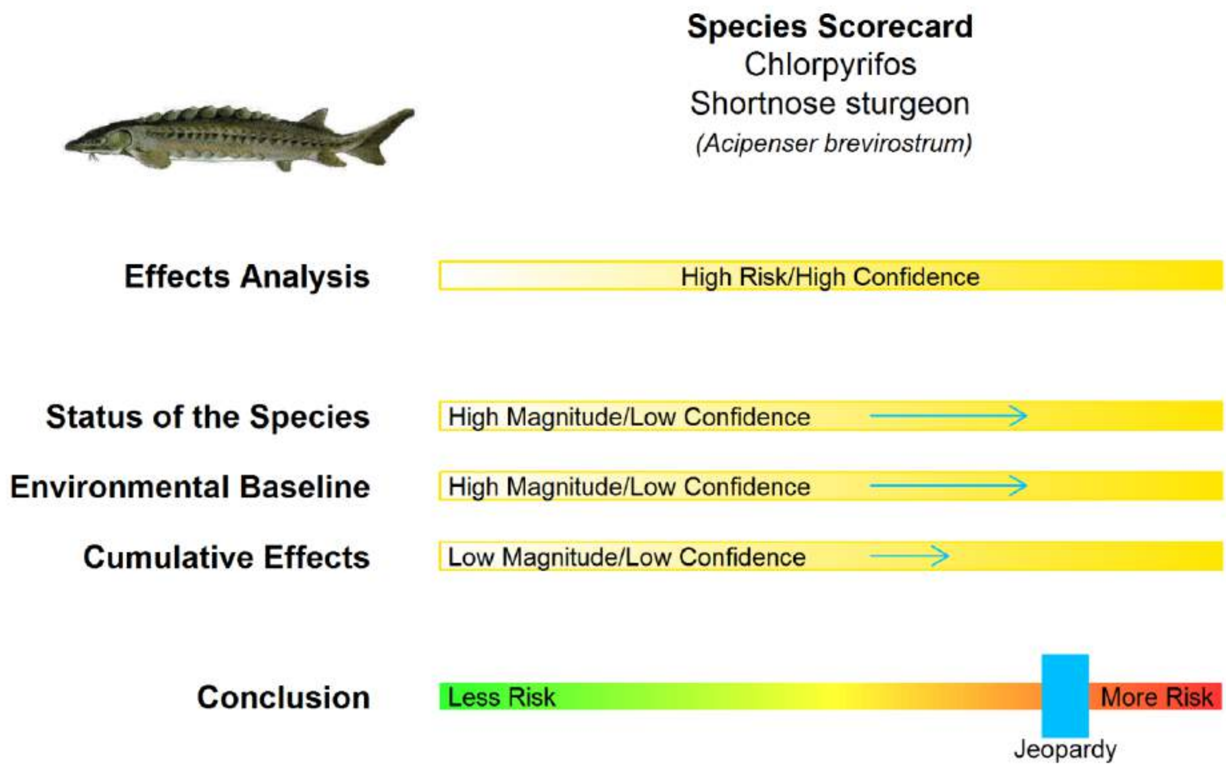

Figure 34. Species Score Card; Shortnose sturgeon; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Increased risk of jeopardy; High magnitude/ low confidence

- Stable to increasing populations, fragmented populations, only 12 known spawning sites
- Endangered;
- Recovery criteria not identified

Environmental Baseline: Increased risk of jeopardy; High magnitude/ Low confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy

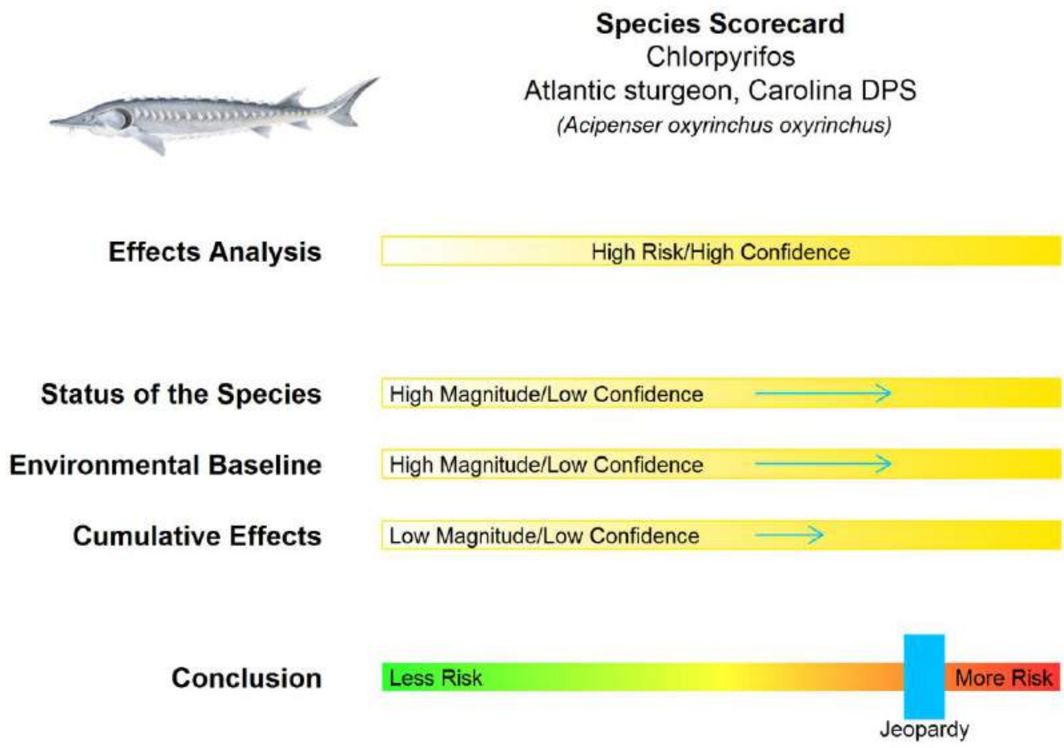

Figure 35. Species Score Card; Atlantic sturgeon, Carolina DPS; Chlorpyrifos

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ low confidence</u>

- <3% of historical abundance
- Endangered;
- Recovery criteria not identified

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ Low confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy</u>

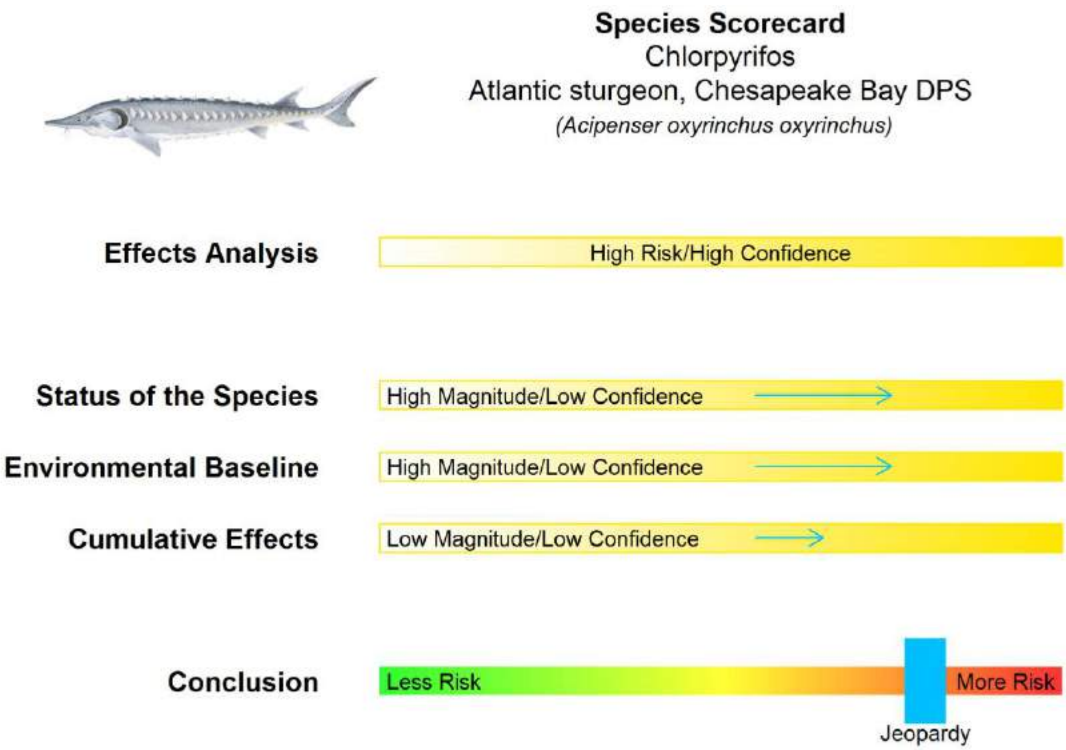

Figure 36. Species Score Card; Atlantic sturgeon, Chesapeake Bay DPS; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Increased risk of jeopardy; High magnitude/ low confidence

- 4% of historical abundance, unknown population growth rate
- Endangered;
- Recovery criteria not identified

Environmental Baseline: Increased risk of jeopardy; High magnitude/ Low confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy

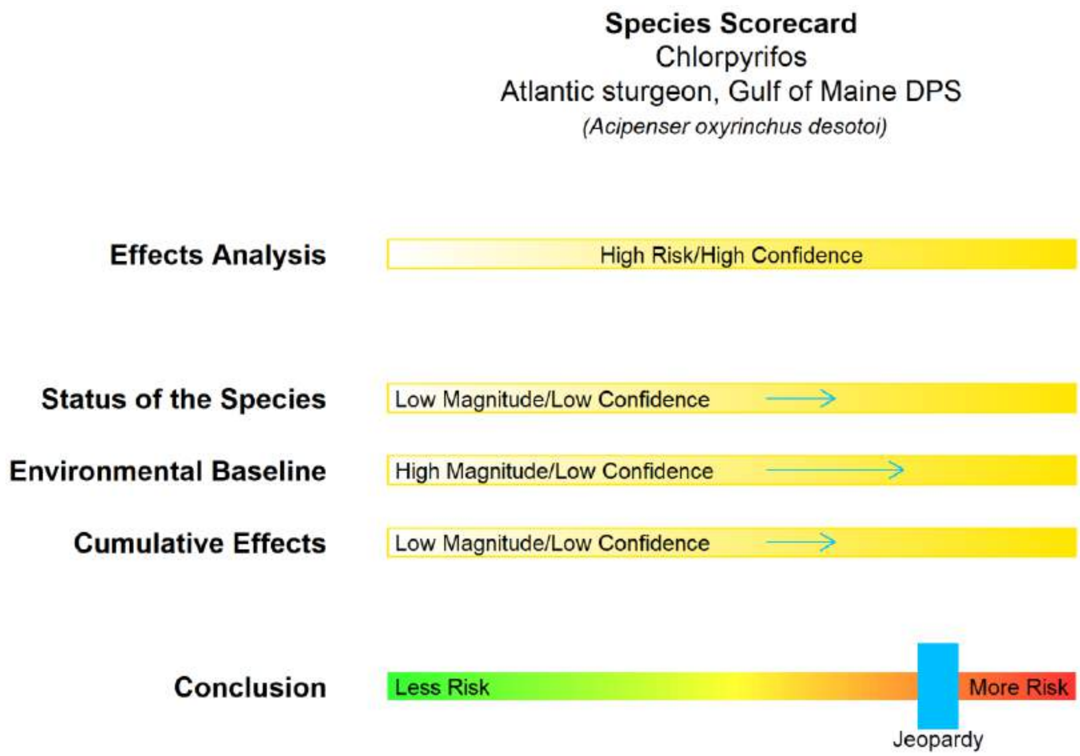

Figure 37. Species Score Card; Atlantic sturgeon, Gulf of Maine DPS; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: minimal increased risk of jeopardy; Low magnitude/ low confidence

- 10% of historical abundance, unknown population growth rate, range expanding
- Threatened;
- Recovery criteria not identified

Environmental Baseline: Increased risk of jeopardy; High magnitude/ Low confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy

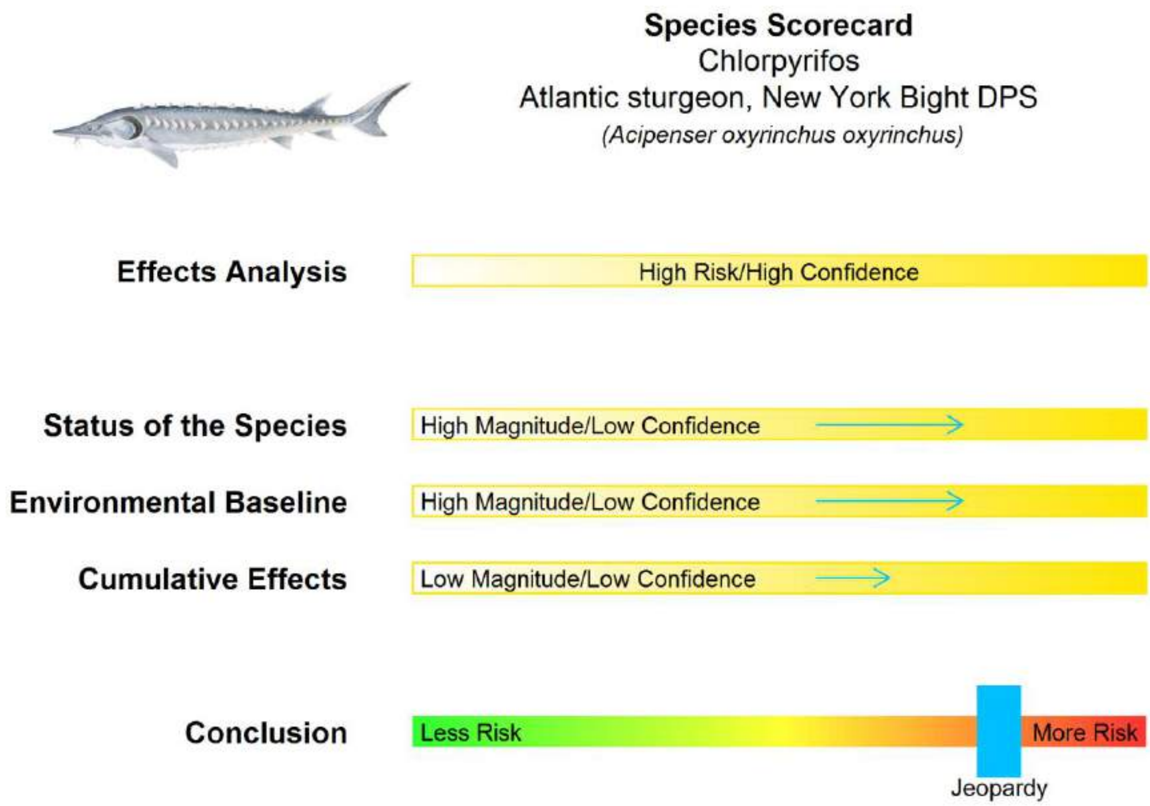

Figure 38. Species Score Card; Atlantic sturgeon, New York Bight DPS; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Increased risk of jeopardy; High magnitude/ low confidence

- 4% of historical abundance, unknown population growth rate
- Endangered;
- Recovery criteria not identified

Environmental Baseline: Increased risk of jeopardy; High magnitude/ Low confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy

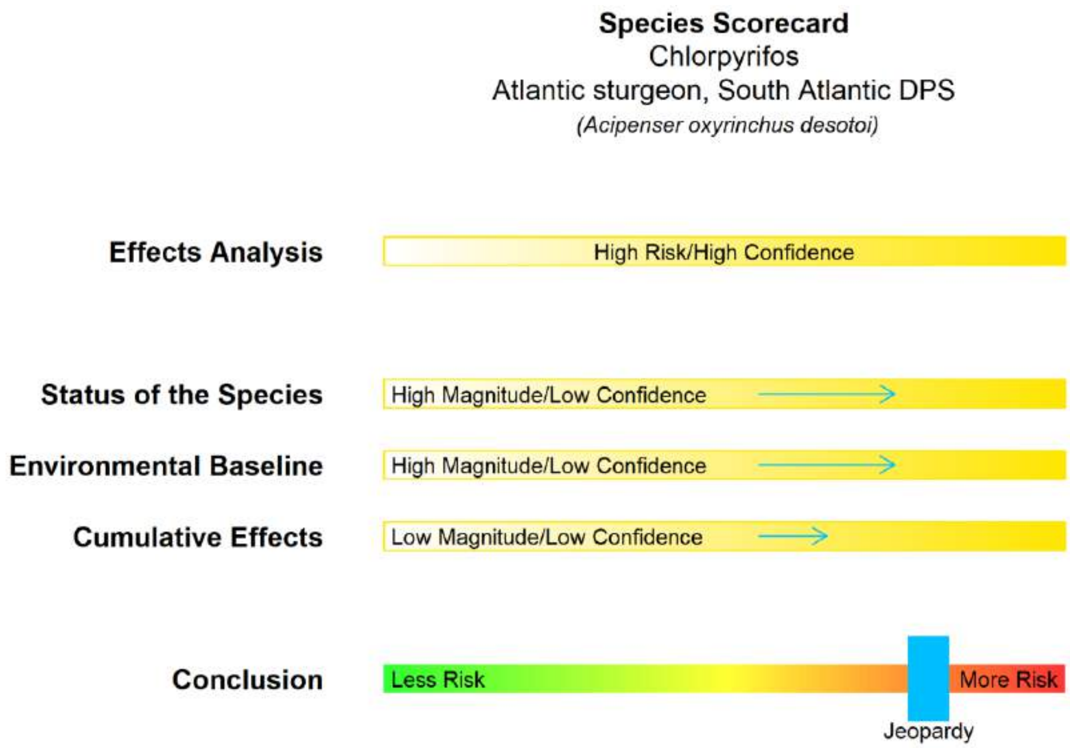

Figure 39. Species Score Card; Atlantic sturgeon, South Atlantic DPS; Chlorpyrifos

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ low confidence</u>

- <6% of historical abundance
- Endangered;
- Recovery criteria not identified

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ Low confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy</u>

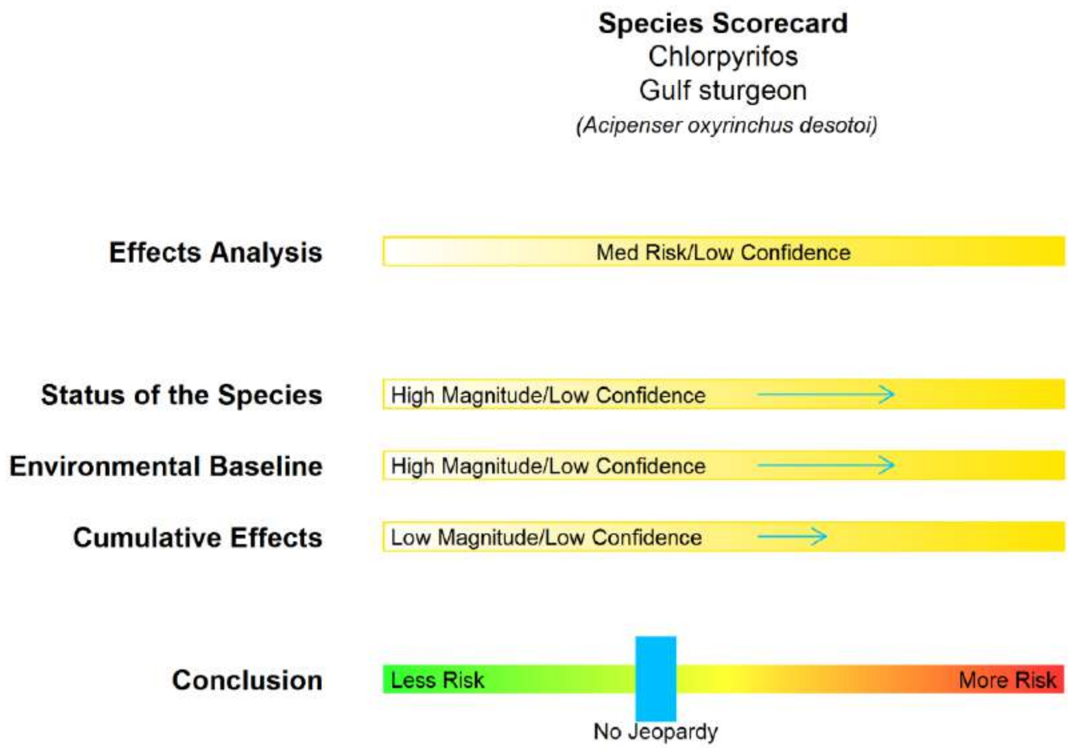

Figure 40. Species Score Card; Gulf sturgeon; Chlorpyrifos

Effects Analysis: Medium risk/Low confidence

- Reduced abundance may occur in estuarine areas
- Potential effects include death, reduced cholinesterase activity, reduced growth and prey abundance, and impaired swimming.

Status of the Species: Increased risk of jeopardy; High magnitude/ Low confidence

- Eastern range populations stable to increasing, western population lower abundances and more uncertainty, minimal growth rate data
- Threatened;
- Recovery criteria not identified

Environmental Baseline: Increased risk of jeopardy; High magnitude/ Low confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures not anticipated to affect species
- Anticipated hydrologic effects in freshwater areas

Conclusion: In estuarine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in these estuarine areas where they rear. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy

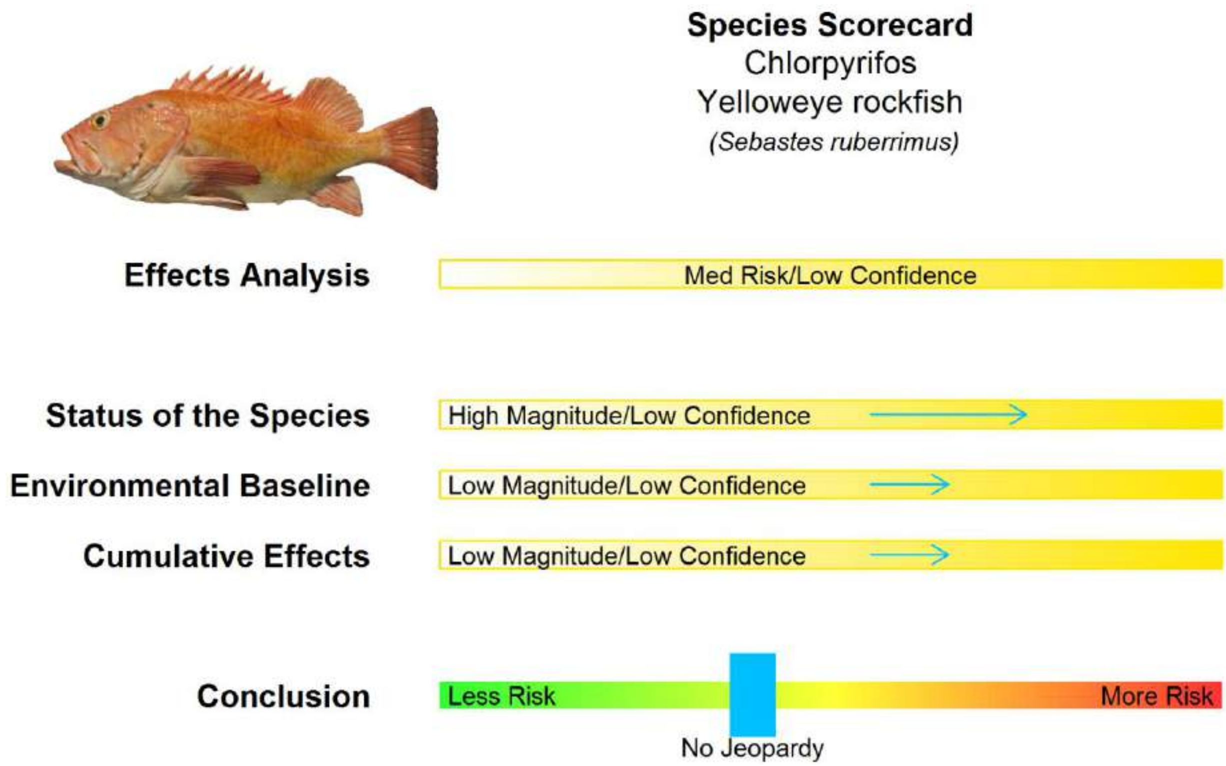

Figure 41. Species Score Card; Yelloweye rockfish; Chlorpyrifos

<u>Effects Analysis: Medium risk/Low confidence</u>

- Reduced abundance may occur in marine areas
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ Low confidence</u>

- Historically low abundance, fragmented populations, altered population age structure
- Threatened;
- Recovery criteria not identified

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures unanticipated in marine waters
- Environmental mixtures at toxic concentrations unanticipated in marine habitats

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures not anticipated

<u>Conclusion:</u> In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations and species use of deep water habitats. The species is most at risk while in shallow surface, marine areas. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

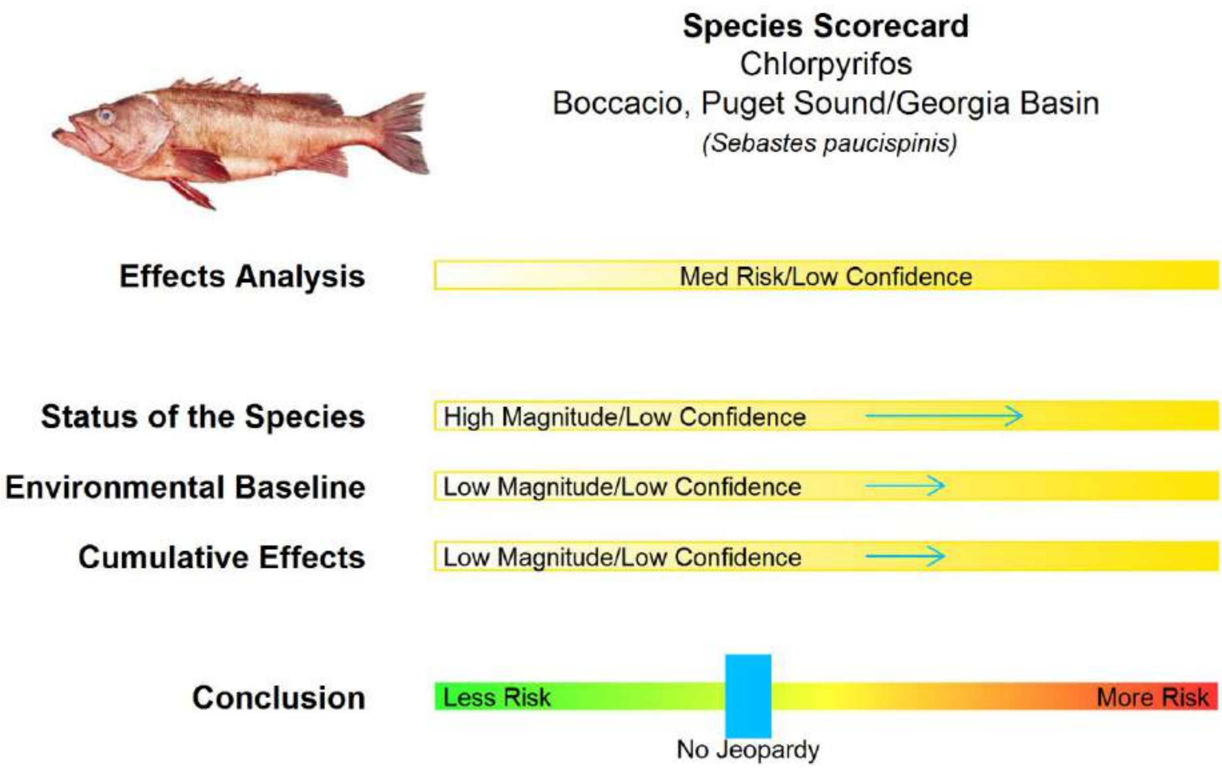

Figure 42. Species Score Card; Boccacio, Puget Sound/Georgia Basin; Chlorpyrifos

<u>Effects Analysis: Medium risk/Low confidence</u>

- Reduced abundance may occur in marine areas
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ Low confidence</u>

- There are no estimates of historical or current abundance across the DPS's full range; Indices suggest declining abundance trends
- Threatened;
- Recovery criteria not identified

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures unanticipated in marine waters
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures not anticipated in marine waters

<u>Conclusion:</u> In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas where they rear. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

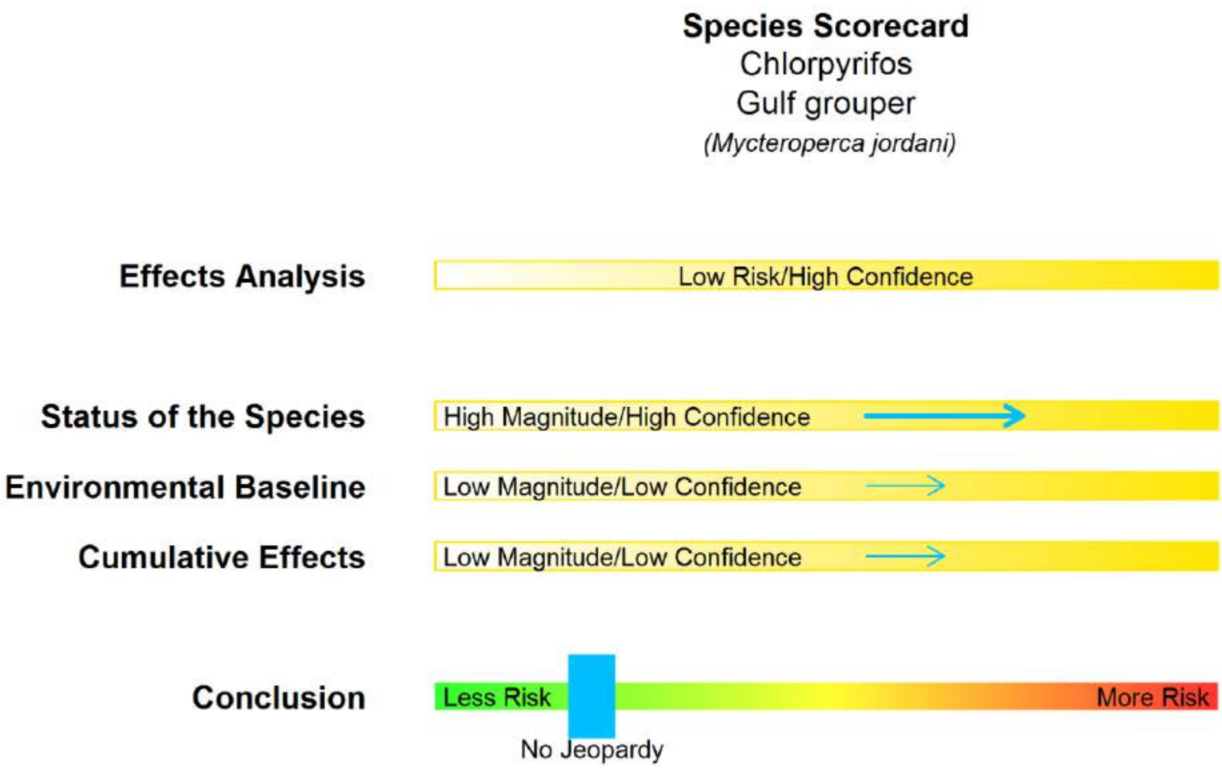

Figure 43. Species Score Card; Gulf grouper; Chlorpyrifos

<u>Effects Analysis: Low risk/High confidence</u>

- Reduced abundance not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Abundance levels less than 1% of their historical levels
- Endangered;
- Recovery criteria not identified

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures unanticipated in marine waters
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures not anticipated in marine waters

<u>Conclusion:</u> In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

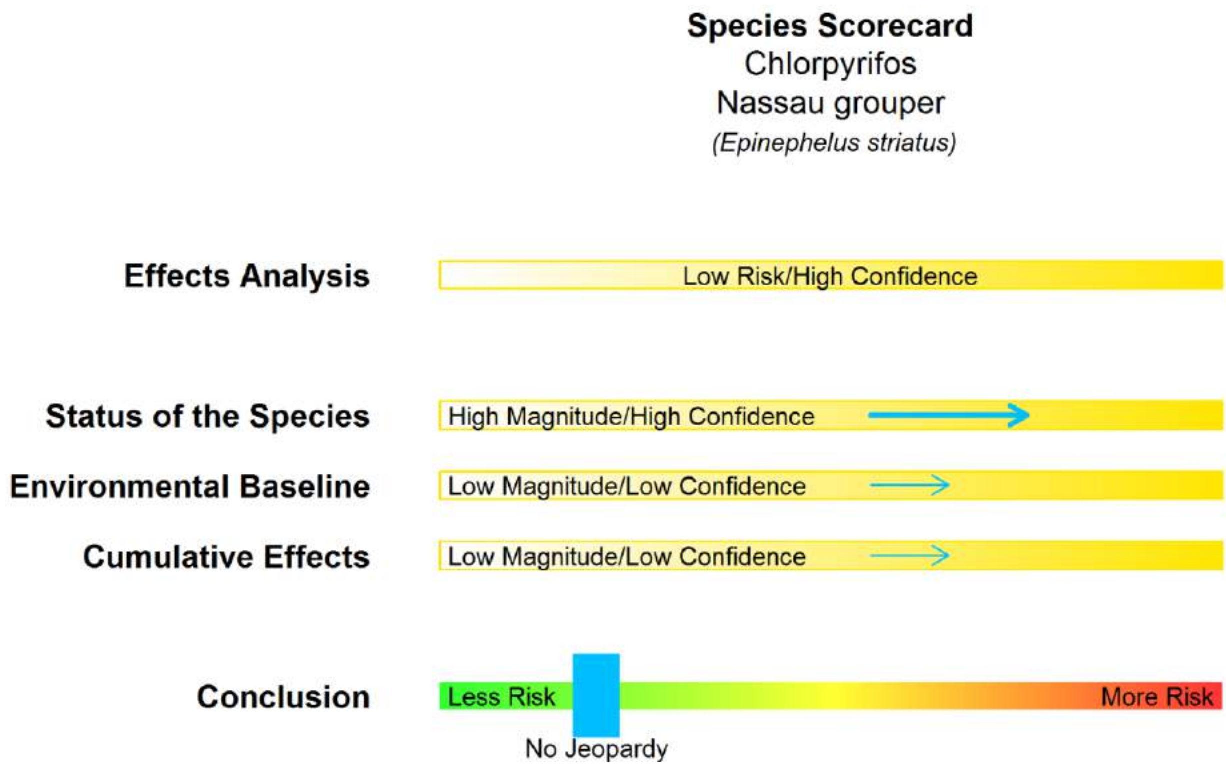

Figure 44. Species Score Card; Nassau grouper; Chlorpyrifos

Effects Analysis: Low risk/High confidence

- Reduced abundance not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence

- The species has pathcy abundance with declining abundance trends. Throughout its range reductions in the size and number of spawning aggregations;
- Threatened;
- Recovery criteria not identified

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures unanticipated in marine waters
- Environmental mixtures not anticipated at toxic concentrations in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures not anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy

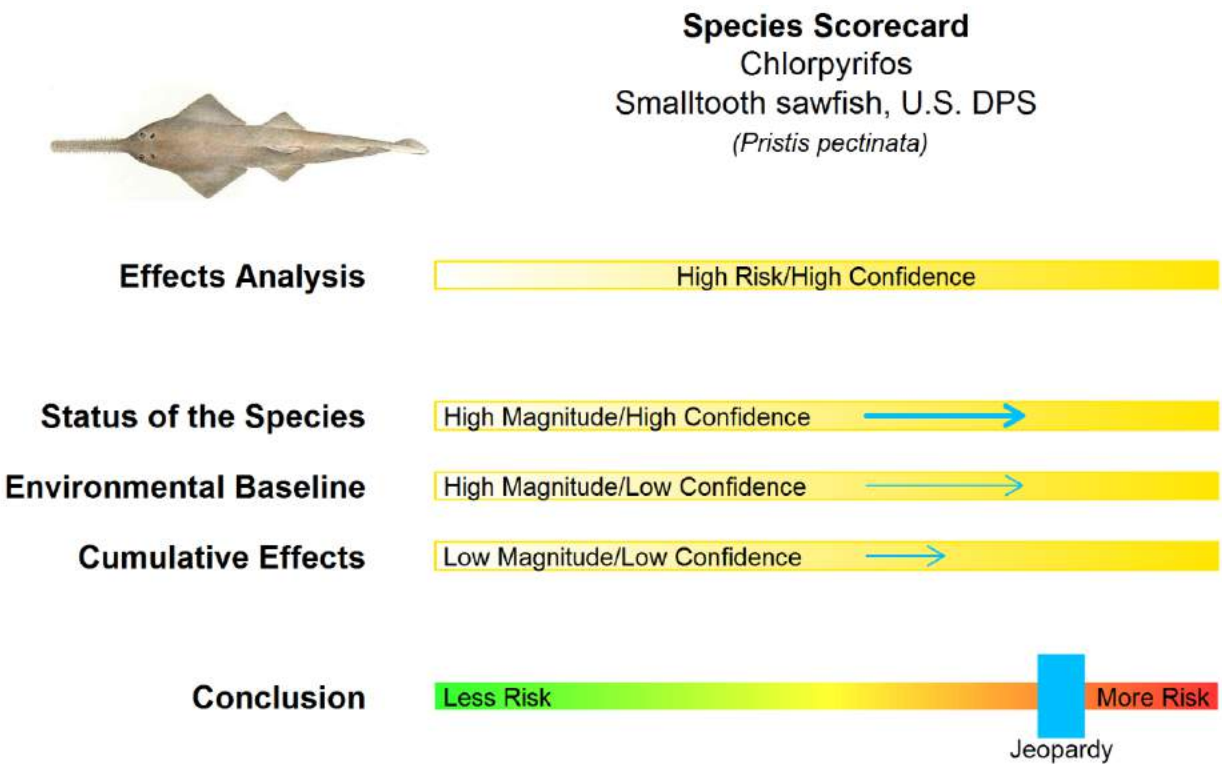

Figure 45. Species Score Card; Smalltooth sawfish, U.S. DPS; Chlorpyrifos

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater and estuarine areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Stable abundance, low population growth rates, <5% of historical abundance
- Endangered;
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ Low confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy</u>

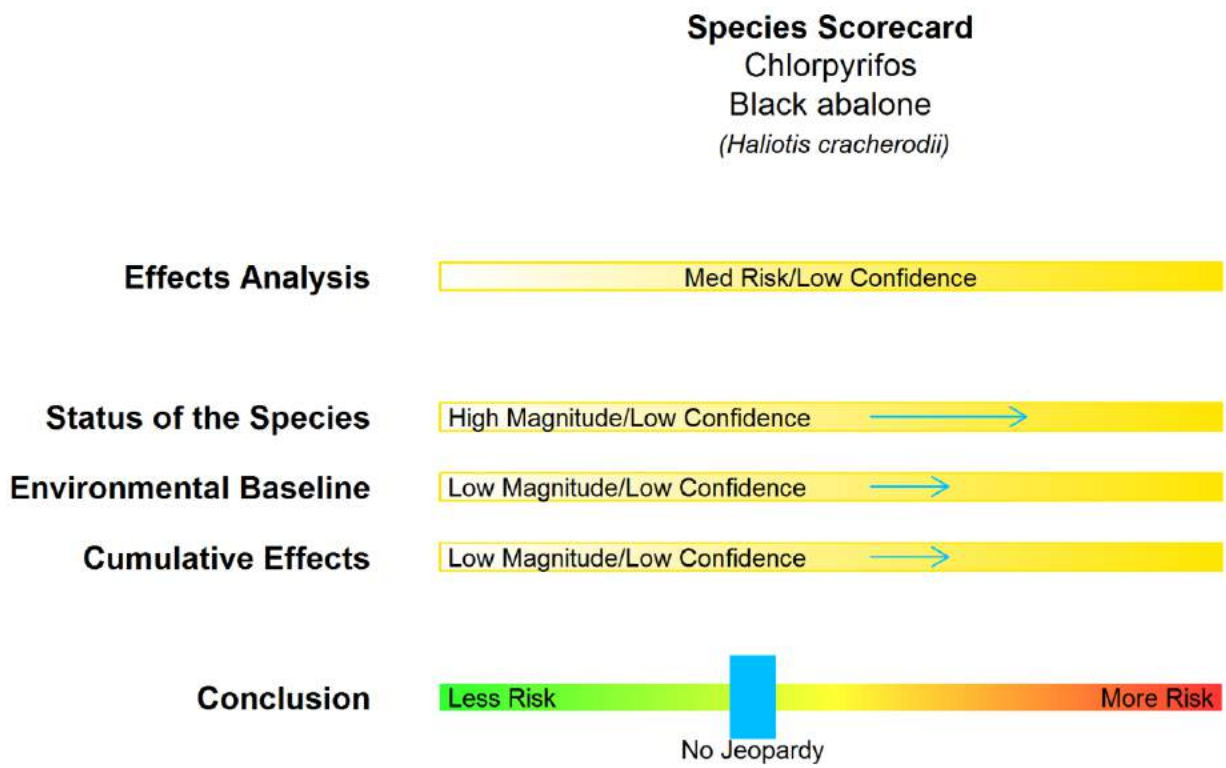

Figure 46. Species Score Card; Black abalone; Chlorpyrifos

Effects Analysis: Medium risk/Low confidence

- Reduced abundance may occur in marine areas
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Increased risk of jeopardy; High magnitude/ Low confidence

- 5% of historical abundance, declining population trend
- Endangered;
- Recovery criteria not identified

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures unanticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures not anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in the surface areas. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy

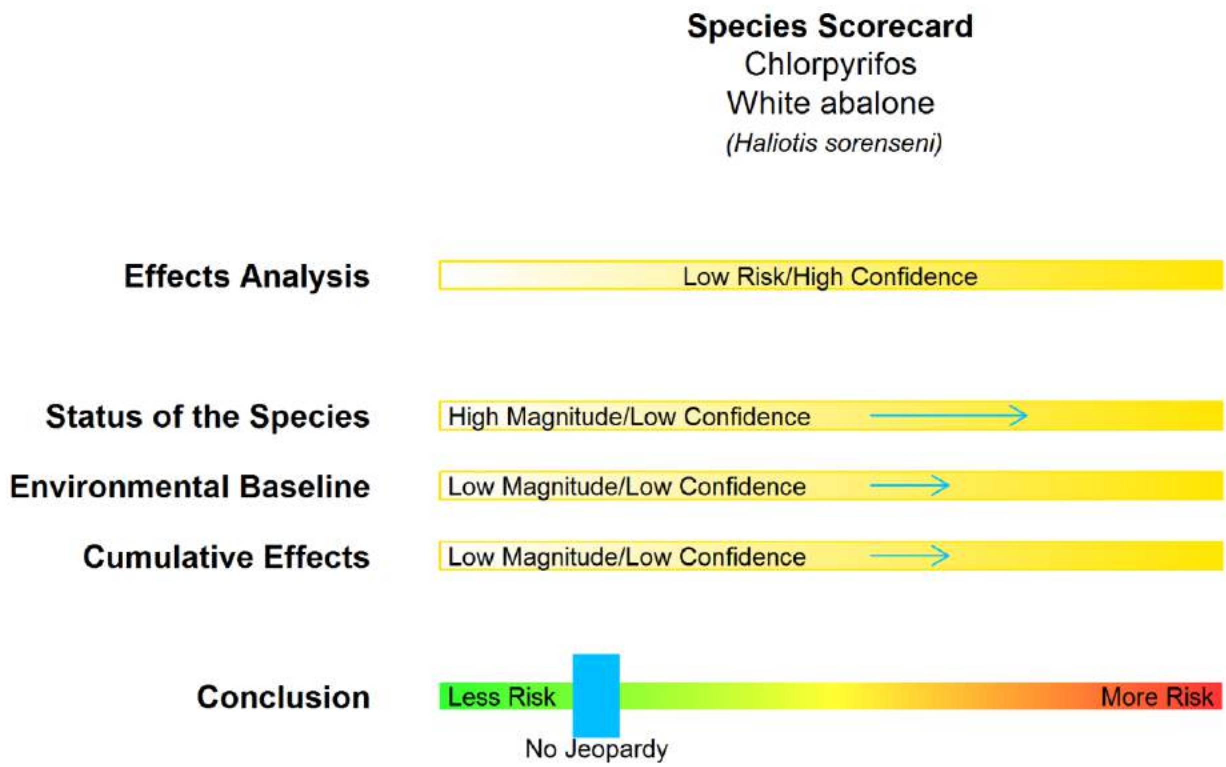

Figure 47. Species Score Card; White abalone; Chlorpyrifos

Effects Analysis: Low risk/High confidence

- Reduced abundance unlikely to occur in marine areas
- Potential effects to some individual include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Increased risk of jeopardy; High magnitude/ Low confidence

- Declining population trend, lack of recruitment, no current estimated population size
- Endangered;
- Recovery criteria not met

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures unanticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures not anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on high confidence in minimal exposure to the stressor of the action. The species is most at risk while in the surface areas. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy

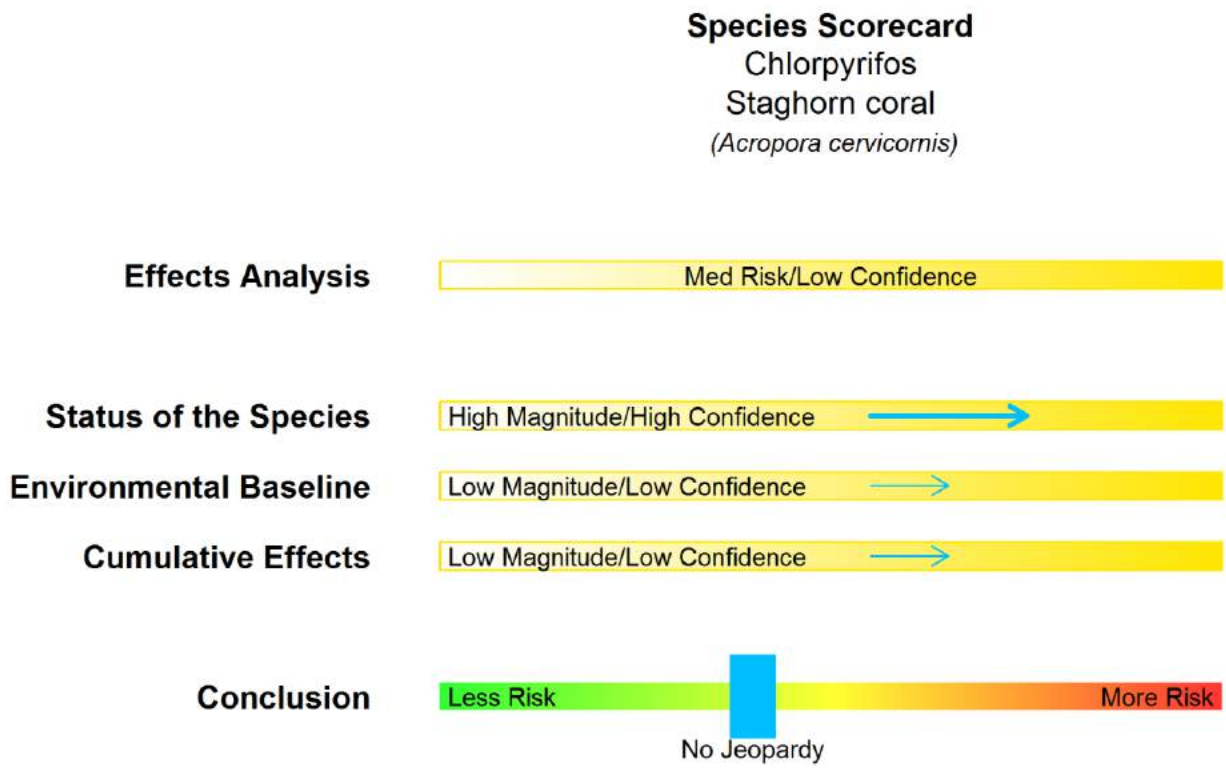

Figure 48. Species Score Card; Staghorn coral; Chlorpyrifos

<u>Effects Analysis: Medium risk/Low confidence</u>

- Reduced abundance unlikely to occur in marine areas
- Potential effects to colonies include death and reduced settling of juveniles.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Severe reductions in abundance in portions of range. Populations remain stable at depressed levels;
- Threatened;
- Recovery criteria not met.

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters

<u>Conclusion:</u> In marine habitats, we find a small likelihood of exposure and effects to the species based on high confidence in minimal exposure to the stressor of the action. Additionally, a maximum of 8% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

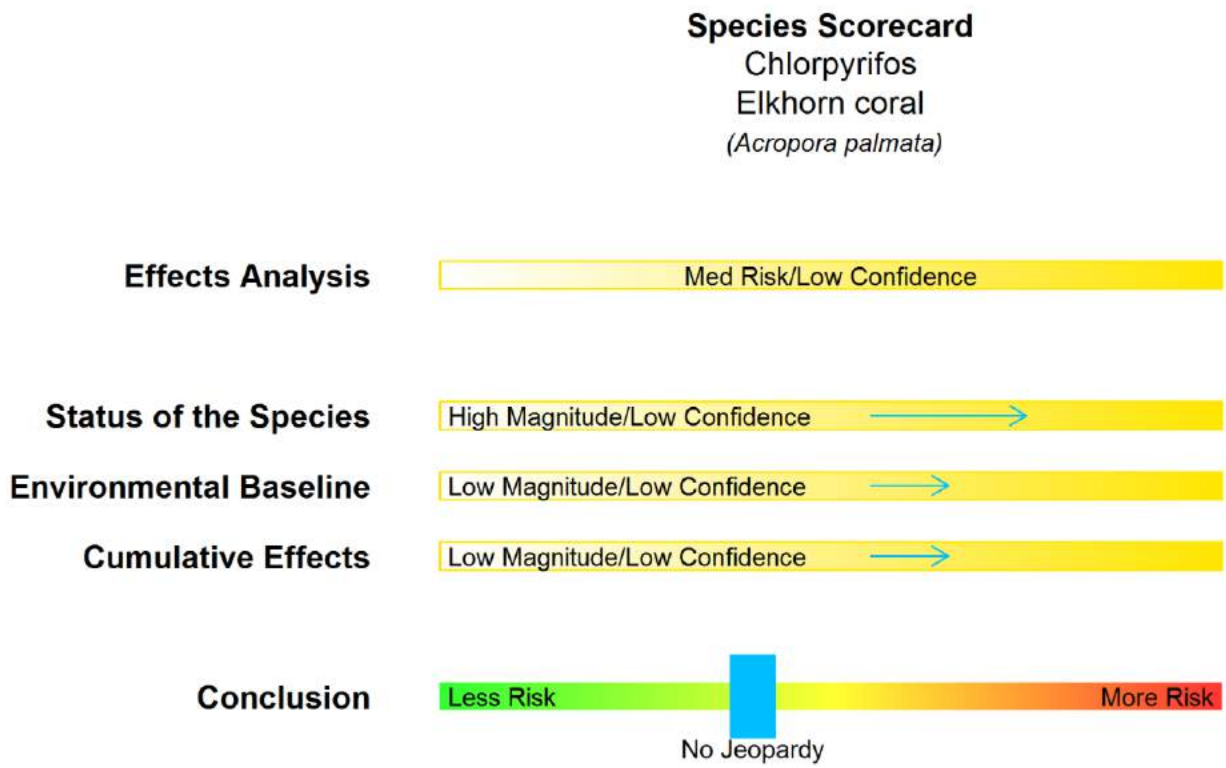

Figure 49. Species Score Card; Elkhorn coral; Chlorpyrifos

Effects Analysis: Medium risk/Low confidence

- Reduced abundance unlikely to occur in marine areas
- Potential effects to colonies include death and reduced settling of juveniles.

Status of the Species: Increased risk of jeopardy; High magnitude/ Low confidence

- Low abundance, large declines over past decades. Genetically depauparate populations in Caribbean. In eastern Caribbean, population is doing better and is genetically richer.
- Threatened;
- Recovery criteria not met.

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on high confidence in minimal exposure to the stressor of the action. Additionally, a maximum of 8% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy

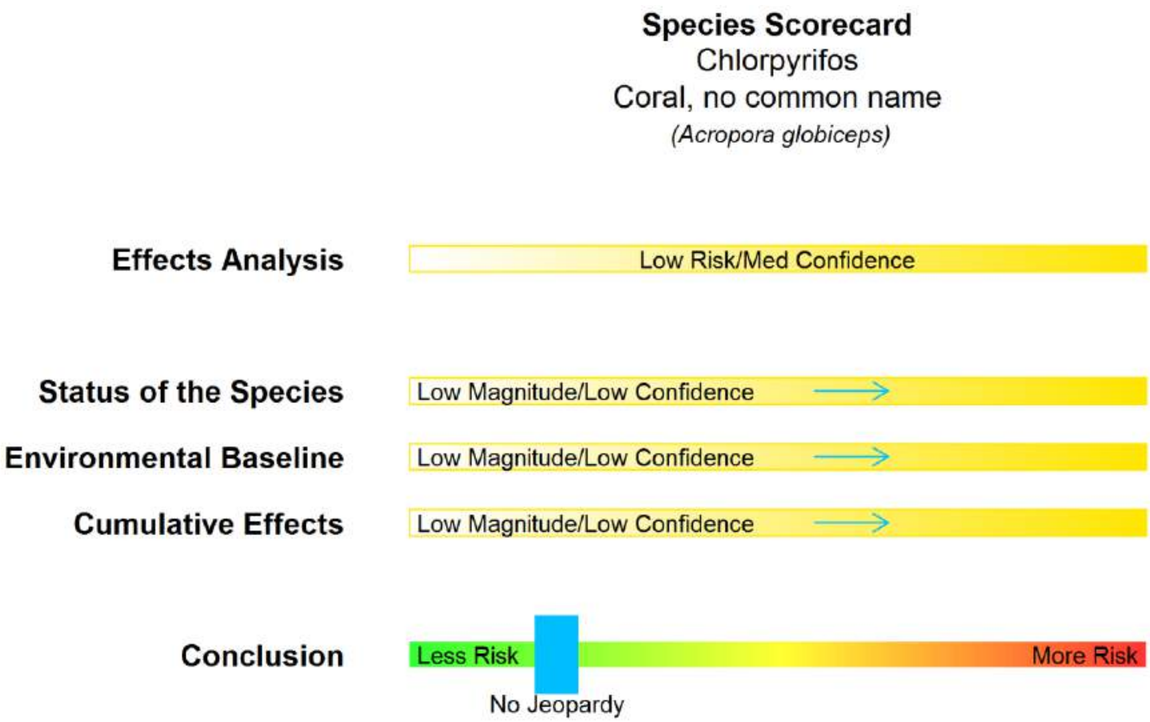

Figure 50. Species Score Card; Coral, Acropora globiceps; Chlorpyrifos

Effects Analysis: Low risk/Medium confidence

- Reduced abundance unlikely to occur in marine areas
- Potential effects to colonies include death and reduced settling of juveniles.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Range is extensive throughout the Indo-Pacific region. Less than 5 % of the population is within the range of the action area. Over-all status unknown. Growth rates of decline or increase are unknown.
- Threatened;
- Recovery criteria not developed

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on medium confidence in minimal exposure to the stressors of the action. Additionally, a maximum of 5% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy

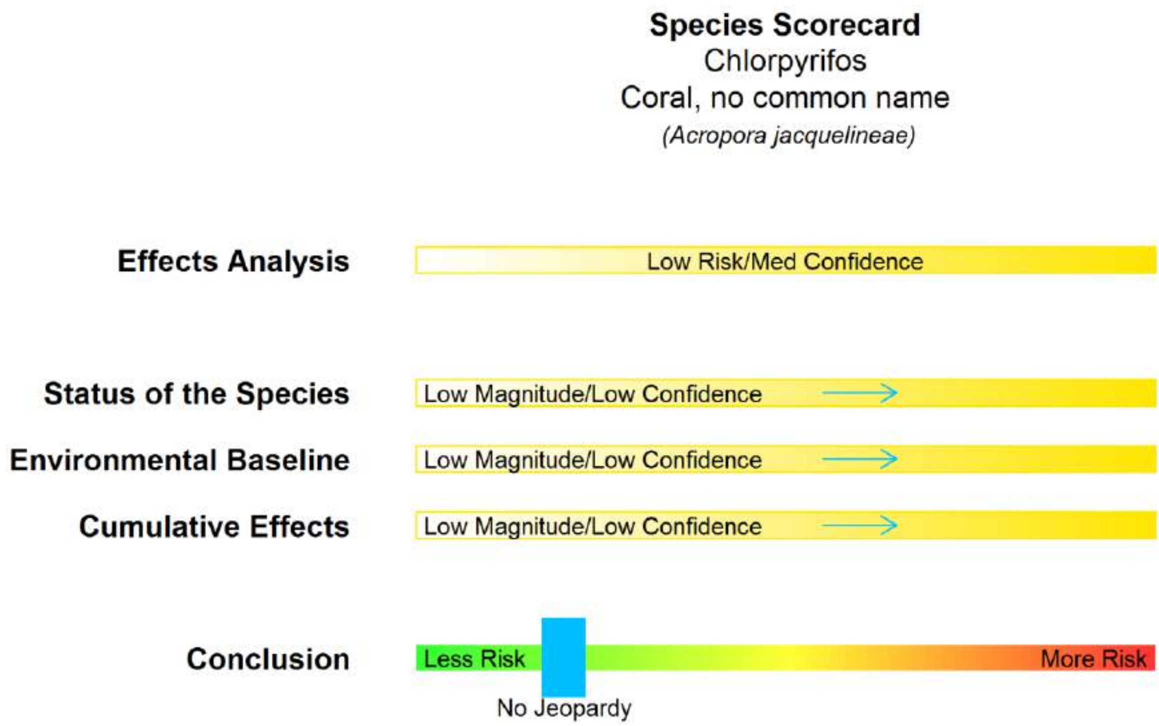

Figure 51. Species Score Card; Coral, Acropora jacquelineae; Chlorpyrifos

Effects Analysis: Low risk/Medium confidence

- Reduced abundance unlikely to occur in marine areas
- Potential effects to colonies include death and reduced settling of juveniles.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Range is extensive throughout the Indo-Pacific region. Less than 5 % of the population is within the range of the action area. Over-all status unknown. Growth rates of decline or increase are unknown.
- Threatened;
- Recovery criteria not developed

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on medium confidence in minimal exposure to the stressors of the action. Additionally, a maximum of 5% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy

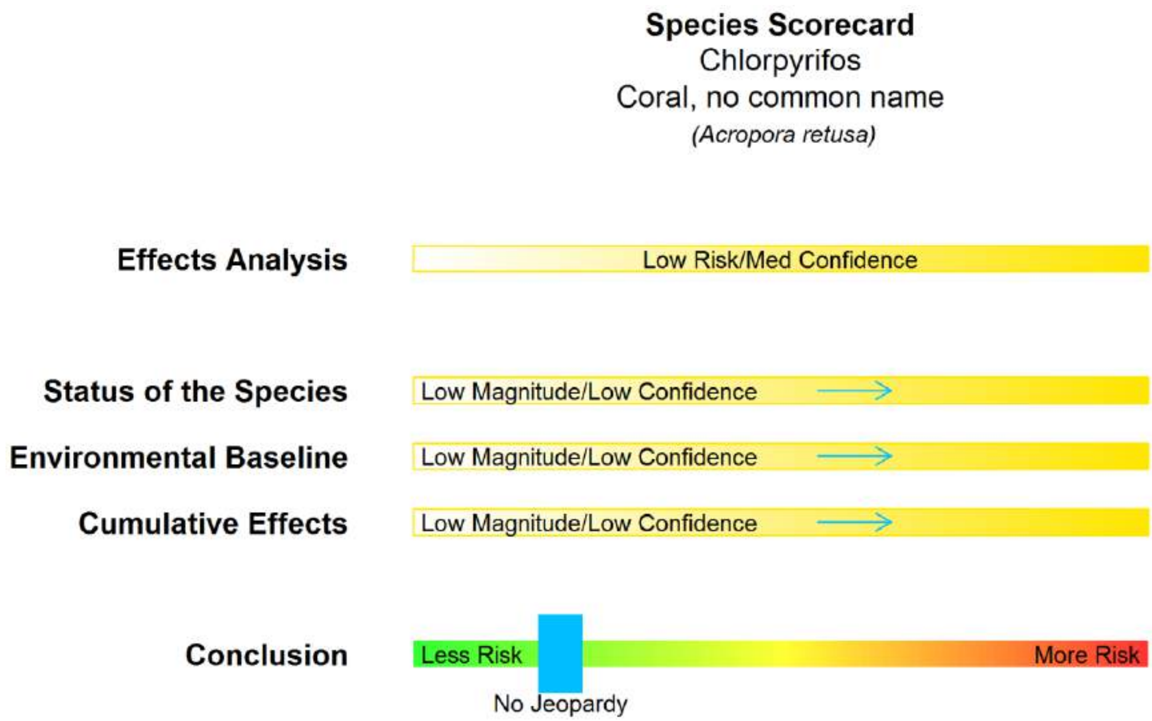

Figure 52. Species Score Card; Coral, Acropora retusa; Chlorpyrifos

Effects Analysis: Low risk/Medium confidence

- Reduced abundance unlikely to occur in marine areas
- Potential effects to colonies include death and reduced settling of juveniles.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Range is extensive throughout the Indo-Pacific region. Less than 5 % of the population is within the range of the action area. Over-all status unknown. Growth rates of decline or increase are unknown.
- Threatened;
- Recovery criteria not developed

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on medium confidence in minimal exposure to the stressors of the action. Additionally, a maximum of 5% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy

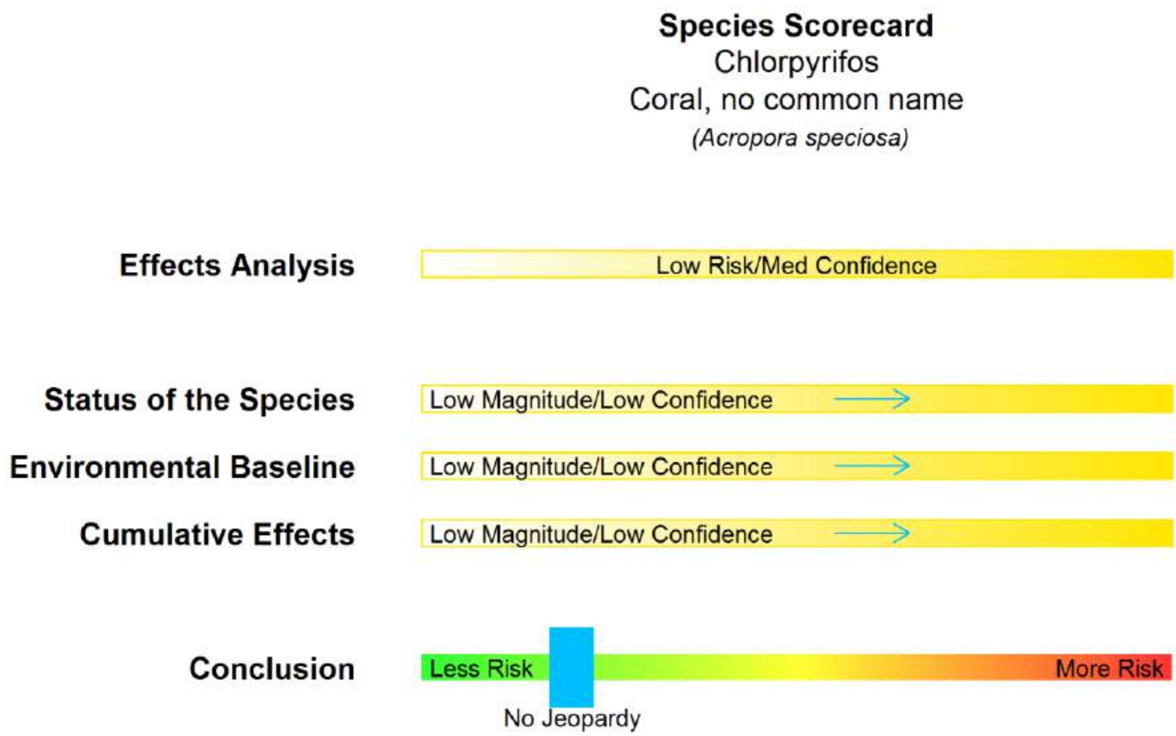

Figure 53. Species Score Card; Coral, Acropora speciosa; Chlorpyrifos

<u>Effects Analysis: Low risk/Medium confidence</u>

- Reduced abundance unlikely to occur in marine areas
- Potential effects to colonies include death and reduced settling of juveniles.

<u>Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Range is extensive throughout the Indo-Pacific region. Less than 5 % of the population is within the range of the action area. Over-all status unknown. Growth rates of decline or increase are unknown.
- Threatened;
- Recovery criteria not developed

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters

<u>Conclusion:</u> In marine habitats, we find a small likelihood of exposure and effects to the species based on medium confidence in minimal exposure to the stressors of the action. Additionally, a maximum of 5% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

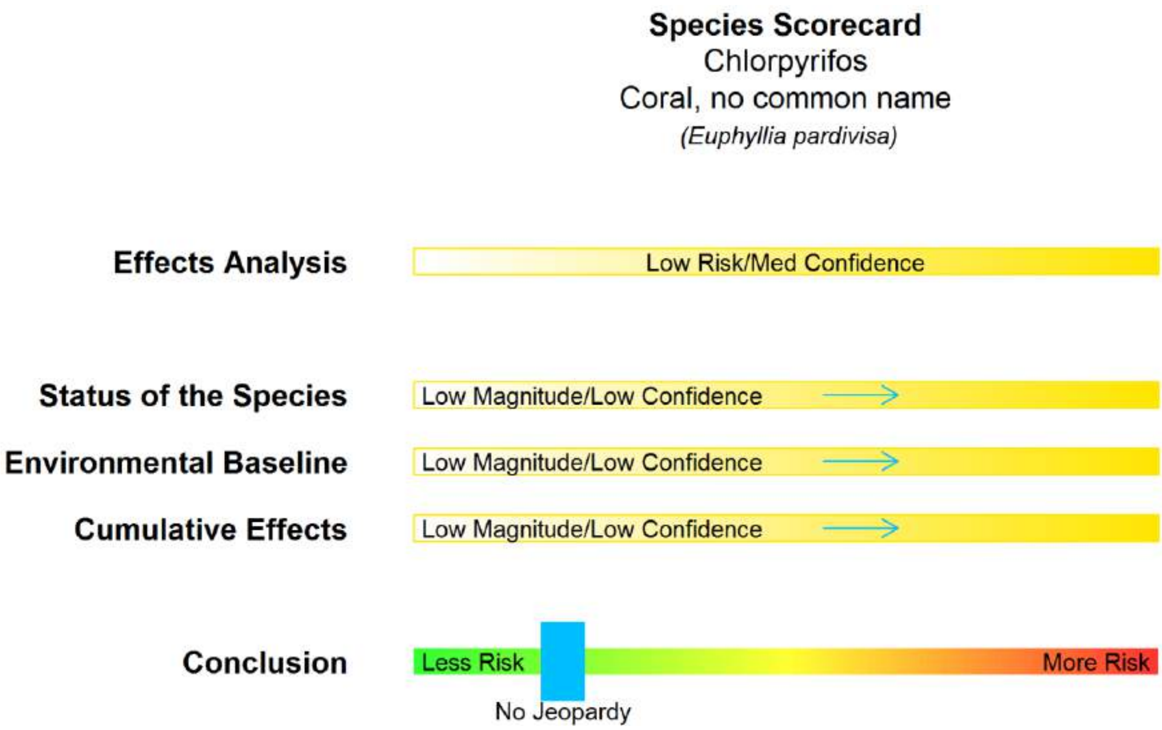

Figure 54. Species Score Card; Coral, Euphyllia pardivisa; Chlorpyrifos

Effects Analysis: Low risk/Medium confidence

- Reduced abundance unlikely to occur in marine areas
- Potential effects to colonies include death and reduced settling of juveniles.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Range is extensive throughout the Indo-Pacific region. Less than 5 % of the population is within the range of the action area. Over-all status unknown. Growth rates of decline or increase are unknown.
- Threatened;
- Recovery criteria not developed

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on medium confidence in minimal exposure to the stressors of the action. Additionally, a maximum of 5% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy

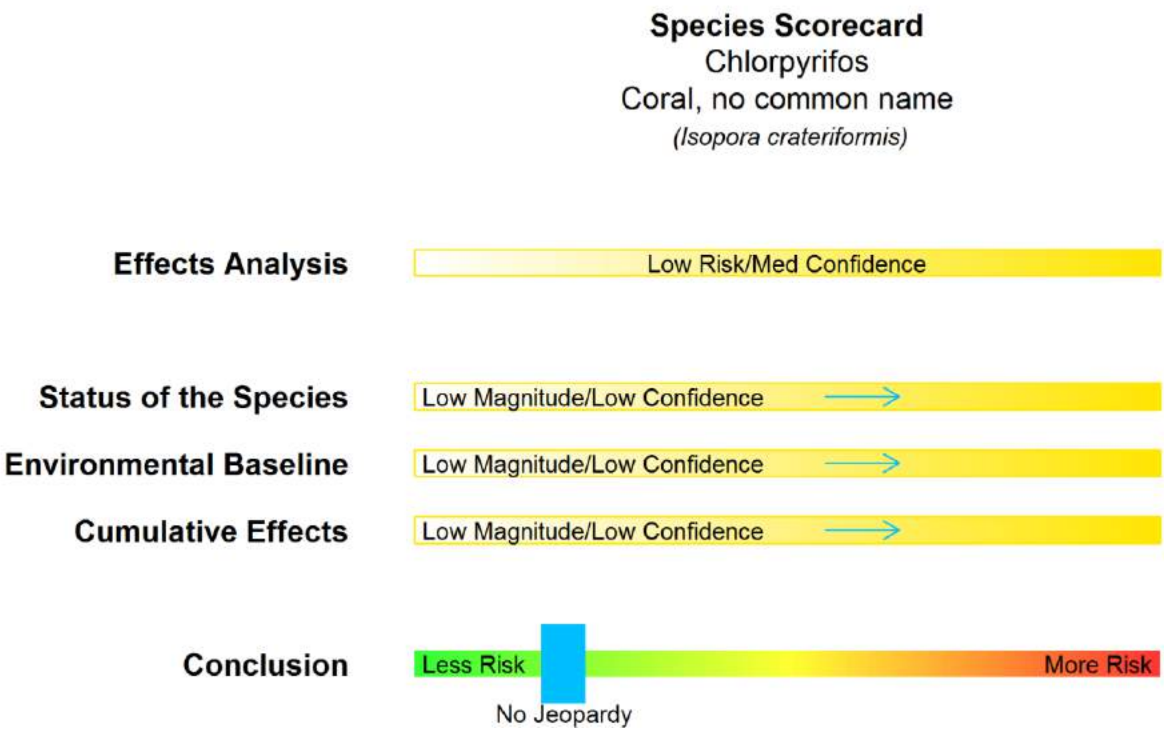

Figure 55. Species Score Card; Coral, Isopora crateriformis; Chlorpyrifos

Effects Analysis: Low risk/Medium confidence

- Reduced abundance unlikely to occur in marine areas
- Potential effects to colonies include death and reduced settling of juveniles.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Range is extensive throughout the Indo-Pacific region. Less than 5 % of the population is within the range of the action area. Over-all status unknown. Growth rates of decline or increase are unknown.
- Threatened;
- Recovery criteria not developed

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on medium confidence in minimal exposure to the stressors of the action. Additionally, a maximum of 5% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy

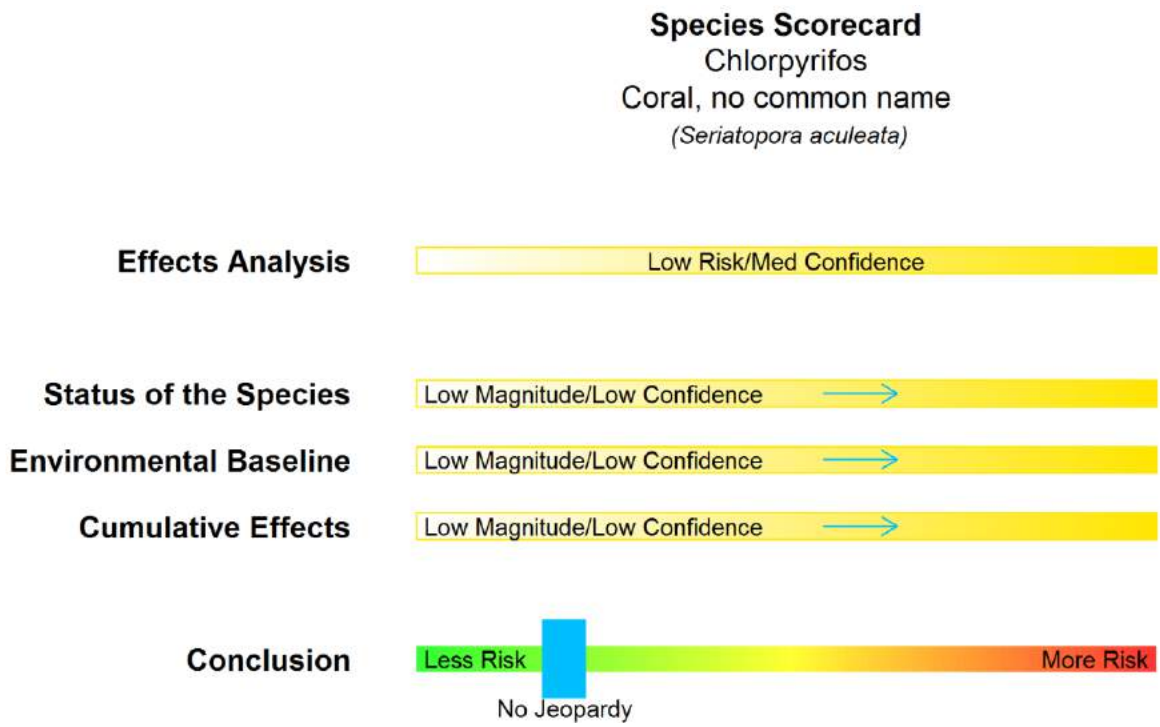

Figure 56. Species Score Card; Coral, Seriatopora aculeata; Chlorpyrifos

Effects Analysis: Low risk/Medium confidence

- Reduced abundance unlikely to occur in marine areas
- Potential effects to colonies include death and reduced settling of juveniles.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Range is extensive throughout the Indo-Pacific region. Less than 5 % of the population is within the range of the action area. Over-all status unknown. Growth rates of decline or increase are unknown.
- Threatened;
- Recovery criteria not developed

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on medium confidence in minimal exposure to the stressors of the action. Additionally, a maximum of 5% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy

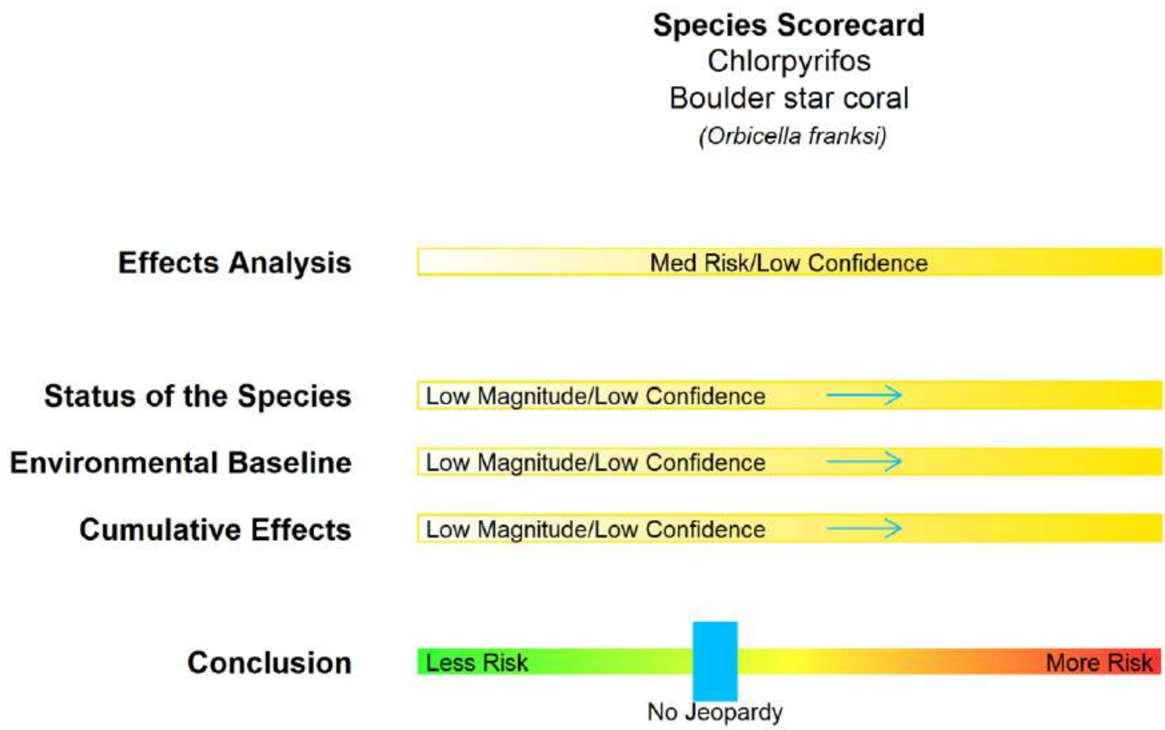

Figure 57. Species Score Card; Boulder star coral; Chlorpyrifos

Effects Analysis: Medium risk/Low confidence

- Reduced abundance unlikely to occur in marine areas
- Potential effects to some colonies include death and reduced settling of juveniles.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Reductions in abundance, population is currently stable
- Threatened;
- Recovery criteria not developed

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on medium confidence in minimal exposure to the stressors of the action. Additionally, a maximum of 5% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy

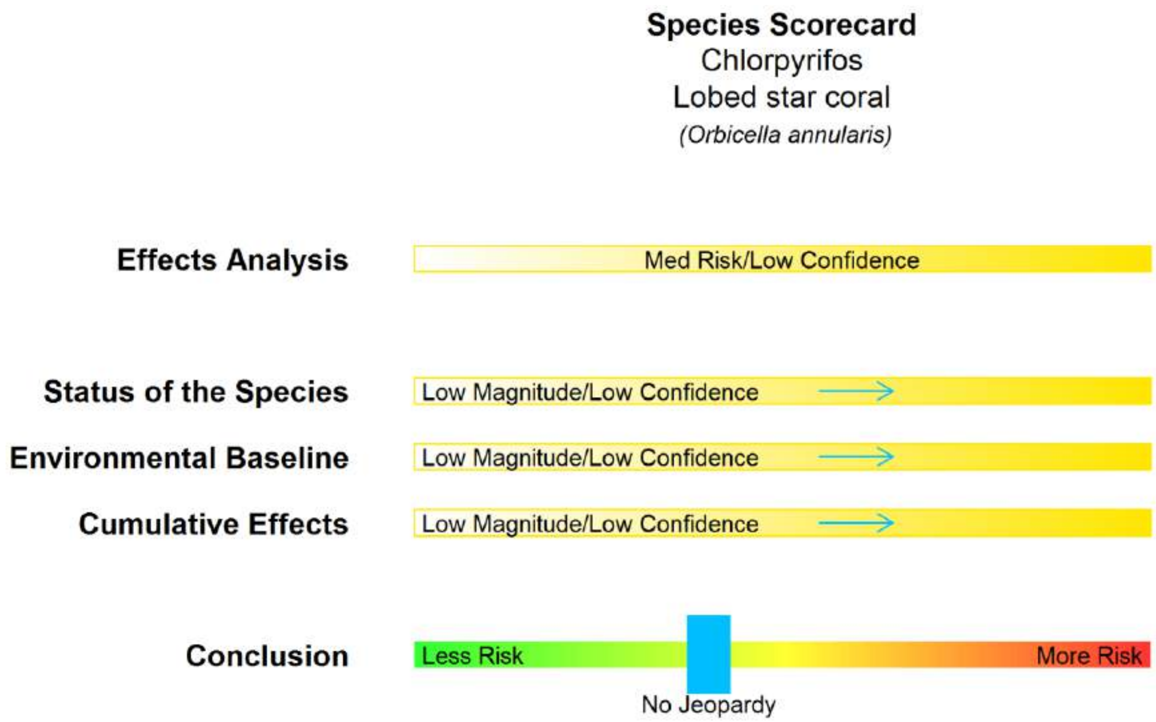

Figure 58. Species Score Card; Lobed star coral; Chlorpyrifos

Effects Analysis: Medium risk/Low confidence

- Reduced abundance unlikely to occur in marine areas
- Potential effects to some colonies include death and reduced settling of juveniles.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- 60% decline 2001-2012 due to bleaching. Most were considered "partial" mortalities to the colony. Abundance is stable.
- Threatened;
- Recovery criteria not developed

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on medium confidence in minimal exposure to the stressors of the action. Additionally, a maximum of 8% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy

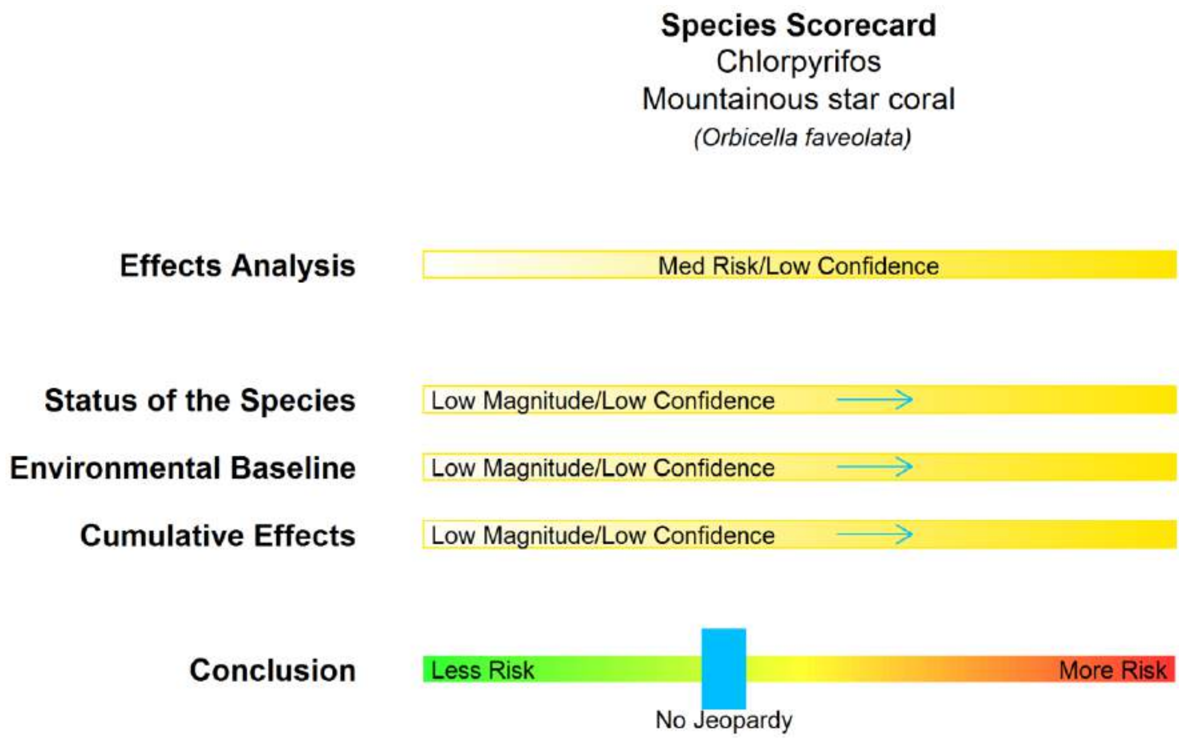

Figure 59. Species Score Card; Mountainous star coral; Chlorpyrifos

Effects Analysis: Medium risk/Low confidence

- Reduced abundance unlikely to occur in marine areas
- Potential effects to some colonies include death and reduced settling of juveniles.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Some areas have shown major declines due to warming induced bleaching and disease; however this species is considered abundant.
- Threatened;
- Recovery criteria not developed

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on medium confidence in minimal exposure to the stressors of the action. Additionally, a maximum of 8% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy

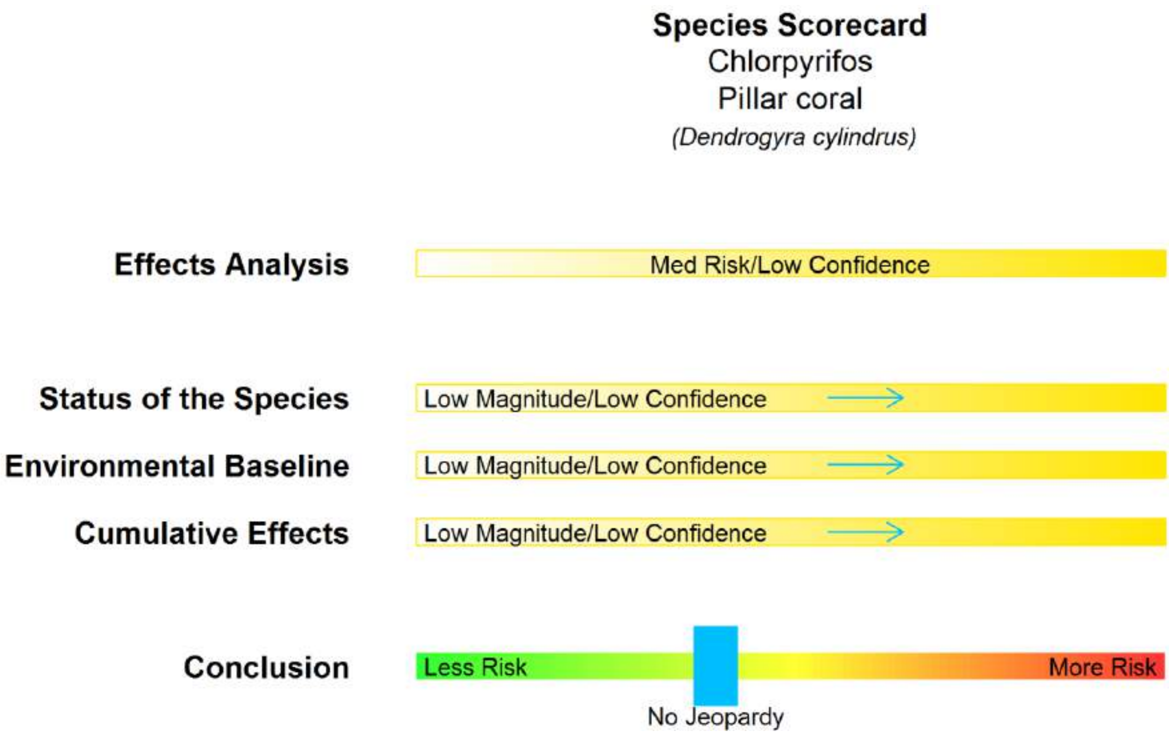

Figure 60. Species Score Card; Pillar coral; Chlorpyrifos

<u>Effects Analysis: Medium risk/Low confidence</u>

- Reduced abundance unlikely to occur in marine areas
- Potential effects to some colonies include death and reduced settling of juveniles.

<u>Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Uncommon, rarely found in aggregations - yet little evidence of population declines over years of monitoring. Unknown trends in abundance or productivity
- Threatened;
- Recovery criteria not developed

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters

<u>Conclusion:</u> In marine habitats, we find a small likelihood of exposure and effects to the species based on medium confidence in minimal exposure to the stressors of the action. Additionally, a maximum of 8% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

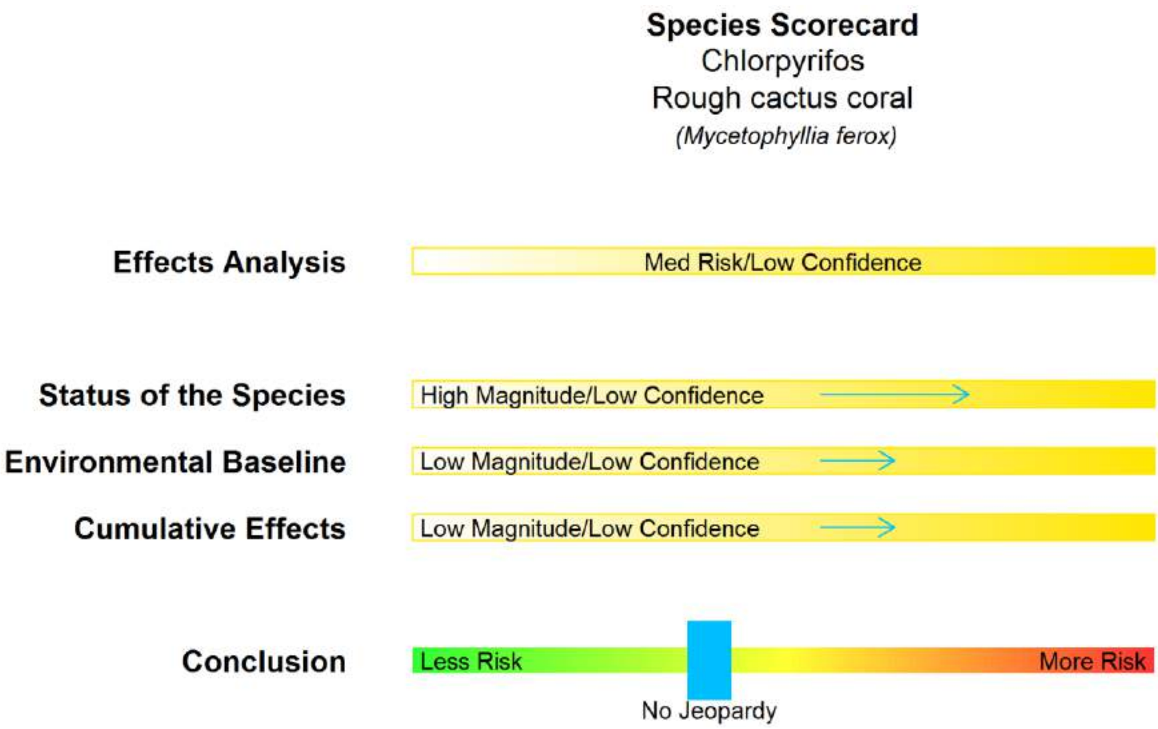

Figure 61. Species Score Card; Rough cactus coral; Chlorpyrifos

Effects Analysis: Medium risk/Low confidence

- Reduced abundance unlikely to occur in marine areas
- Potential effects to some colonies include death and reduced settling of juveniles.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Uncommon to rare. Species saw declines since the 1970's. Highly affected by disease. Unknown trends in abundance or productivity
- Threatened;
- Recovery criteria not developed

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on medium confidence in minimal exposure to the stressors of the action. Additionally, a maximum of 8% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy

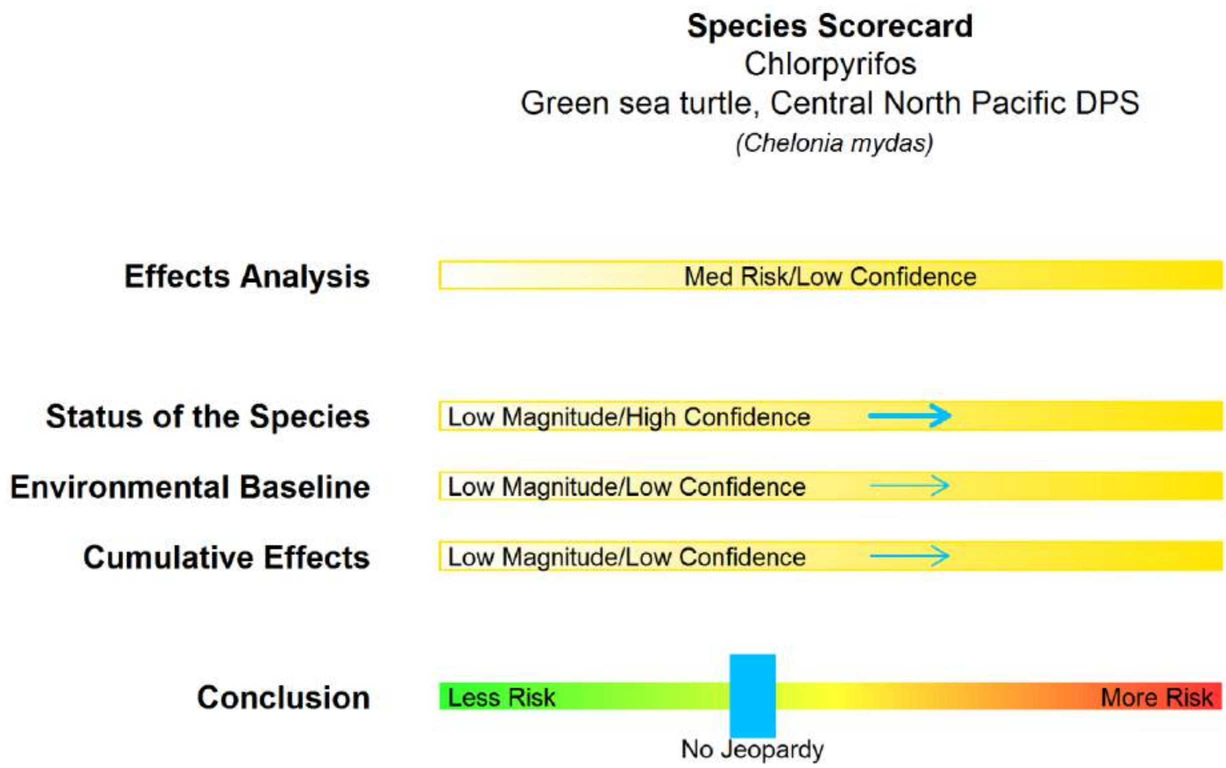

Figure 62. Species Score Card; Green sea turtle, Central North Pacific DPS; Chlorpyrifos

Effects Analysis: Medium risk/Low confidence

- Reduced abundance not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ High confidence

- Population nesting abundance is increasing at estimated rate of 4.8% annually. DPS has low level of genetic diversity. Population considered resilient.
- Threatened;
- Recovery criteria not met

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy

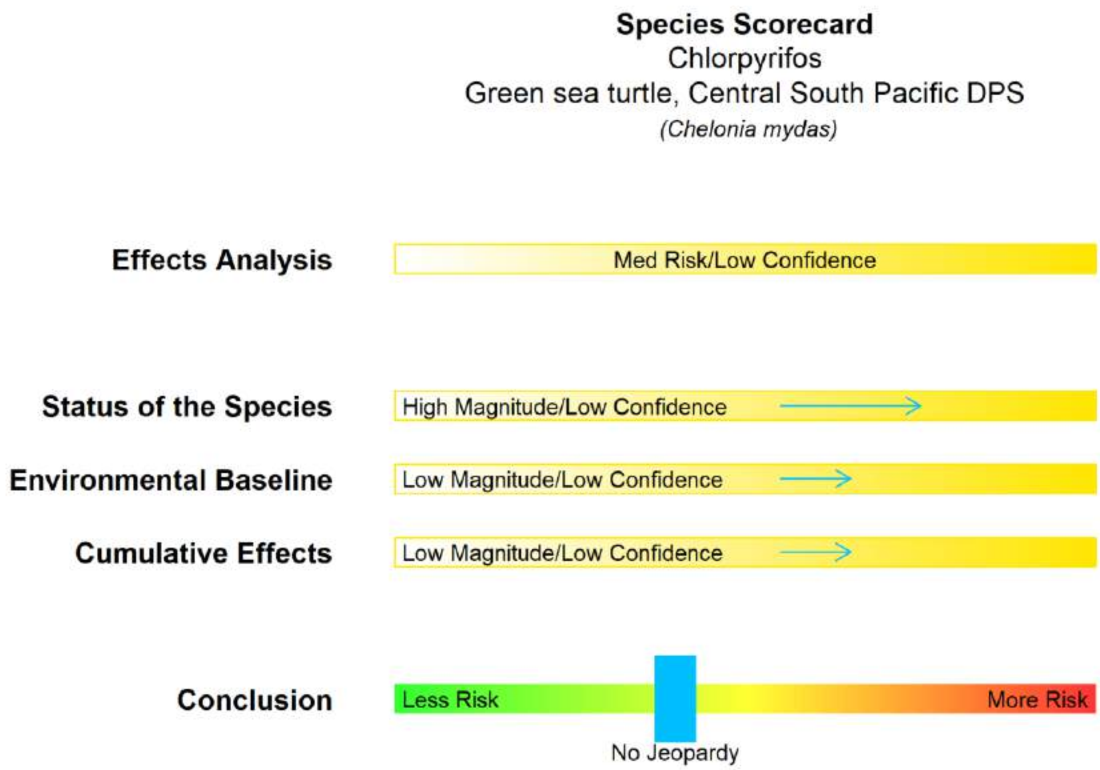

Figure 63. Species Score Card; Green sea turtle, Central South Pacific DPS; Chlorpyrifos

Effects Analysis: Medium risk/Low confidence

- Reduced abundance not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Increased risk of jeopardy; High magnitude/ Low confidence

- Nesting abundance considered low, 59 known sites; Unknown population trends; Existing data suggest steep declines due to illegal harvest of eggs. Nesting areas typically outside of the action area (US, territories, protectorates, etc.)
- Endangered;
- Recovery criteria not met

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy

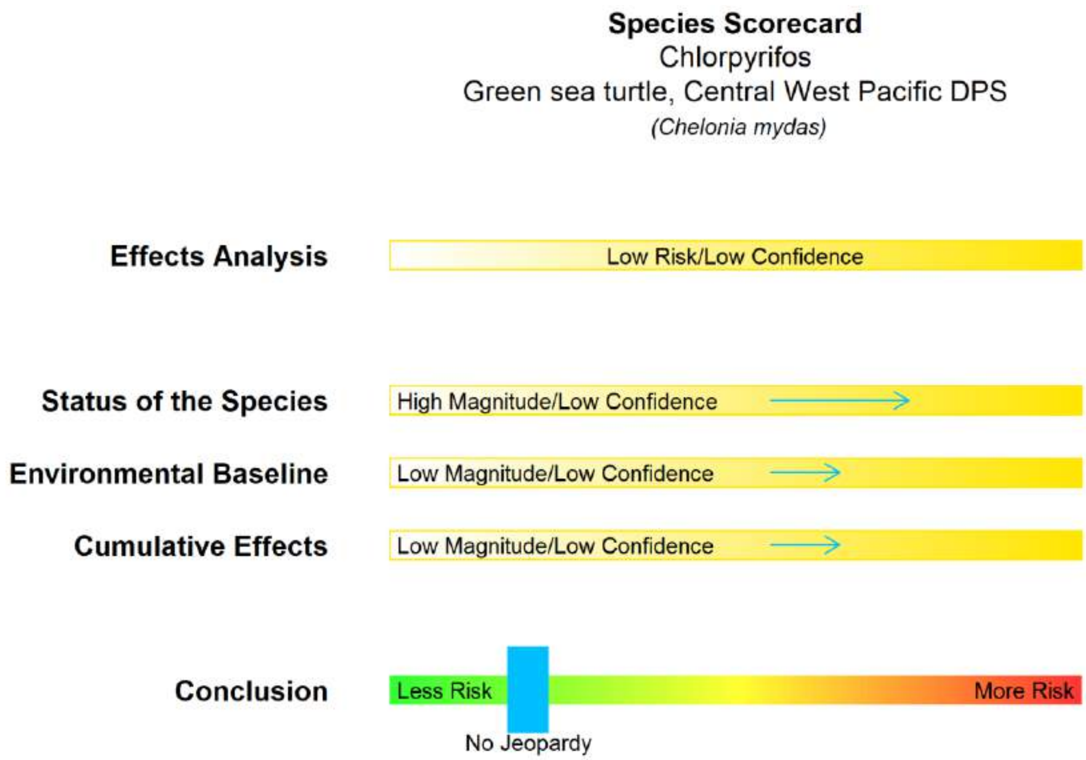

Figure 64. Species Score Card; Green sea turtle, Central West Pacific DPS; Chlorpyrifos

Effects Analysis: Low risk/Low confidence

- Reduced abundance not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Increased risk of jeopardy; High magnitude/ Low confidence

- No available population trend data; Most of species' range outside of action area.
- Endangered;
- Recovery criteria not met

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy

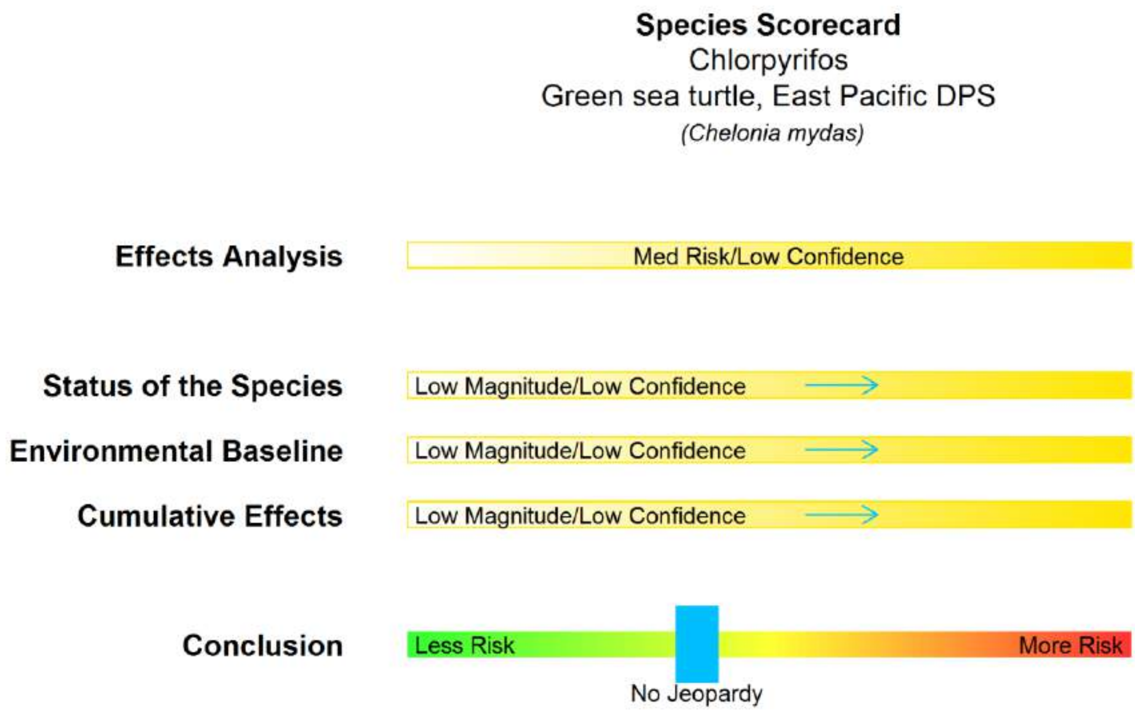

Figure 65. Species Score Card; Green sea turtle, East Pacific DPS; Chlorpyrifos

Effects Analysis: Medium risk/Low confidence

- Reduced abundance not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- 39 nesting sites with an estimated 20,062 nesting females.; The largest nesting site is at Colola, Mexico, which hosts 58% of the nesting females for the DPS where monitoring data suggest the population is increasing.
- Threatened;
- Recovery criteria not met

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas and rivers/streams. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy

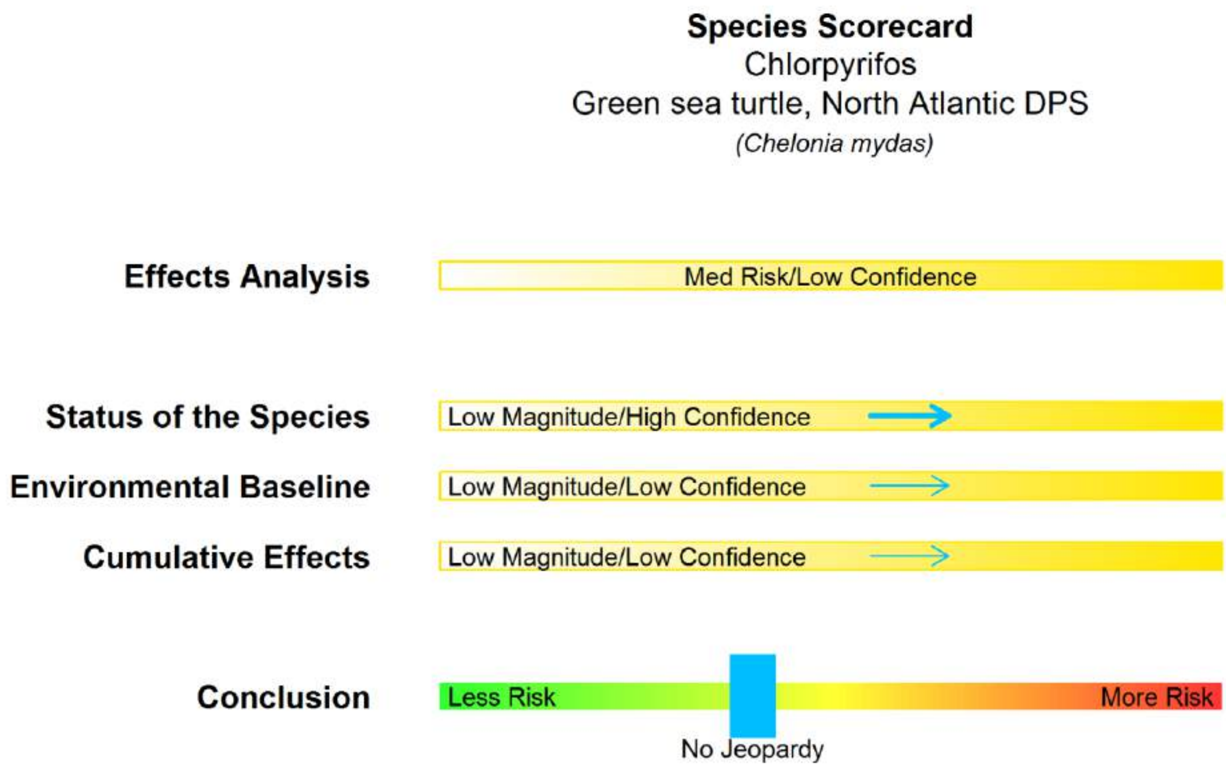

Figure 66. Species Score Card; Green sea turtle, North Atlantic DPS; Chlorpyrifos

Effects Analysis: Medium risk/Low confidence

- Reduced abundance not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Population shows increasing trend.
- Threatened;
- Recovery criteria not met

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas and rivers/streams. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy

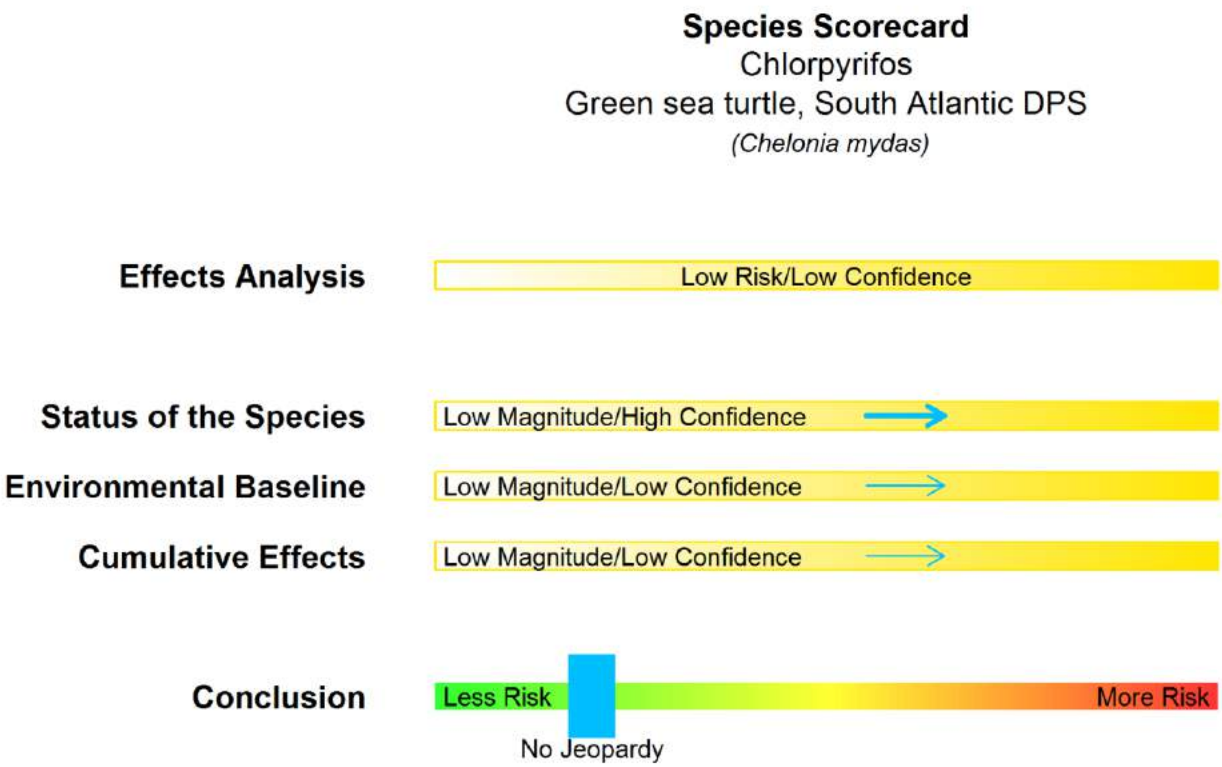

Figure 67. Species Score Card; Green sea turtle, South Atlantic DPS; Chlorpyrifos

Effects Analysis: Low risk/Low confidence

- Reduced abundance not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Sparse data available, suggests population is increasing; Most of DPS range outside of the action area;
- Threatened;
- Recovery criteria not all met

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas and rivers/streams. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy

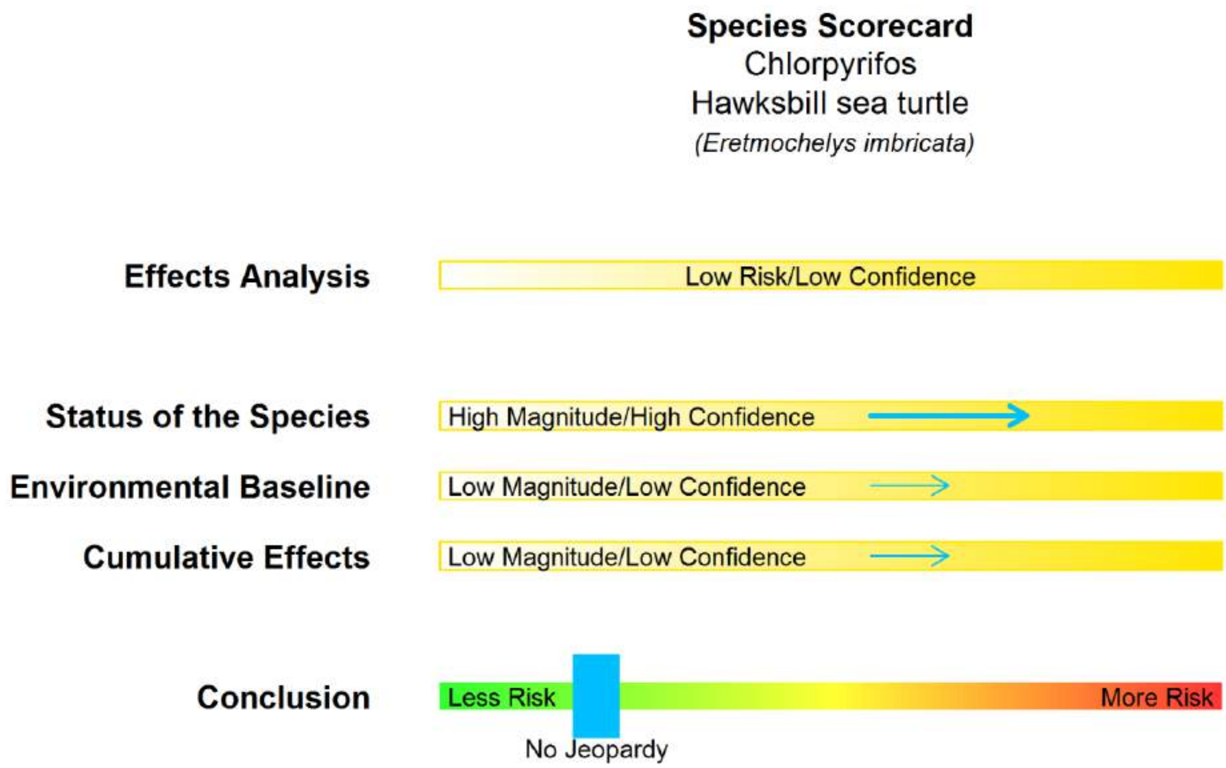

Figure 68. Species Score Card; Hawksbill sea turtle; Chlorpyrifos

Effects Analysis: Low risk/Low confidence

- Reduced abundance not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Population abundance improving in Atlantic and Indian Ocean; abundance declining in Pacific Ocean over the last 20 - 100 years. 68% of nesting sites exhibited declines.
- Endangered;
- Recovery criteria not met

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in marine waters yet effects uncertain

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas and rivers/streams. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy

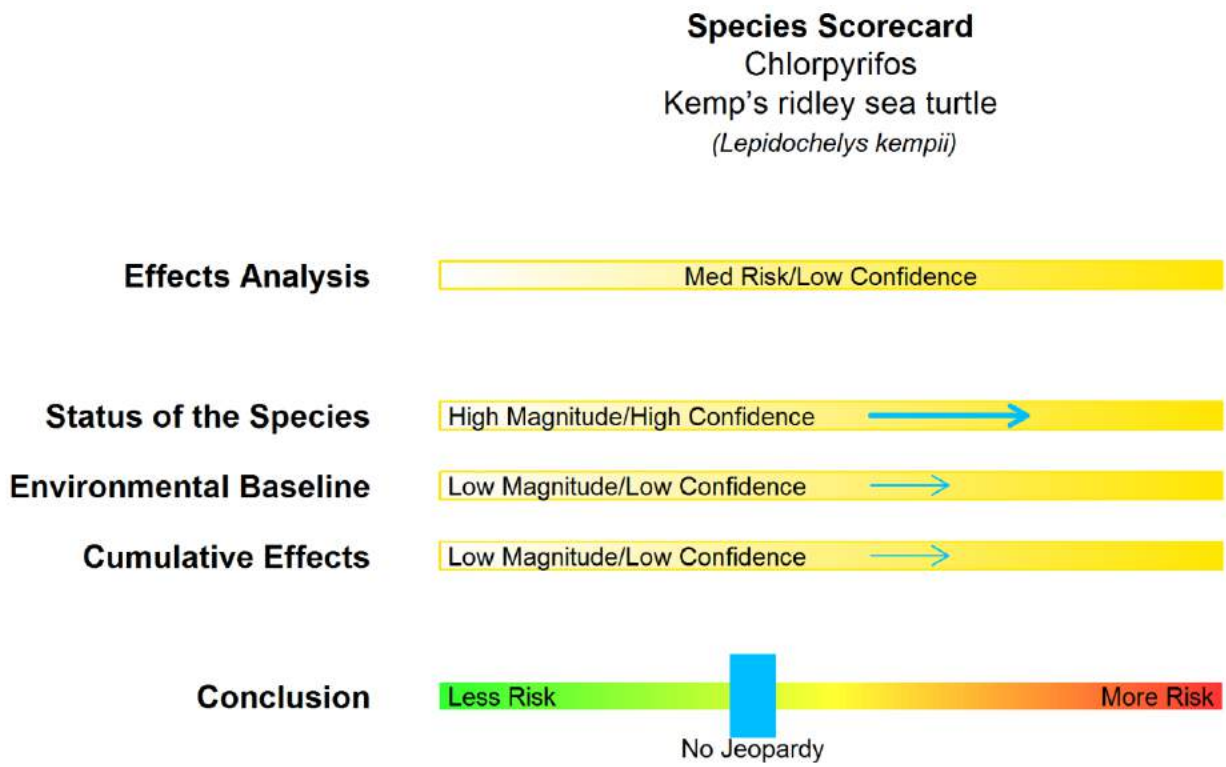

Figure 69. Species Score Card; Kemp's ridley sea turtle; Chlorpyrifos

<u>Effects Analysis: Medium risk/Low confidence</u>

- Reduced abundance not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

<u>Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ High confidence</u>

- Abundance trends negative;
- Endangered;
- Recovery criteria not met

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in marine waters yet effects uncertain

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters

<u>Conclusion:</u> In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas and rivers/streams. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

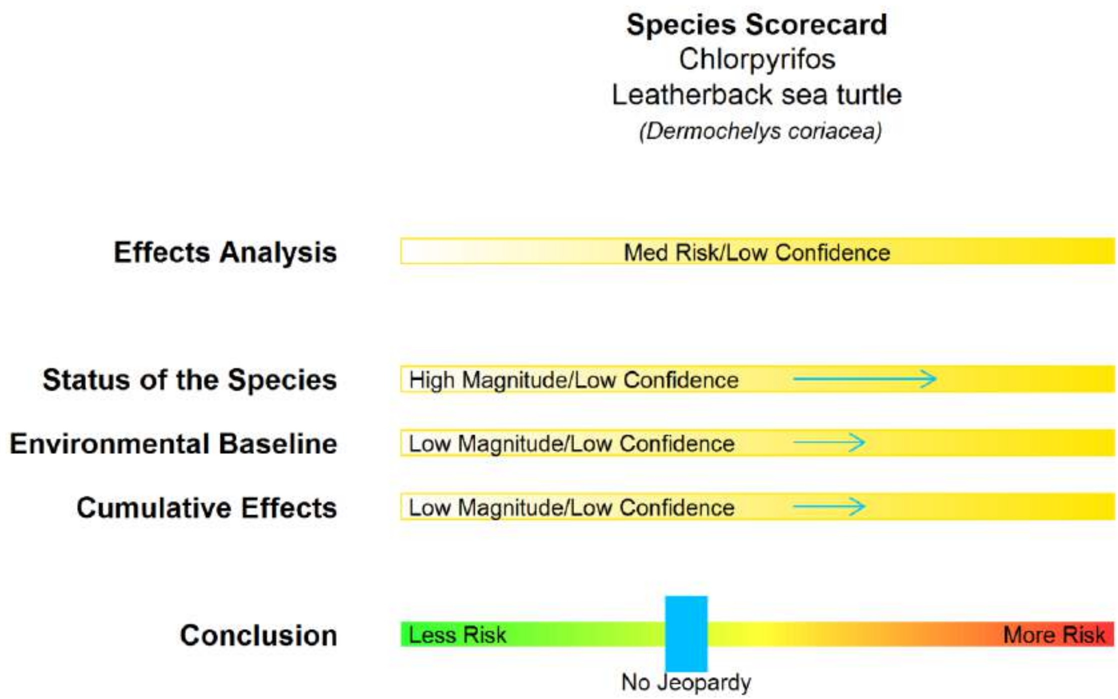

Figure 70. Species Score Card; Leatherback sea turtle; Chlorpyrifos

<u>Effects Analysis: Medium risk/Low confidence</u>

- Reduced abundance not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

<u>Status of the Species: Minimal increased risk of jeopardy; High magnitude/ Low confidence</u>

- Pacific population declined from 81,000 in to less than 3,000 with a continued rate of loss of approximately 6 %. Atlantic population is stable and showing signs of increasing growth of between 4-5.6% and 9-13% in Florida and the U.S. Virgin Islands, respectively.
- Endangered;
- Recovery criteria not met

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in marine waters yet effects uncertain

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters

<u>Conclusion:</u> In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas and rivers/streams. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

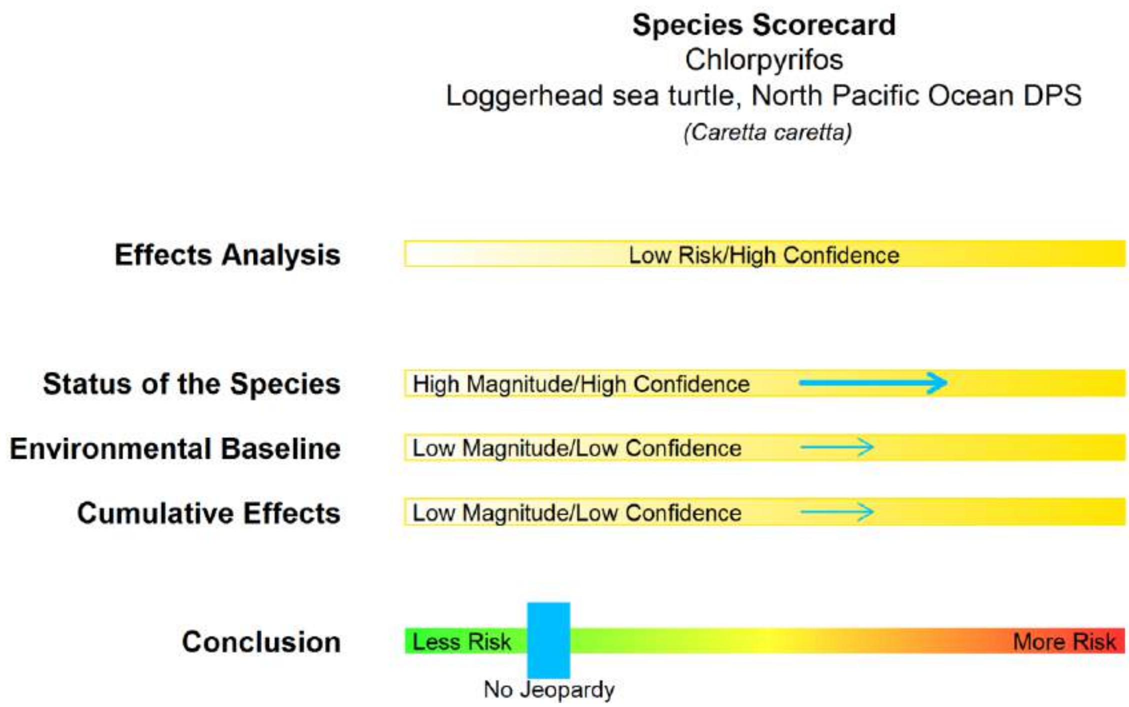

Figure 71. Species Score Card; Loggerhead sea turtle, North Pacific Ocean DPS; Chlorpyrifos

Effects Analysis: Low risk/High confidence

- Reduced abundance not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Population growth rate estimated at 0.032. Population depressed compared to historical numbers.
- Threatened; Population has declined an estimated 80% in past 20 years.
- Recovery criteria not met

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in marine waters yet effects uncertain

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters but effects uncertain

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas and rivers/streams. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy

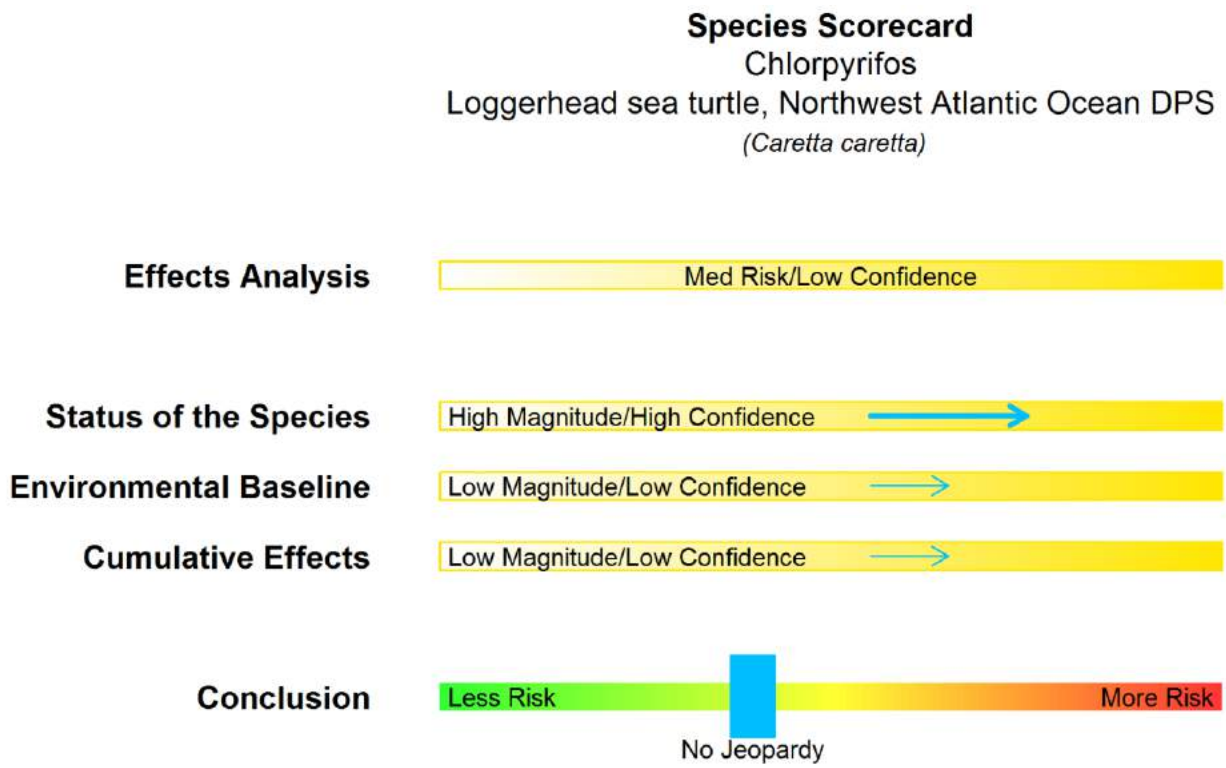

Figure 72. Species Score Card; Loggerhead sea turtle, Northwest Atlantic Ocean DPS; Chlorpyrifos

Effects Analysis: Medium risk/Low confidence

- Reduced abundance not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence

- All sub-populations exhibiting negative population growth rates;
- Threatened;
- Recovery criteria not met;

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in marine waters yet effects uncertain

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters but effects uncertain

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas and rivers/streams. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy

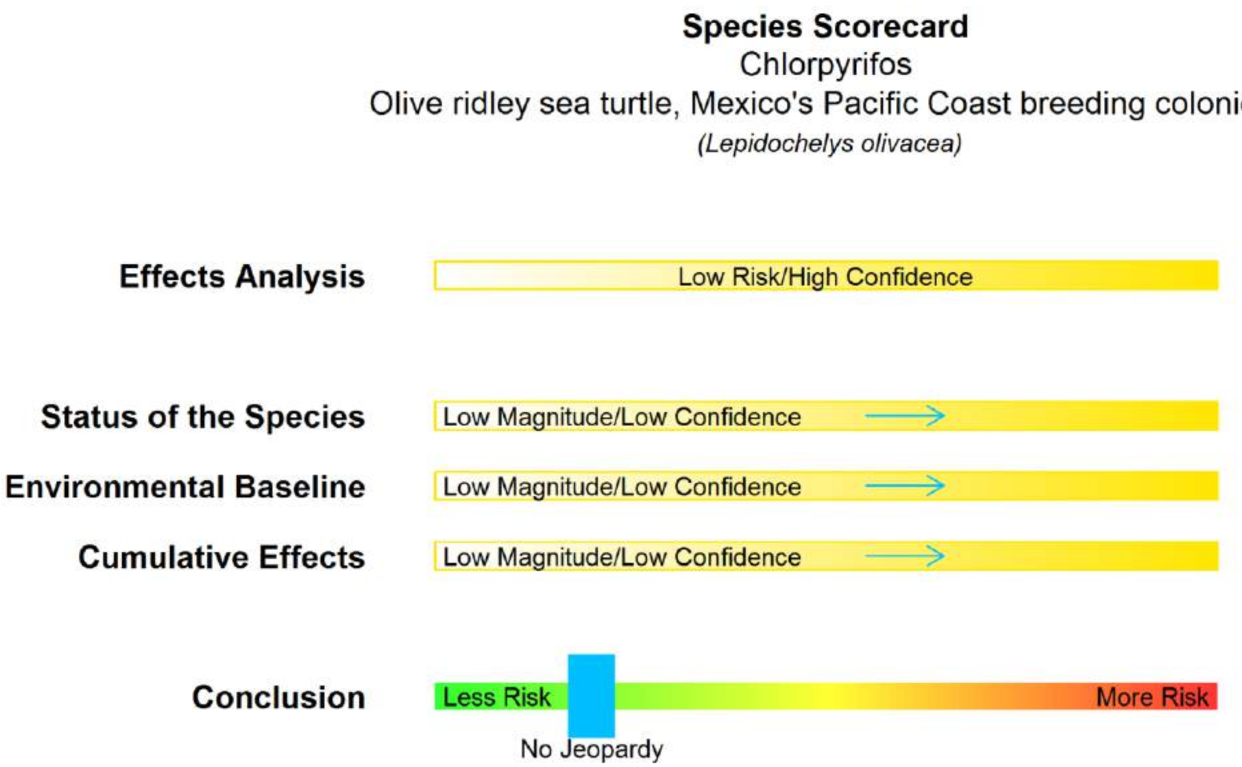

Figure 73. Species Score Card; Olive ridley sea turtle, Mexico's Pacific Coast breeding colonies; Chlorpyrifos

Effects Analysis: Low risk/High confidence

- Reduced abundance not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- 50% decline in a population abundance since the 1960's; 80% reductions in some nesting populations in the Western Atlantic Ocean since 1967;
- Threatened;
- Recovery criteria not met;

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in marine waters yet effects uncertain

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters but effects uncertain

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas and rivers/streams. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy

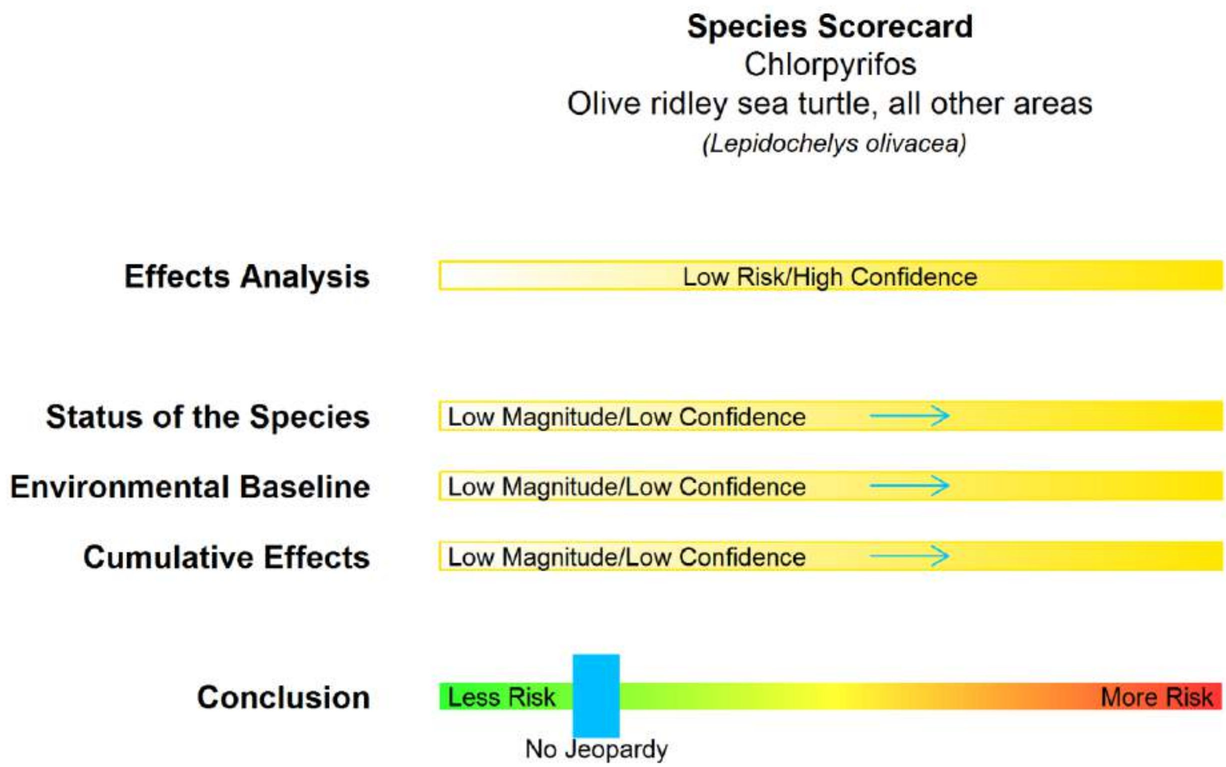

Figure 74. Species Score Card; Olive ridley sea turtle, all other areas; Chlorpyrifos

<u>Effects Analysis: Low risk/High confidence</u>

- Reduced abundance not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

<u>Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Some nesting populations are stable or increasing, but most remain severely depressed. Populations are outside of the action area.
- Threatened;
- Recovery criteria not met;

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in marine waters yet effects uncertain

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters but effects uncertain

<u>Conclusion:</u> In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas and rivers/streams. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

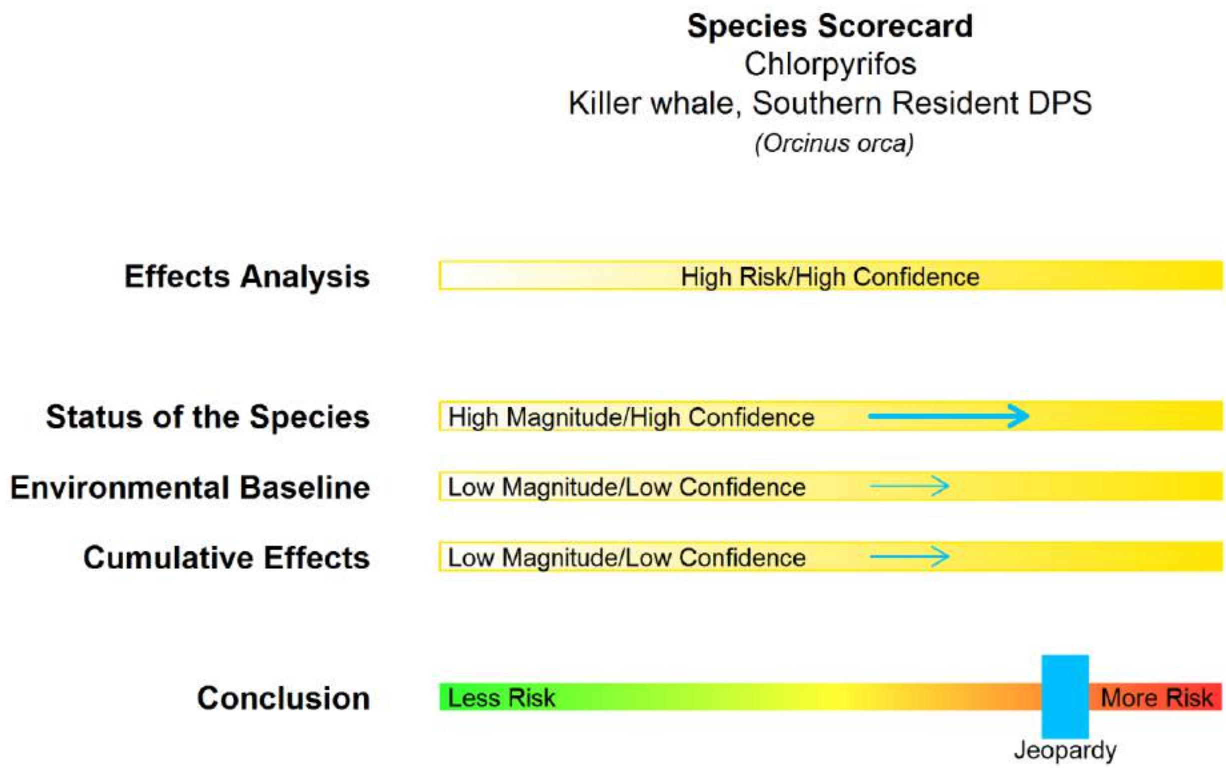

Figure 75. Species Score Card; Killer whale, Southern Resident DPS; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reduced abundance anticipated based on effects to prey (Chinook salmon)
- Anticipated effects include reduced availability of Chinook salmon and other fish prey leading to reduced growth, chronic lack of food;

Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence

- Stable to declining populations in past decade, unstable population structure
- Endangered, very small population size (n=76 individuals);
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/Low confidence

- Elevated temperatures may occur in marine habitats;
- Environmental mixtures anticipated in marine habitats with high uncertainty of toxicity

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures may occur in marine waters

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to orca whales' prey base. We have high confidence in exposure concentrations predicted for freshwater habitats. The species prey is most at risk while spawning, rearing, and migrating in freshwaters. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action due to continuous reductions in prey.

Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy

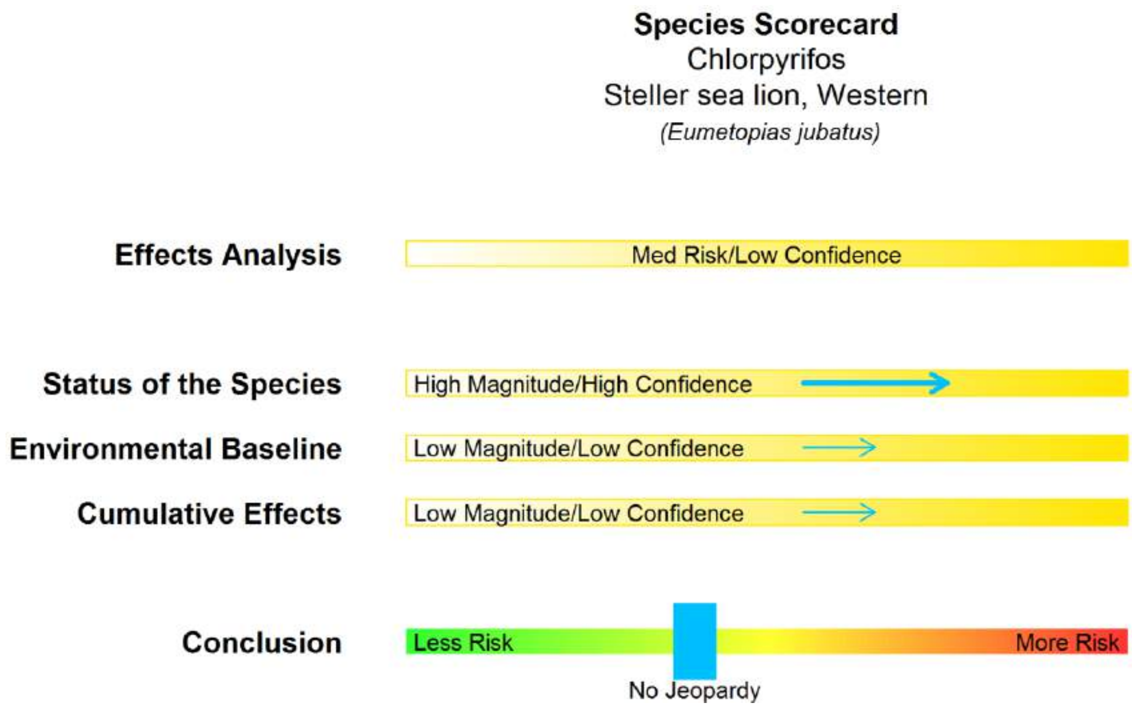

Figure 76. Species Score Card; Steller sea lion, Western; Chlorpyrifos

Effects Analysis: Medium risk/Low confidence

- Reduced abundance not anticipated
- Potential effects include reduced prey abundance

Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence

- 30% of 1950s historical abundance, stable to slight negative population trend;
- Endangered;
- Recovery criteria not met;

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect sea lions
- Environmental mixtures anticipated in marine waters yet effects uncertain

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters but effects uncertain

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk from reductions in prey. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy

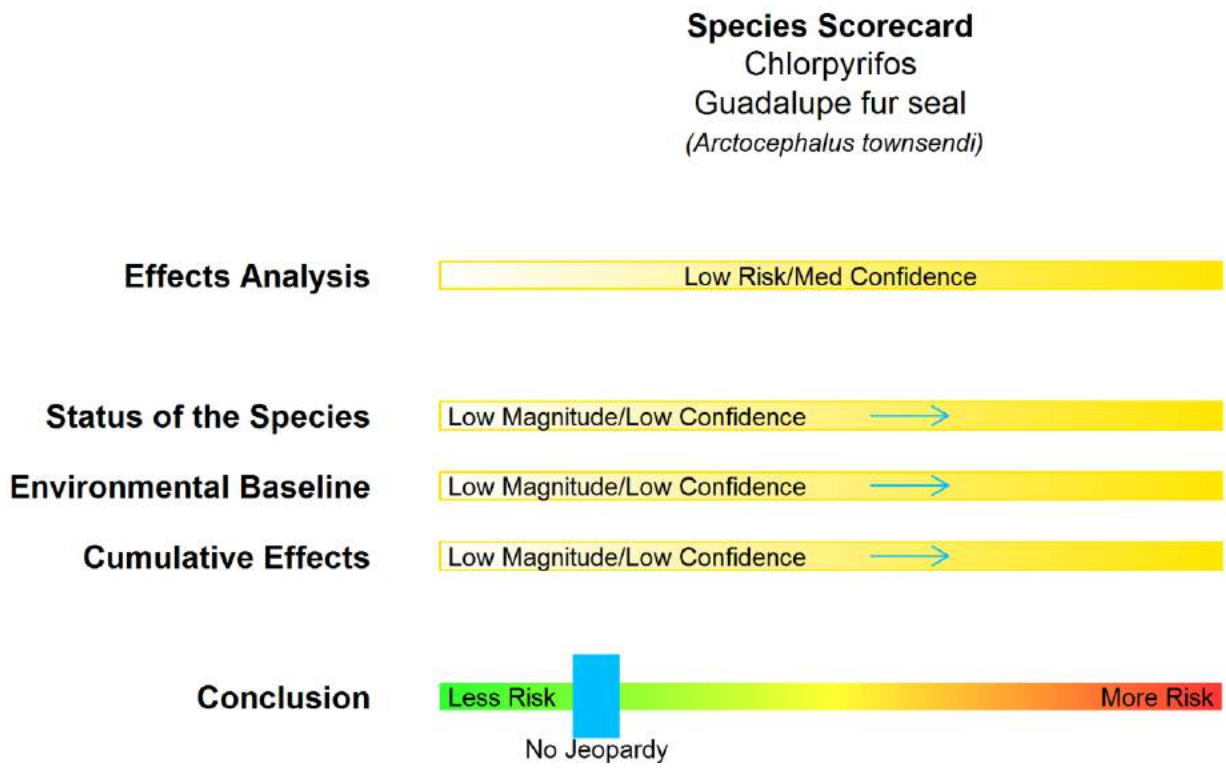

Figure 77. Species Score Card; Guadalupe fur seal; Chlorpyrifos

<u>Effects Analysis: Low risk/Medium confidence</u>

- Reduced abundance not anticipated
- Potential effects include reduced prey abundance

<u>Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- 5% of historical abundance, increasing abundance trend;
- Threatened;
- No recovery criteria established;

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures in marine waters not anticipated to affect sea lions
- Environmental mixtures anticipated in marine waters yet effects uncertain

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters but effects uncertain

<u>Conclusion:</u> In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk from reductions in prey. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

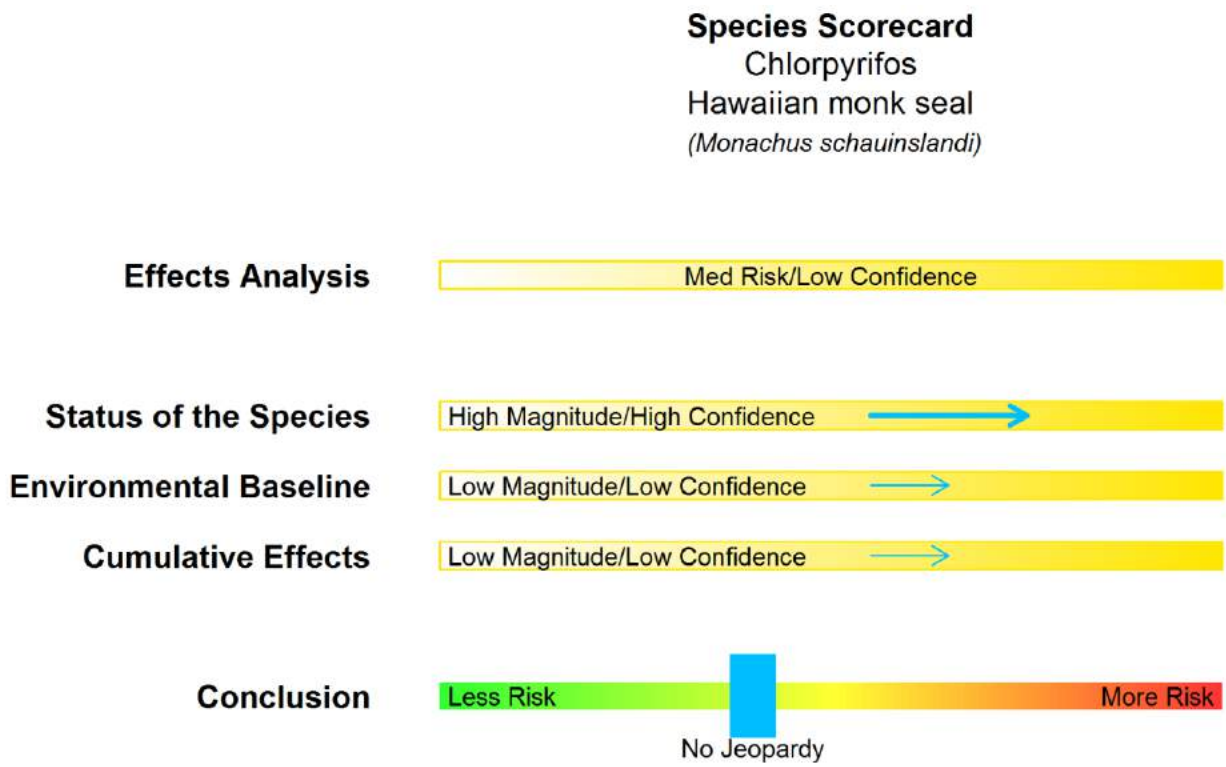

Figure 78. Species Score Card; Hawaiian monk seal; Chlorpyrifos

Effects Analysis: Medium risk/Low confidence

- Reduced abundance not anticipated
- Potential effects include reduced prey abundance

Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence

- <40% of 1958 abundance, two populations have increasing trends, six populations have declining trends, very low genetic diversity
- Endangered;
- Recovery criteria not met

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters not anticipated to affect sea lions
- Environmental mixtures anticipated in marine waters yet effects uncertain

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters but effects uncertain

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk from reductions in prey. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy

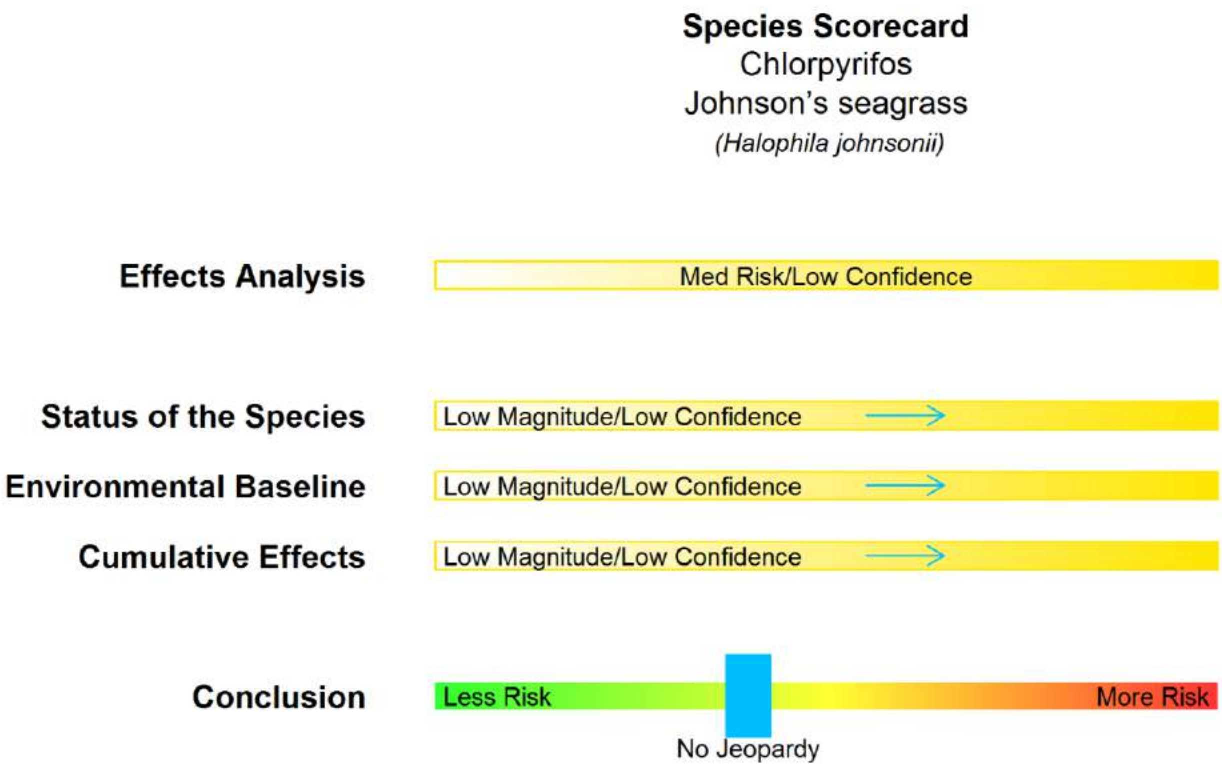

Figure 79. Species Score Card; Johnson's seagrass; Chlorpyrifos

<u>Effects Analysis: Medium risk/Low confidence</u>

- Reduced abundance not anticipated
- Potential effects include phytotoxicity, primarily from use on developed areas

<u>Status of the Species: Increased risk of jeopardy; Low magnitude/ Low confidence</u>

- No trend data on abundance
- Threatened;
- Recovery criteria not met

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures in marine waters not anticipated to affect seagrass
- Environmental mixtures anticipated in marine waters yet effects uncertain

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters but effects uncertain

<u>Conclusion:</u> In marine habitats, we find a high likelihood of exposure and a low likelihood of effects to the species based on low confidence in exposure concentrations and low toxicity. The species is most at risk from direct toxicity. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Chlorpyrifos is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

CHAPTER 20

INTEGRATION AND SYNTHESIS FOR LISTED SPECIES

DIAZINON

TABLE OF CONTENTS

20 DIAZINON

20.1 Introduction

The integration and synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Chapter 13) to the environmental baseline (Chapter 10) and the cumulative effects (Chapter 18) to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of an Endangered Species Act (ESA)-listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated critical habitat for the conservation of an ESA-listed species. These assessments are made in full consideration of the Status of the Species (Chapter 9).

We treat the information from the status of the species, environmental baseline, and cumulative effects, as "risk modifiers," in that the effects described in the Effects Analysis section may be modified by the condition of the species; the condition of environmental baseline, and the anticipated cumulative effects. The key questions addressed include:

1) Status of the Species:
    - Are abundance, spatial distribution, and productivity trends increasing, decreasing or stable?
    - Is the species listed as threatened, or as endangered?
    - Have recovery goals been met, or are they on a sustained positive trajectory toward recovery?
2) Environmental Baseline:
    - Are freshwater temperatures elevated?
    - Are pesticide mixtures present, or anticipated based on current land use?
3) Cumulative Effects:
    - Will future temperatures impair species aquatic habitats?
    - Will future hydrologic flows impair freshwater species habitats?

Once each of the above sections is evaluated i.e., questions answered, the effects of the action and the risk modifiers are depicted graphically on a "scorecard." First, we assign a magnitude of influence (low or high) indicated graphically with one of two lengths of arrows. The shorter of the two arrows indicates a low magnitude, while the longer of the two arrows indicates a high magnitude as a risk modifier. The direction an arrow is pointed indicates the directionality of the risk modifier. For example, an environmental baseline arrow pointing towards more risk may indicate that environmental mixtures and elevated temperatures occur in the Environmental Baseline, which further stresses the species in question. We also assign a level of confidence in our selection of the small and large magnitude, indicated by a bold arrow (high confidence) or an un-bolded arrow (low confidence). The final arrow representing the influence on risk is graphically depicted on each species' scorecard.

Figure 1. Example of arrows to represent direction, magnitude, and confidence of risk modifiers

Conclusion Section:
With full consideration of the status of the species and the designated critical habitat, we construct a description of the effects of the action within the action area on populations or subpopulations, when added to the environmental baseline and the cumulative effects, to determine whether the action could reasonably be expected to:

- Reduce appreciably the likelihood of survival and recovery of ESA-listed species in the wild by reducing its numbers, reproduction, or distribution, and state our conclusion as to whether the action is likely to jeopardize the continued existence of such species; or
- Appreciably diminish the value of designated critical habitat for the conservation of an ESA-listed species, and state our conclusion as to whether the action is likely to destroy or adversely modify designated critical habitat.

A scorecard is generated for each species and designated critical habitat. The effects of the proposed action is considered, as modified by the magnitude and confidence of the three arrows. Next, a no-jeopardy or jeopardy bar is placed on the risk bar i.e., the colored bar beginning with green (less risk) to red (more risk) (***Figure 2***).

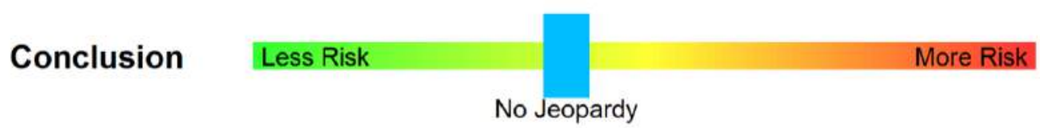

Figure 2: Example conclusion graphic

20.2 Species Scorecards

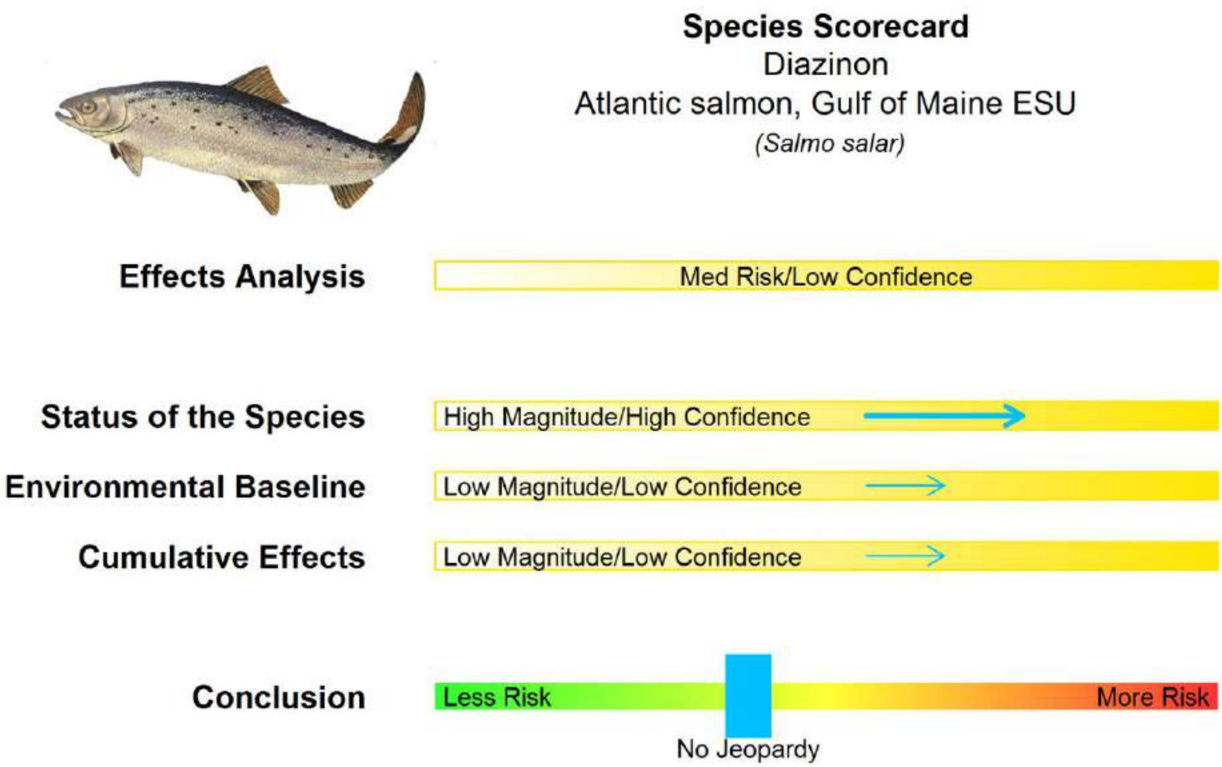

Figure 3. Species Score Card; Atlantic salmon, Gulf of Maine Evolutionarily Significant Unit (ESU); Diazinon

<u>Effects Analysis: Medium risk/Low confidence</u>

- Significant reductions in abundance or productivity not anticipated
- Uncertainty in predicted diazinon concentrations in coastal marine habitats

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Abundance is declining, low resilience to disturbance, sustained by hatcheries
- Proposed action may hinder attainment of recovery goals in coastal areas

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures in marine waters not anticipated to affect species
- Environmental mixtures not anticipated to substantially affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures in marine areas uncertain to affect species
- No anticipated hydrologic effects in marine waters that would affect species

<u>Conclusion:</u> We find low confidence of a medium level of risk to the species as a whole based on the expected toxicity from uncertain exposure concentrations predicted in saltwater habitats. The species is most at risk while in coastal, estuarine areas where they spend a small portion of their lives. Potential reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

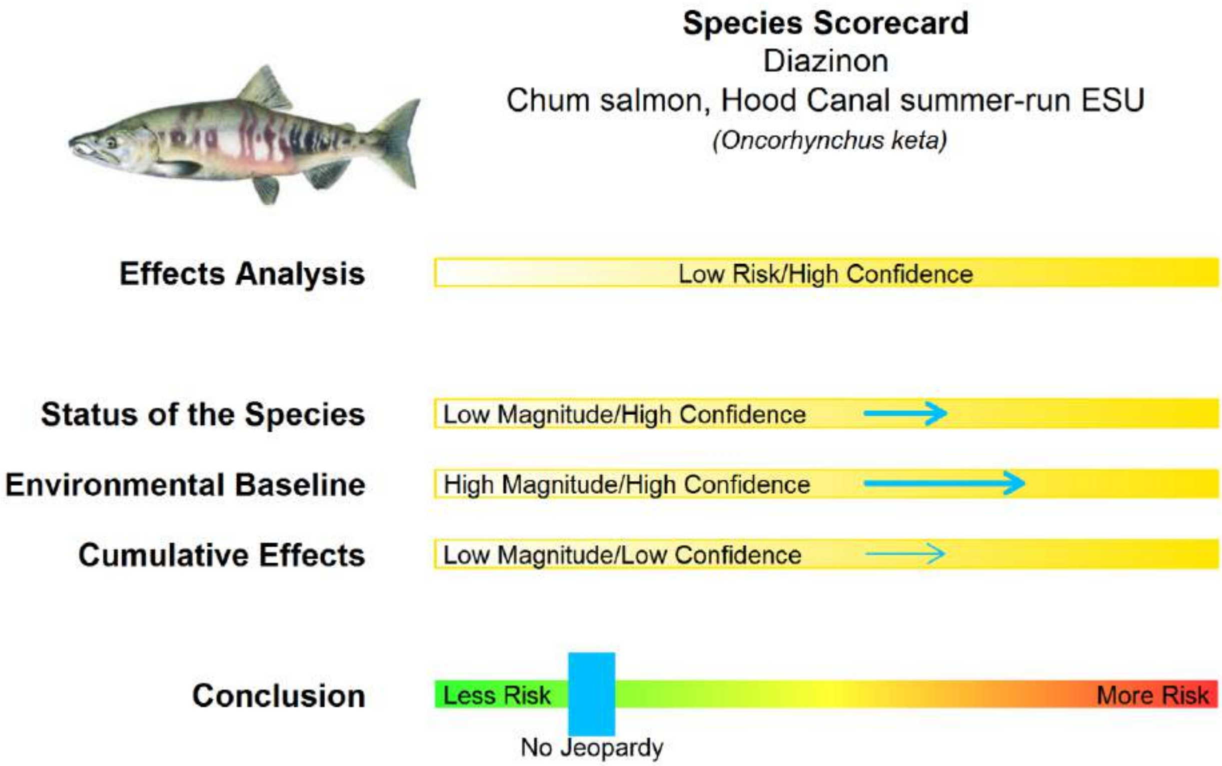

Figure 4. Species Score Card; Chum salmon, Hood Canal summer-run ESU; Diazinon

<u>Effects Analysis: Low risk/High confidence</u>

- Significant reductions in abundance or productivity not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

<u>Status of the Species: Increased risk of jeopardy; Low magnitude/ High confidence</u>

- Stable to increasing abundance trend, increasing population productivity
- Proposed action may hinder attainment of some recovery goals

<u>Environmental Baseline: Minimal increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures anticipated in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures likely
- Anticipated hydrologic effects in freshwater areas may affect species

<u>Conclusion:</u> We find high confidence of low risk to the species as a whole based on exposure concentrations predicted for freshwater habitats and expected effects to the population. The species is most vulnerable while in freshwater and nearshore areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

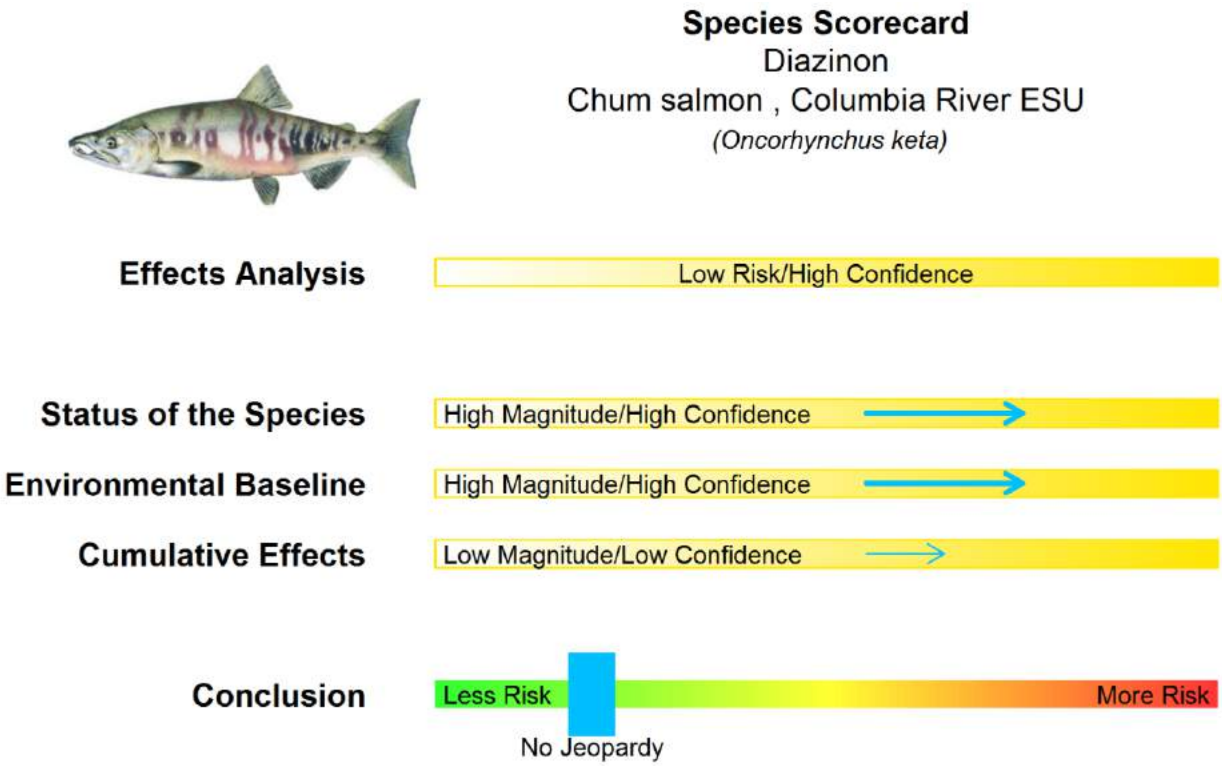

Figure 5. Species Score Card; Chum salmon, Columbia River ESU; Diazinon

<u>Effects Analysis: Low risk/High confidence</u>

- Significant reductions in abundance or productivity not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Declining abundance trends, high risk of extinction
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Minimal increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures anticipated in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas that may affect species

<u>Conclusion:</u> We find high confidence in low risk to the species based on exposure concentrations predicted for freshwater habitats and expected population-level effects. The species is most at risk when in freshwater areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

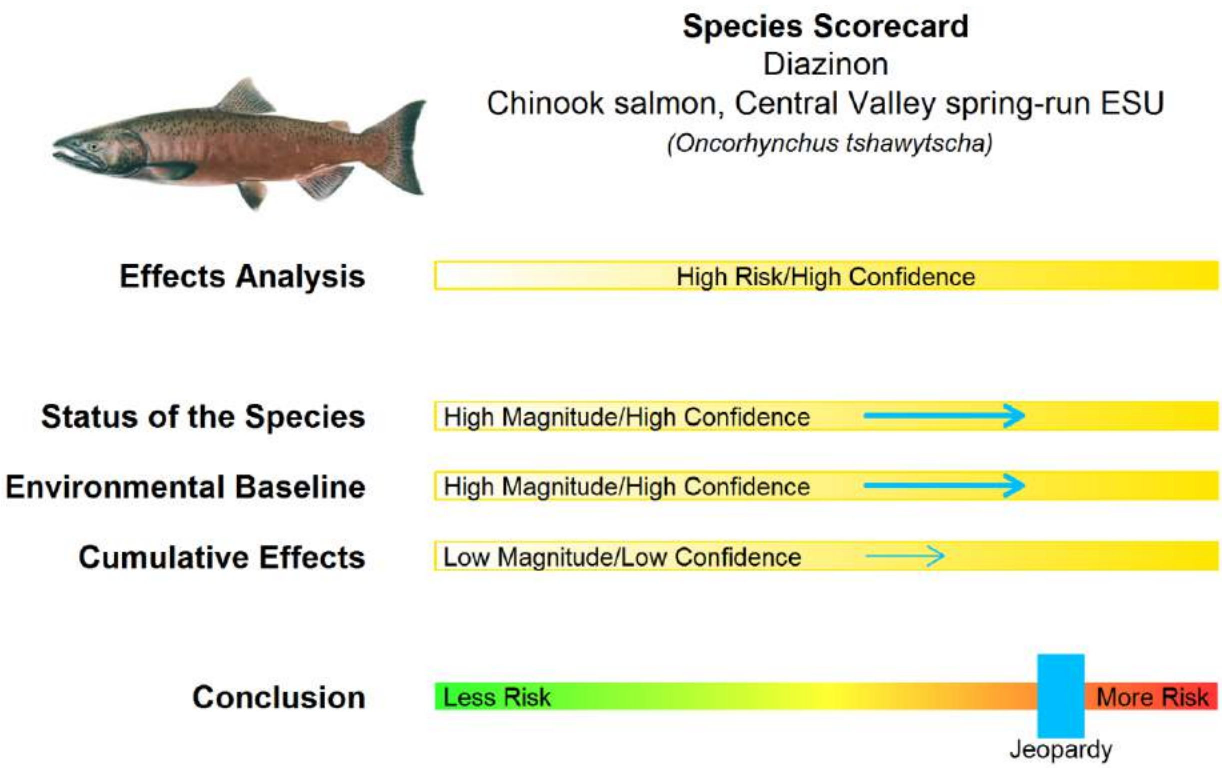

Figure 6. Species Score Card; Chinook salmon, Central Valley spring-run ESU; Diazinon

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater and nearshore areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Stable to declining abundance trends, low abundances and fragmented populations
- Threatened species
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> We find high confidence in high risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater habitats where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Diazinon is likely to jeopardize the continued existence of this species: Jeopardy</u>

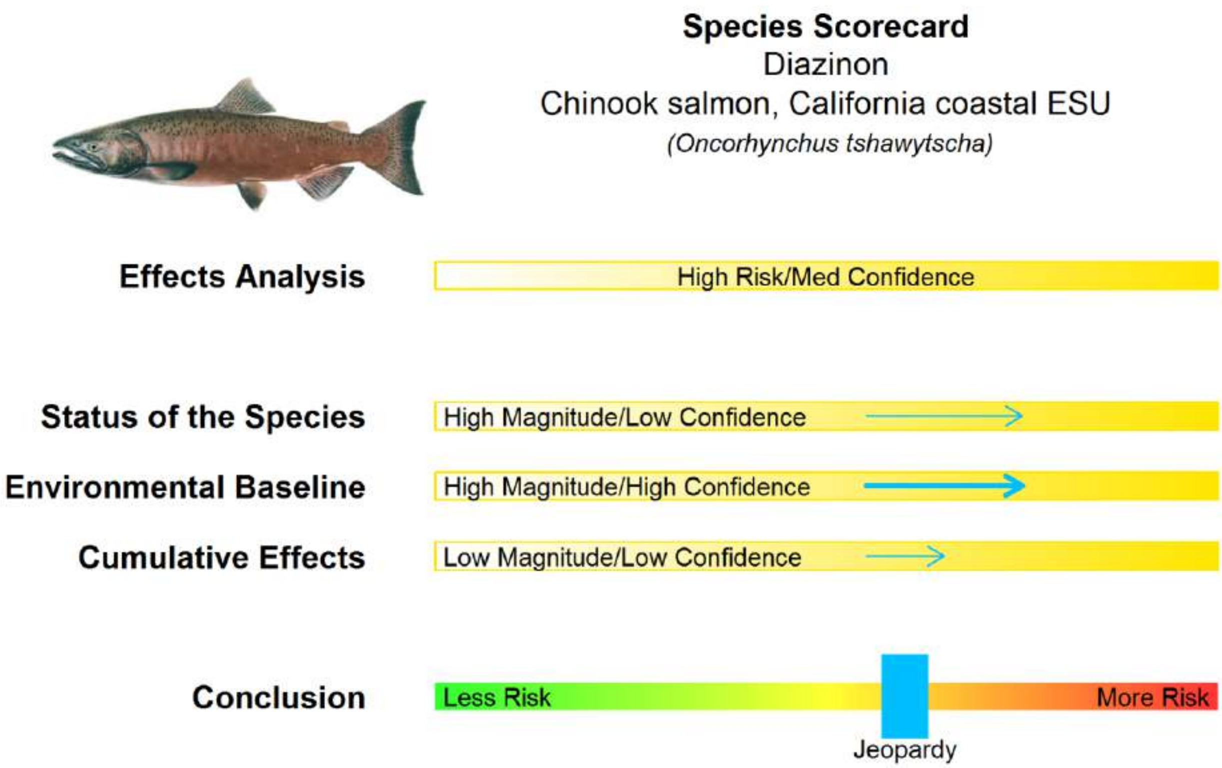

Figure 7. Species Score Card; Chinook salmon, California coastal ESU; Diazinon

<u>Effects Analysis: High risk/Medium confidence</u>

- Reduced abundance and productivity anticipated in freshwater and nearshore areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Minimal increased risk of jeopardy; High magnitude/ Low confidence</u>

- One population with greater than 1000 spawners, declining trends in abundance
- Threatened
- Some recovery criteria not met, yet reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> We find medium confidence of high risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Diazinon is likely to jeopardize the continued existence of this species: Jeopardy</u>

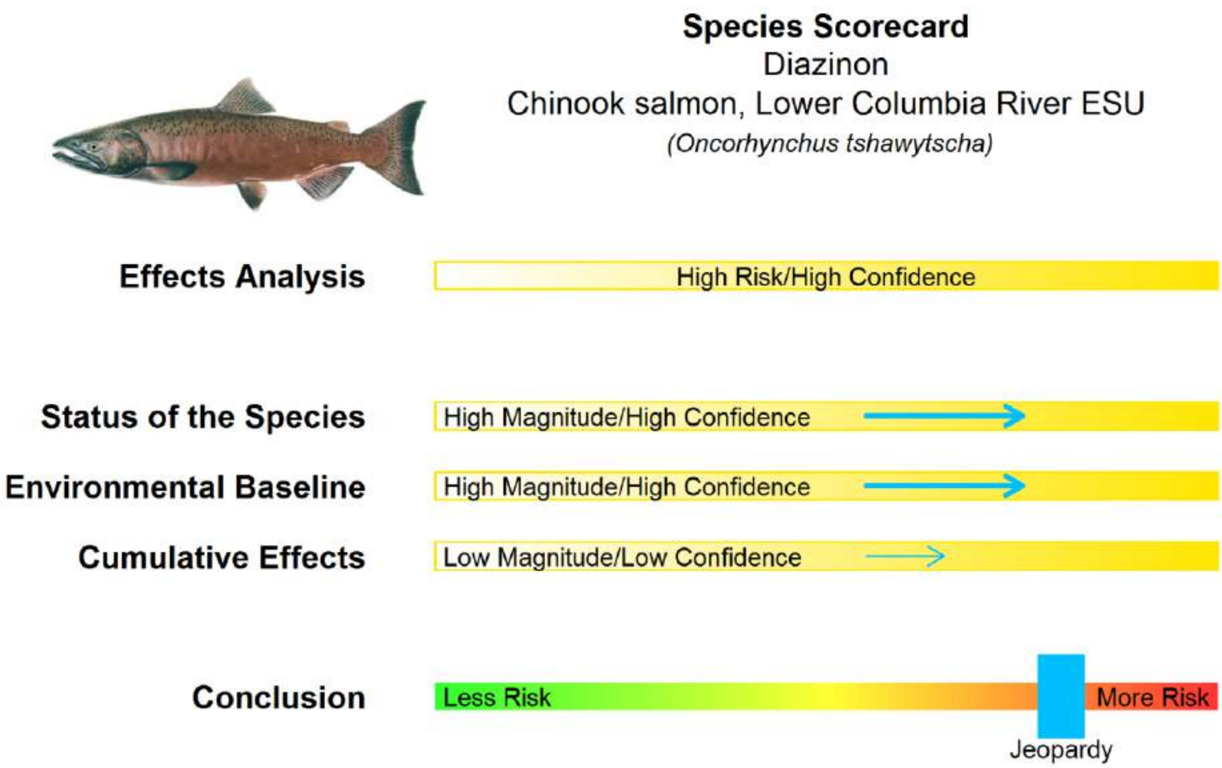

Figure 8. Species Score Card; Chinook salmon, Lower Columbia River ESU; Diazinon

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater and nearshore areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence

- Declining trends in abundance, one self-sustaining population, low genetic diversity
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: We find high confidence of high risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Diazinon is likely to jeopardize the continued existence of this species: Jeopardy

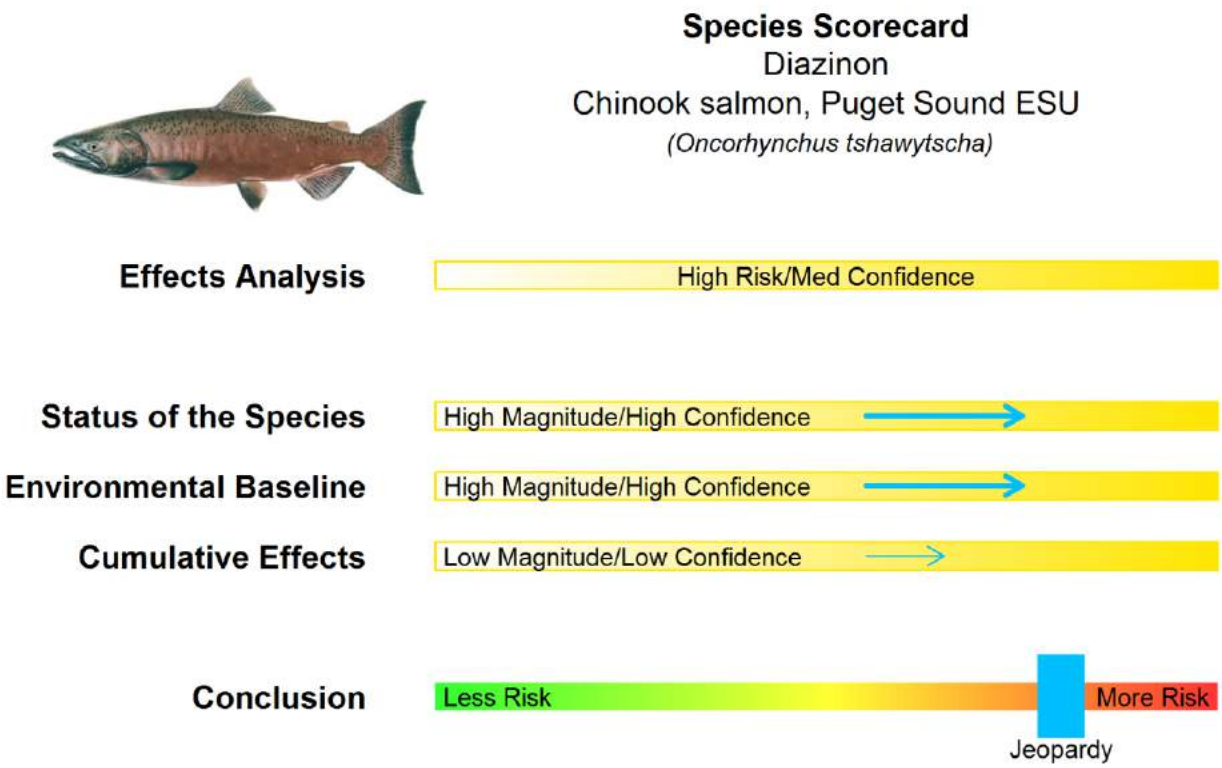

Figure 9. Species Score Card; Chinook salmon, Puget Sound ESU; Diazinon

<u>Effects Analysis: High risk/Medium confidence</u>

- Reduced abundance and productivity anticipated in freshwater and nearshore areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Half of the populations declining and half increasing in abundance
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> We find medium confidence of high risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Diazinon is likely to jeopardize the continued existence of this species: Jeopardy</u>

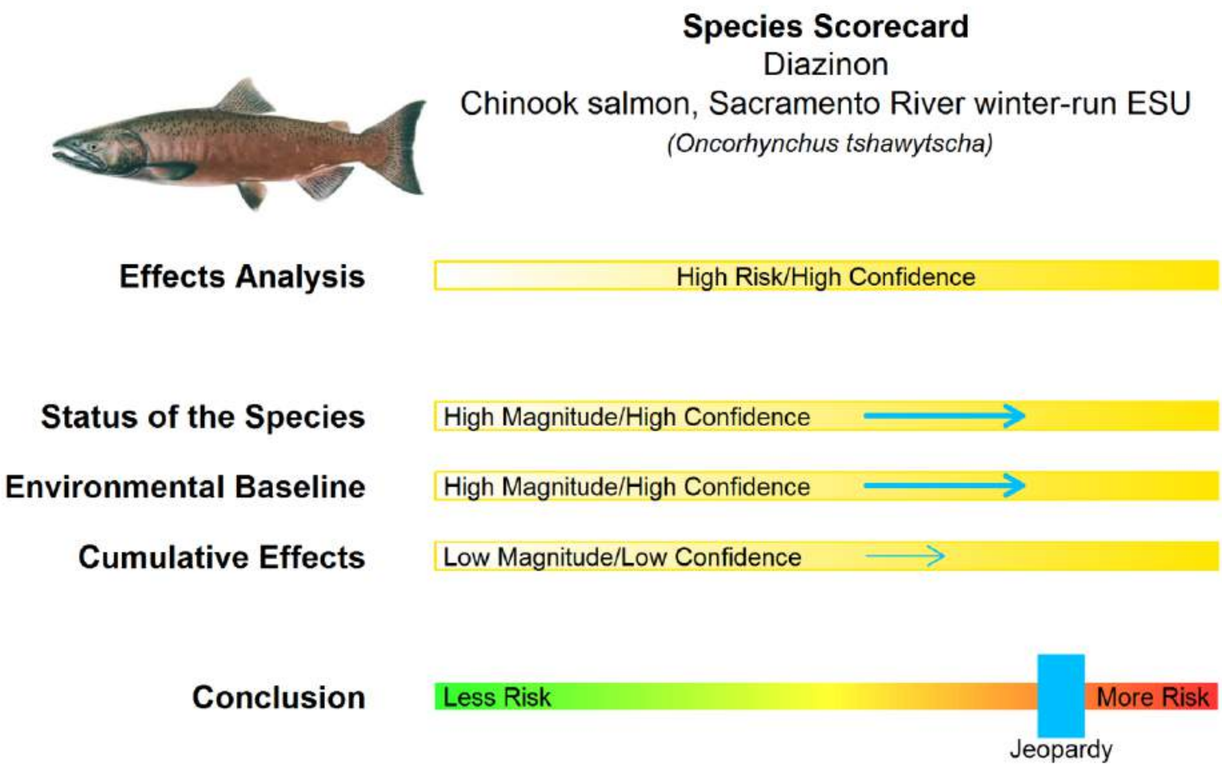

Figure 10. Species Score Card; Chinook salmon, Sacramento River winter-run ESU; Diazinon

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater and nearshore areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- One extant population, declining abundance trends, hatchery-supported
- Endangered species
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> We find high confidence of high risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>**Dianinon is likely to jeopardize the continued existence of this species: Jeopardy**</u>

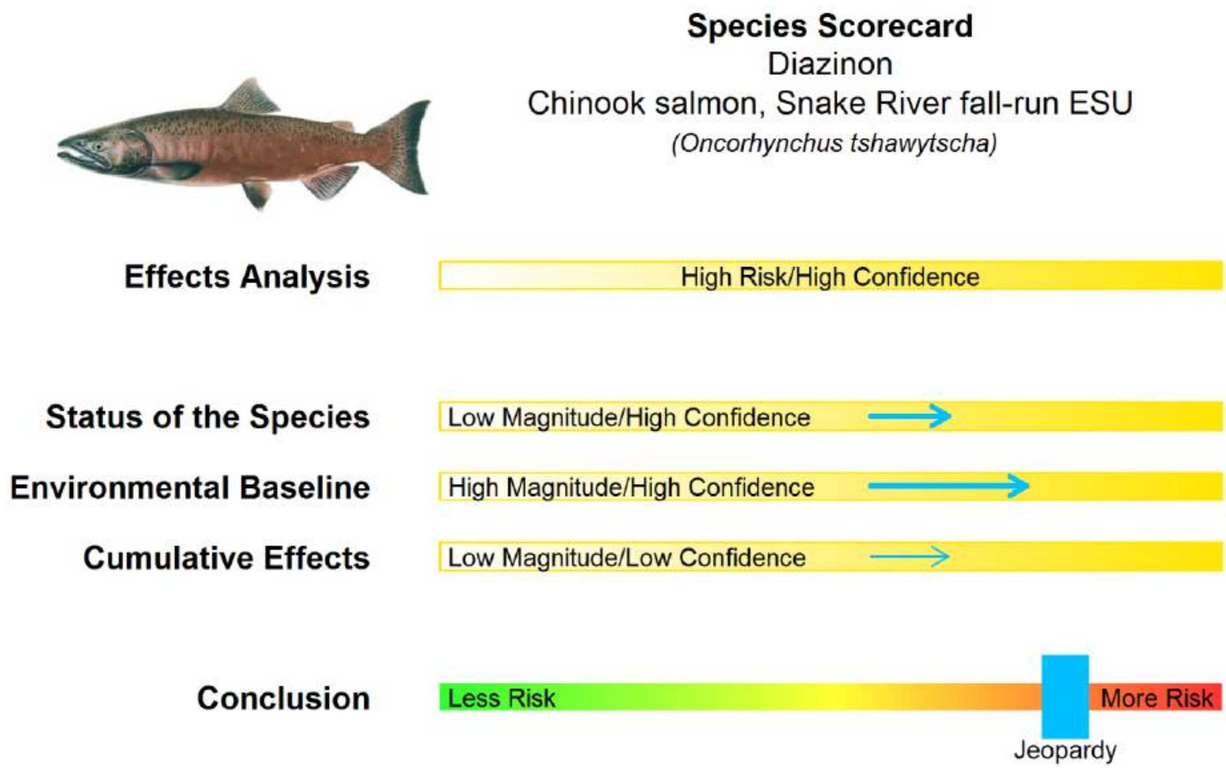

Figure 11. Species Score Card; Chinook salmon, Snake River fall-run ESU; Diazinon

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater and nearshore areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; Low magnitude/ High confidence</u>

- Stable to increasing abundance trends, moderate extinction risk, hatchery supported
- Threatened species
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> We find high confidence of high risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Diazinon is likely to jeopardize the continued existence of this species: Jeopardy</u>

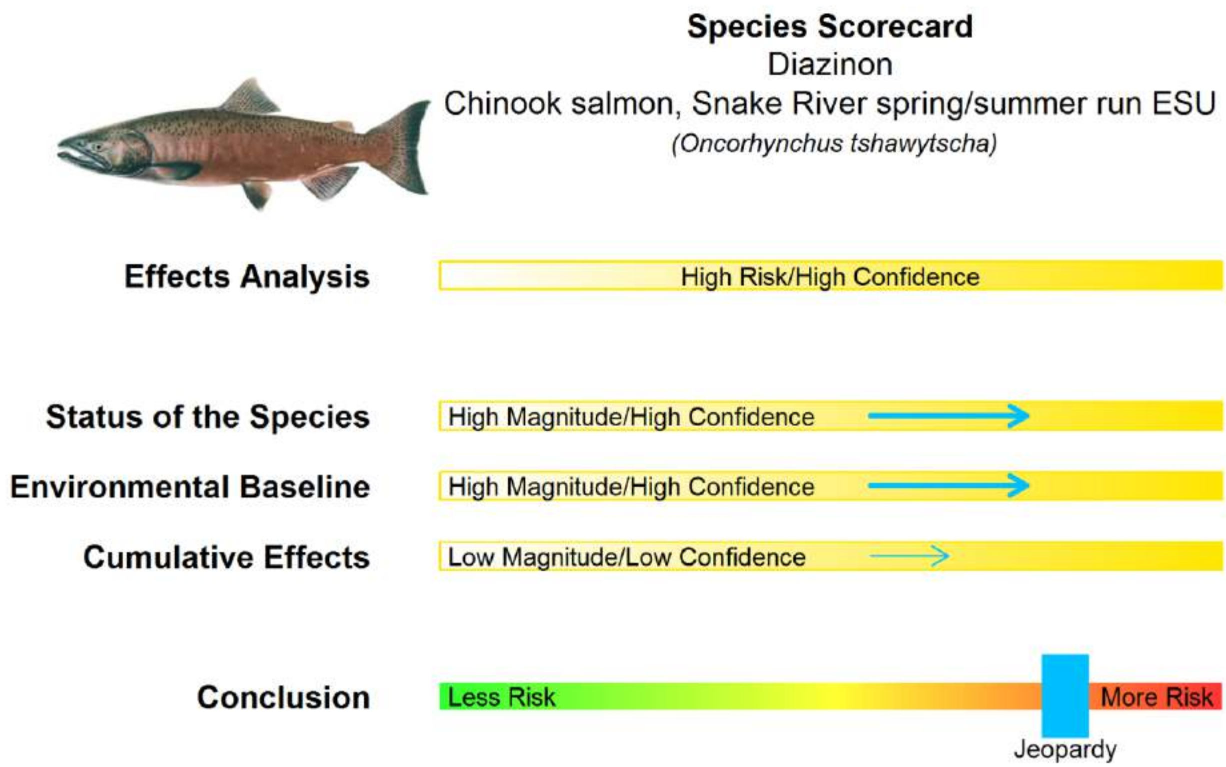

Figure 12. Species Score Card; Chinook salmon, Snake River spring/summer run ESU; Diazinon

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater and nearshore areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; Low magnitude/ High confidence</u>

- Decreasing abundance trends, high extinction risk, moderate genetic diversity
- Threatened species
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> We find high confidence of high risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Diazinon is likely to jeopardize the continued existence of this species: Jeopardy</u>

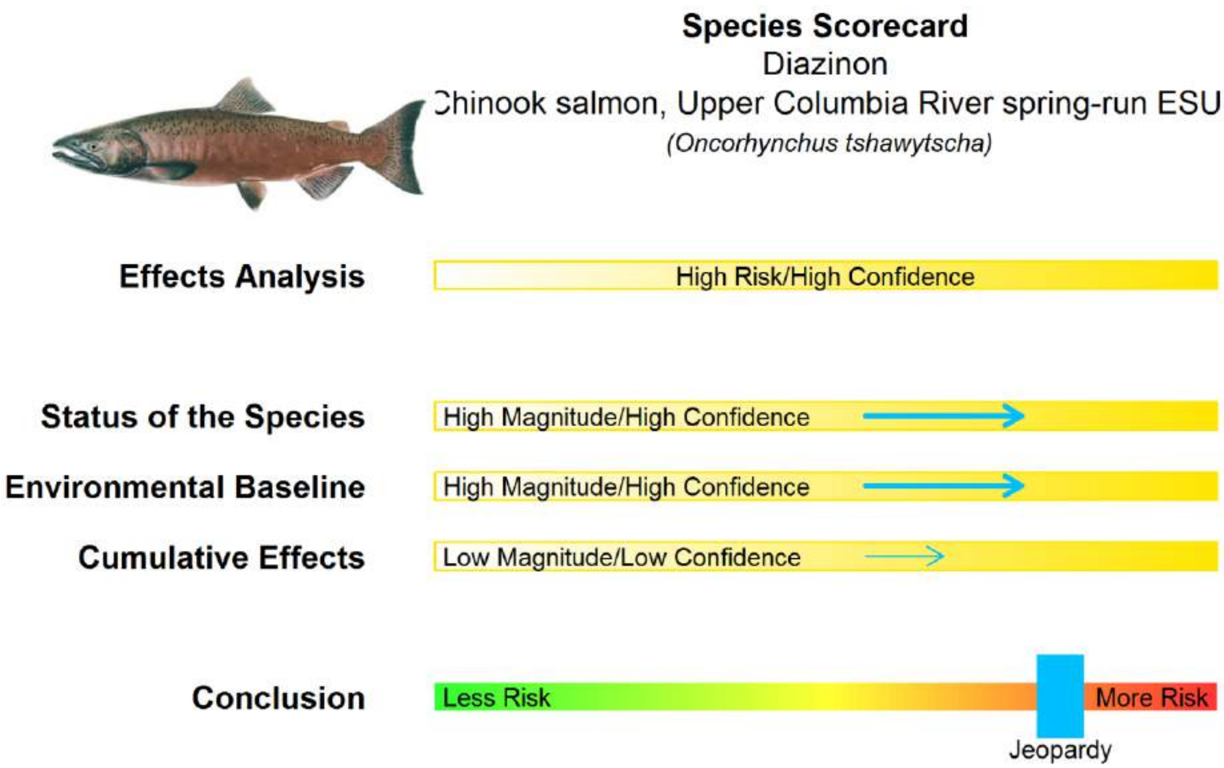

Figure 13. Species Score Card; Chinook salmon, Upper Columbia River spring-run ESU; Diazinon

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater and nearshore areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Decreasing abundance trends, independent populations not replacing themselves
- Endangered species (all independent population experiencing low abundance)
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> We find high confidence of high risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Diazinon is likely to jeopardize the continued existence of this species: Jeopardy</u>

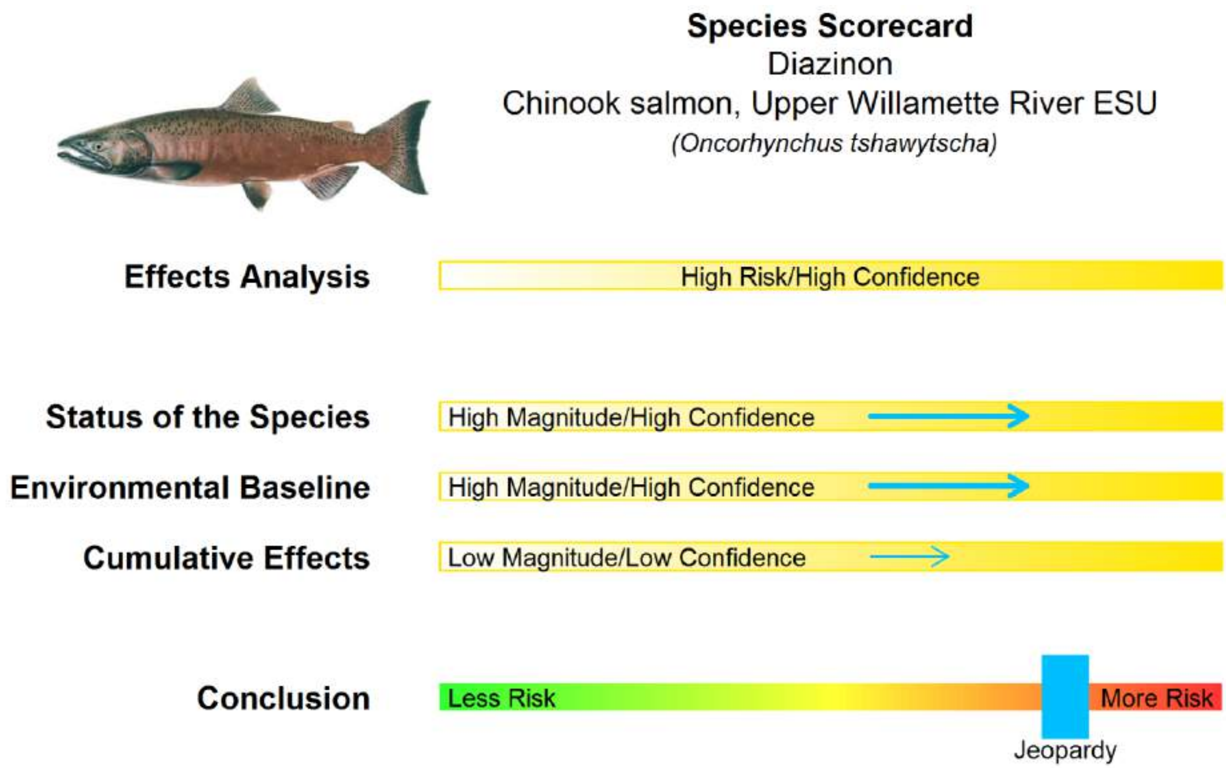

Figure 14. Species Score Card; Chinook salmon, Upper Willamette River ESU; Diazinon

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater and nearshore areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; How magnitude/ High confidence</u>

- Decreasing abundance trends, 1 of 7 remaining naturally reproducing populations
- Threatened species
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> We find high confidence of high risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Diazinon is likely to jeopardize the continued existence of this species: Jeopardy</u>

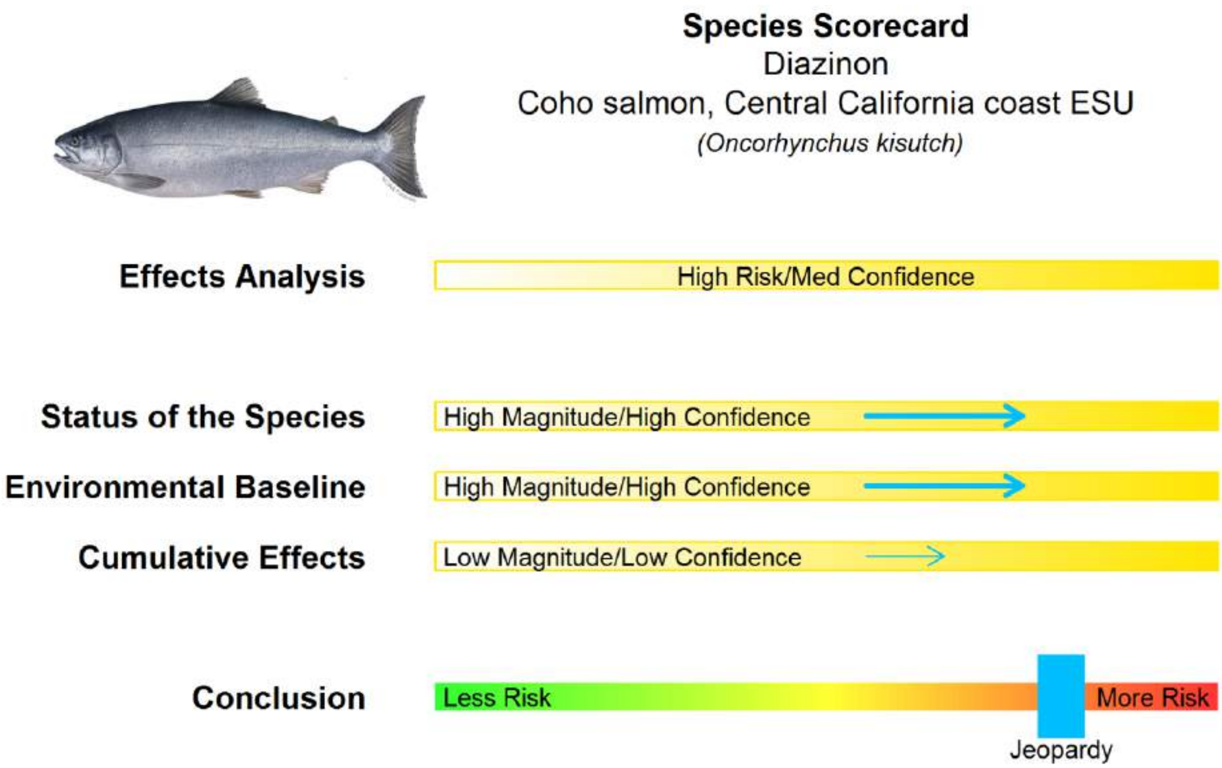

Figure 15. Species Score Card; Coho salmon, Central California coast ESU; Diazinon

<u>Effects Analysis: High risk/Medium confidence</u>

- Reduced abundance and productivity anticipated in freshwater and nearshore areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; How magnitude/ High confidence</u>

- Stable population trend, fragmented populations, supported by hatchery propagation
- Endangered species (low abundances)
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> We find medium confidence of high risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Diazinon is likely to jeopardize the continued existence of this species: Jeopardy</u>

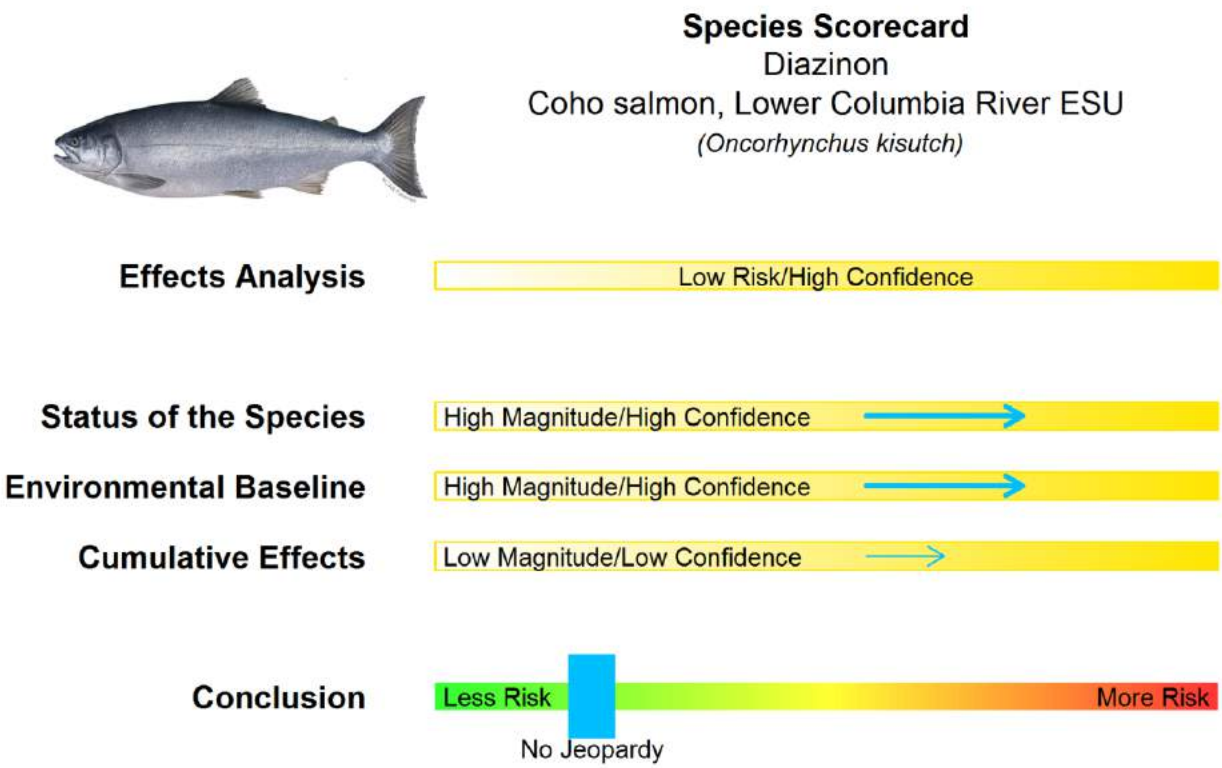

Figure 16. Species Score Card; Coho salmon, Lower Columbia River ESU; Diazinon

<u>Effects Analysis: Low risk/High confidence</u>

- Significant reductions in abundance or productivity not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

<u>Status of the Species: Increased risk of jeopardy; How magnitude/ High confidence</u>

- Negative long/short term lambda projections. Only 2 of 25 populations exhibit natural production. Diversity in "high risk" category.
- Endangered species (90% reduction in abundance of all independent populations)
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> We find high confidence of low risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species juvenile stage is most at risk while in freshwater areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>**Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy**</u>

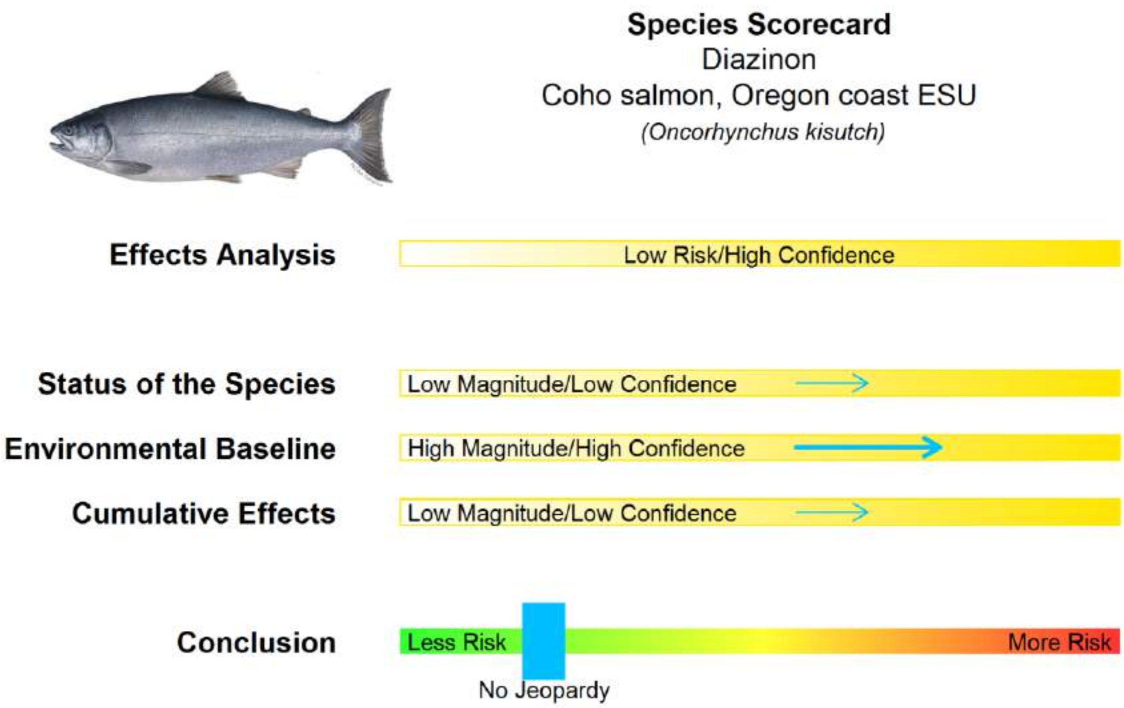

Figure 17. Species Score Card; Coho salmon, Oregon coast ESU; Diazinon

<u>Effects Analysis: Low risk/High confidence</u>

- Significant reductions in abundance or productivity not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

<u>Status of the Species: Increased risk of jeopardy; How magnitude/ Low confidence</u>

- Variable abundances with periods of severe declines. Negative long term trends negative
- Threatened (Severe reductions in ESU abundance compared to historical estimates)
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> We find high confidence of low risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species juvenile stage is most at risk while in freshwater areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

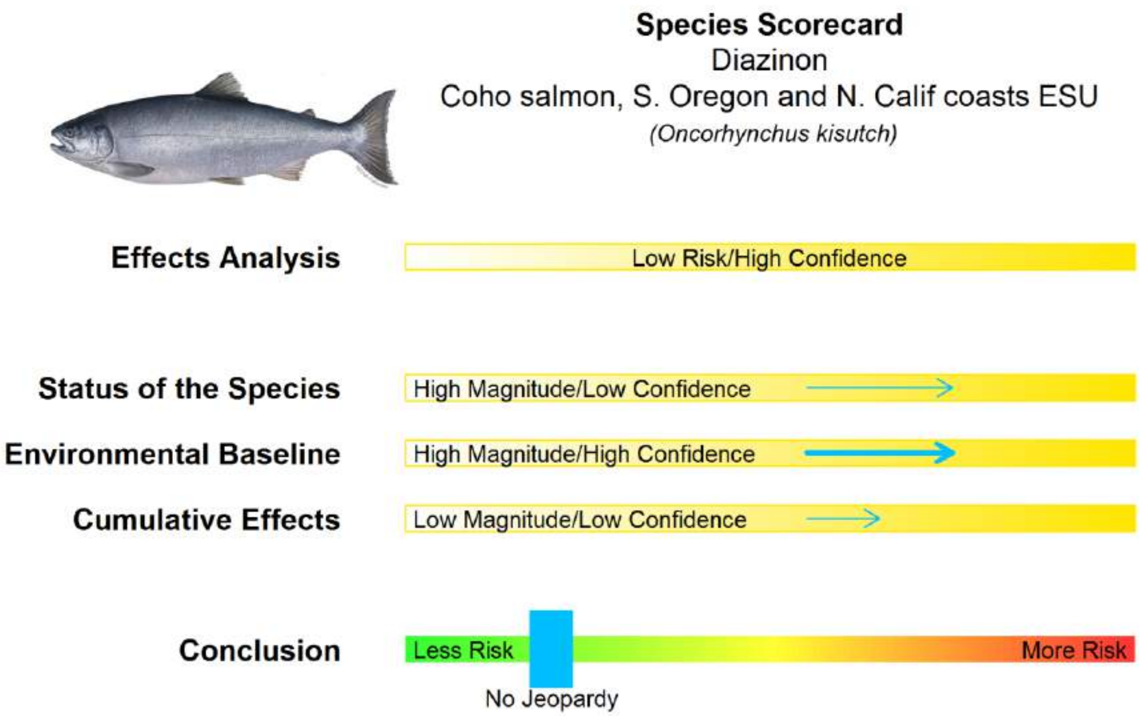

Figure 18. Species Score Card; Coho salmon, S. Oregon and N. Calif coasts ESU; Diazinon

<u>Effects Analysis: Low risk/High confidence</u>

- Significant reductions in abundance or productivity not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

<u>Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Limited data on population abundance, thus trend data unavailable
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> We find high confidence of low risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species juvenile stage is most at risk while in freshwater areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

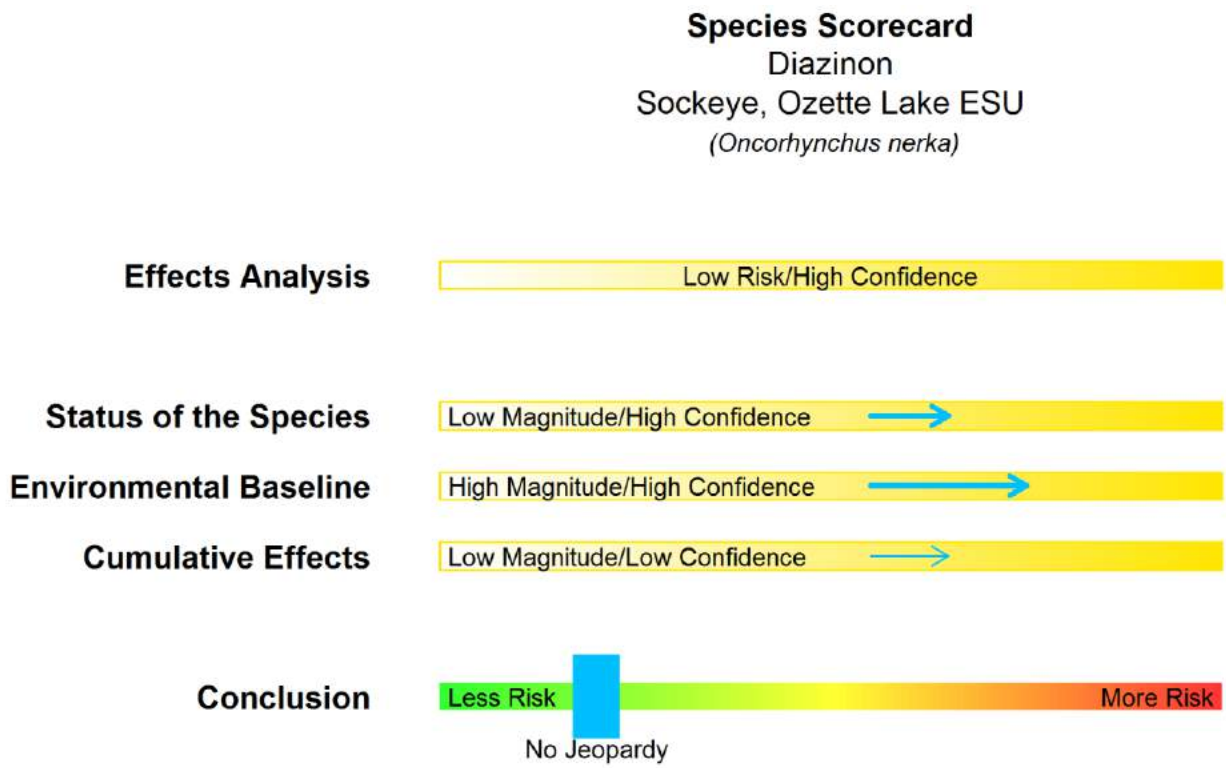

Figure 19. Species Score Card; Sockeye, Ozette Lake ESU; Diazinon

Effects Analysis: Low risk/High confidence

- Significant reductions in abundance or productivity not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ High confidence

- Stable productivity rates; low genetic diversity and low resilience to future perturbations
- Threatened (abundance only 1% of historical levels)
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: We find high confidence of low risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species juvenile stage is most at risk while in freshwater areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy

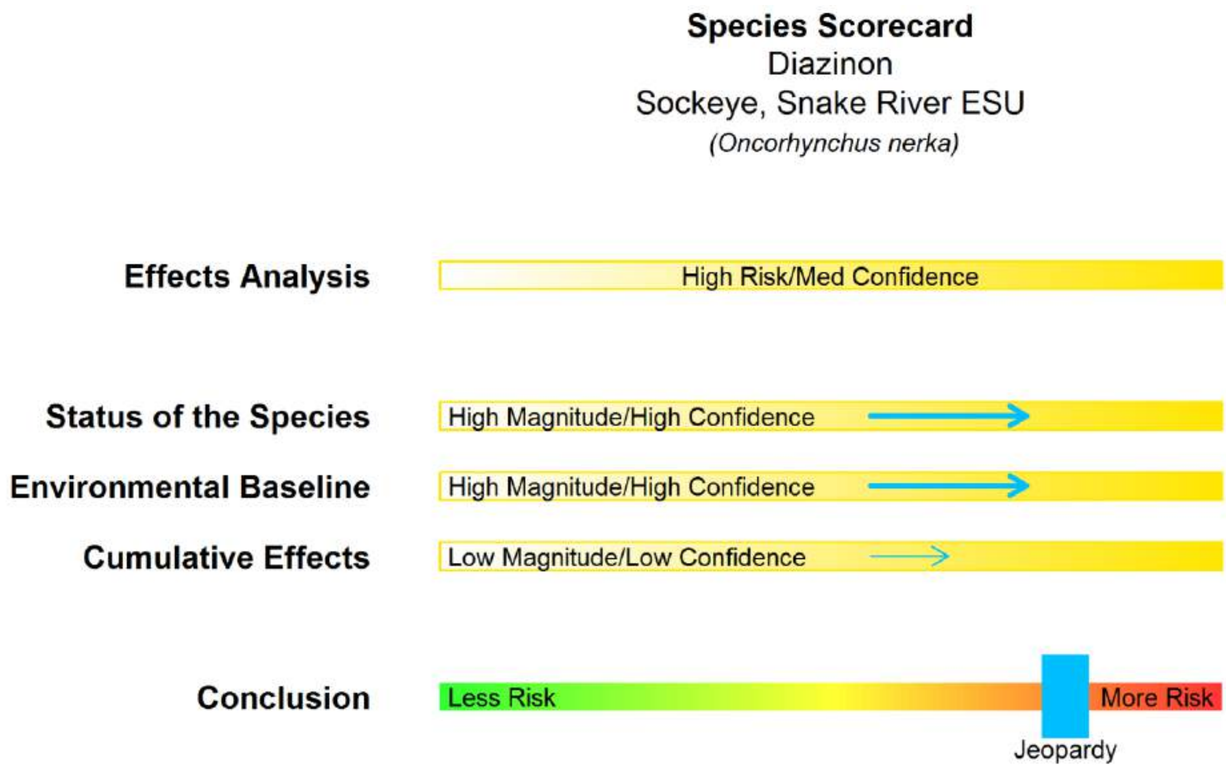

Figure 20. Species Score Card; Sockeye, Snake River ESU; Diazinon

Effects Analysis: High risk/Medium confidence

- Reduced abundance and productivity anticipated in freshwater and nearshore areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence

- One population remaining supported by hatchery propagation. Increasing abundance, well below sustainable natural production. Low resilience to perturbations.
- Endangered (abundance only 1% of historical levels)
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: We find medium confidence of high risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species juvenile stage is most at risk while in freshwater areas. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Diazinon is likely to jeopardize the continued existence of this species: Jeopardy

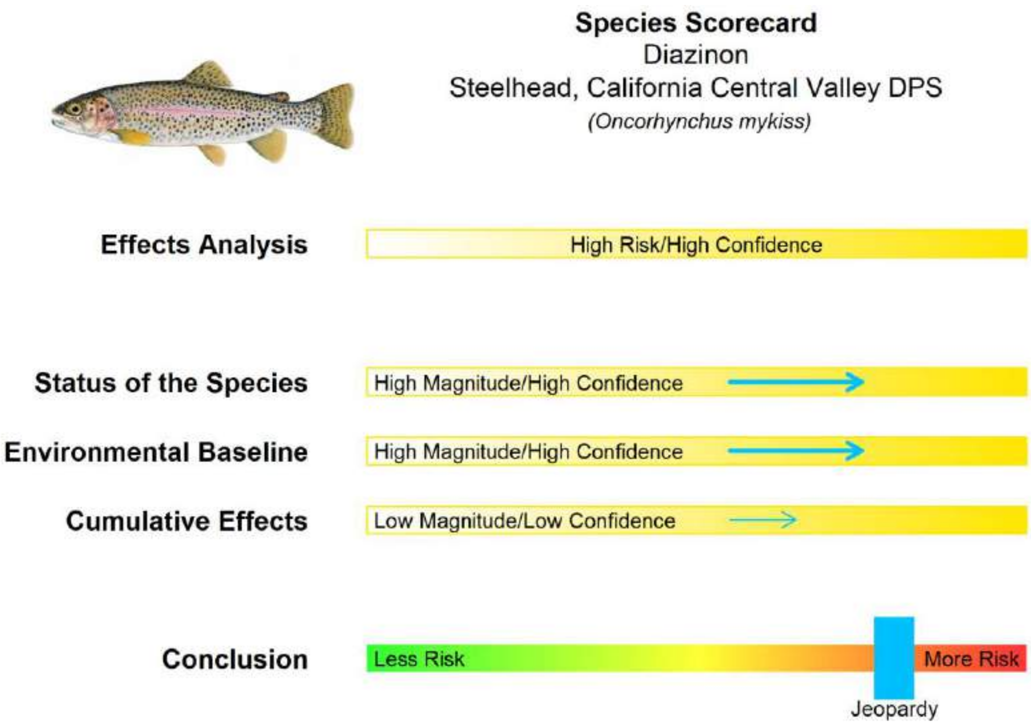

Figure 21. Species Score Card; Steelhead, California Central Valley Distinct Population Segment (DPS); Diazinon

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater and nearshore areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Long-term trend of declining abundances and reduced genetic diversity. Populations supplemented by hatchery propagation.
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> We find high confidence of high risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Diazinon is likely to jeopardize the continued existence of this species: Jeopardy</u>

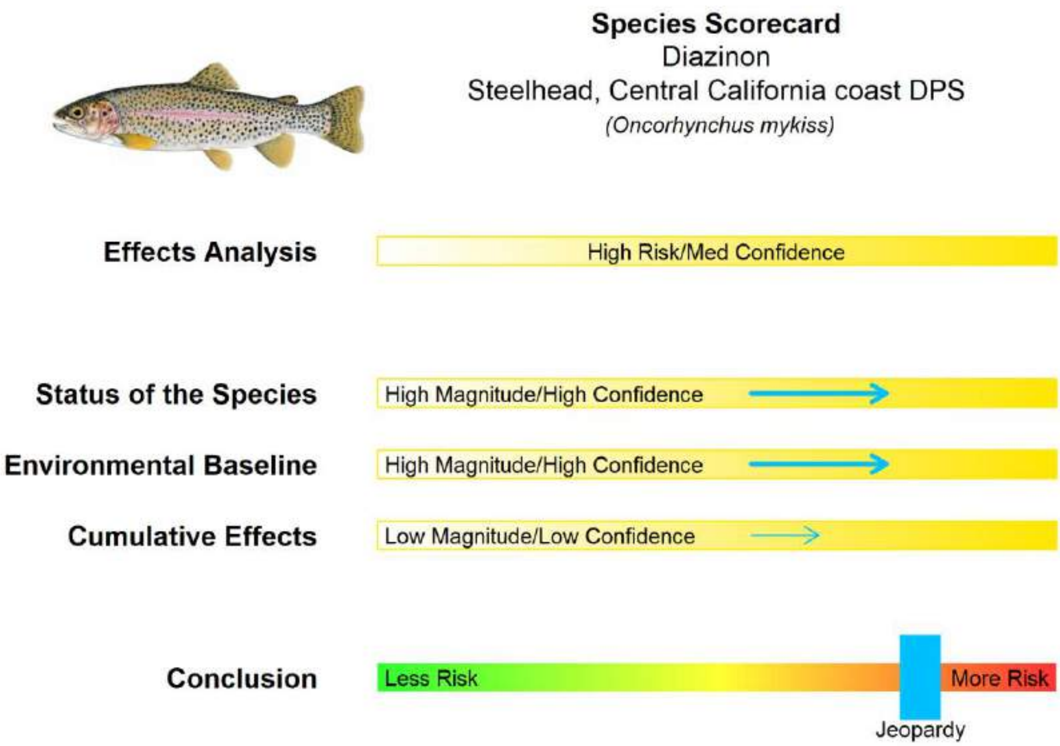

Figure 22. Species Score Card; Steelhead, Central California coast DPS; Diazinon

<u>Effects Analysis: High risk/Medium confidence</u>

- Reduced abundance and productivity anticipated in freshwater and nearshore areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- 5-year population trend uncertain. Population abundance supplemented by hatchery propagation. Populations likely not viable, and have lost spatial structure.
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> We find medium confidence of high risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Diazinon is likely to jeopardize the continued existence of this species: Jeopardy</u>

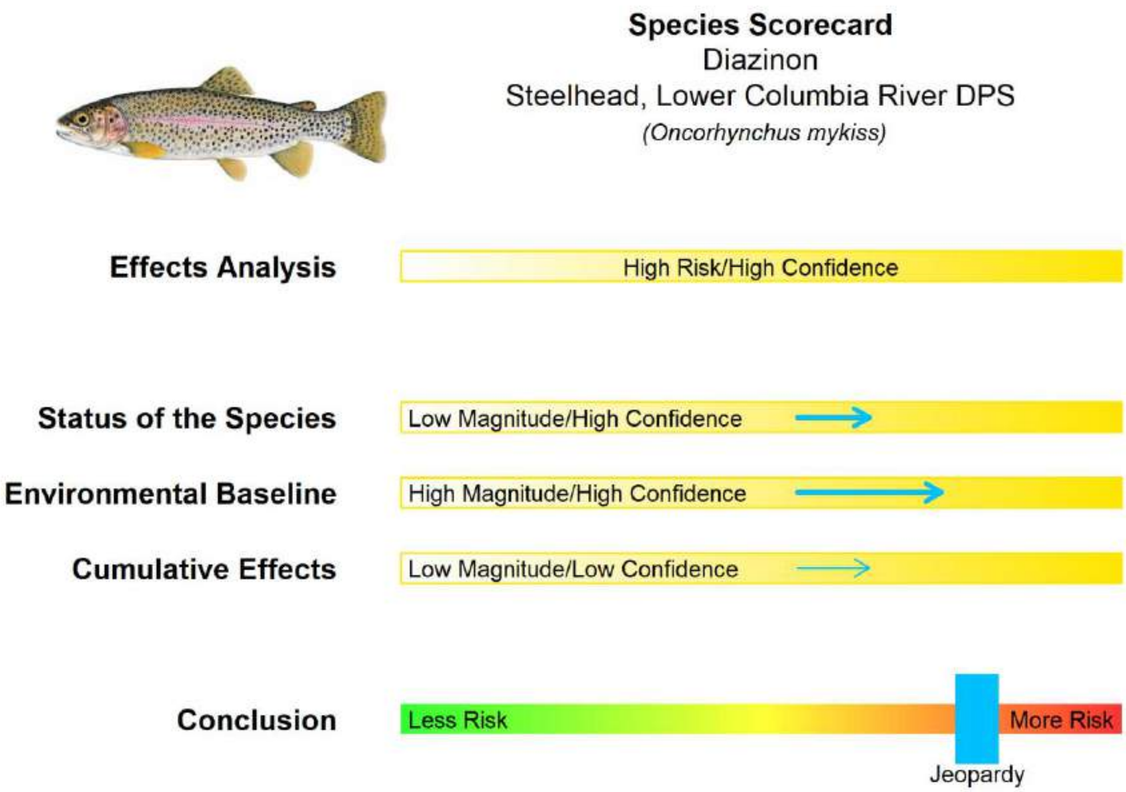

Figure 23. Species Score Card; Steelhead, Lower Columbia River DPS; Diazinon

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater and nearshore areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ High confidence</u>

- 5-year population trend stable. Populations exhibit low genetic diversity and impacted by a loss of available habitat.
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> We find high confidence of high risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>**Diazinon is likely to jeopardize the continued existence of this species: Jeopardy**</u>

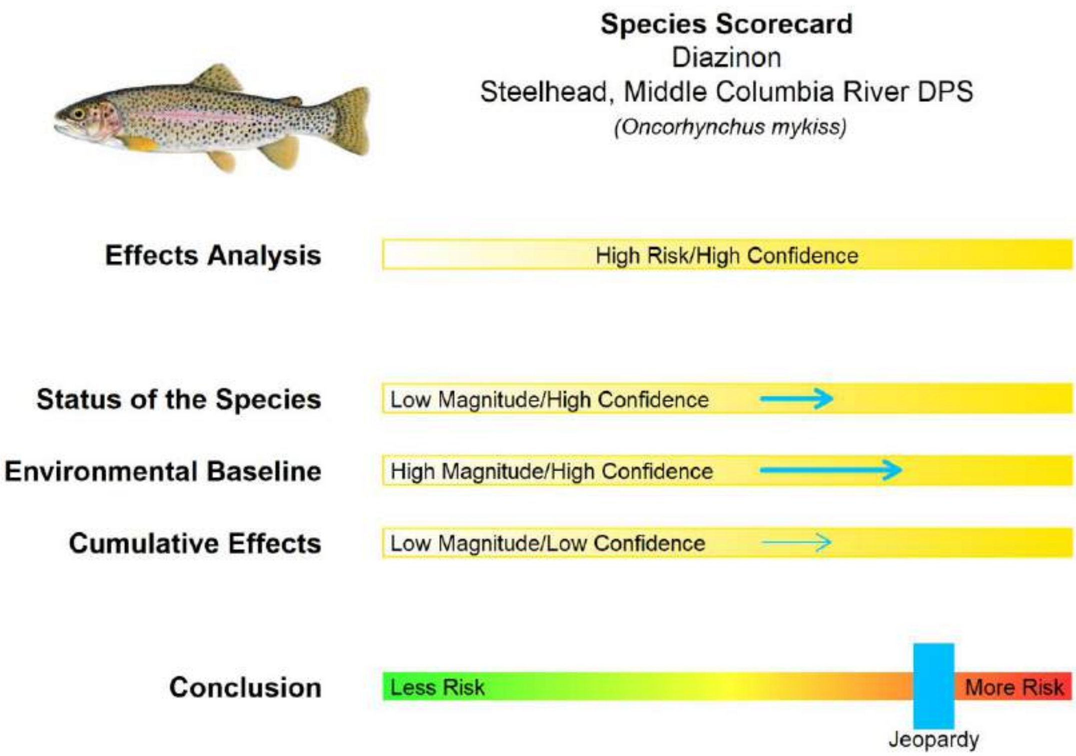

Figure 24. Species Score Card; Steelhead, Middle Columbia River DPS; Diazinon

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater and nearshore areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ High confidence

- 5-year population trend stable to improving; abundances remain low compared to historical numbers
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: We find high confidence of high risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Diazinon is likely to jeopardize the continued existence of this species: Jeopardy

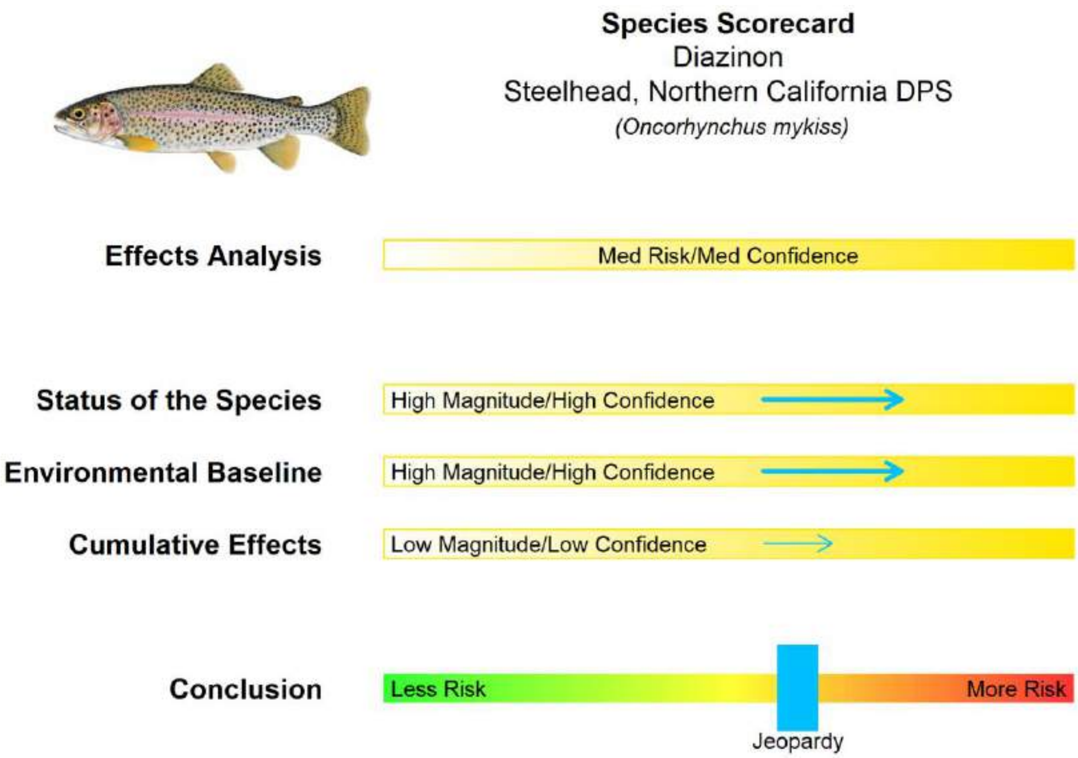

Figure 25. Species Score Card; Steelhead, Northern California DPS; Diazinon

Effects Analysis: Medium risk/Medium confidence

- Reduced abundance and productivity anticipated in freshwater and nearshore areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Icreased risk of jeopardy; High magnitude/ High confidence

- Variable 5-year population abundance trends; Population supplemented by hatchery propagation. Populations exhibit low abundances and productivity.
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: We find medium confidence of medium risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Diazinon is likely to jeopardize the continued existence of this species: Jeopardy

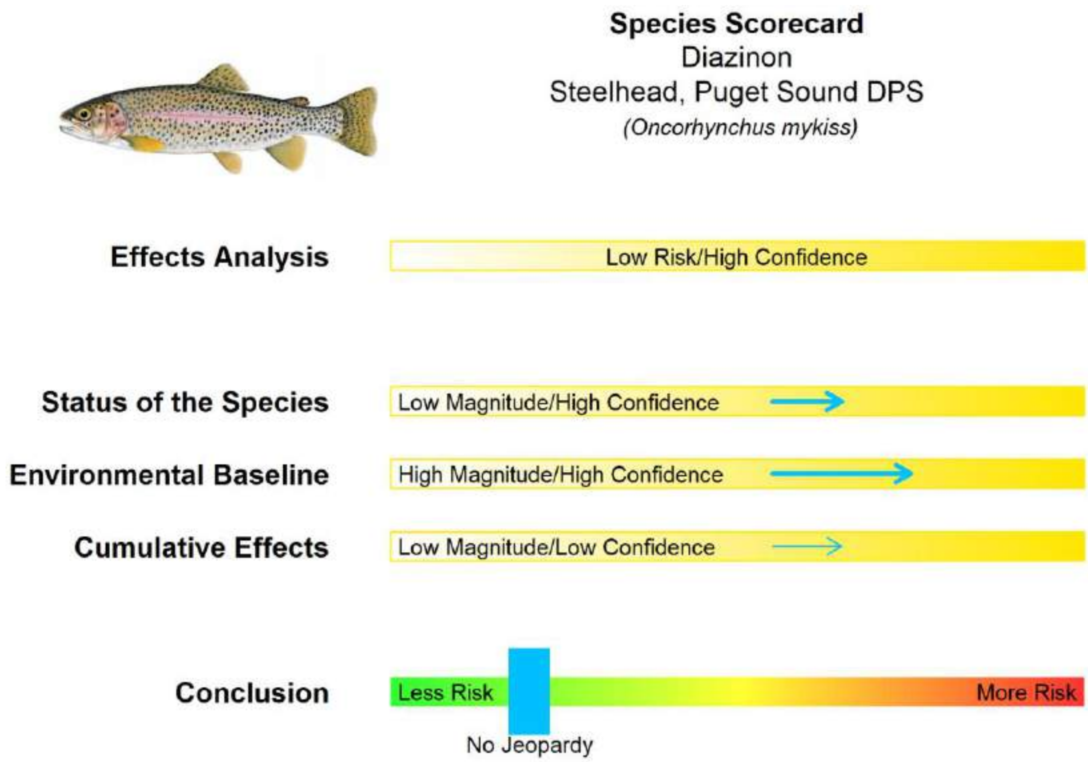

Figure 26. Species Score Card; Steelhead, Puget Sound DPS; Diazinon

<u>Effects Analysis: Low risk/High confidence</u>

- Significant reductions in abundance or productivity not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

<u>Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ High confidence</u>

- 5-year population trend stable, but populations have reduced genetic diversity
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> We find high confidence of low risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

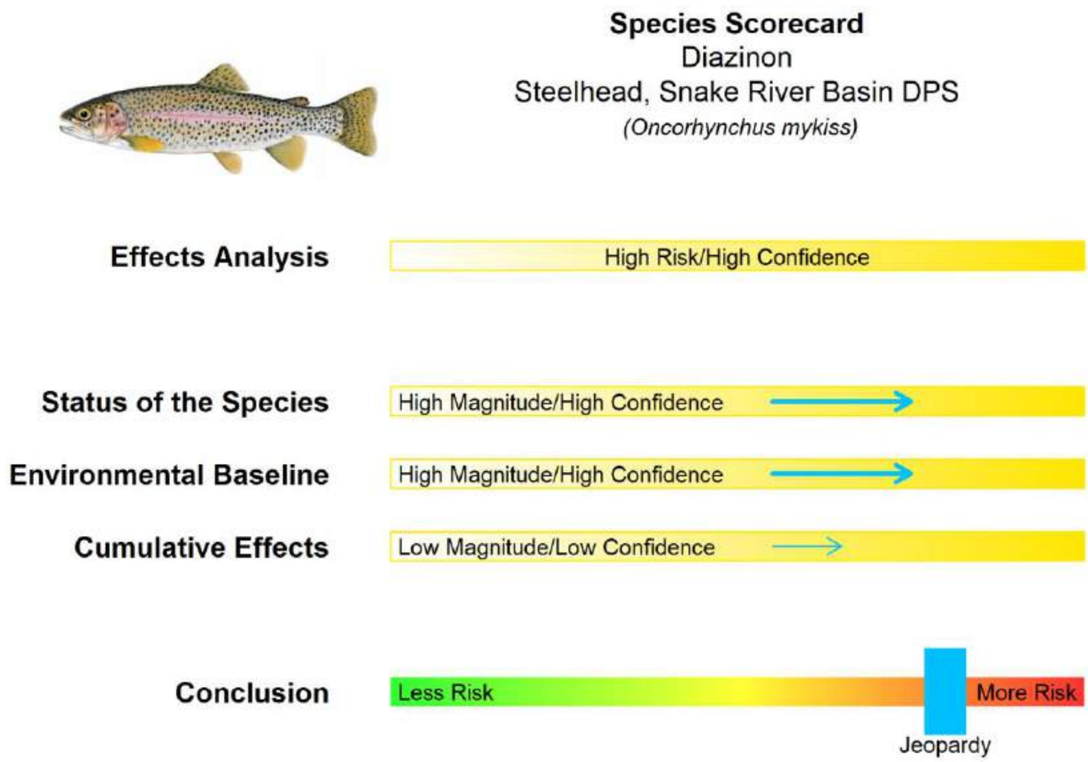

Figure 27. Species Score Card; Steelhead, Snake River Basin DPS; Diazinon

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater and nearshore areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- 5-year population trend stable to improving, but still in moderate danger of extinction. Overall abundances remain below thresholds necessary for recovery.
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> We find high confidence of high risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Diazinon is likely to jeopardize the continued existence of this species: Jeopardy</u>

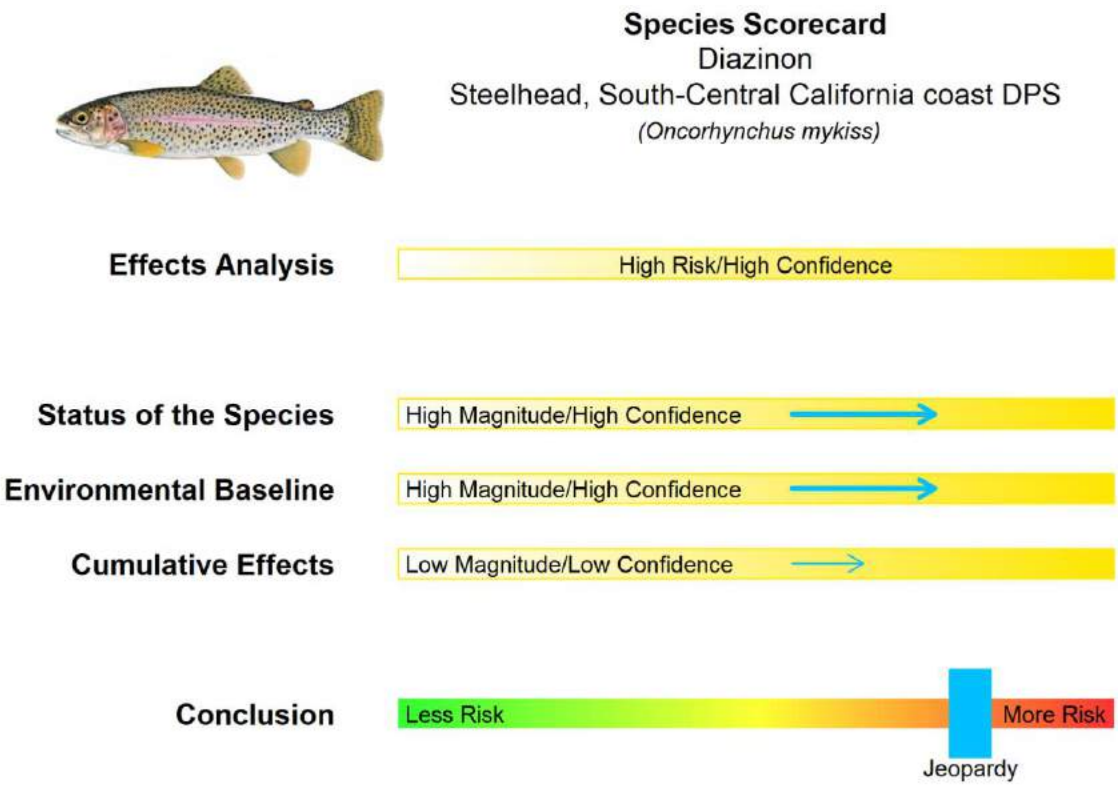

Figure 28. Species Score Card; Steelhead, South-Central California coast DPS; Diazinon

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater and nearshore areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- 5-year population trend declining, depressed abundances.
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> We find high confidence of high risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy</u>

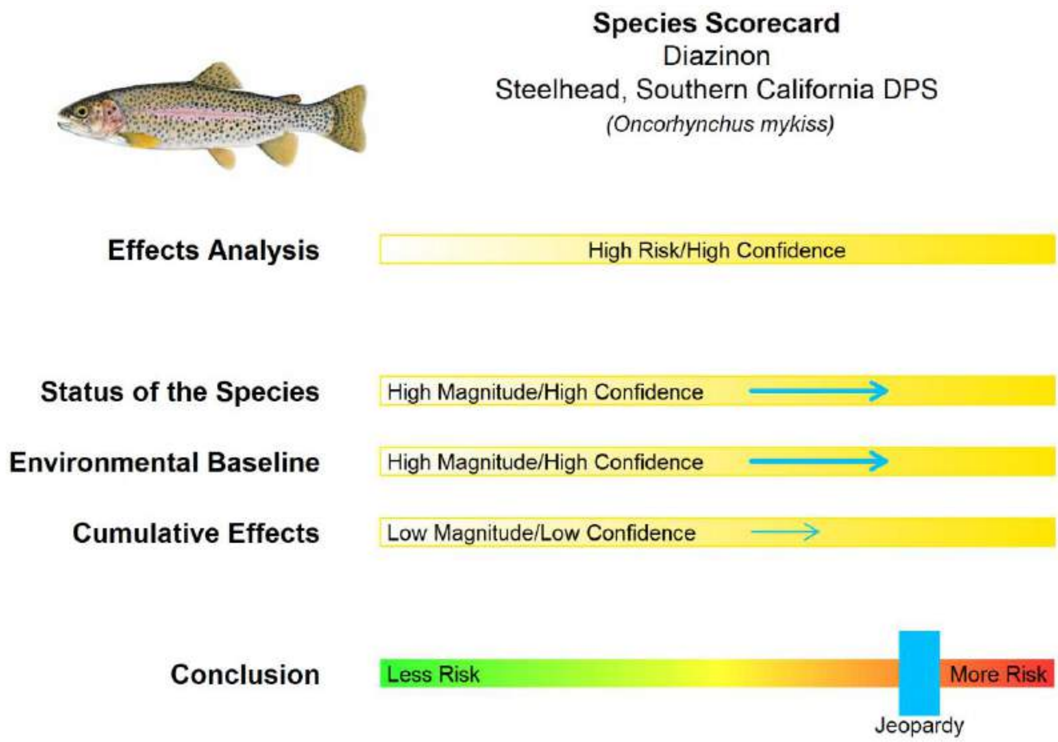

Figure 29. Species Score Card; Steelhead, Southern California DPS; Diazinon

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater and nearshore areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- 5-year population trend uncertain (large annual variations); supplemented by hatchery propagation; fragmented distributions.
- Endangered; Populations at extreme southern end of species' range
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> We find high confidence of high risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy</u>

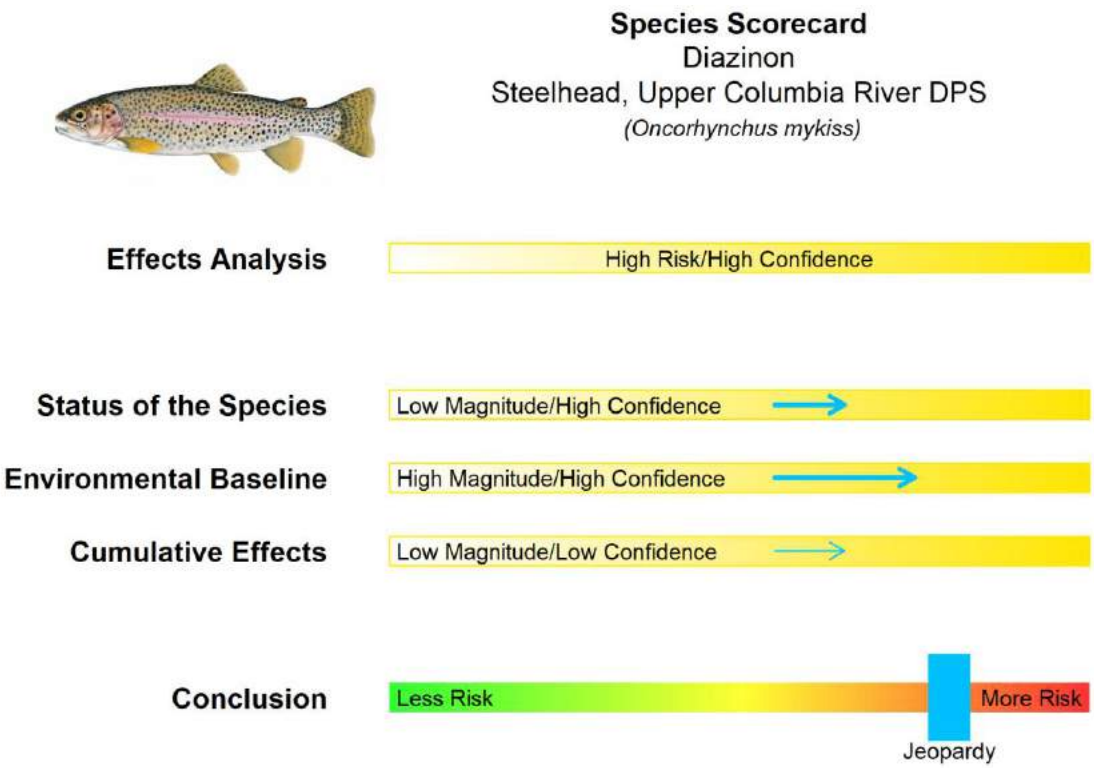

Figure 30. Species Score Card; Steelhead, Upper Columbia River DPS; Diazinon

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater and nearshore areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Increased risk of jeopardy; Low magnitude/ High confidence

- 5-year population trend improving, but low genetic diversity.
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: We find high confidence of high risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Diazinon is likely to jeopardize the continued existence of this species: Jeopardy

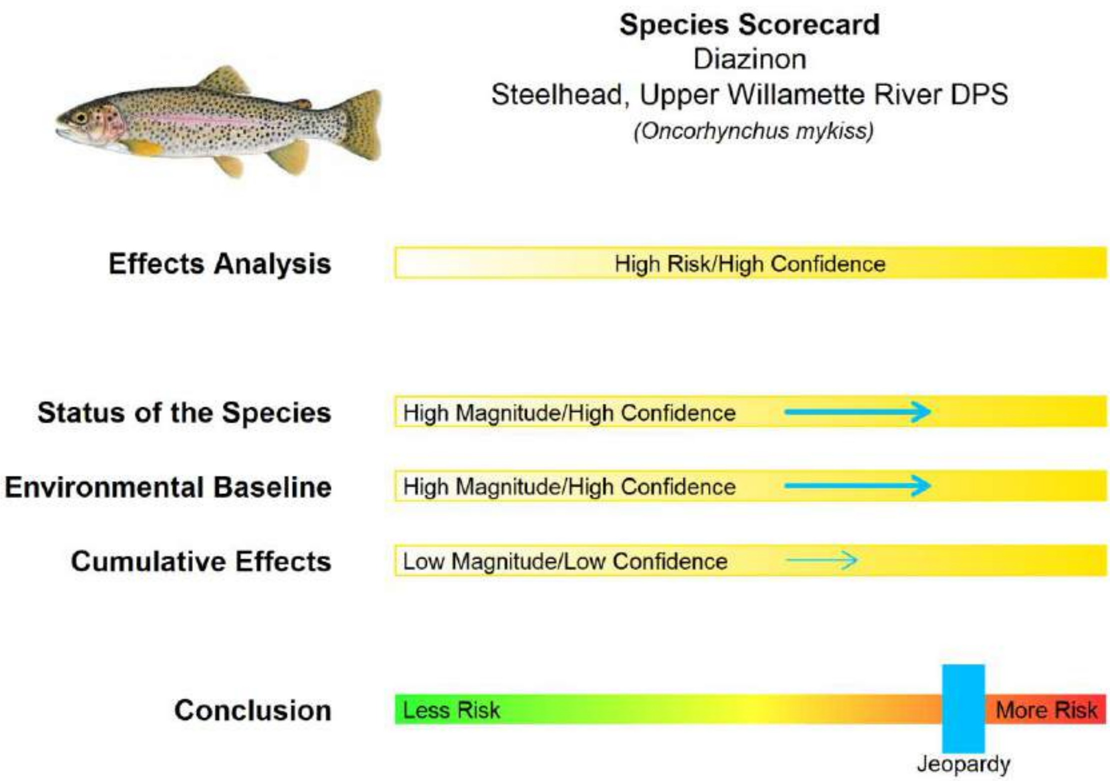

Figure 31. Species Score Card; Steelhead, Upper Willamette River DPS; Diazinon

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater and nearshore areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence

- 5-year population trend declining, large fluctuations in abundances.
- Threatened;
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: We find high confidence of high risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Diazinon is likely to jeopardize the continued existence of this species: Jeopardy

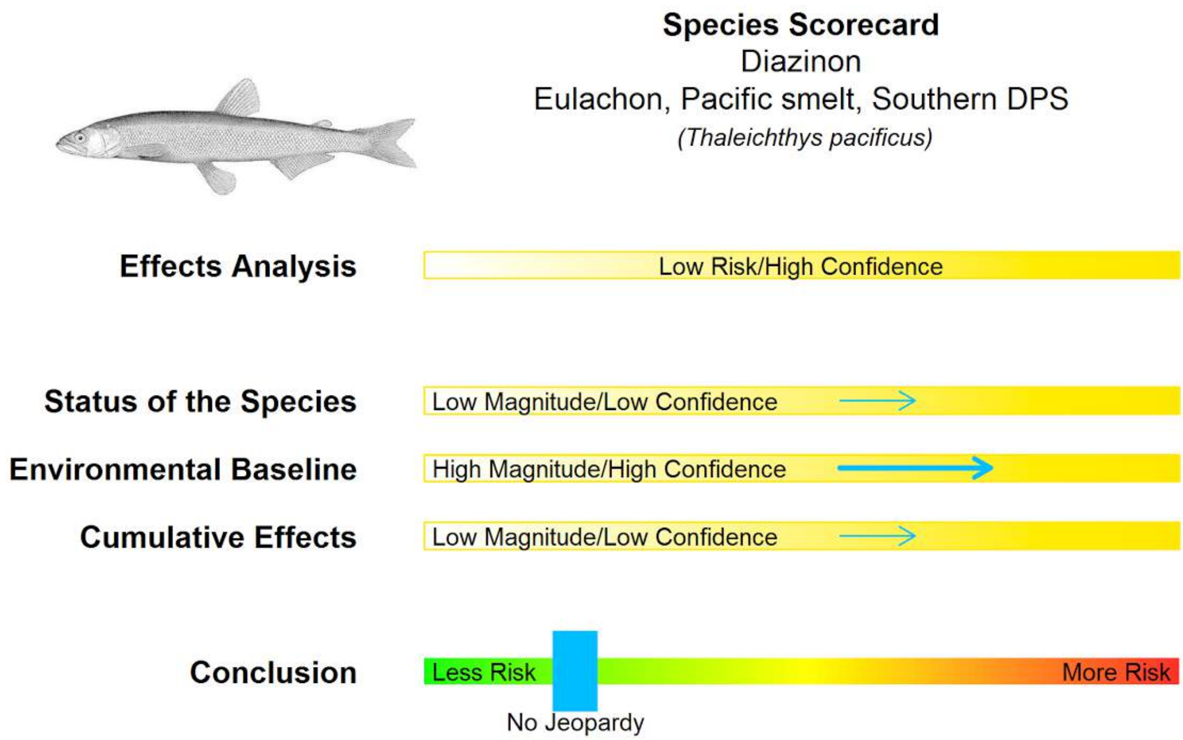

Figure 32. Species Score Card; Eulachon, Pacific smelt, Southern DPS; Diazinon

Effects Analysis: Low risk/High confidence

- Significant reductions in abundance or productivity not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ High confidence

- Population abundance improving, especially in the 2013–2015 return years; in upcoming return years population declines may be widespread from poor ocean conditions
- Threatened; severely depressed abundance mid-late 1990s to late 2000s;
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: We find high confidence of low risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy

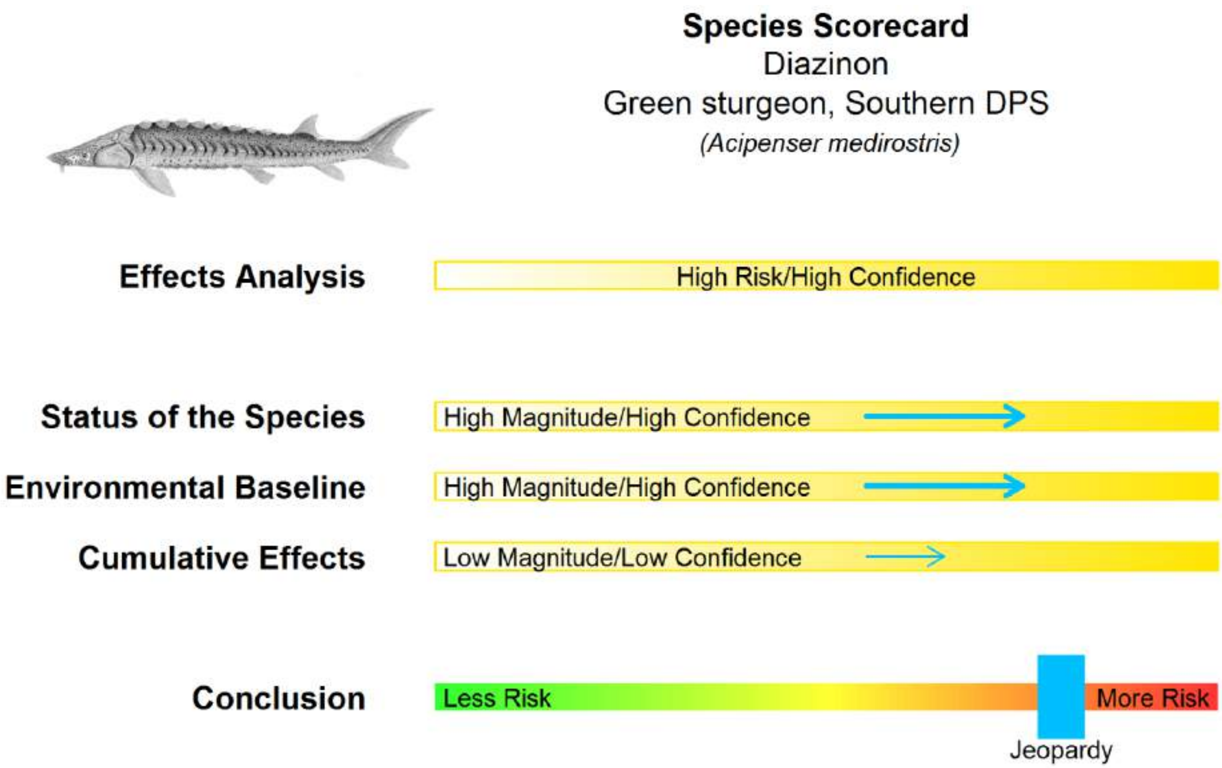

Figure 33. Species Score Card; Green sturgeon, Southern DPS; Diazinon

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater and nearshore areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence

- Small population size, little population data, few remaining spawning sites
- Threatened;
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: We find high confidence of high risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Diazinon is likely to jeopardize the continued existence of this species: Jeopardy

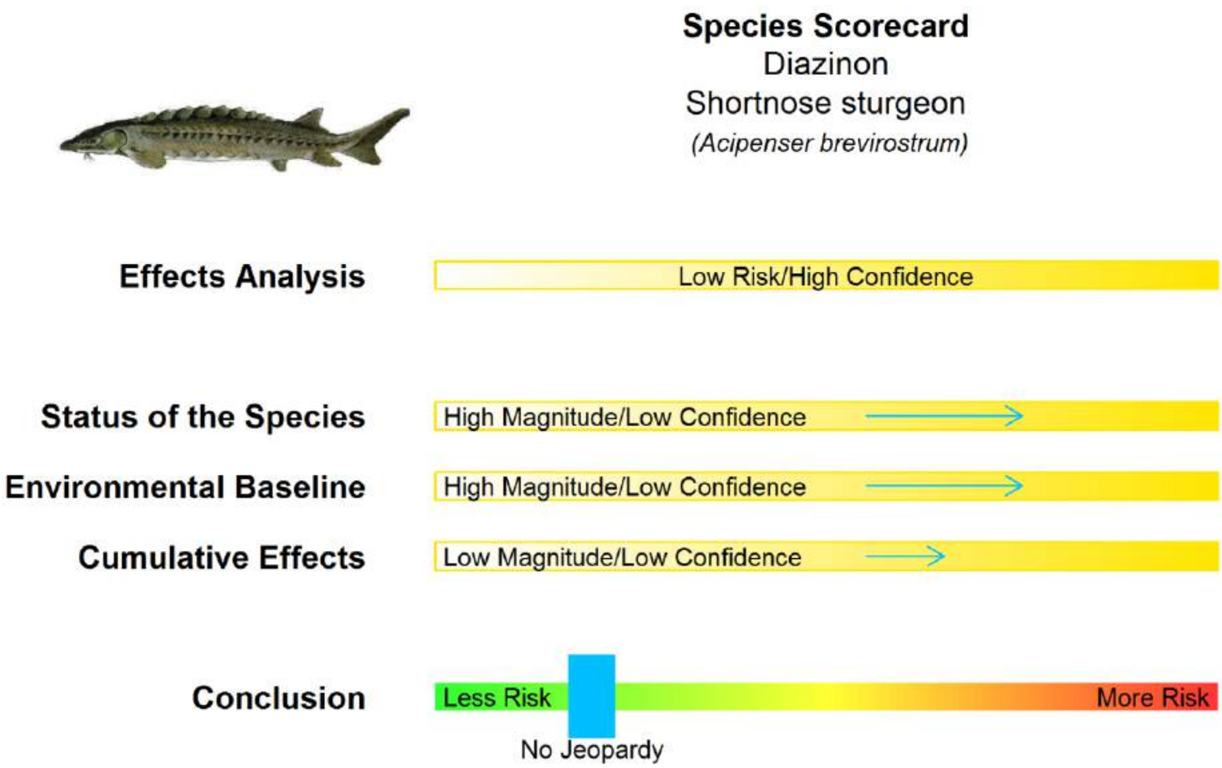

Figure 34. Species Score Card; Shortnose sturgeon; Diazinon

Effects Analysis: Low risk/High confidence

- Significant reductions in abundance or productivity not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Increased risk of jeopardy; High magnitude/ low confidence

- Stable to increasing populations, fragmented populations, only 12 known spawning sites
- Endangered;
- Recovery criteria not identified

Environmental Baseline: Increased risk of jeopardy; High magnitude/ Low confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: We find high confidence of low risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy

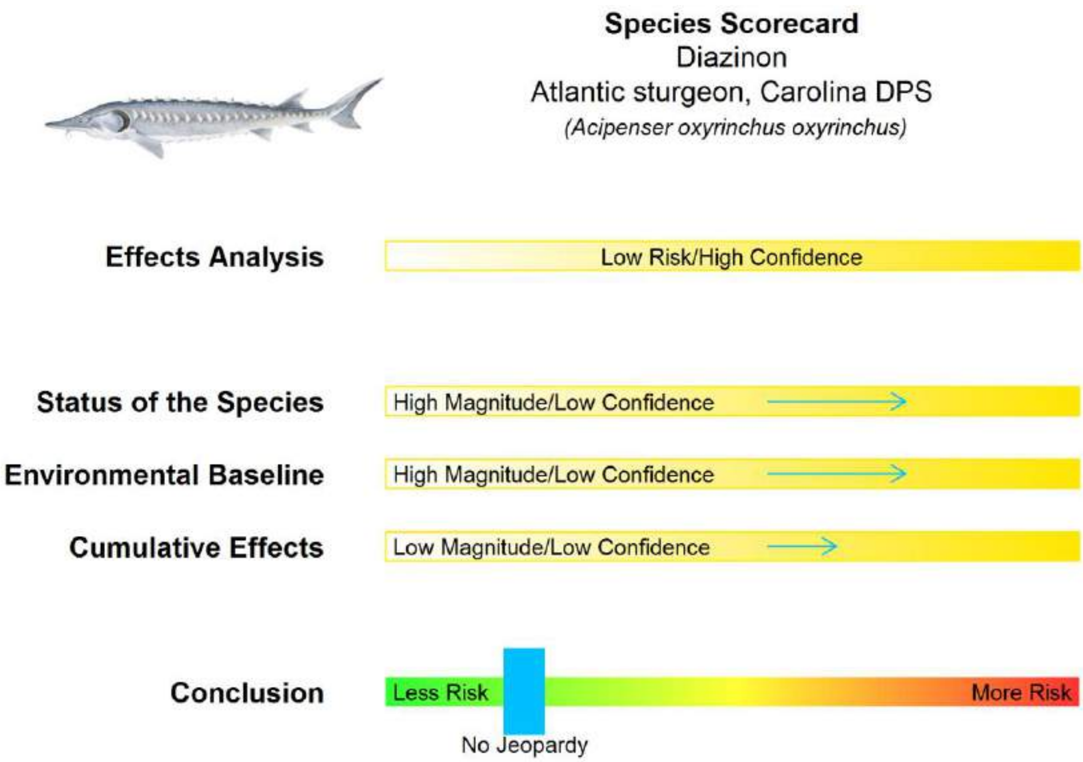

Figure 35. Species Score Card; Atlantic sturgeon, Carolina DPS; Diazinon

Effects Analysis: Low risk/High confidence

- Significant reductions in abundance or productivity not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Increased risk of jeopardy; High magnitude/ low confidence

- <3% of historical abundance
- Endangered;
- Recovery criteria not identified

Environmental Baseline: Increased risk of jeopardy; High magnitude/ Low confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: We find high confidence of low risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy

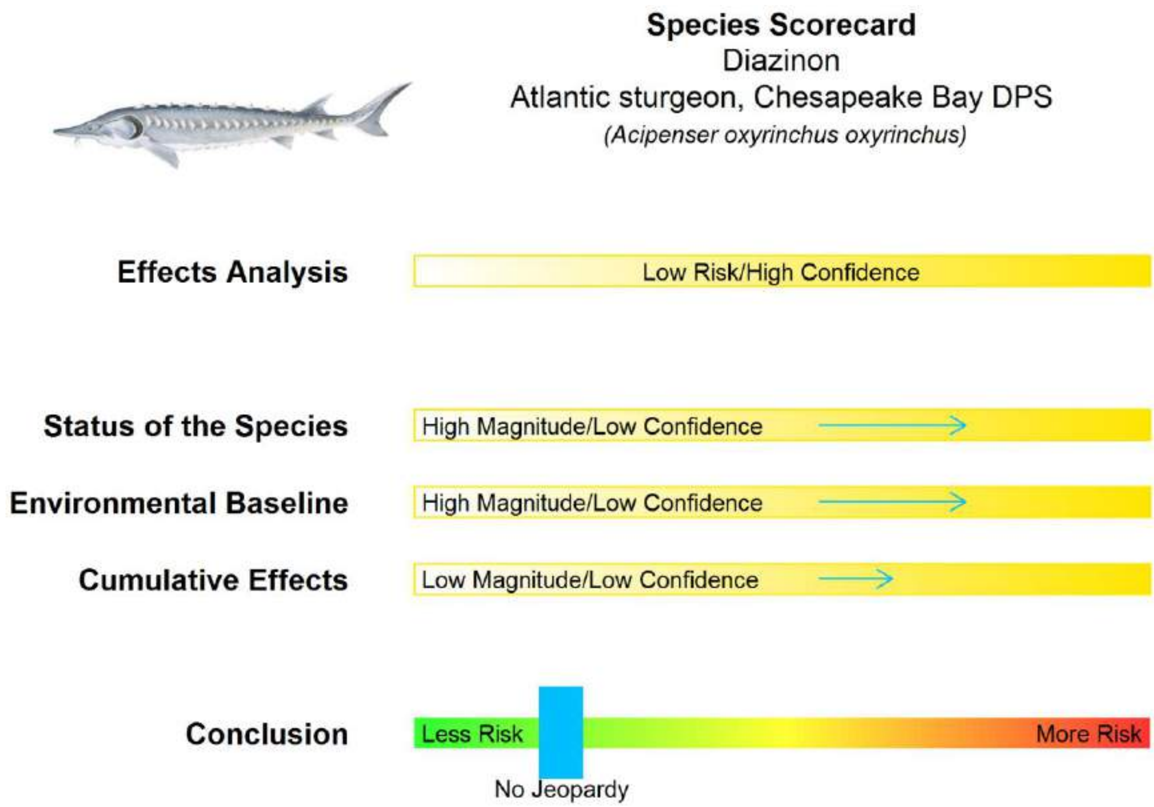

Figure 36. Species Score Card; Atlantic sturgeon, Chesapeake Bay DPS; Diazinon

Effects Analysis: Low risk/High confidence

- Significant reductions in abundance or productivity not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Increased risk of jeopardy; High magnitude/ low confidence

- 4% of historical abundance, unknown population growth rate
- Endangered;
- Recovery criteria not identified

Environmental Baseline: Increased risk of jeopardy; High magnitude/ Low confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: We find high confidence of low risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy

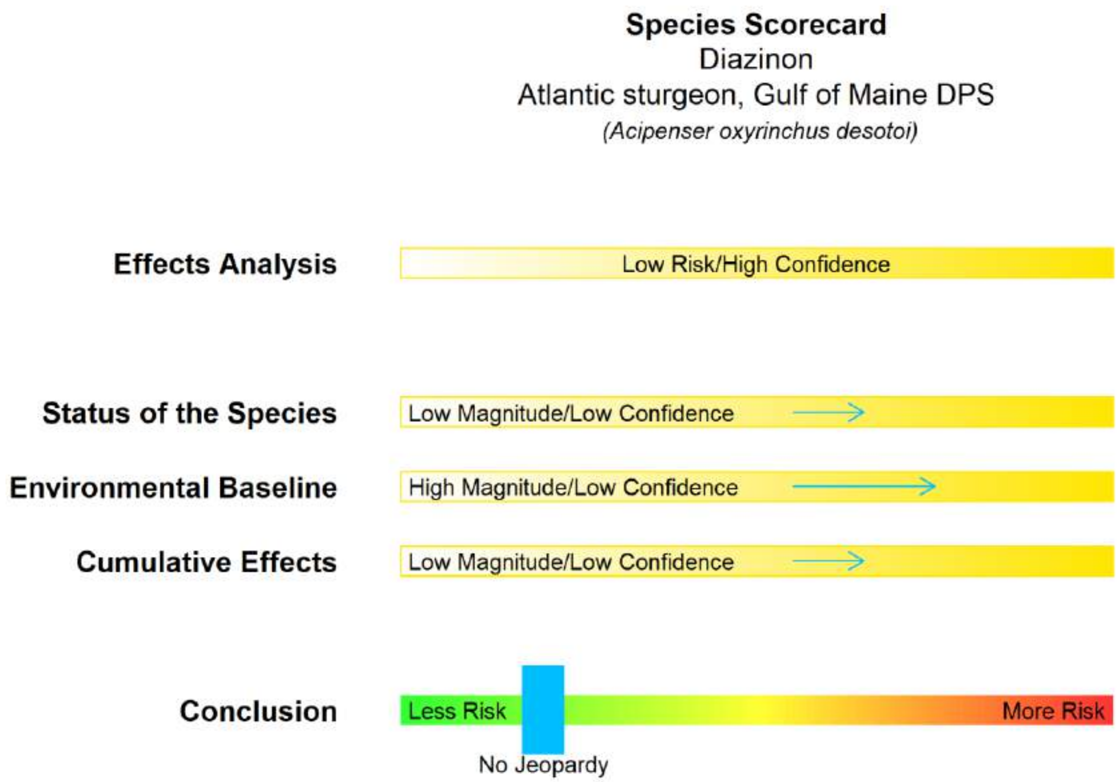

Figure 37. Species Score Card; Atlantic sturgeon, Gulf of Maine DPS; Diazinon

Effects Analysis: Low risk/High confidence

- Significant reductions in abundance or productivity not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: minimal increased risk of jeopardy; Low magnitude/ low confidence

- 10% of historical abundance, unknown population growth rate, range expanding
- Threatened;
- Recovery criteria not identified

Environmental Baseline: Increased risk of jeopardy; High magnitude/ Low confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: We find high confidence of low risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy

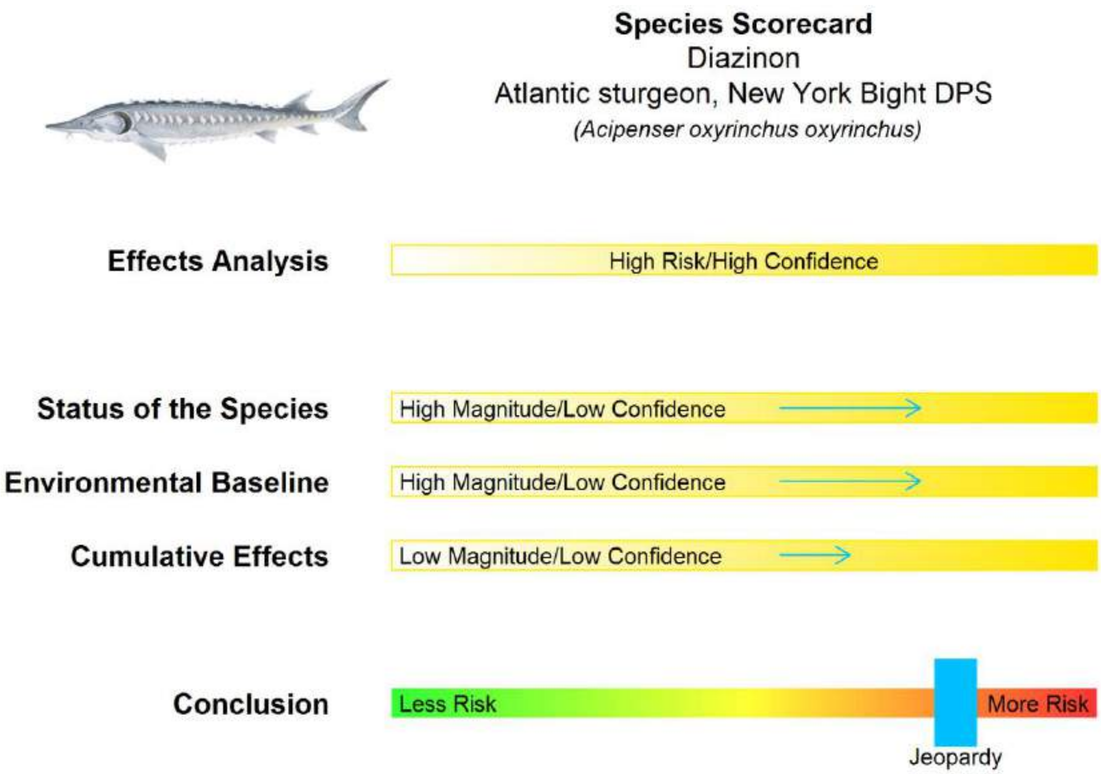

Figure 38. Species Score Card; Atlantic sturgeon, New York Bight DPS; Diazinon

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater and nearshore areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ low confidence</u>

- 4% of historical abundance, unknown population growth rate
- Endangered;
- Recovery criteria not identified

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ Low confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> We find high confidence of high risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Diazinon is likely to jeopardize the continued existence of this species: Jeopardy</u>

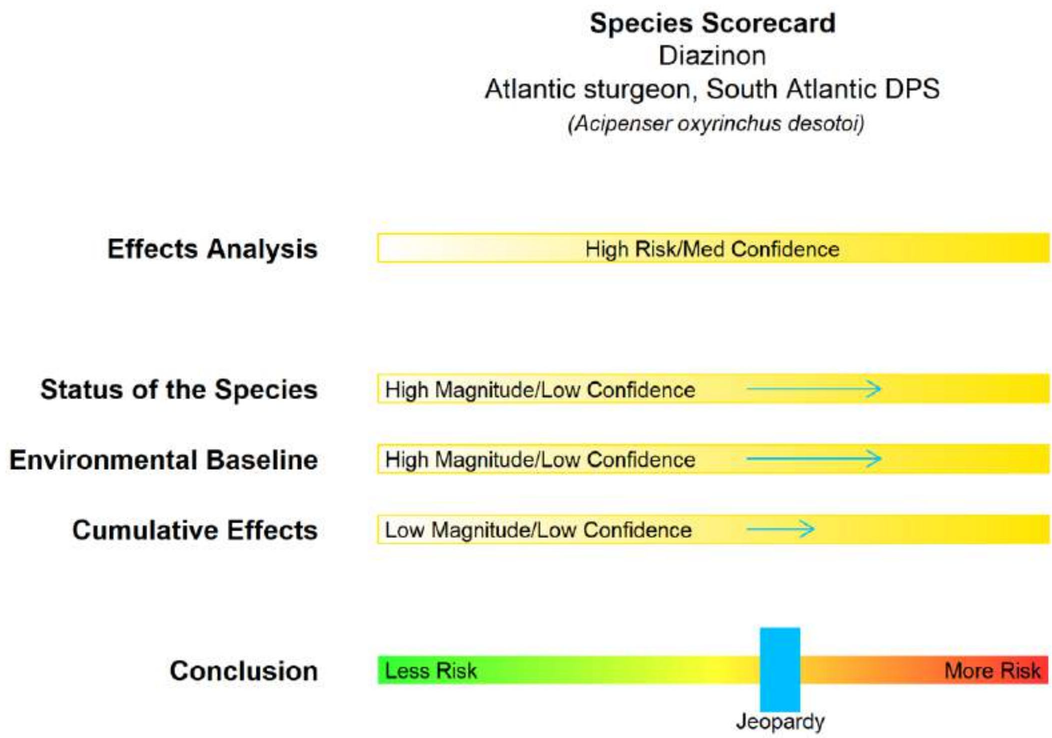

Figure 39. Species Score Card; Atlantic sturgeon, South Atlantic DPS; Diazinon

Effects Analysis: High risk/Medium confidence

- Reduced abundance and productivity anticipated in freshwater and nearshore areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Increased risk of jeopardy; High magnitude/ low confidence

- <6% of historical abundance
- Endangered;
- Recovery criteria not identified

Environmental Baseline: Increased risk of jeopardy; High magnitude/ Low confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: We find medium confidence of high risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Diazinon is likely to jeopardize the continued existence of this species: Jeopardy

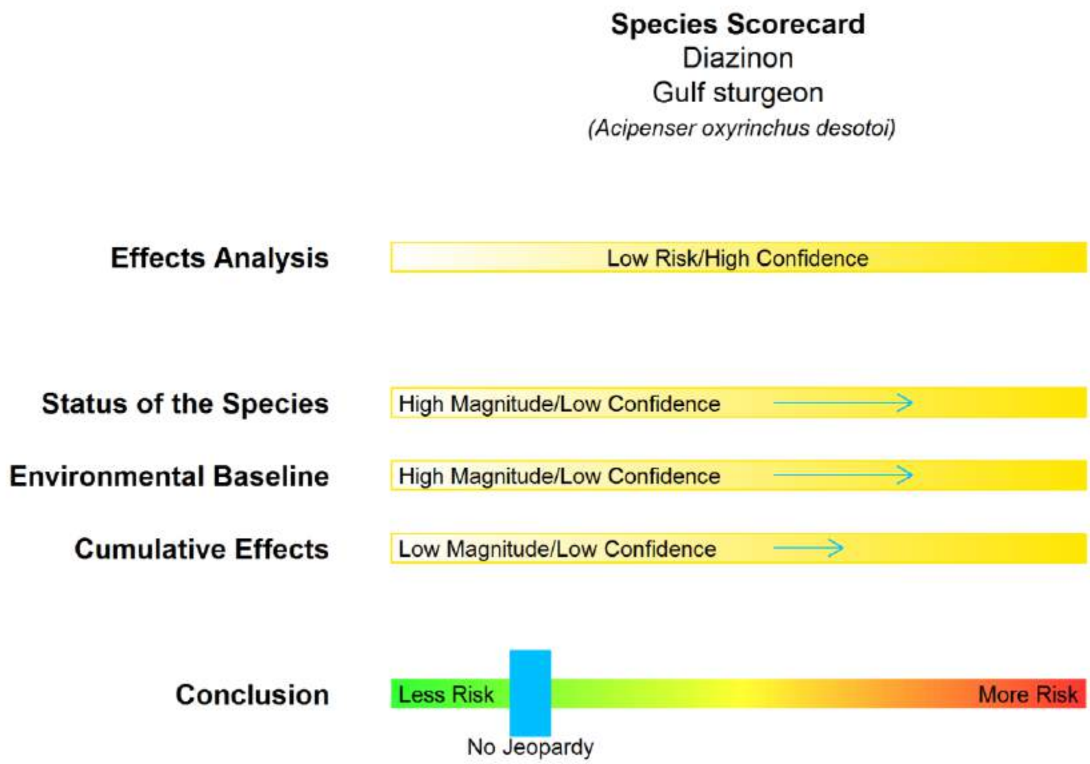

Figure 40. Species Score Card; Gulf sturgeon; Diazinon

Effects Analysis: Low risk/High confidence

- Significant reductions in abundance or productivity not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Increased risk of jeopardy; High magnitude/ Low confidence

- Eastern range populations stable to increasing, western population lower abundances and more uncertainty, minimal growth rate data
- Threatened
- Recovery criteria not identified

Environmental Baseline: Increased risk of jeopardy; High magnitude/ Low confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures not anticipated to affect species
- Anticipated hydrologic effects in freshwater areas

Conclusion: We find high confidence of low risk to the species based on predicted freshwater exposure concentrations and expected population-level effects. The species is most at risk while in freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy

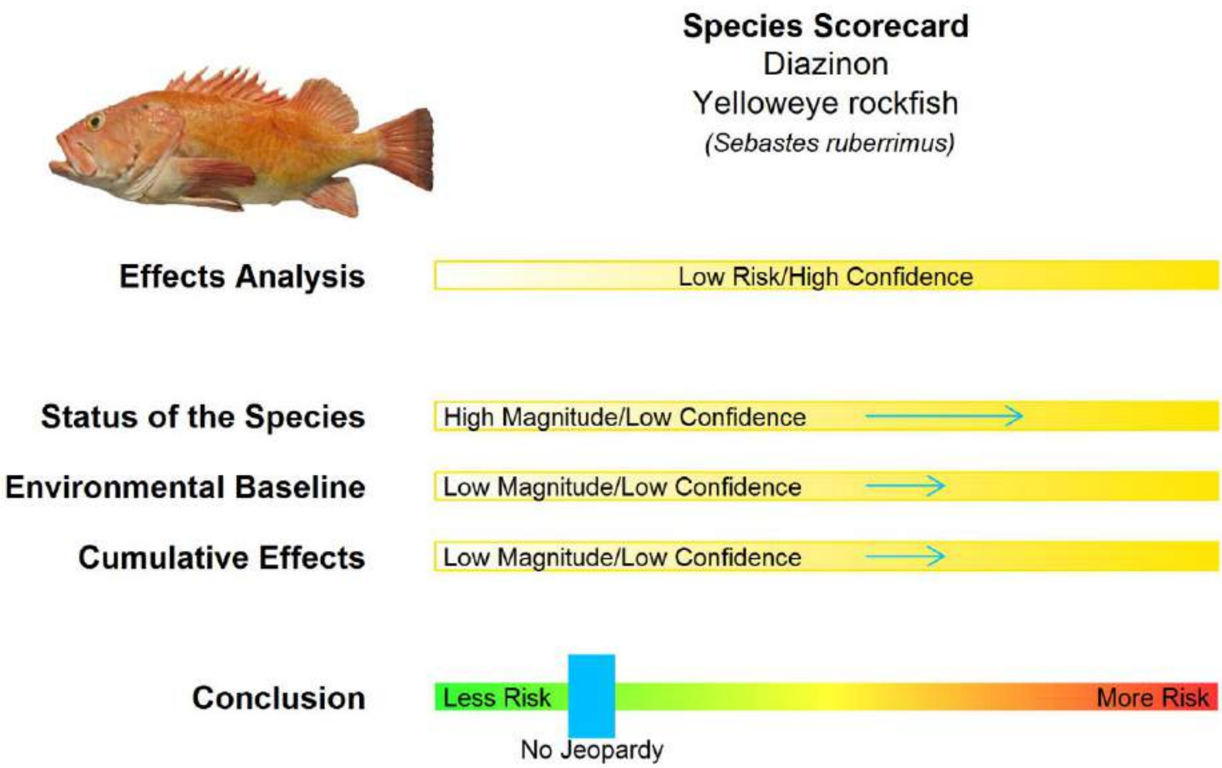

Figure 41. Species Score Card; Yelloweye rockfish; Diazinon

Effects Analysis: Low risk/High confidence

- Reduced abundance and productivity of adults in deeper marine waters not anticipated
- Exposure to mixtures expected to enhance toxicity
- Uncertain exposure concentrations in marine waters

Status of the Species: Increased risk of jeopardy; High magnitude/ Low confidence

- Historically low abundance, fragmented populations, altered population age structure
- Threatened
- Recovery criteria not identified

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures not anticipated in marine waters
- Environmental mixtures at toxic concentrations not anticipated in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures not anticipated

Conclusion: We find high confidence of low risk to the species based on predicted marine exposure concentrations and expected population-level effects. Exposure is uncertain in deep marine habitats where this species resides. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy

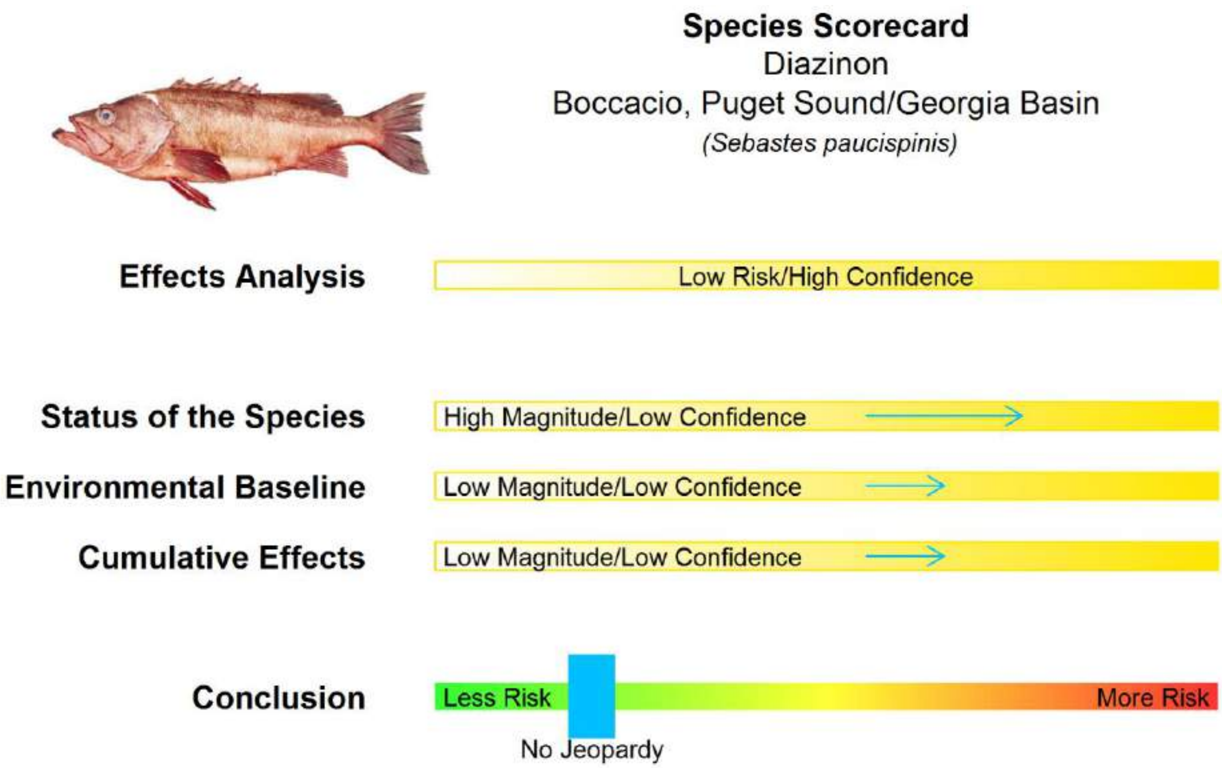

Figure 42. Species Score Card; Boccacio, Puget Sound/Georgia Basin; Diazinon

<u>Effects Analysis: Low risk/High confidence</u>

- Reduced abundance and productivity of adults in deeper marine waters not anticipated
- Exposure to mixtures expected to enhance toxicity
- Uncertain exposure concentrations in marine habitats

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ Low confidence</u>

- There are no estimates of historical or current abundance across the DPS's full range; Indices suggest declining abundance trends
- Threatened
- Recovery criteria not identified

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures unanticipated in marine waters
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures not anticipated in marine waters

<u>Conclusion:</u> We find high confidence of low risk to the species based on predicted marine exposure concentrations and expected population-level effects. Exposure is uncertain in deep marine habitats where this species resides. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>**Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy**</u>

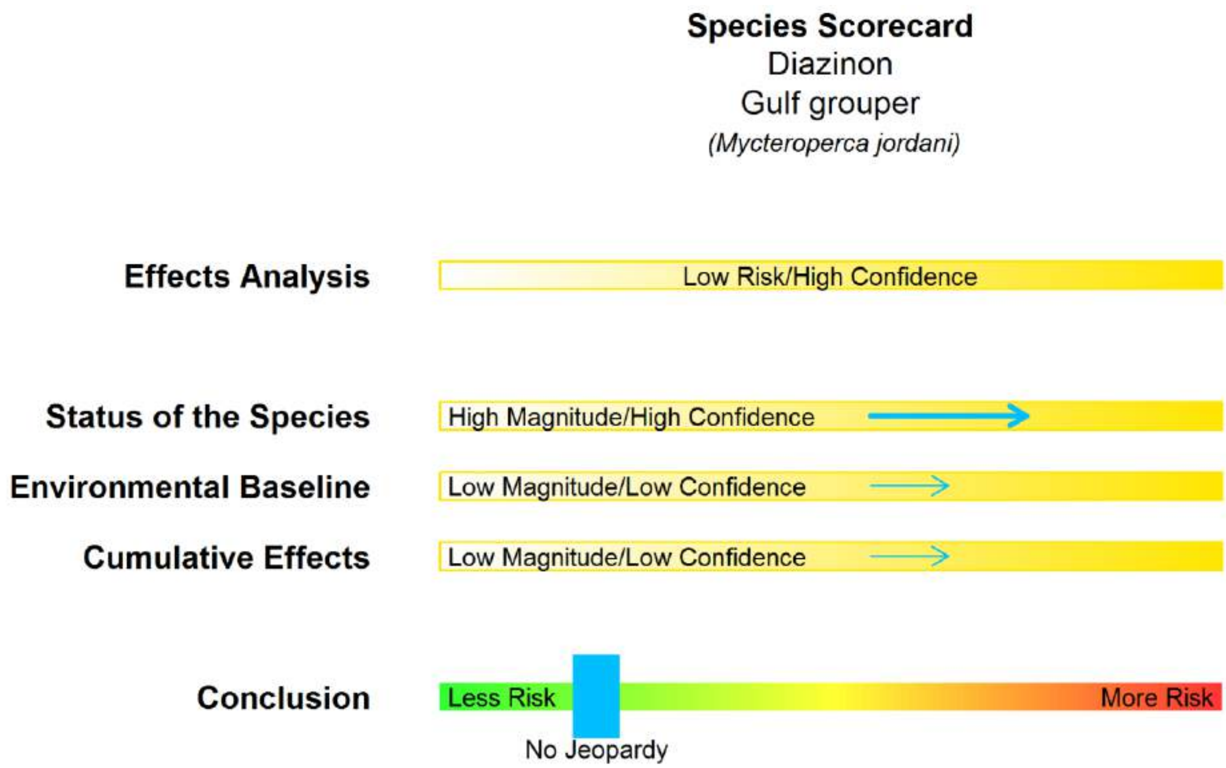

Figure 43. Species Score Card; Gulf grouper; Diazinon

<u>Effects Analysis: Low risk/High confidence</u>

- Reduced abundance and productivity of adults in deeper marine waters not anticipated
- Exposure to mixtures expected to enhance toxicity
- Uncertain exposure concentrations in marine habitats

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Abundance levels less than 1% of their historical levels
- Endangered
- Recovery criteria not identified

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures unanticipated in marine waters
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures not anticipated in marine waters

<u>Conclusion:</u> We find high confidence of low risk to the species based on predicted marine exposure concentrations and expected population-level effects. Exposure is uncertain in deep marine habitats where this species resides. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

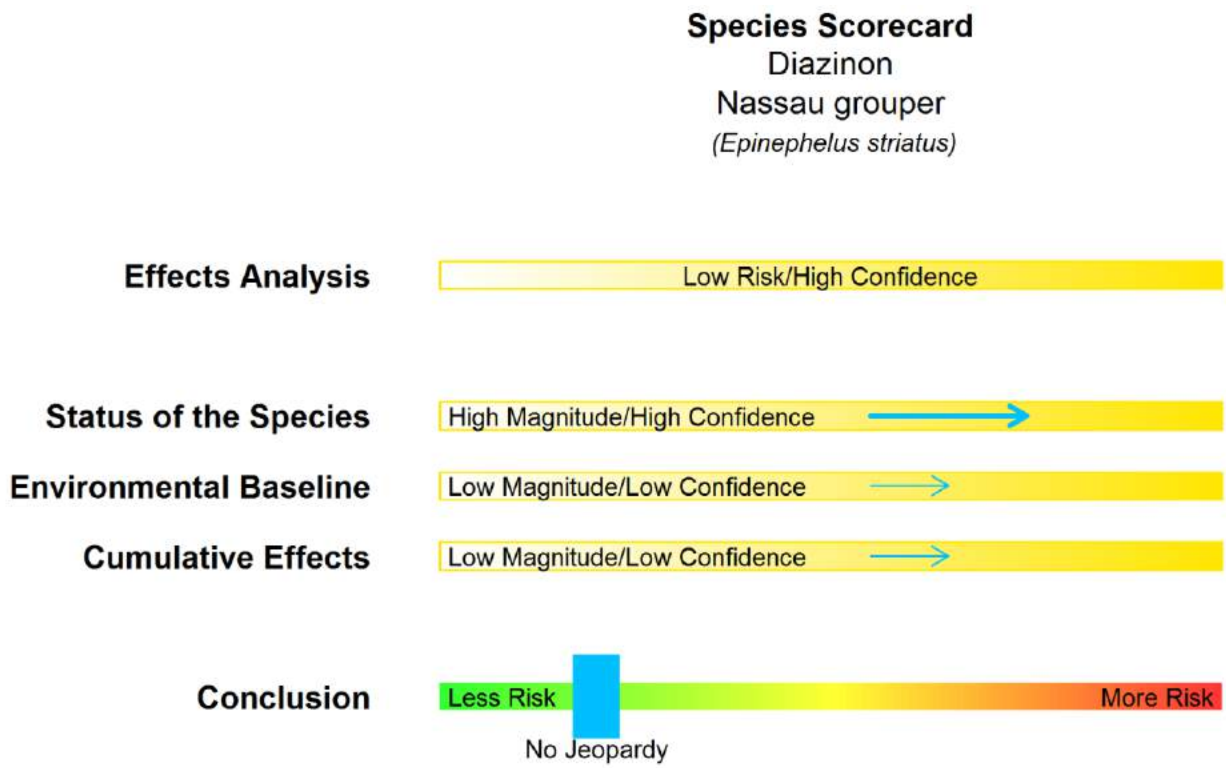

Figure 44. Species Score Card; Nassau grouper; Diazinon

<u>Effects Analysis: Low risk/High confidence</u>

- Reduced abundance and productivity of adults in deeper marine waters not anticipated
- Exposure to mixtures expected to enhance toxicity
- Uncertain exposure concentrations in marine habitats

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- The species has pathcy abundance with declining abundance trends. Throughout its range reductions in the size and number of spawning aggregations;
- Threatened
- Recovery criteria not identified

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures unanticipated in marine waters
- Environmental mixtures not anticipated at toxic concentrations in marine habitats

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures not anticipated in marine waters

<u>Conclusion:</u> We find high confidence of low risk to the species based on predicted marine exposure concentrations and expected population-level effects. Exposure is uncertain in deep marine habitats where this species resides. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

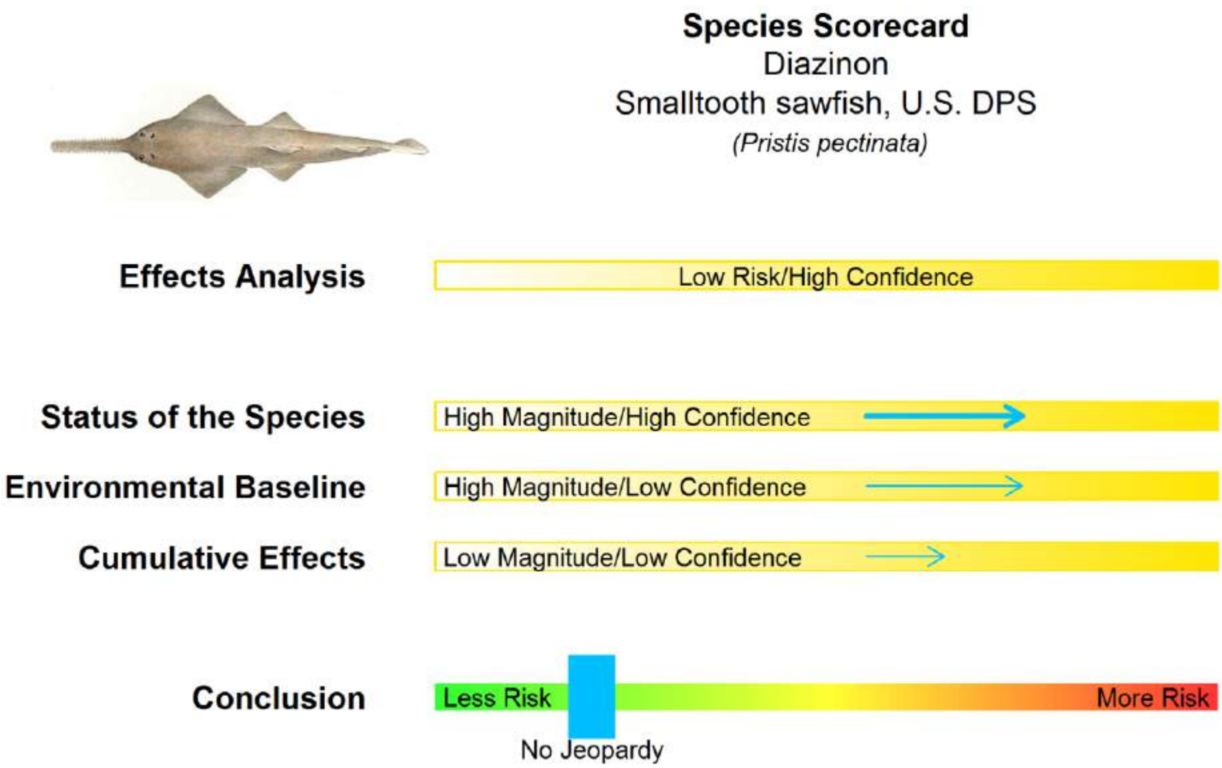

Figure 45. Species Score Card; Smalltooth sawfish, U.S. DPS; Diazinon

<u>Effects Analysis: Low risk/High confidence</u>

- Reduced abundance and productivity of adults in deeper marine waters not anticipated
- Exposure to mixtures expected to enhance toxicity
- Uncertain exposure concentrations in marine habitats

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Stable abundance, low population growth rates, <5% of historical abundance
- Endangered
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ Low confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> We find high confidence of low risk to the species based on predicted marine exposure concentrations and expected population-level effects. Exposure is uncertain in deep marine habitats where this species resides. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

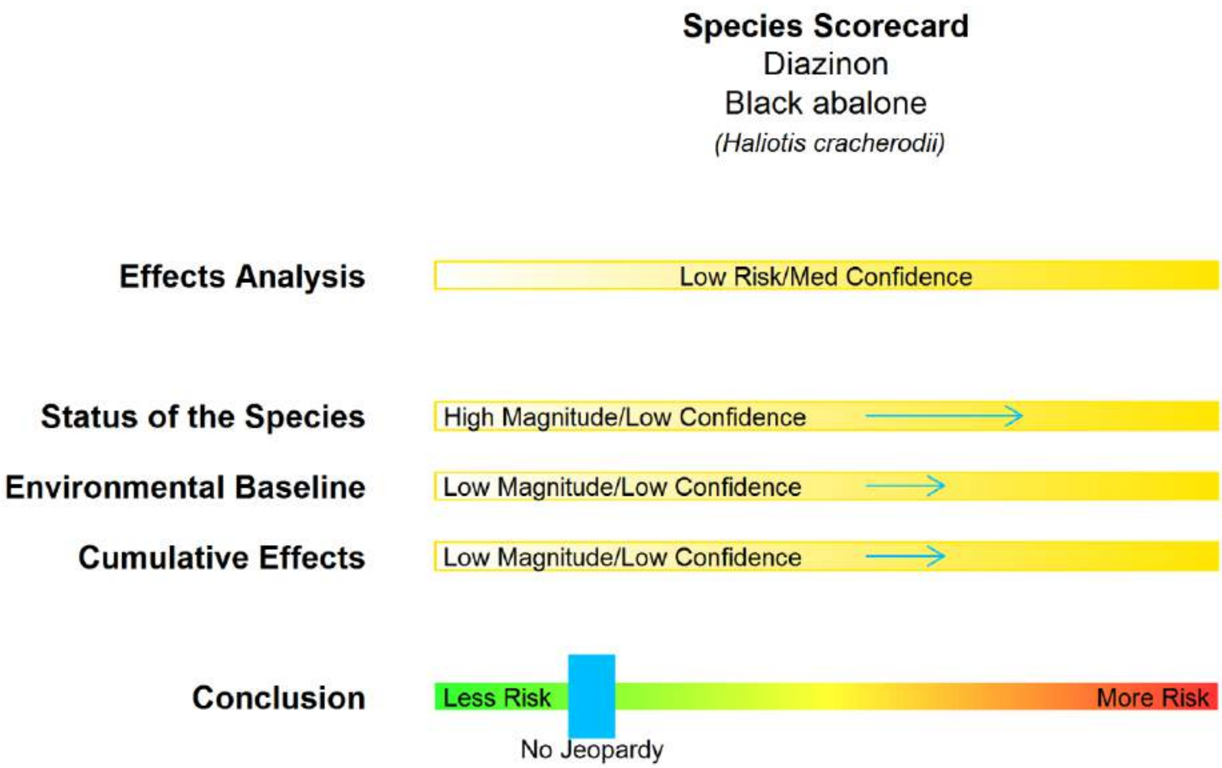

Figure 46. Species Score Card; Black abalone; Diazinon

Effects Analysis: Low risk/Medium confidence

- Reduced abundance and productivity not anticipated in marine areas
- Uncertain exposure concentrations in coastal and marine habitats
- Impacts may occur to individuals occupying shallow tidepools

Status of the Species: Increased risk of jeopardy; High magnitude/ Low confidence

- 5% of historical abundance, declining population trend
- Endangered
- Recovery criteria not identified

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures unanticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentrations in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures not anticipated in marine waters

Conclusion: We find medium confidence of low risk to the species based on predicted marine exposure concentrations and expected population-level effects. Exposure is uncertain in tidepools and marine habitats where this species resides. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy

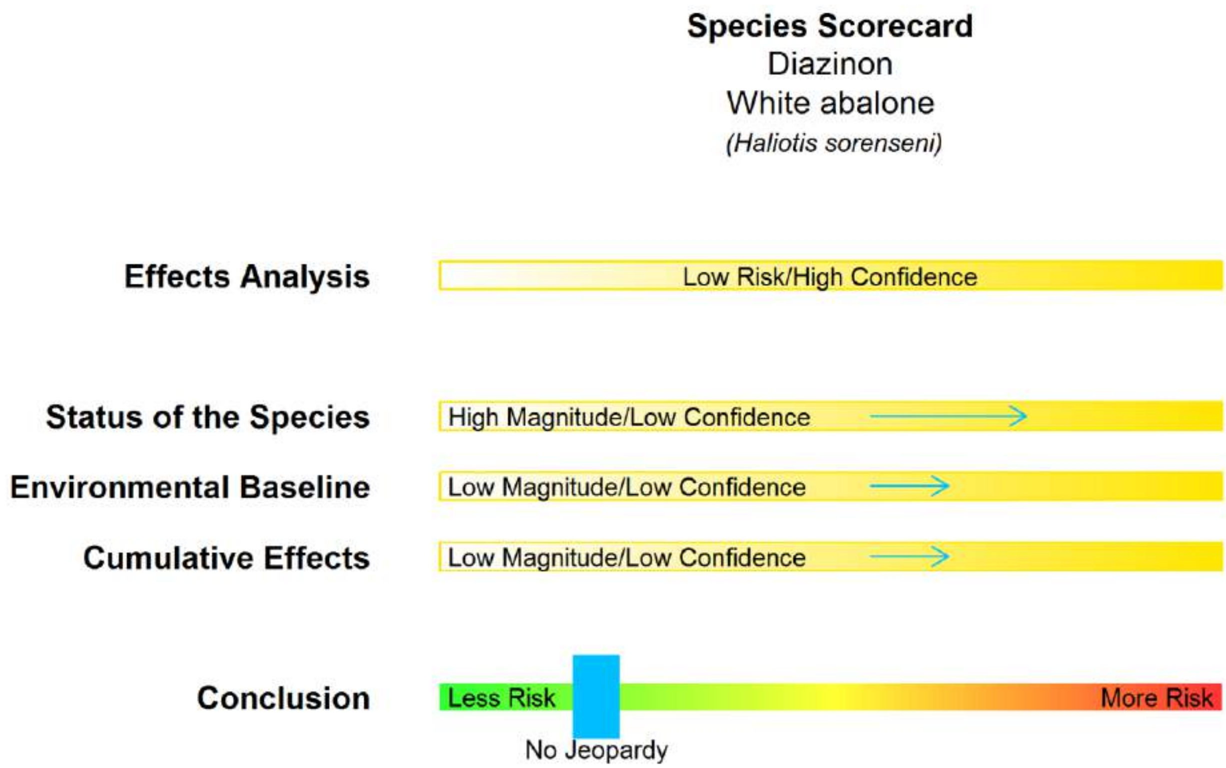

Figure 47. Species Score Card; White abalone; Diazinon

<u>Effects Analysis: Low risk/High confidence</u>

- Reduced abundance and productivity not anticipated in marine areas
- Uncertain exposure concentrations in deep marine habitats

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ Low confidence</u>

- Declining population trend, lack of recruitment, no current estimated population size
- Endangered;
- Recovery criteria not met

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures unanticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentrations in marine habitats

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures not anticipated in marine waters

<u>Conclusion:</u> We find high confidence of low risk to the species based on predicted marine exposure concentrations and expected population-level effects. Exposure is uncertain in deep marine habitats where adults and juveniles reside. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

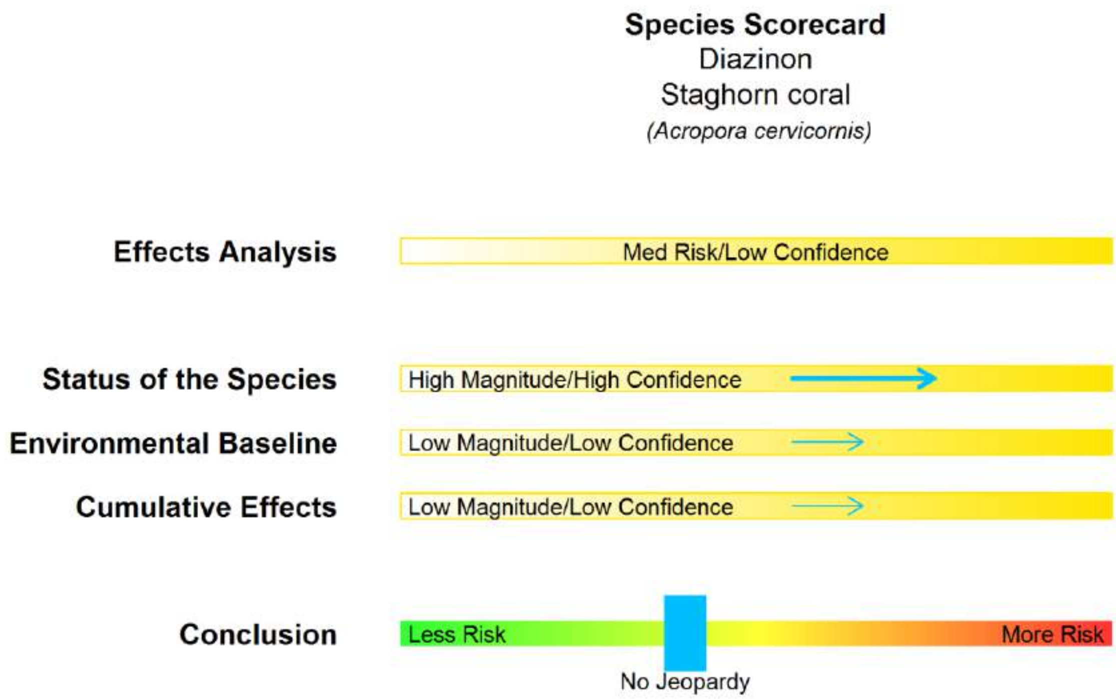

Figure 48. Species Score Card; Staghorn coral; Diazinon

<u>Effects Analysis: Medium risk/Low confidence</u>

- Reduced abundance and productivity not anticipated in marine areas
- Potential effects to colonies including death and reduced settling of larvae
- Uncertain exposure concentrations in marine habitats

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Severe reductions in abundance in portions of range; populations remain stable at depressed levels
- Threatened
- Recovery criteria not met

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentrations in marine habitats

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters

<u>Conclusion:</u> We find low confidence of medium risk to the species based on predicted marine exposure concentrations and expected population-level effects. Exposure is uncertain in marine habitats. A maximum of 8% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

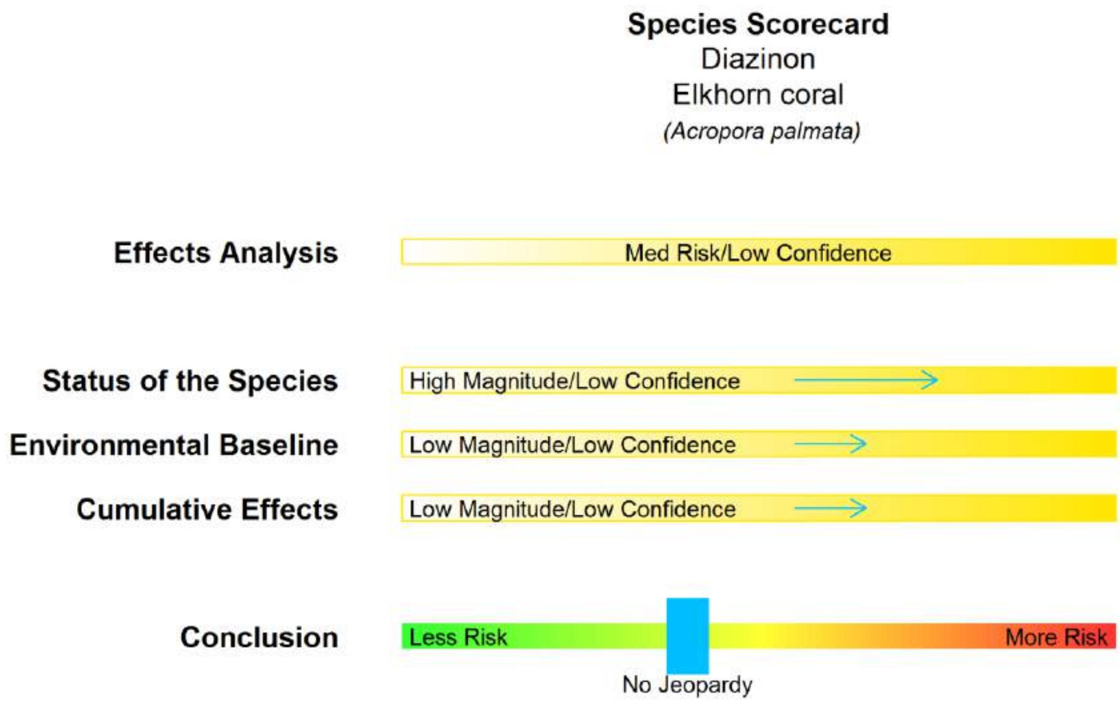

Figure 49. Species Score Card; Elkhorn coral; Diazinon

Effects Analysis: Medium risk/Low confidence

- Reduced abundance and productivity not anticipated in marine areas
- Potential effects to colonies including death and reduced settling of larvae
- Uncertain exposure concentrations in marine habitats

Status of the Species: Increased risk of jeopardy; High magnitude/ Low confidence

- Low abundance, large declines over past decades. Genetically depauparate populations in Caribbean. In eastern Caribbean, population is doing better and is genetically richer.
- Threatened
- Recovery criteria not met

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentrations in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: We find low confidence of medium risk to the species based on predicted marine exposure concentrations and expected population-level effects. Exposure is uncertain in marine habitats. A maximum of 8% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy

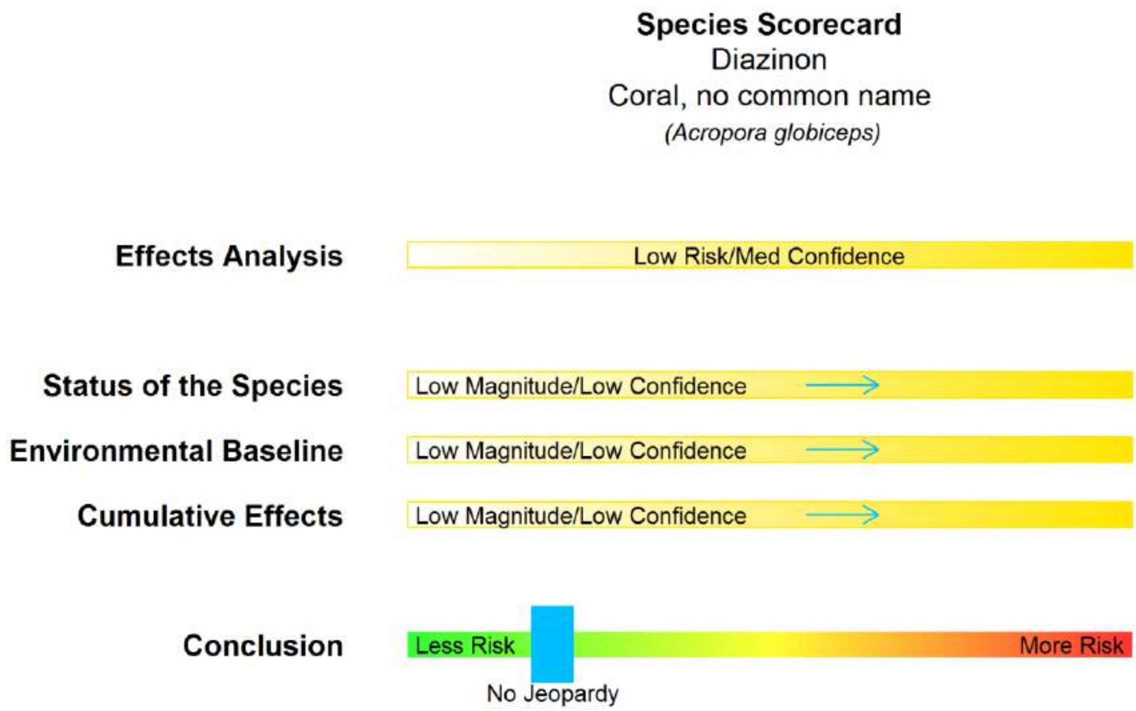

Figure 50. Species Score Card; Coral, Acropora globiceps; Diazinon

<u>Effects Analysis: Low risk/Medium confidence</u>

- Reduced abundance and productivity not anticipated in marine areas
- Potential effects to colonies including death and reduced settling of larvae
- Uncertain exposure concentrations in marine habitats

<u>Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Range is extensive throughout the Indo-Pacific region; less than 5% of the population is within the action area; overall status and growth rates unknown
- Threatened
- Recovery criteria not developed

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentrations in marine habitats

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters

<u>Conclusion:</u> We find low confidence of medium risk to the species based on predicted marine exposure concentrations and expected population-level effects. Exposure is uncertain in marine habitats. About 5% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

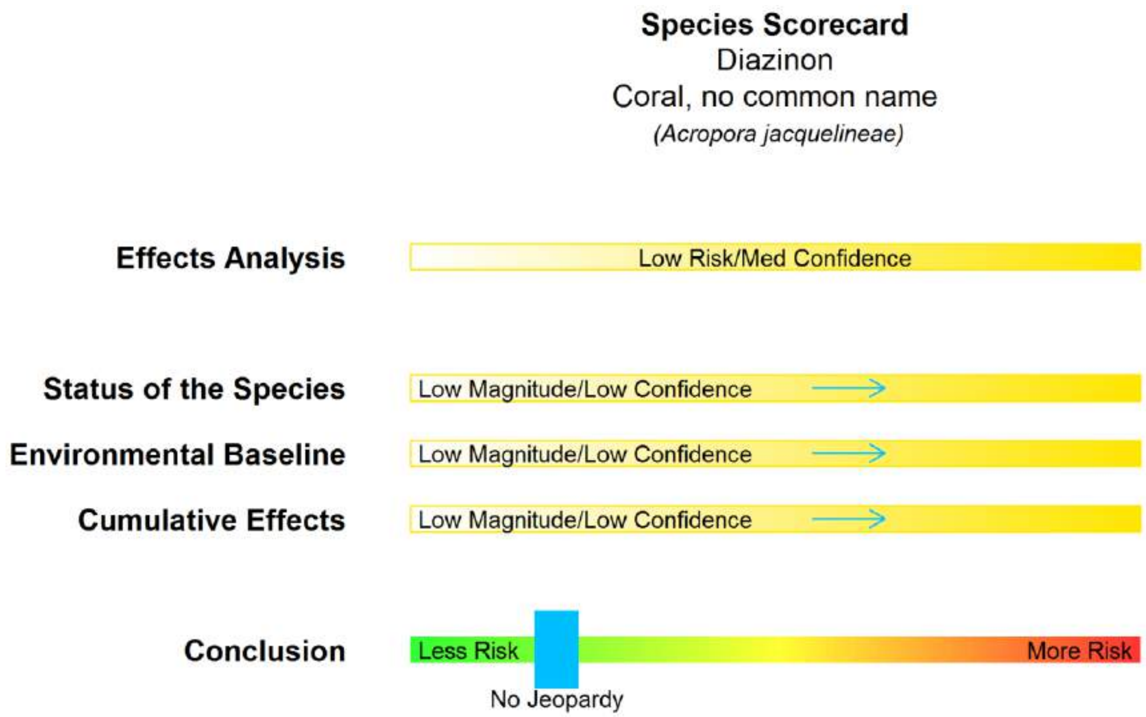

Figure 51. Species Score Card; Coral, Acropora jacquelineae; Diazinon

Effects Analysis: Low risk/Medium confidence

- Reduced abundance and productivity not anticipated in marine areas
- Potential effects to colonies including death and reduced settling of larvae
- Uncertain exposure concentrations in marine habitats

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Range is extensive throughout the Indo-Pacific region; less than 5% of the population is within the action area; overall status and growth rates unknown
- Threatened
- Recovery criteria not developed

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentrations in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: We find low confidence of medium risk to the species based on predicted marine exposure concentrations and expected population-level effects. Exposure is uncertain in marine habitats. About 5% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy

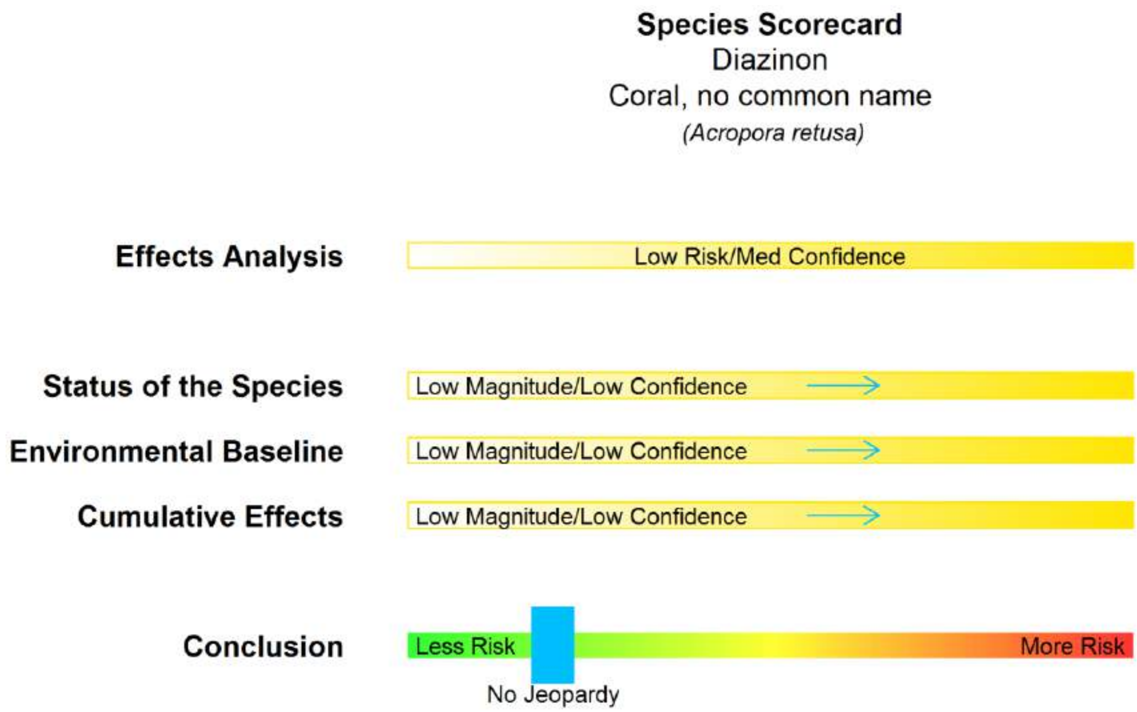

Figure 52. Species Score Card; Coral, Acropora retusa; Diazinon

Effects Analysis: Low risk/Medium confidence

- Reduced abundance and productivity not anticipated in marine areas
- Potential effects to colonies including death and reduced settling of larvae
- Uncertain exposure concentrations in marine habitats

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Range is extensive throughout the Indo-Pacific region; less than 5% of the population is within the action area; overall status and growth rates unknown
- Threatened
- Recovery criteria not developed

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentrations in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: We find low confidence of medium risk to the species based on predicted marine exposure concentrations and expected population-level effects. Exposure is uncertain in marine habitats. About 5% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy

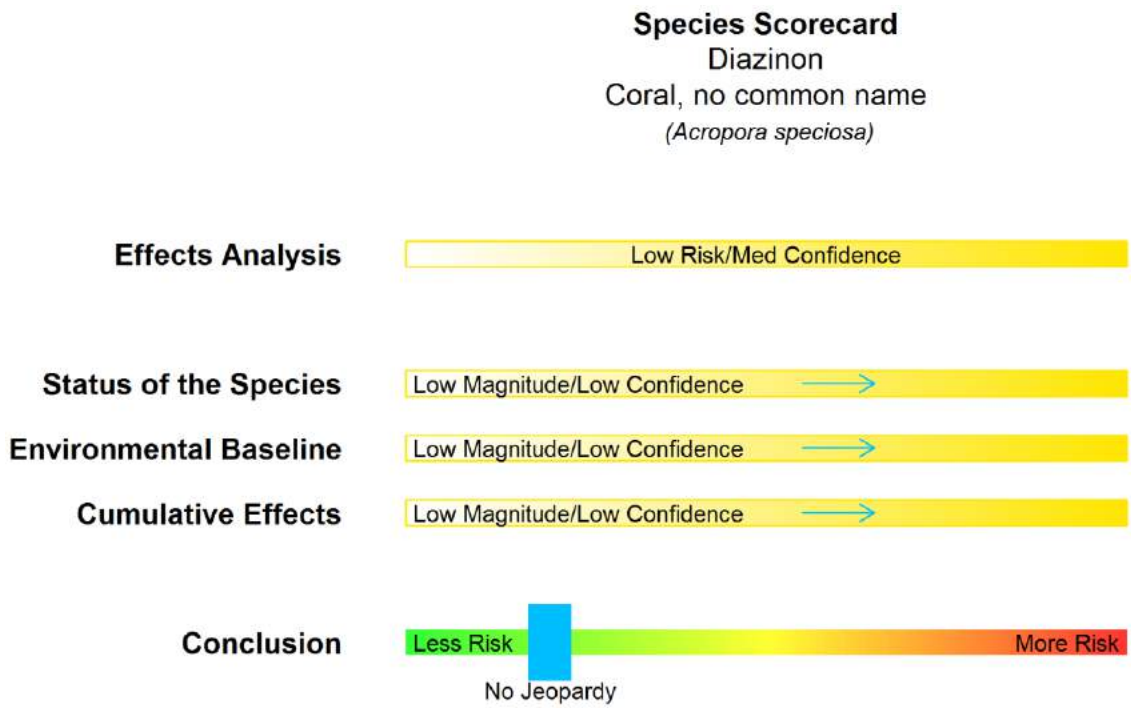

Figure 53. Species Score Card; Coral, Acropora speciosa; Diazinon

Effects Analysis: Low risk/Medium confidence

- Reduced abundance and productivity not anticipated in marine areas
- Potential effects to colonies including death and reduced settling of larvae
- Uncertain exposure concentrations in marine habitats

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Range is extensive throughout the Indo-Pacific region; less than 5% of the population is within the action area; overall status and growth rates unknown
- Threatened
- Recovery criteria not developed

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentrations in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: We find low confidence of medium risk to the species based on predicted marine exposure concentrations and expected population-level effects. Exposure is uncertain in marine habitats. About 5% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy

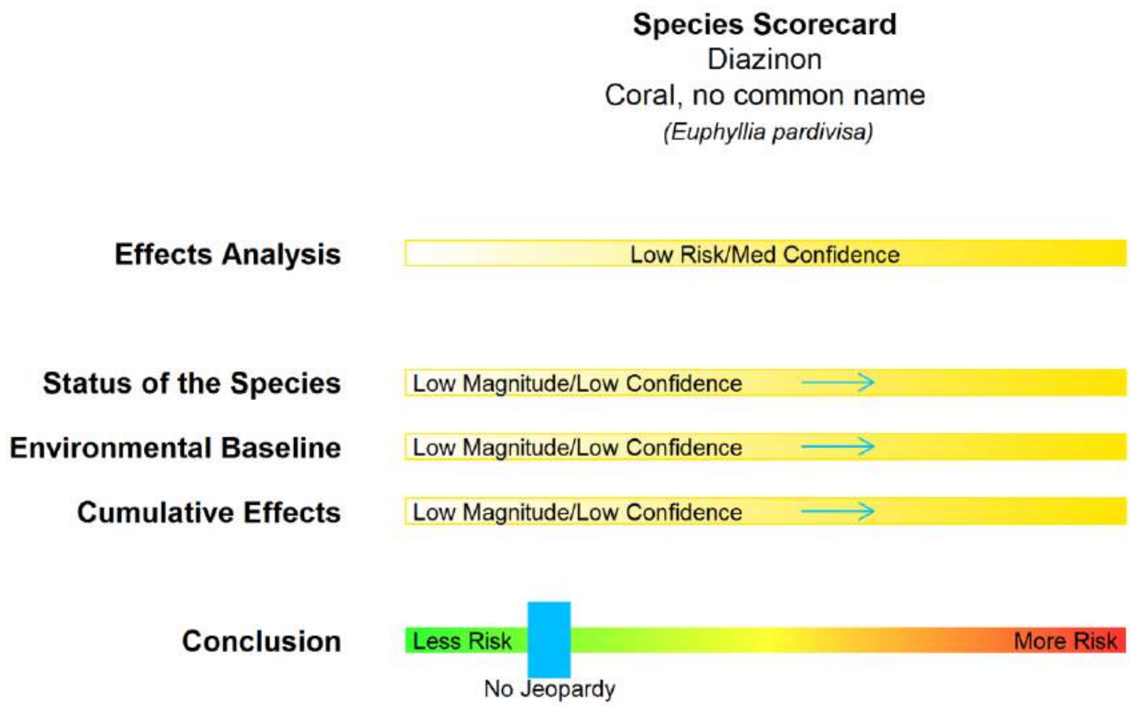

Figure 54. Species Score Card; Coral, Euphyllia pardivisa; Diazinon

Effects Analysis: Low risk/Medium confidence

- Reduced abundance and productivity not anticipated in marine areas
- Potential effects to colonies including death and reduced settling of larvae
- Uncertain exposure concentrations in marine habitats

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Range is extensive throughout the Indo-Pacific region; less than 5% of the population is within the action area; overall status and growth rates unknown
- Threatened
- Recovery criteria not developed

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentrations in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: We find low confidence of medium risk to the species based on predicted marine exposure concentrations and expected population-level effects. Exposure is uncertain in marine habitats. About 5% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy

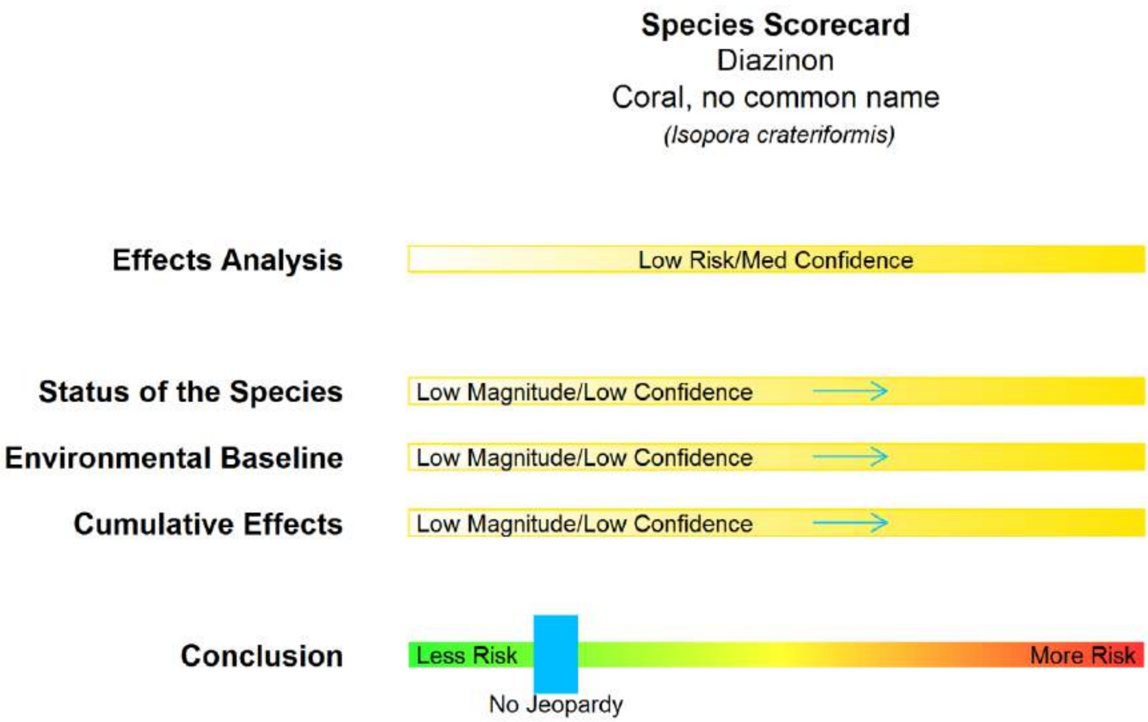

Figure 55. Species Score Card; Coral, Isopora crateriformis; Diazinon

Effects Analysis: Low risk/Medium confidence

- Reduced abundance and productivity not anticipated in marine areas
- Potential effects to colonies including death and reduced settling of larvae
- Uncertain exposure concentrations in marine habitats

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Range is extensive throughout the Indo-Pacific region; less than 5% of the population is within the action area; overall status and growth rates unknown
- Threatened
- Recovery criteria not developed

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentrations in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: We find low confidence of medium risk to the species based on predicted marine exposure concentrations and expected population-level effects. Exposure is uncertain in marine habitats. About 5% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy

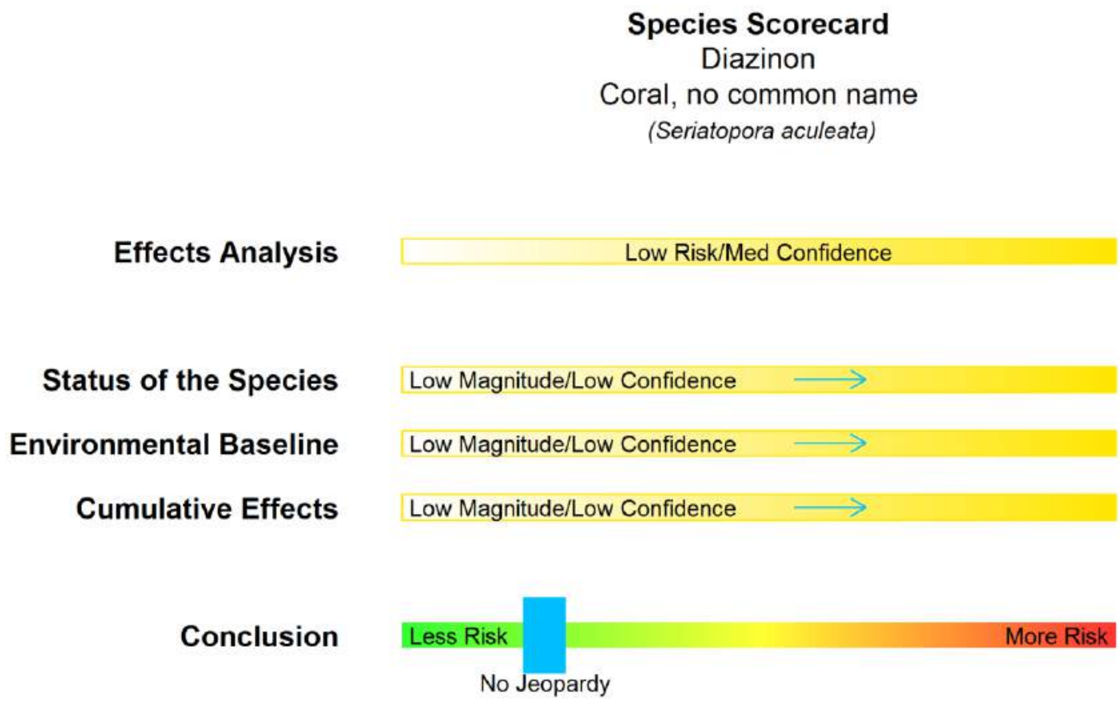

Figure 56. Species Score Card; Coral, Seriatopora aculeata; Diazinon

Effects Analysis: Low risk/Medium confidence

- Reduced abundance and productivity not anticipated in marine areas
- Potential effects to colonies including death and reduced settling of larvae
- Uncertain exposure concentrations in marine habitats

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Range is extensive throughout the Indo-Pacific region; less than 5% of the population is within the action area; overall status and growth rates unknown
- Threatened
- Recovery criteria not developed

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentrations in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: We find low confidence of medium risk to the species based on predicted marine exposure concentrations and expected population-level effects. Exposure is uncertain in marine habitats. About 5% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy

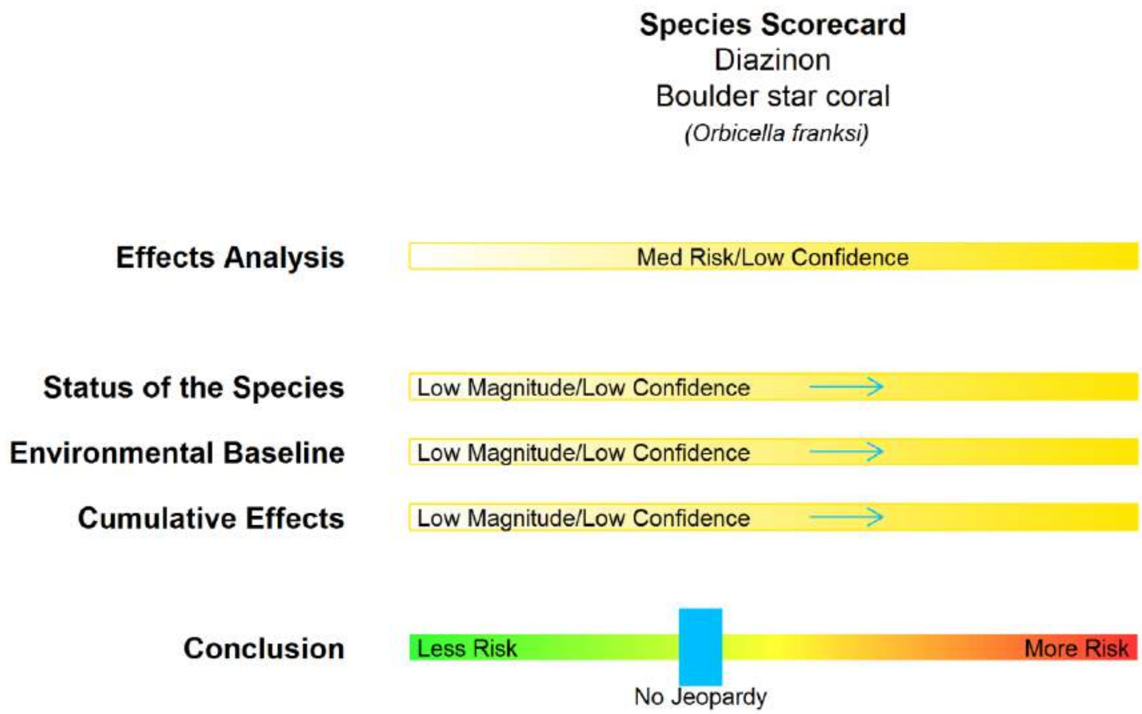

Figure 57. Species Score Card; Boulder star coral; Diazinon

Effects Analysis: Medium risk/Low confidence

- Reduced abundance and productivity not anticipated in marine areas
- Potential effects to colonies including death and reduced settling of larvae
- Uncertain exposure concentrations in marine habitats

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Reductions in abundance, population is currently stable
- Threatened
- Recovery criteria not developed

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentrations in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: We find low confidence of medium risk to the species based on predicted marine exposure concentrations and expected population-level effects. Exposure is uncertain in marine habitats, but most likely where colonies are proximate to river and stream mouths. A small portion of the species' range is in U.S. jurisdiction. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy

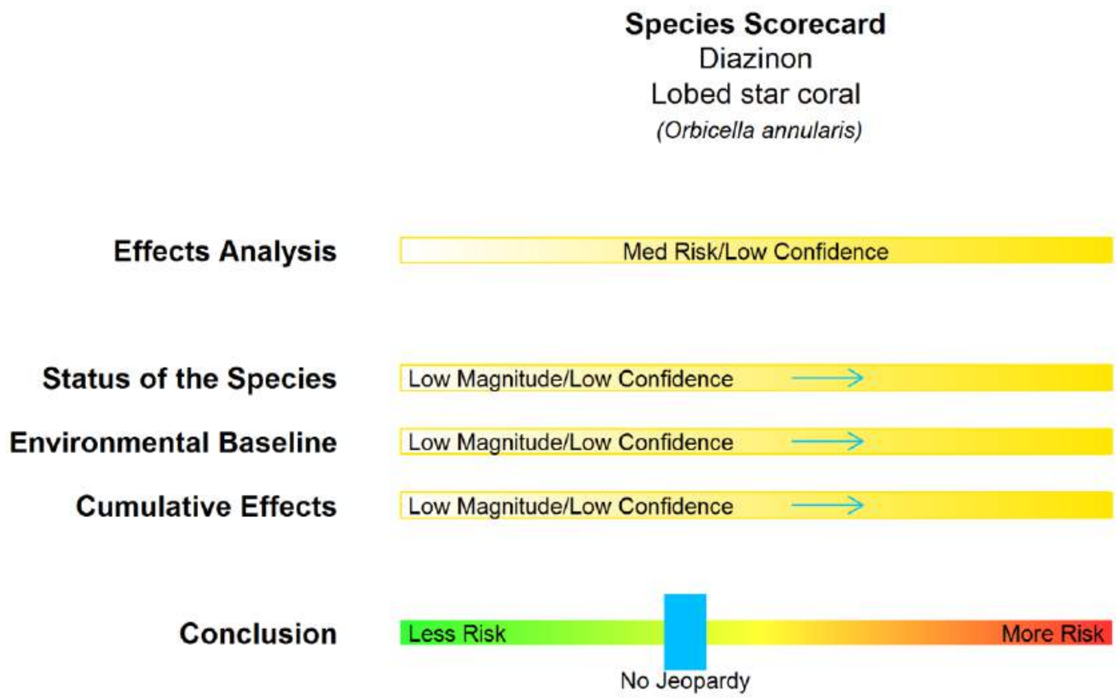

Figure 58. Species Score Card; Lobed star coral; Diazinon

Effects Analysis: Medium risk/Low confidence

- Reduced abundance and productivity not anticipated in marine areas
- Potential effects to colonies including death and reduced settling of larvae
- Uncertain exposure concentrations in marine habitats

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- 60% decline 2001-2012 due to bleaching. Most were considered "partial" mortalities to the colony. Abundance is stable.
- Threatened
- Recovery criteria not developed

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentrations in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: We find low confidence of medium risk to the species based on predicted marine exposure concentrations and expected population-level effects. Exposure is uncertain in marine habitats, but most likely where colonies are proximate to river and stream mouths. A small portion of the species' range is in U.S. jurisdiction. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy

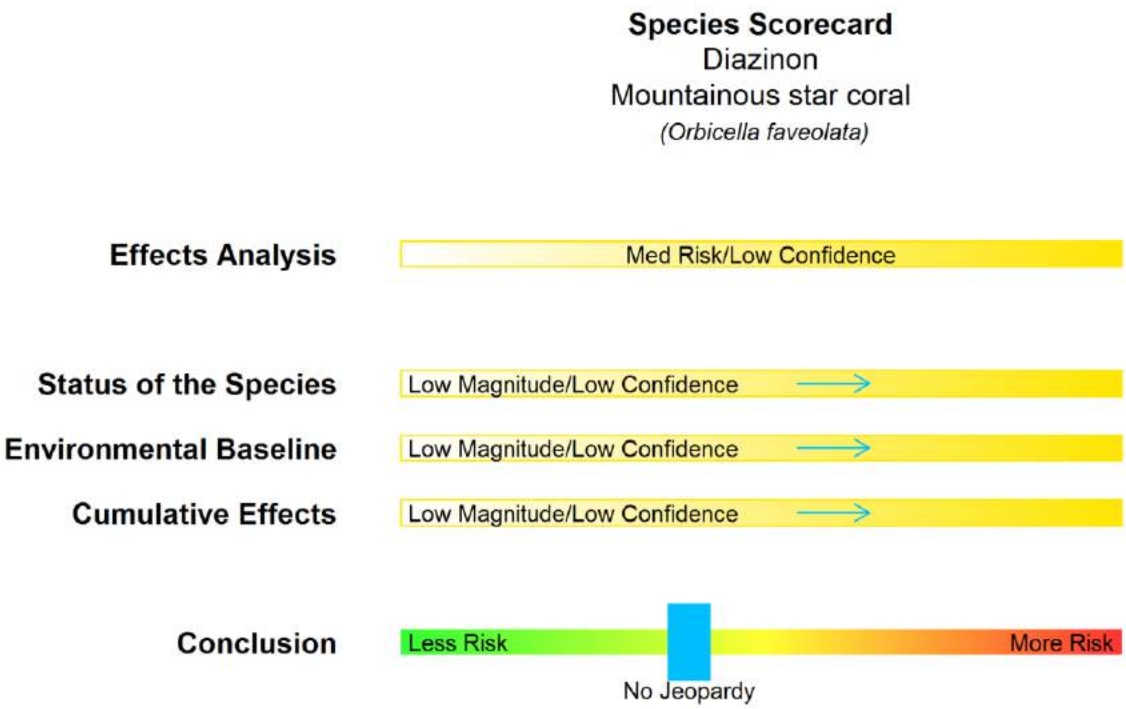

Figure 59. Species Score Card; Mountainous star coral; Diazinon

<u>Effects Analysis: Medium risk/Low confidence</u>

- Reduced abundance and productivity not anticipated in marine areas
- Potential effects to colonies including death and reduced settling of larvae
- Uncertain exposure concentrations in marine habitats

<u>Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Considered abundant; some areas have shown major declines due to warming-induced bleaching and disease
- Threatened
- Recovery criteria not developed

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters

<u>Conclusion:</u> We find low confidence of medium risk to the species based on predicted marine exposure concentrations and expected population-level effects. Exposure is uncertain in marine habitats, but most likely where colonies are proximate to river and stream mouths. A small portion of the species' range is in U.S. jurisdiction. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

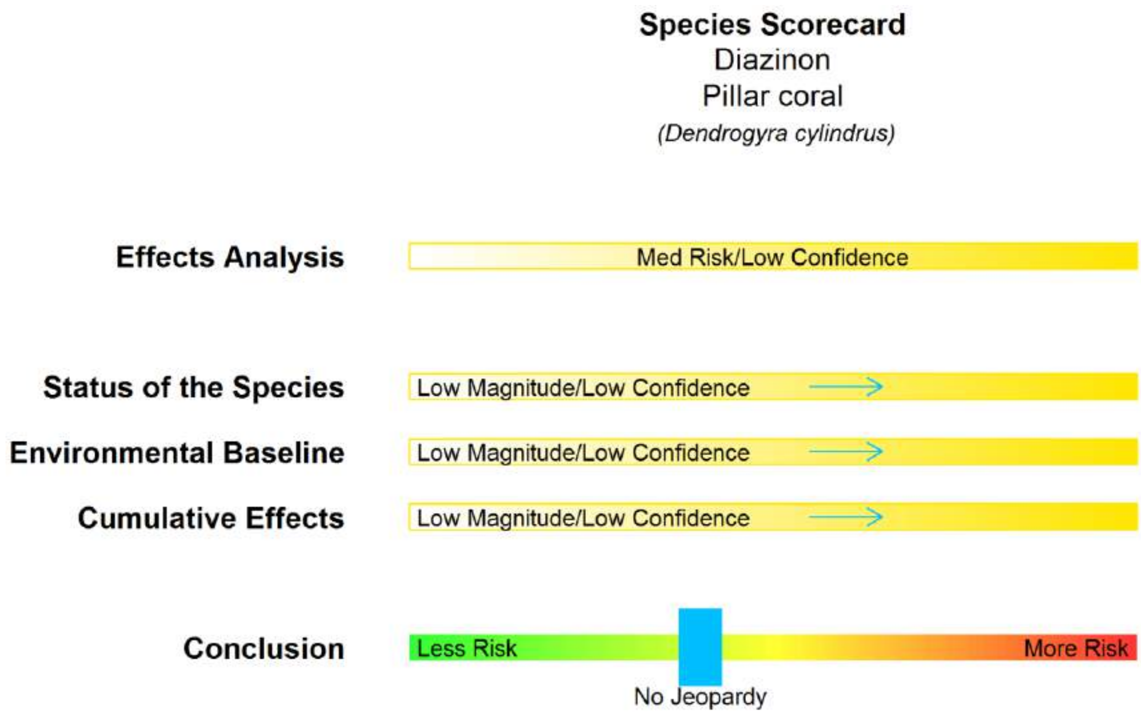

Figure 60. Species Score Card; Pillar coral; Diazinon

<u>Effects Analysis: Medium risk/Low confidence</u>

- Reduced abundance and productivity not anticipated in marine areas
- Potential effects to colonies including death and reduced settling of larvae
- Uncertain exposure concentrations in marine habitats

<u>Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Uncommon, rarely found in aggregations - yet little evidence of population declines over years of monitoring. Unknown trends in abundance or productivity
- Threatened
- Recovery criteria not developed

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentrations in marine habitats

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters

<u>Conclusion:</u> We find low confidence of medium risk to the species based on predicted marine exposure concentrations and expected population-level effects. Exposure is uncertain in marine habitats, but most likely where colonies are proximate to river and stream mouths. Only a small portion of the species' range is in U.S. jurisdiction. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

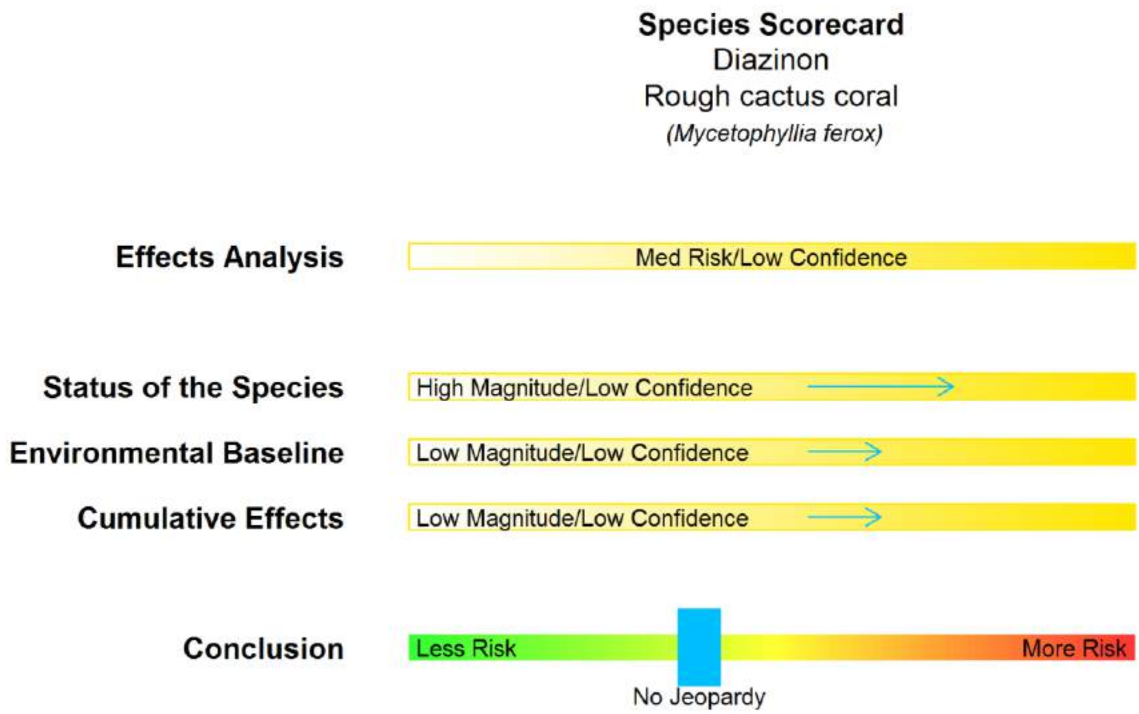

Figure 61. Species Score Card; Rough cactus coral; Diazinon

Effects Analysis: Medium risk/Low confidence

- Reduced abundance and productivity not anticipated in marine areas
- Potential effects to colonies including death and reduced settling of larvae
- Uncertain exposure concentrations in marine habitats

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Uncommon to rare. Species saw declines since the 1970's. Highly affected by disease. Unknown trends in abundance or productivity
- Threatened
- Recovery criteria not developed

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentrations in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: We find low confidence of medium risk to the species based on predicted marine exposure concentrations and expected population-level effects. Exposure is uncertain in marine habitats, but most likely where colonies are proximate to river and stream mouths. Only a small portion of the species' range is in U.S. jurisdiction. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy

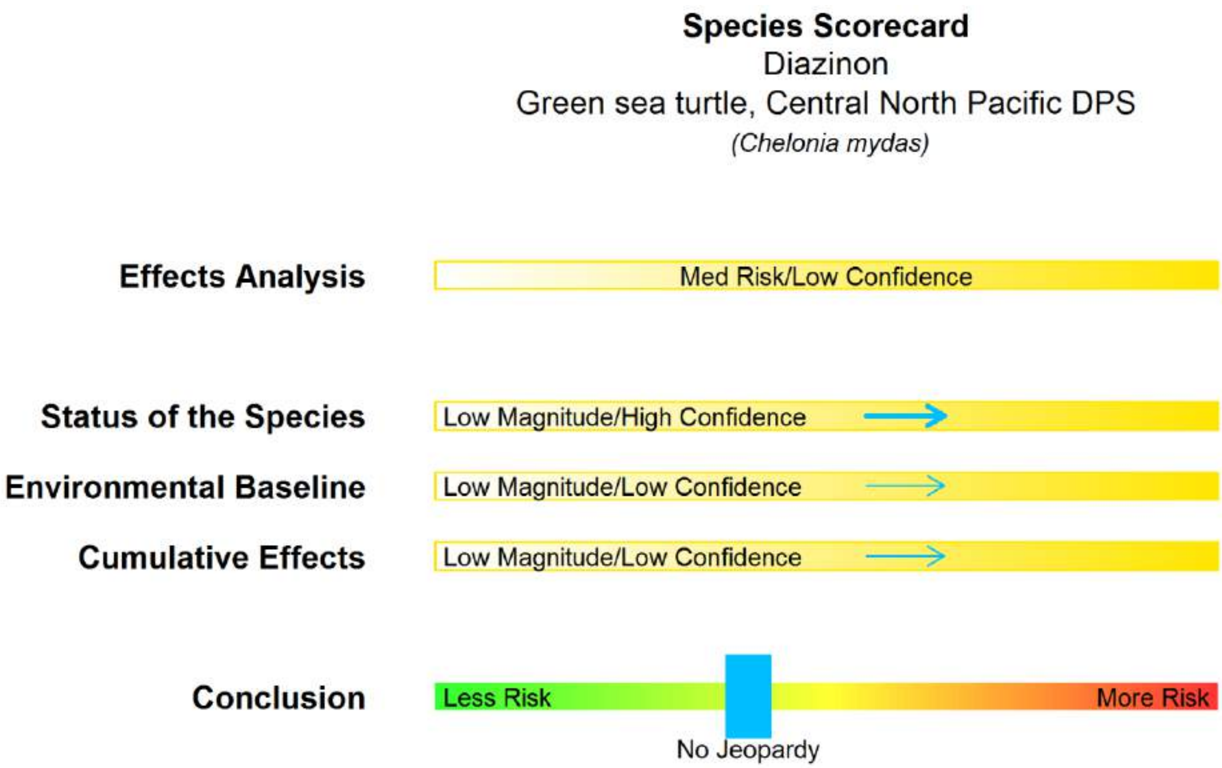

Figure 62. Species Score Card; Green sea turtle, Central North Pacific DPS; Diazinon

<u>Effects Analysis: Medium risk/Low confidence</u>

- Significant reductions in abundance and productivity not anticipated in marine areas
- Potential effects include reduced cholinesterase activity and impaired swimming
- Uncertain exposure concentrations in marine habitats

<u>Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ High confidence</u>

- Population nesting abundance is increasing at estimated rate of 4.8% annually. DPS has low level of genetic diversity. Population considered resilient.
- Threatened
- Recovery criteria not met

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in freshwater habitats

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters

<u>Conclusion:</u> We find low confidence of medium risk to the species based on predicted marine exposure concentrations and expected population-level effects. The species is most at risk while in shallow coastal areas. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

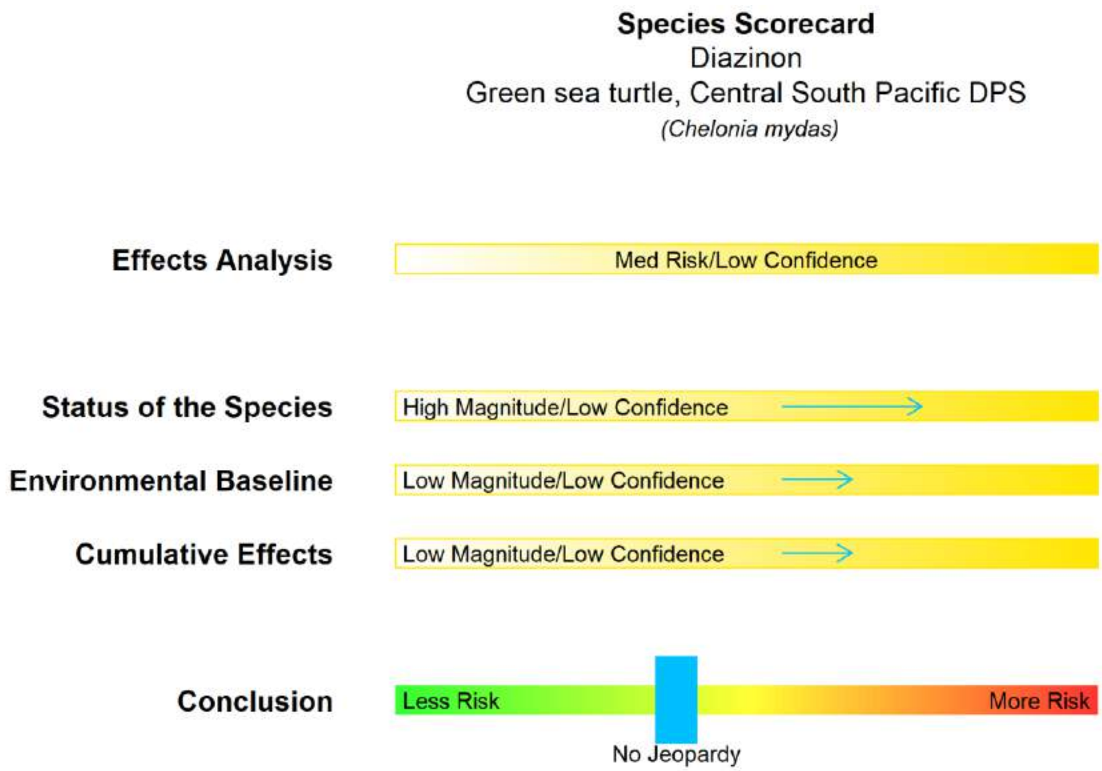

Figure 63. Species Score Card; Green sea turtle, Central South Pacific DPS; Diazinon

<u>Effects Analysis: Medium risk/Low confidence</u>

- Significant reductions in abundance and productivity not anticipated in marine areas
- Potential effects include reduced cholinesterase activity and impaired swimming
- Uncertain exposure concentrations in marine habitats

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ Low confidence</u>

- Nesting abundance considered low, 59 known sites, most outside action area; Unknown population trends; Existing data suggest steep declines due to illegal harvest of eggs
- Endangered
- Recovery criteria not met

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in freshwater habitats

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters

<u>Conclusion:</u> We find low confidence of medium risk to the species based on predicted marine exposure concentrations and expected population-level effects. The species is most at risk while in shallow coastal areas. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

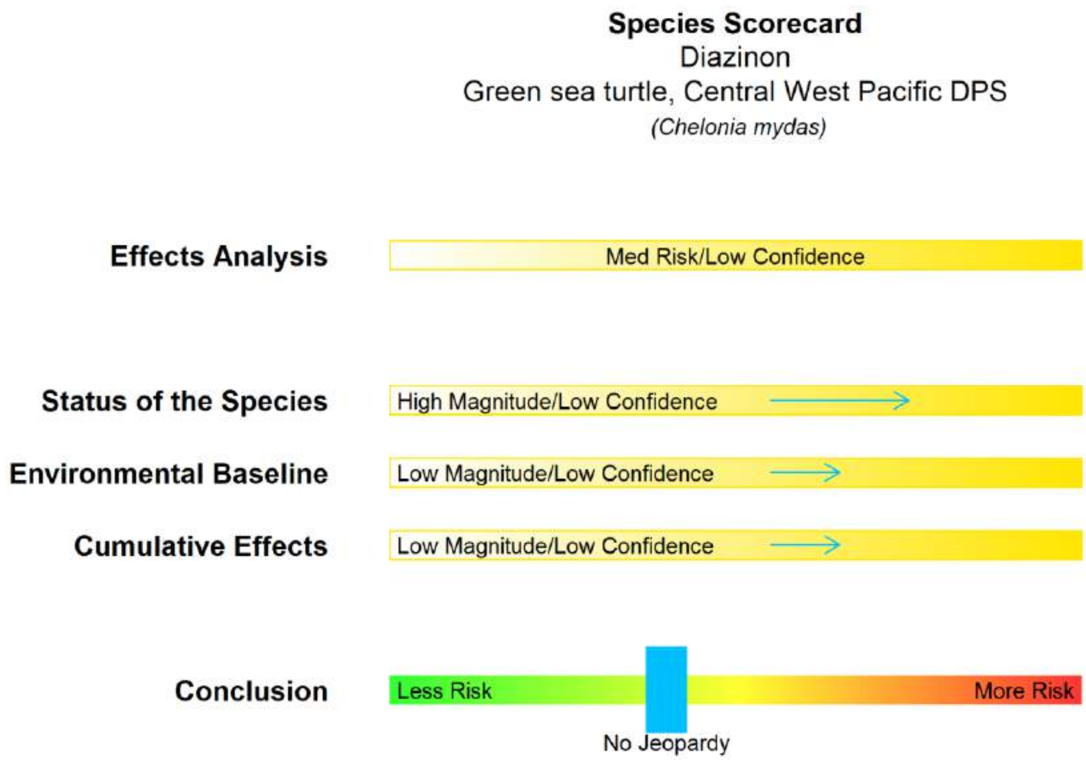

Figure 64. Species Score Card; Green sea turtle, Central West Pacific DPS; Diazinon

<u>Effects Analysis: Medium risk/Low confidence</u>

- Significant reductions in abundance and productivity not anticipated in marine areas
- Potential effects include reduced cholinesterase activity and impaired swimming
- Uncertain exposure concentrations in marine habitats

<u>Status of the Species: Minimal increased risk of jeopardy; High magnitude/ Low confidence</u>

- No available population trend data; Most of species' range outside of action area.
- Endangered
- Recovery criteria not met

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in freshwater habitats

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters

<u>Conclusion:</u> We find low confidence of medium risk to the species based on predicted marine exposure concentrations and expected population-level effects. The species is most at risk while in shallow coastal areas. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

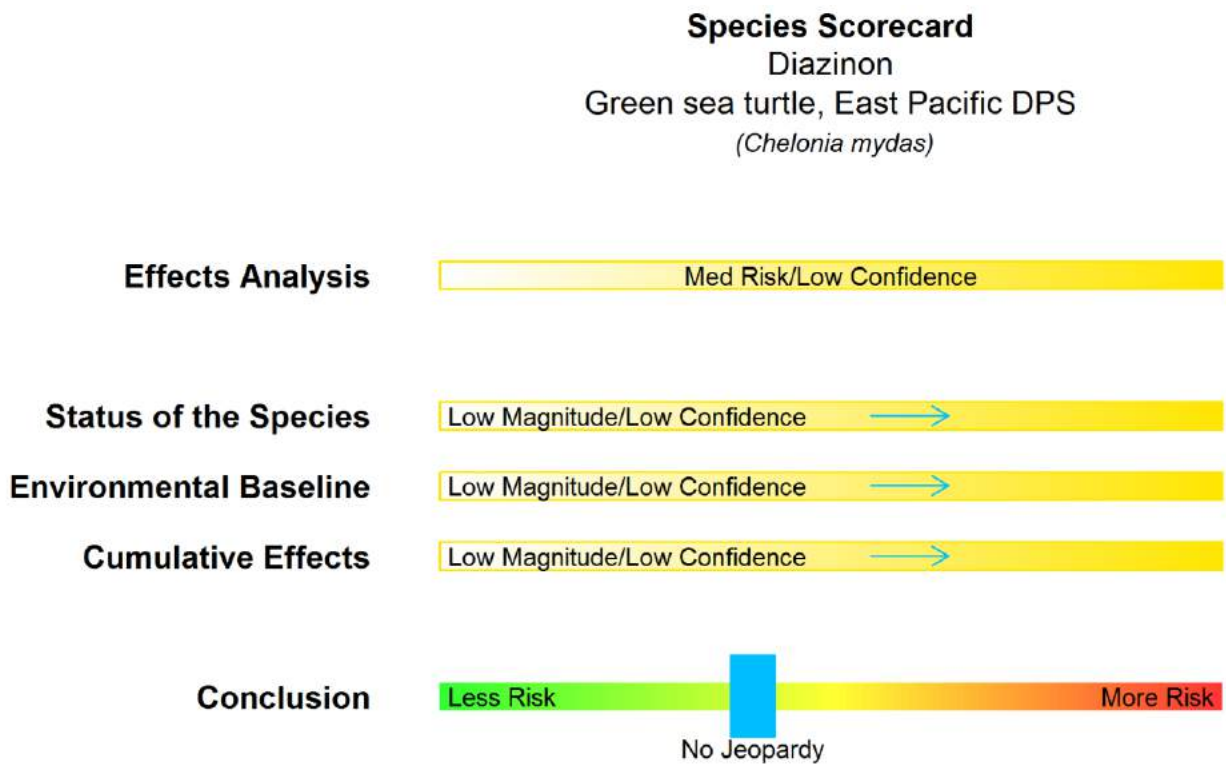

Figure 65. Species Score Card; Green sea turtle, East Pacific DPS; Diazinon

Effects Analysis: Medium risk/Low confidence

- Significant reductions in abundance and productivity not anticipated in marine areas
- Potential effects include reduced cholinesterase activity and impaired swimming
- Uncertain exposure concentrations in marine habitats

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- 39 nesting sites with an estimated 20,062 nesting females (58% of those at the largest nesting site in Colola, Mexico). Monitoring data suggest the population is increasing.
- Threatened
- Recovery criteria not met

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in freshwater habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: We find low confidence of medium risk to the species based on predicted marine exposure concentrations and expected population-level effects. The species is most at risk while in shallow coastal areas. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy

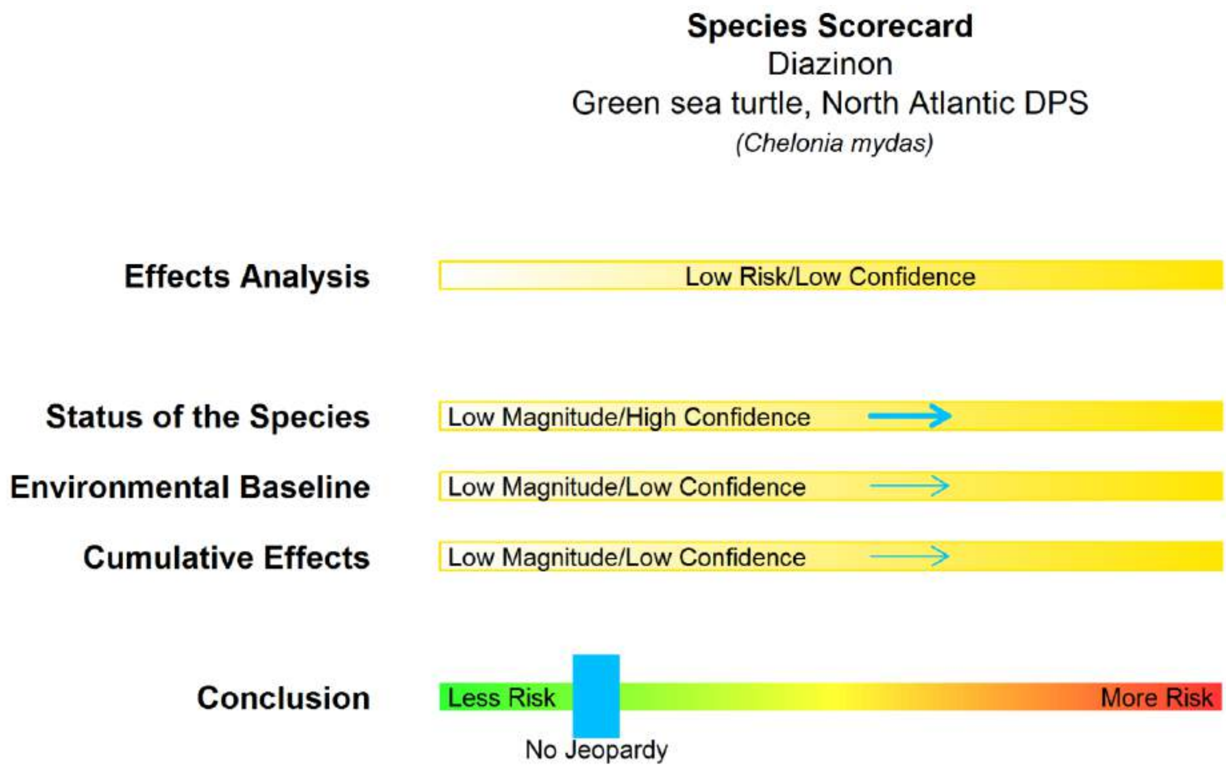

Figure 66. Species Score Card; Green sea turtle, North Atlantic DPS; Diazinon

<u>Effects Analysis: Low risk/Low confidence</u>

- Significant reductions in abundance and productivity not anticipated in marine areas
- Potential effects include reduced cholinesterase activity and impaired swimming
- Uncertain exposure concentrations in marine habitats

<u>Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Population shows increasing trend
- Threatened
- Recovery criteria not met

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in freshwater habitats

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters

<u>Conclusion:</u> We find low confidence of low risk to the species based on predicted marine exposure concentrations and expected population-level effects. The species is most at risk while in shallow coastal areas. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

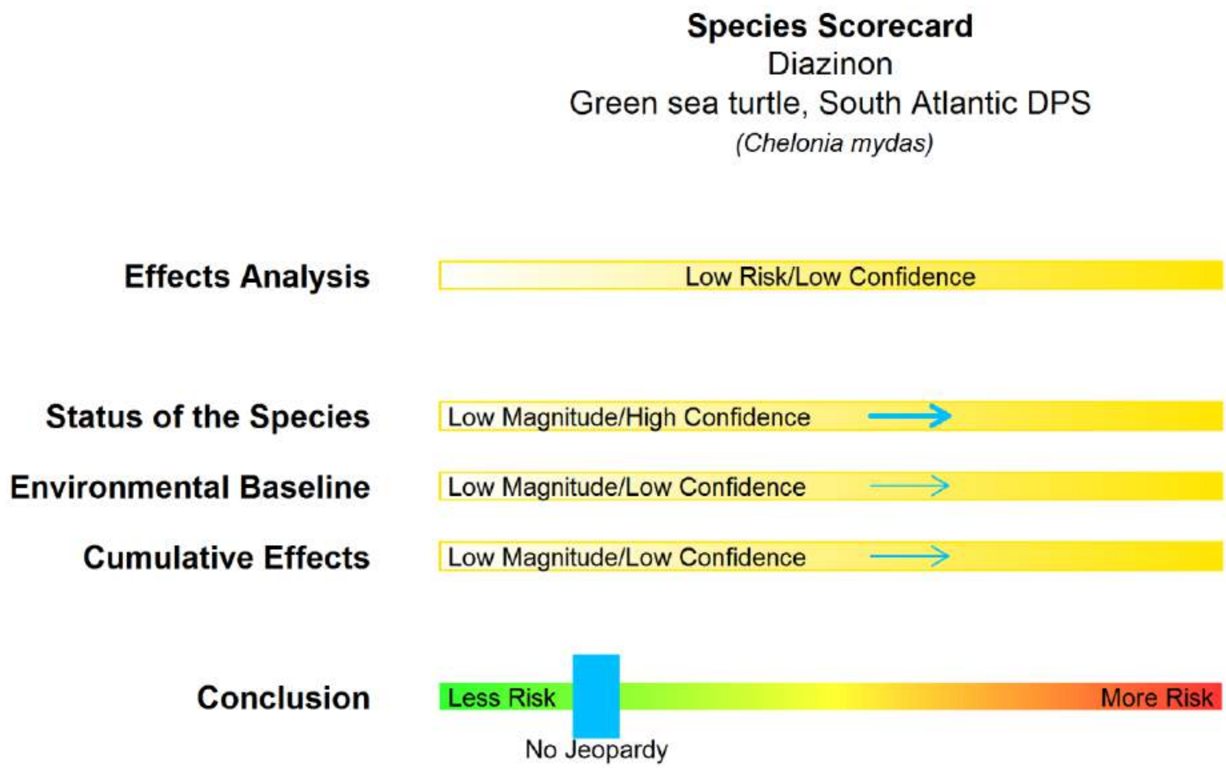

Figure 67. Species Score Card; Green sea turtle, South Atlantic DPS; Diazinon

Effects Analysis: Low risk/Low confidence

- Significant reductions in abundance and productivity not anticipated in marine areas
- Potential effects include reduced cholinesterase activity and impaired swimming
- Uncertain exposure concentrations in marine habitats

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Sparse data available, suggests population is increasing; Most of DPS range outside of the action area
- Threatened
- Recovery criteria not all met

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: We find low confidence of low risk to the species based on predicted marine exposure concentrations and expected population-level effects. The species is most at risk while in shallow coastal areas. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy

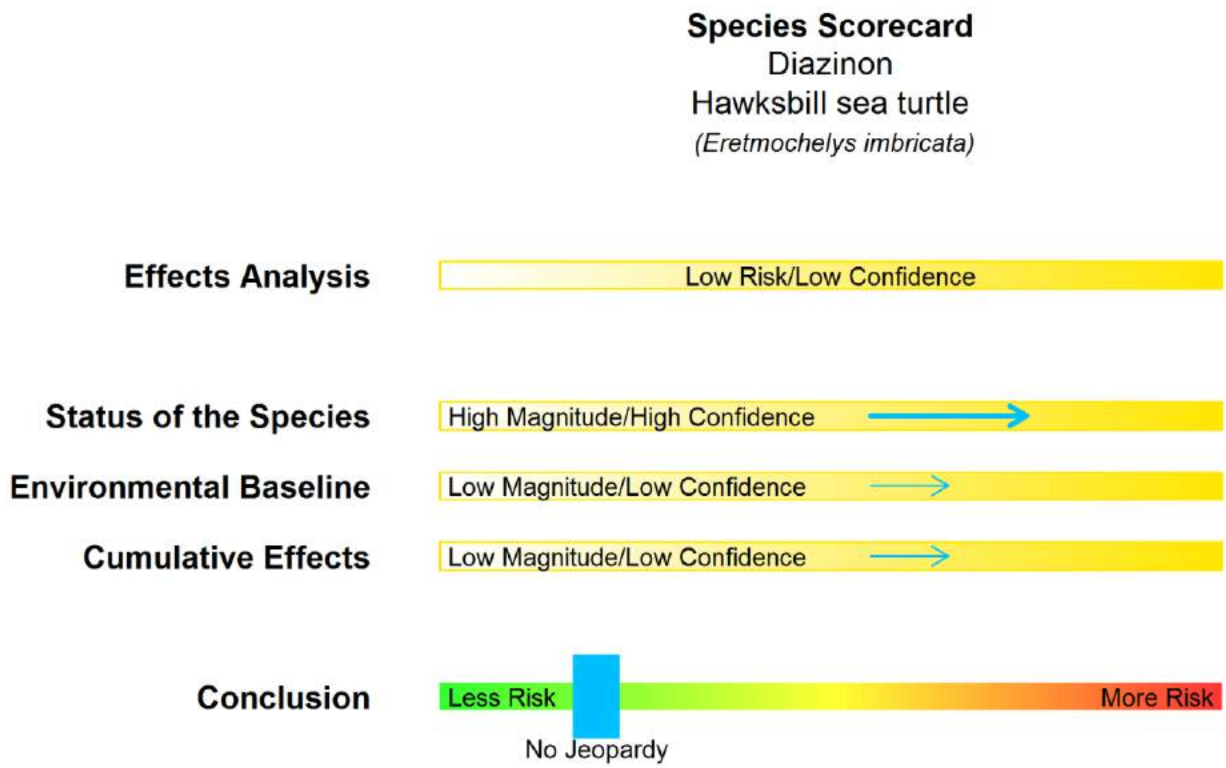

Figure 68. Species Score Card; Hawksbill sea turtle; Diazinon

<u>Effects Analysis: Low risk/Low confidence</u>

- Significant reductions in abundance and productivity not anticipated in marine areas
- Potential effects include reduced cholinesterase activity and impaired swimming
- Uncertain exposure concentrations in marine habitats

<u>Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Population abundance improving in Atlantic and Indian Ocean; abundance declining in Pacific Ocean over the last 20 - 100 years. 68% of nesting sites exhibited declines.
- Endangered
- Recovery criteria not met

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in marine waters yet effects uncertain

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters

<u>Conclusion:</u> We find low confidence of low risk to the species based on predicted marine exposure concentrations and expected population-level effects. The species is most at risk while in shallow coastal areas. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>**Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy**</u>

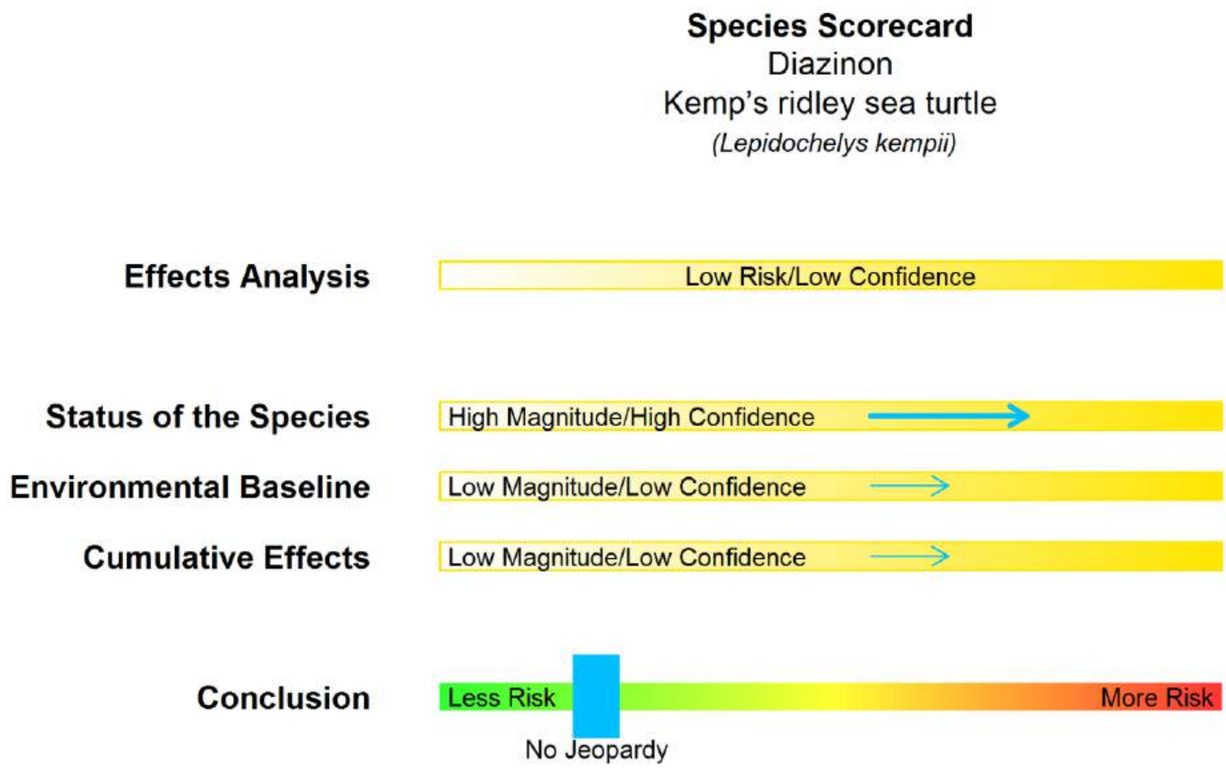

Figure 69. Species Score Card; Kemp's ridley sea turtle; Diazinon

<u>Effects Analysis: Low risk/Low confidence</u>

- Significant reductions in abundance and productivity not anticipated in marine areas
- Potential effects include reduced cholinesterase activity and impaired swimming
- Uncertain exposure concentrations in marine habitats

<u>Status of the Species: Minimal increased risk of jeopardy; High magnitude/ High confidence</u>

- Abundance trends negative
- Endangered
- Recovery criteria not met

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in marine waters yet effects uncertain

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters

<u>Conclusion:</u> We find low confidence of low risk to the species based on predicted marine exposure concentrations and expected population-level effects. The species is most at risk while in shallow coastal areas. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>**Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy**</u>

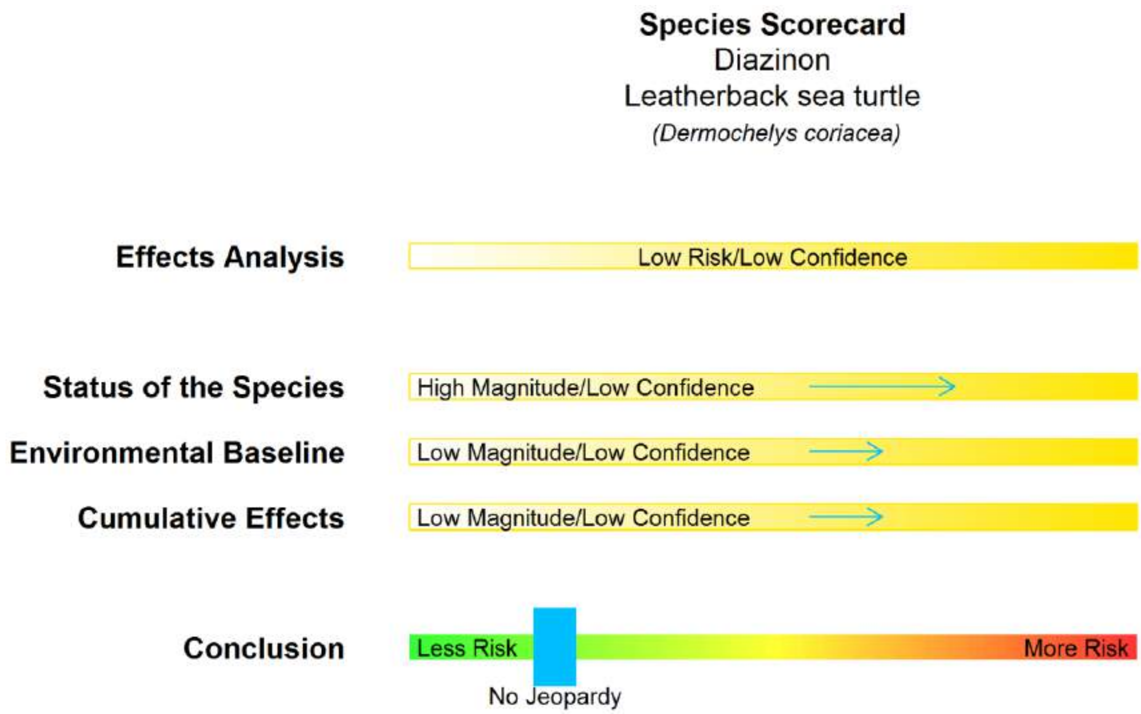

Figure 70. Species Score Card; Leatherback sea turtle; Diazinon

Effects Analysis: Low risk/Low confidence

- Significant reductions in abundance and productivity not anticipated in marine areas
- Potential effects include reduced cholinesterase activity and impaired swimming
- Uncertain exposure concentrations in marine habitats

Status of the Species: Minimal increased risk of jeopardy; High magnitude/ Low confidence

- Pacific population declined from 81,000 in to less than 3,000 with a continued rate of loss of approximately 6%. Atlantic population is stable and showing signs of increasing growth of between 4-5.6% in Florida and 9-13% in the U.S. Virgin Islands.
- Endangered
- Recovery criteria not met

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in marine waters yet effects uncertain

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: We find low confidence of low risk to the species based on predicted marine exposure concentrations and expected population-level effects. The species is most at risk while in shallow coastal areas. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy

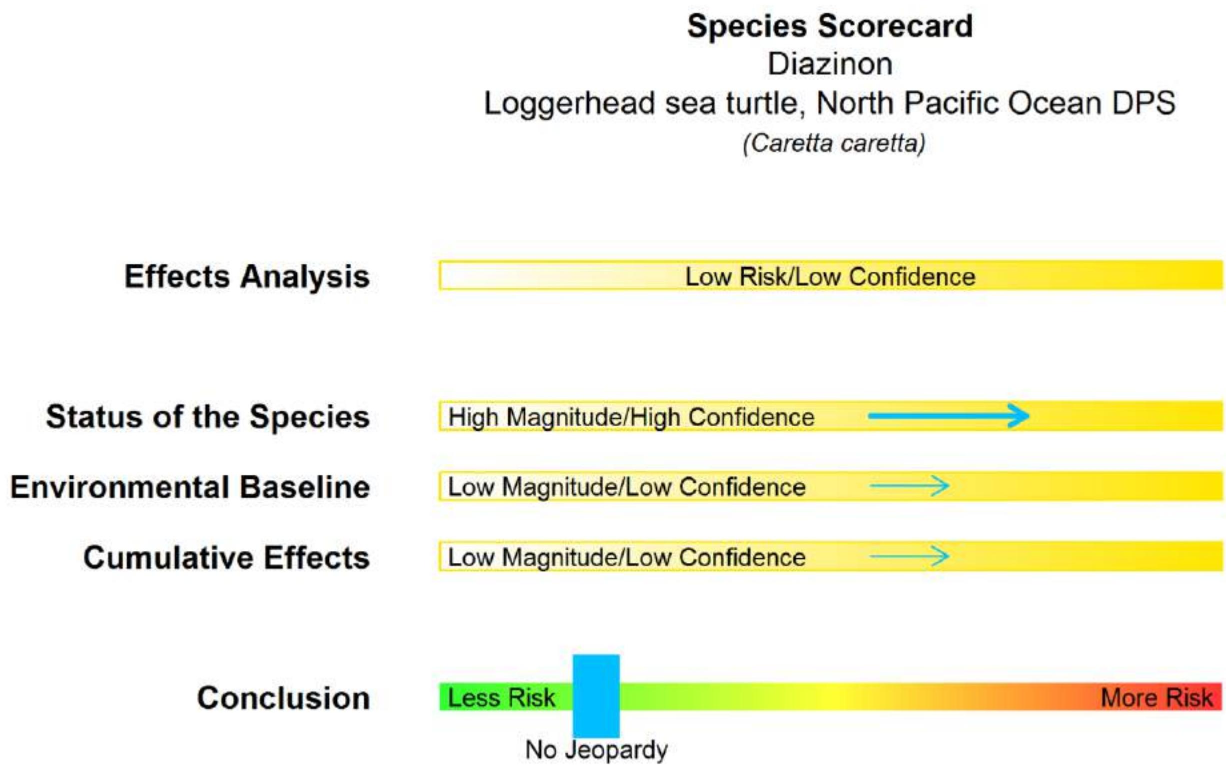

Figure 71. Species Score Card; Loggerhead sea turtle, North Pacific Ocean DPS; Diazinon

Effects Analysis: Low risk/Low confidence

- Significant reductions in abundance and productivity not anticipated in marine areas
- Potential effects include reduced cholinesterase activity and impaired swimming
- Uncertain exposure concentrations in marine habitats

Status of the Species: Minimal increased risk of jeopardy; High magnitude/ High confidence

- Population growth rate estimated at 0.032; depressed compared to historical numbers.
- Threatened; Population has declined an estimated 80% in past 20 years.
- Recovery criteria not met

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in marine waters yet effects uncertain

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters but effects uncertain

Conclusion: We find low confidence of low risk to the species based on predicted marine exposure concentrations and expected population-level effects. The species is most at risk while in shallow coastal areas. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy

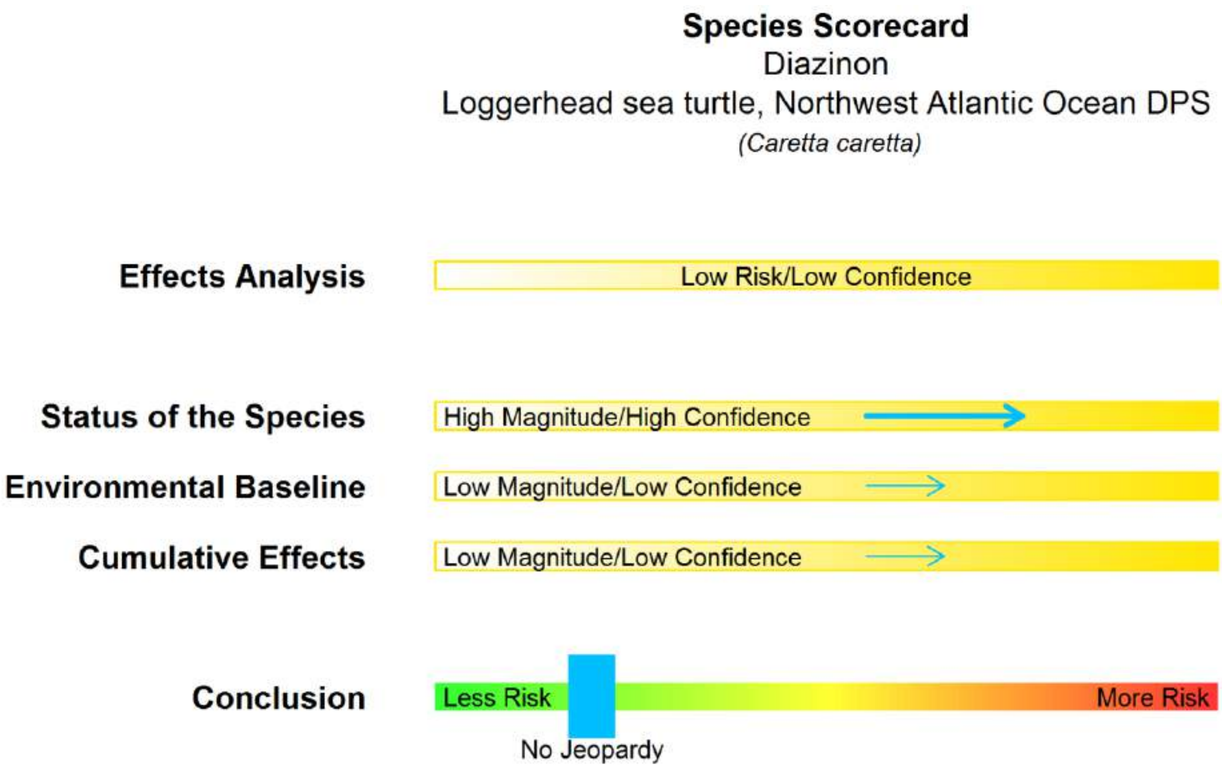

Figure 72. Species Score Card; Loggerhead sea turtle, Northwest Atlantic Ocean DPS; Diazinon

Effects Analysis: Low risk/Low confidence

- Significant reductions in abundance and productivity not anticipated in marine areas
- Potential effects include reduced cholinesterase activity and impaired swimming
- Uncertain exposure concentrations in marine habitats

Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence

- All sub-populations exhibiting negative population growth rates
- Threatened
- Recovery criteria not met

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in marine waters yet effects uncertain

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters but effects uncertain

Conclusion: We find low confidence of low risk to the species based on predicted marine exposure concentrations and expected population-level effects. The species is most at risk while in shallow coastal areas. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy

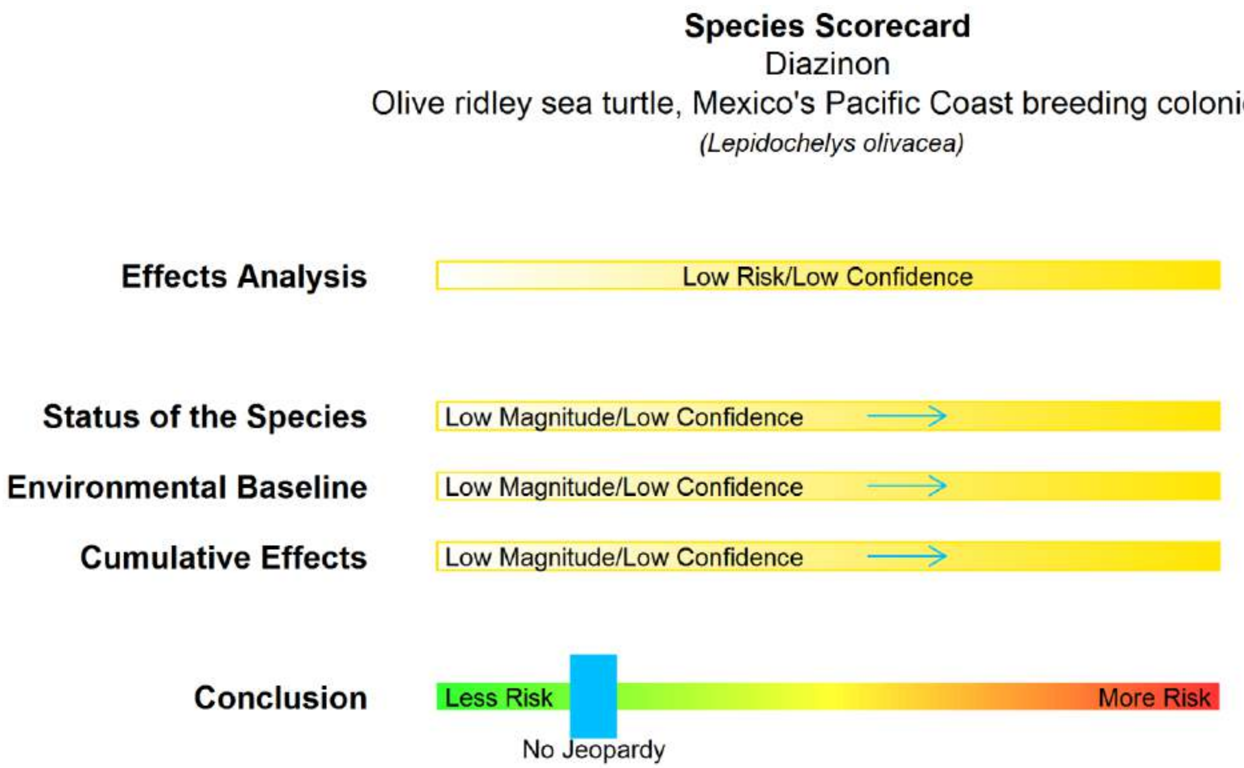

Figure 73. Species Score Card; Olive ridley sea turtle, Mexico's Pacific Coast breeding colonies; Diazinon

Effects Analysis: Low risk/Low confidence

- Significant reductions in abundance and productivity not anticipated in marine areas
- Potential effects include reduced cholinesterase activity and impaired swimming
- Uncertain exposure concentrations in marine habitats

Status of the Species: Increased risk of jeopardy; Low magnitude/ Low confidence

- 50% decline in a population abundance since the 1960's; 80% reductions in some nesting populations in the Western Atlantic Ocean since 1967;
- Threatened;
- Recovery criteria not met;

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in marine waters yet effects uncertain

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters but effects uncertain

Conclusion: We find low confidence of low risk to the species based on predicted marine exposure concentrations and expected population-level effects. The species is most at risk while in shallow coastal areas. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy

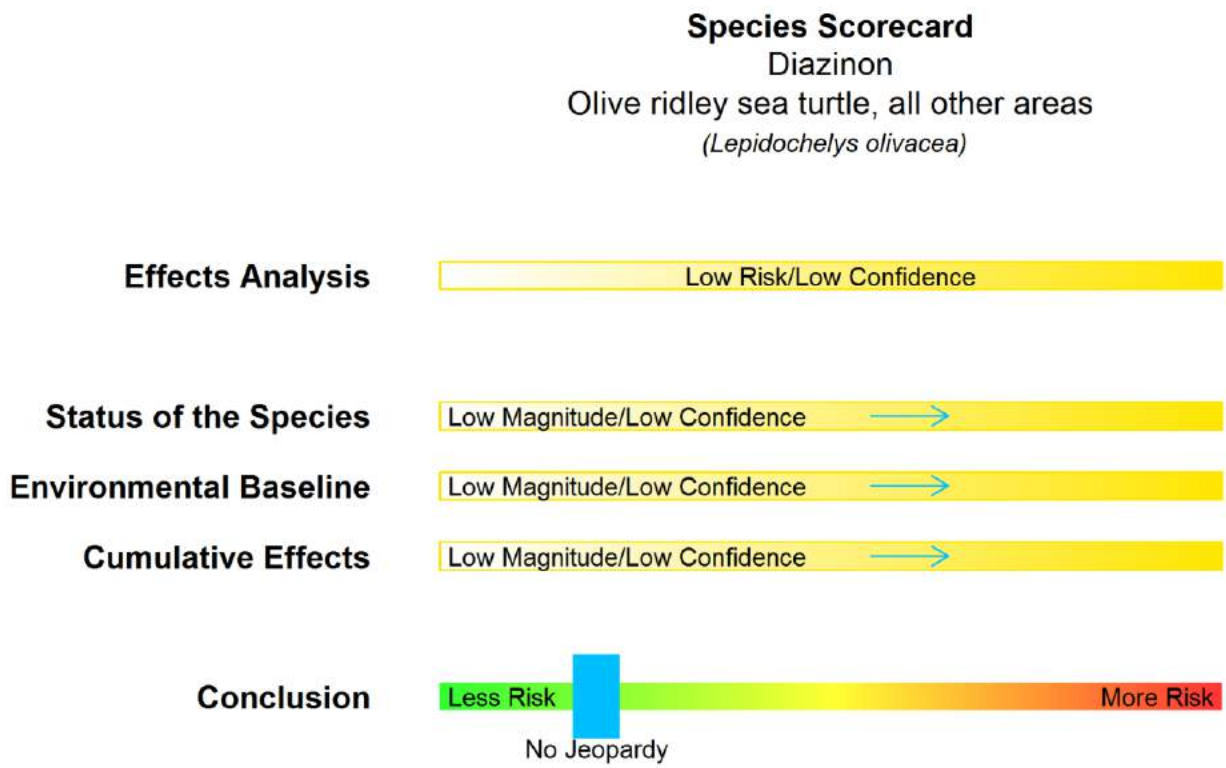

Figure 74. Species Score Card; Olive ridley sea turtle, all other areas; Diazinon

Effects Analysis: Low risk/Low confidence

- Significant reductions in abundance and productivity not anticipated in marine areas
- Potential effects include reduced cholinesterase activity and impaired swimming
- Uncertain exposure concentrations in marine habitats

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Some nesting populations are stable or increasing, but most remain severely depressed. Most populations are outside of the action area.
- Threatened
- Recovery criteria not met

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in marine waters yet effects uncertain

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters but effects uncertain

Conclusion: We find low confidence of low risk to the species based on predicted marine exposure concentrations and expected population-level effects. The species is most at risk while in shallow coastal areas. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy

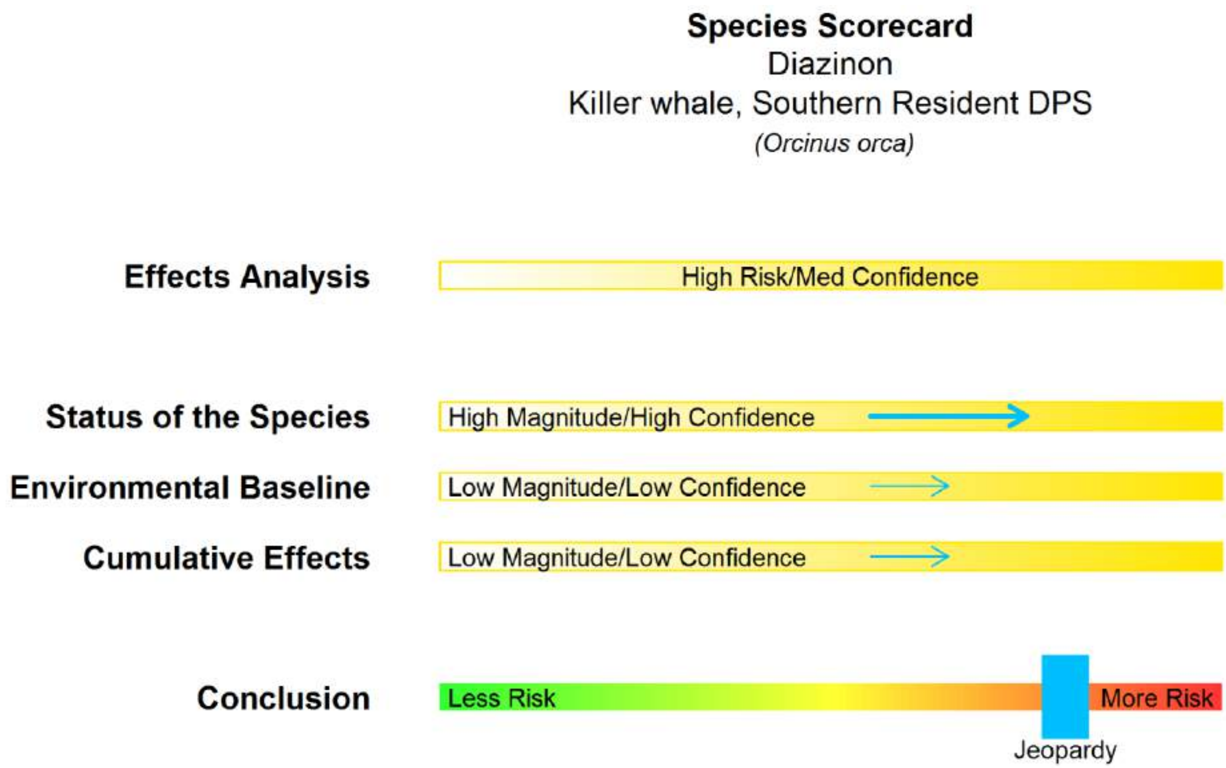

Figure 75. Species Score Card; Killer whale, Southern Resident DPS; Diazinon

<u>Effects Analysis: High risk/Medium confidence</u>

- Reduced abundance anticipated based on effects to prey (Chinook salmon)
- Anticipated effects include reduced availability of Chinook salmon and other fish prey leading to reduced growth, chronic lack of food;

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Stable to declining populations in past decade, unstable population structure
- Endangered, very small population size (n=76 individuals)
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/Low confidence</u>

- Elevated temperatures may occur in marine habitats;
- Environmental mixtures anticipated in marine habitats with high uncertainty of toxicity

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures may occur in marine waters

<u>Conclusion:</u> We find medium confidence of a high risk to Southern Resident Killer whales based on expected adverse effects to orca whales' prey base. We have high confidence in exposure concentrations predicted for freshwater habitats where the Orca's prey is most at risk during spawning, rearing, and migration. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action due to continuous reductions in prey.

<u>Diazinon is likely to jeopardize the continued existence of this species: Jeopardy</u>

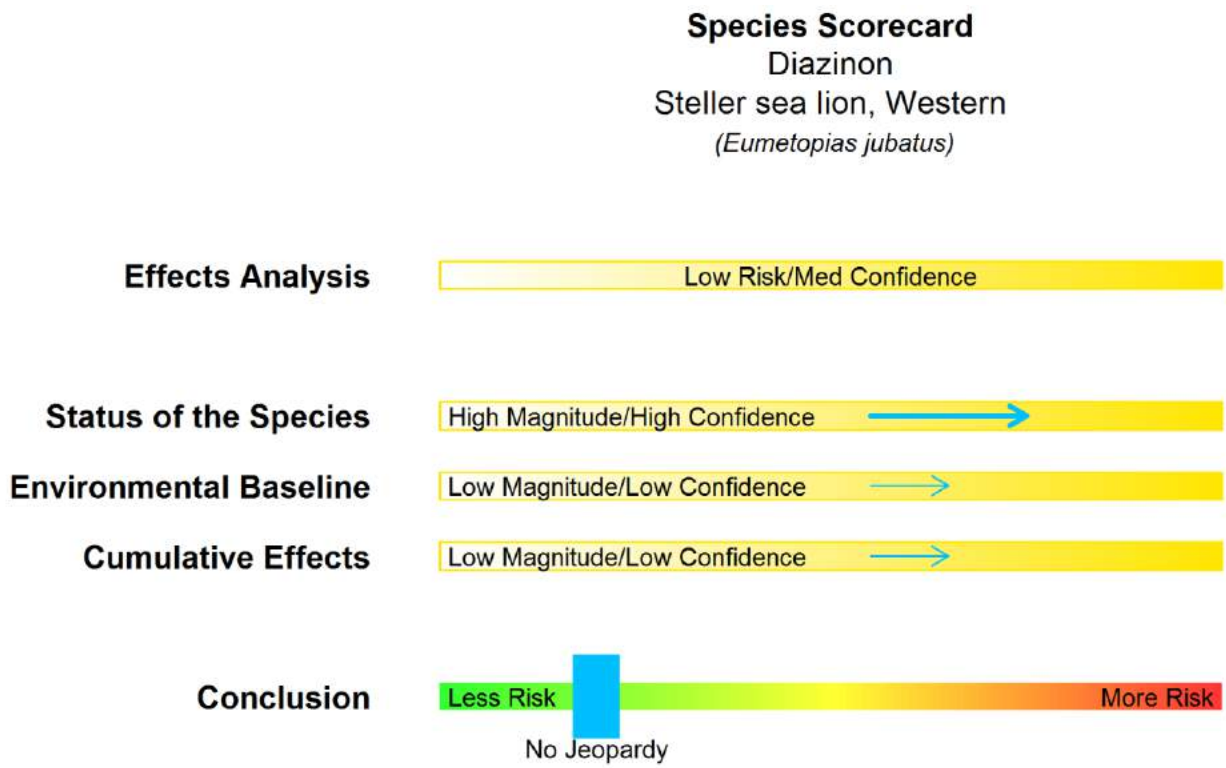

Figure 76. Species Score Card; Steller sea lion, Western; Diazinon

Effects Analysis: Low risk/Medium confidence

- Significant reductions in abundance and productivity not anticipated in marine areas
- Potential effects include reduced cholinesterase activity, impaired swimming, and reduced prey abundance
- Uncertain exposure concentrations in marine habitats

Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence

- 30% of 1950's historical abundance, stable to slight negative population trend
- Endangered
- Recovery criteria not met

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect sea lions
- Environmental mixtures anticipated in marine waters yet effects uncertain

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters but effects uncertain

Conclusion: We find medium confidence of low risk to the species based on predicted marine exposure concentrations and expected population-level effects. The species is most at risk from reductions in prey. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy

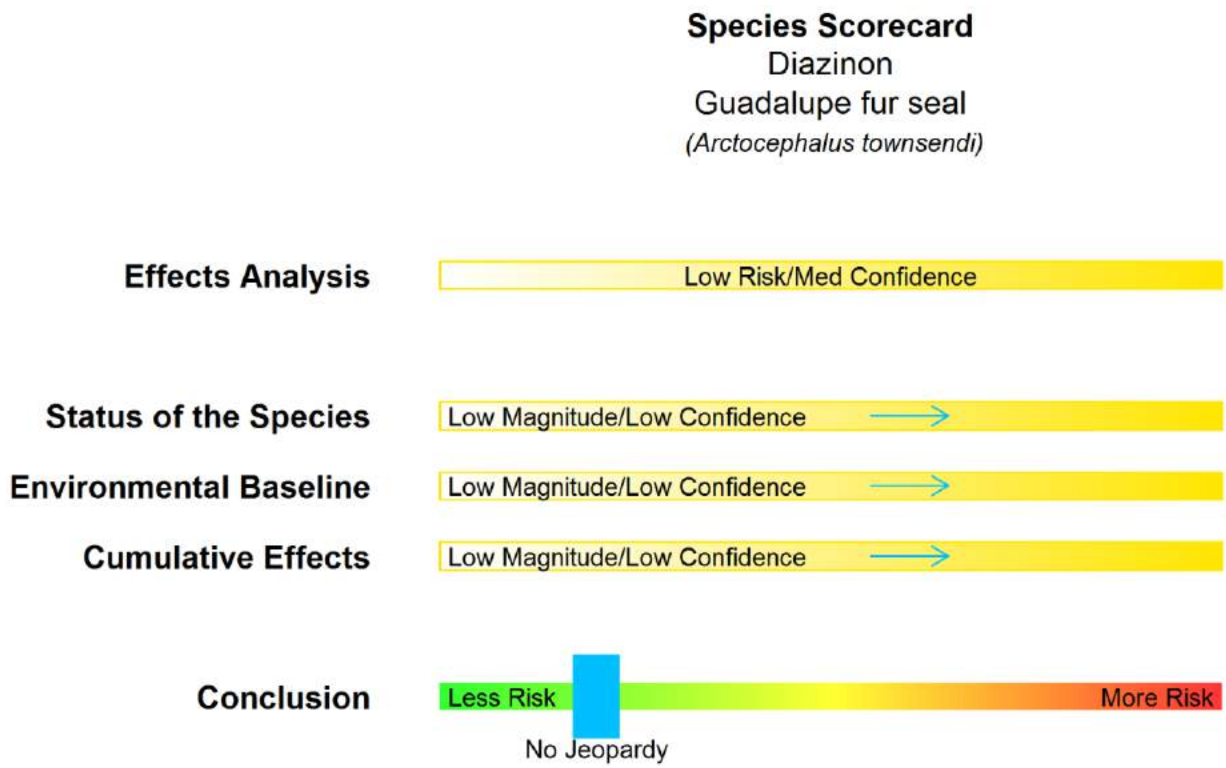

Figure 77. Species Score Card; Guadalupe fur seal; Diazinon

<u>Effects Analysis: Low risk/Medium confidence</u>

- Significant reductions in abundance and productivity not anticipated in marine areas
- Potential effects include reduced cholinesterase activity, impaired swimming, and reduced prey abundance
- Uncertain exposure concentrations in marine habitats

<u>Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- 5% of historical abundance, increasing abundance trend;
- Threatened;
- No recovery criteria established;

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures in marine waters not anticipated to affect sea lions
- Environmental mixtures anticipated in marine waters yet effects uncertain

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters but effects uncertain

<u>Conclusion:</u> We find medium confidence of low risk to the species based on predicted marine exposure concentrations and expected population-level effects. The species is most at risk from reductions in prey. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

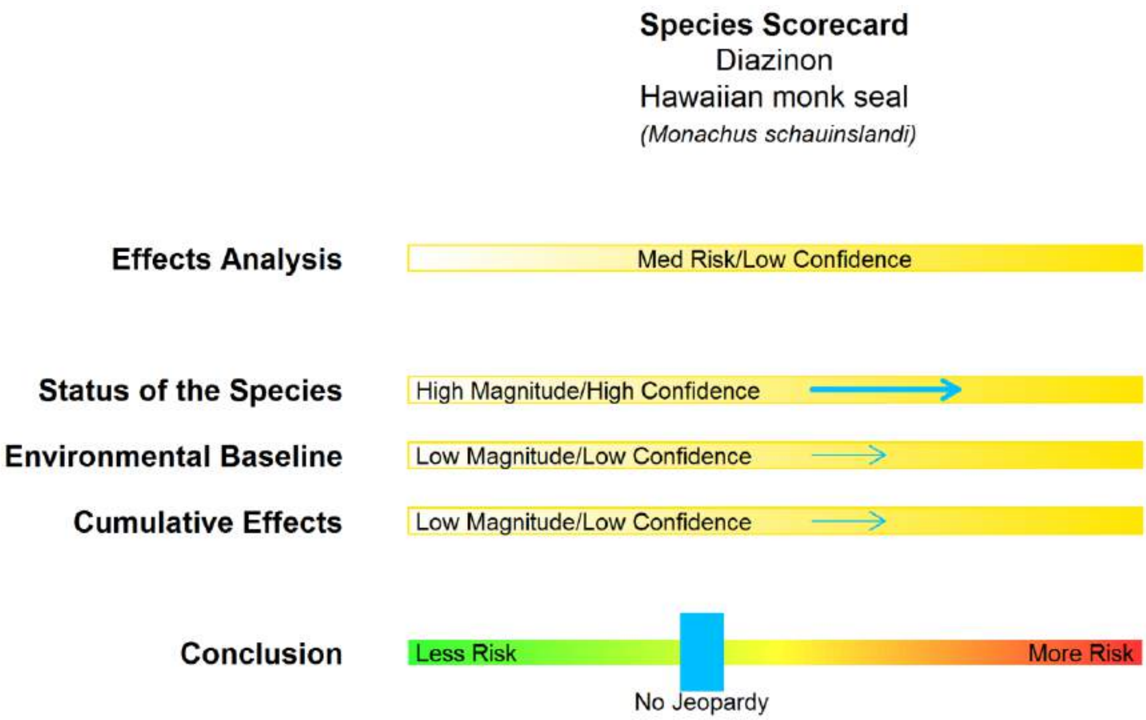

Figure 78. Species Score Card; Hawaiian monk seal; Diazinon

<u>Effects Analysis: Medium risk/Low confidence</u>

- Significant reductions in abundance and productivity not anticipated in marine areas
- Potential effects include reduced cholinesterase activity, impaired swimming, and reduced prey abundance
- Uncertain exposure concentrations in marine habitats

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Less than 40% of 1958 abundance, two populations have increasing trends, six populations have declining trends; very low genetic diversity
- Endangered
- Recovery criteria not met

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures in marine waters not anticipated to affect sea lions
- Environmental mixtures anticipated in marine waters yet effects uncertain

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters but effects uncertain

<u>Conclusion:</u> We find medium confidence of low risk to the species based on predicted marine exposure concentrations and expected population-level effects. The species is most at risk from reductions in prey. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

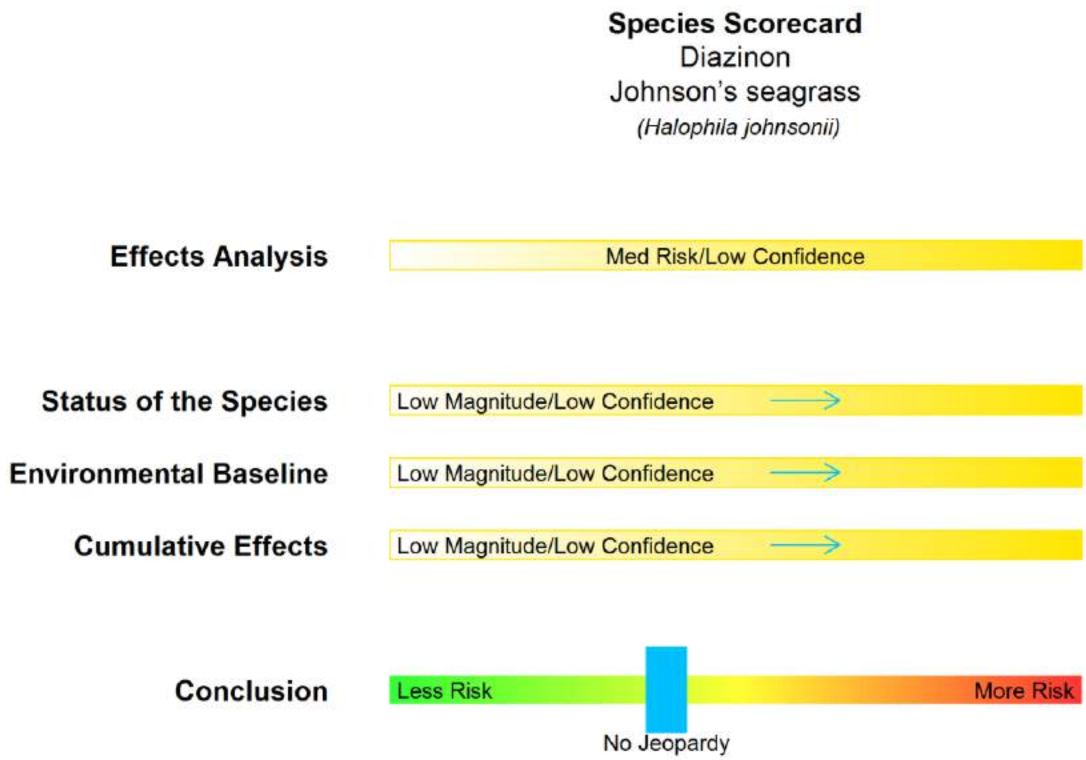

Figure 79. Species Score Card; Johnson's seagrass; Diazinon

Effects Analysis: Medium risk/Low confidence
- Reduced abundance not anticipated
- Potential effects include phytotoxicity

Status of the Species: Increased risk of jeopardy; Low magnitude/ Low confidence
- No trend data on abundance
- Threatened;
- Recovery criteria not met

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence
- Elevated temperatures in marine waters not anticipated to affect seagrass
- Environmental mixtures anticipated in marine waters yet effects uncertain

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence
- Future elevated temperatures anticipated in marine waters but effects uncertain

Conclusion: In marine habitats, we find a high likelihood of exposure and a low likelihood of effects to the species based on low confidence in exposure concentrations and low toxicity. The species is most at risk from direct toxicity. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Diazinon is not likely to jeopardize the continued existence of this species: No Jeopardy

CHAPTER 21

INTEGRATION AND SYNTHESIS FOR LISTED SPECIES

MALATHION

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21 MALATHION

21.1 Introduction

The integration and synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Chapter 14) to the environmental baseline (Chapter 10) and the cumulative effects (Chapter 18) to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of an Endangered Species Act (ESA)-listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated critical habitat for the conservation of an ESA-listed species. These assessments are made in full consideration of the status of the species (Chapter 9).

We treat the information from the status of the species, environmental baseline, and cumulative effects, as "risk modifiers," in that the effects described in the effects analysis section may be modified by the condition of the species; the condition of environmental baseline, and the anticipated cumulative effects. The key questions addressed include:

1) Status of the Species:
    - Are abundance, spatial distribution, and productivity trends increasing, decreasing or stable?
    - Is the species listed as threatened, or as endangered?
    - Have recovery goals been met, or are they on a sustained positive trajectory toward recovery?
2) Environmental Baseline:
    - Are freshwater temperatures elevated?
    - Are pesticide mixtures present, or anticipated based on current land use?
3) Cumulative Effects:
    - Will future temperatures impair species aquatic habitats?
    - Will future hydrologic flows impair freshwater species habitats?

Once each of the above sections is evaluated i.e., questions answered, the effects of the action and the risk modifiers are depicted graphically on a "scorecard." First, we assign a magnitude of influence (low or high) indicated graphically with one of two lengths of arrows. The shorter of the two arrows indicates a low magnitude, while the longer of the two arrows indicates a high magnitude as a risk modifier. The direction an arrow is pointed indicates the directionality of the risk modifier. For example, an environmental baseline arrow pointing towards more risk may indicate that environmental mixtures and elevated temperatures occur in the Environmental Baseline, which further stresses the species in question. We also assign a level of confidence in our selection of the small and large magnitude, indicated by a bold arrow (high confidence) or an un-bolded arrow (low confidence). The final arrow representing the influence on risk is graphically depicted on each species' scorecard.

Figure 1. Example of arrows to represent direction, magnitude, and confidence of risk modifiers

Conclusion Section:

With full consideration of the status of the species and the designated critical habitat, we construct a description of the effects of the action within the action area on populations or subpopulations, when added to the environmental baseline and the cumulative effects, to determine whether the action could reasonably be expected to:

- Reduce appreciably the likelihood of survival and recovery of ESA-listed species in the wild by reducing its numbers, reproduction, or distribution, and state our conclusion as to whether the action is likely to jeopardize the continued existence of such species; or
- Appreciably diminish the value of designated critical habitat for the conservation of an ESA-listed species, and state our conclusion as to whether the action is likely to destroy or adversely modify designated critical habitat.

A scorecard is generated for each species and designated critical habitat. The effects of the proposed action is considered, as modified by the magnitude and confidence of the three arrows. Next, a no-jeopardy or jeopardy bar is placed on the risk bar i.e., the colored bar beginning with green (less risk) to red (more risk) (***Figure 2***).

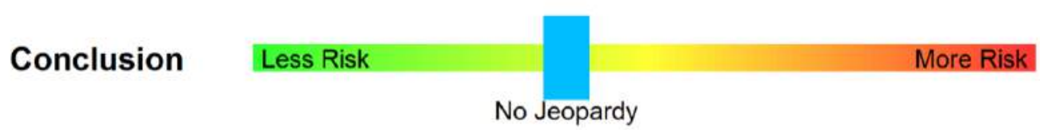

Figure 2: Example conclusion graphic

21.2 Species Scorecards

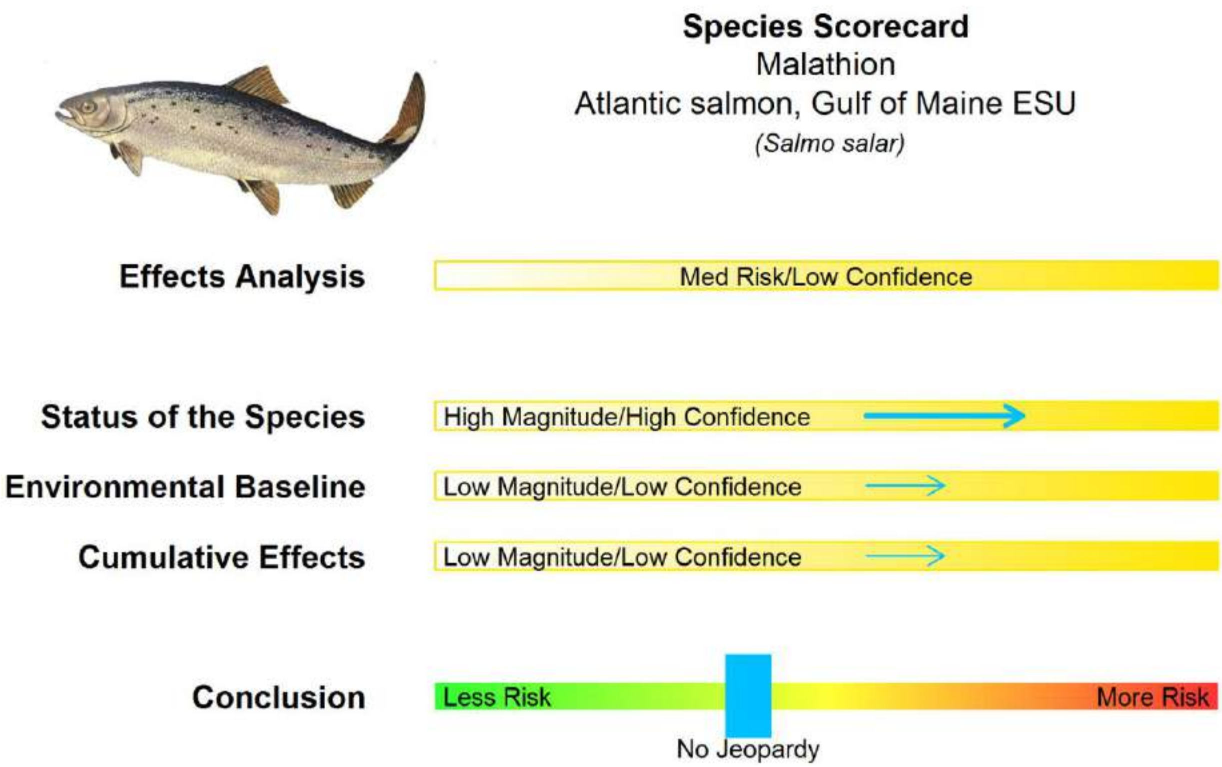

Figure 3. Species Score Card; Atlantic salmon, Gulf of Maine Evolutionarily Significant Unit (ESU); Malathion

Effects Analysis: Medium risk/Low confidence

- Salmon occupying coastal, shallow areas may experience reduced abundance.
- Anticipated effects may include death, reduced cholinesterase activity, reduced prey abundance, and impaired swimming.

Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence

- Abundance is declining, low resilience to disturbance, sustained by hatcheries
- Endangered species population estimated at 0.3% of historical levels
- Proposed action may hinder attainment of recovery goals in coastal areas

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters not anticipated to affect species
- Environmental mixtures not anticipated to substantially affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures in marine areas uncertain to affect species
- No anticipated hydrologic effects in marine waters that would affect species

Conclusion: In their marine habitats, we find a low likelihood of exposure and effects to the species as a whole based on low confidence in exposure concentrations predicted for these open water saltwater habitats. The species is most at risk while in coastal, estuarine areas where they spend a small portion of their lives. Potential reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy

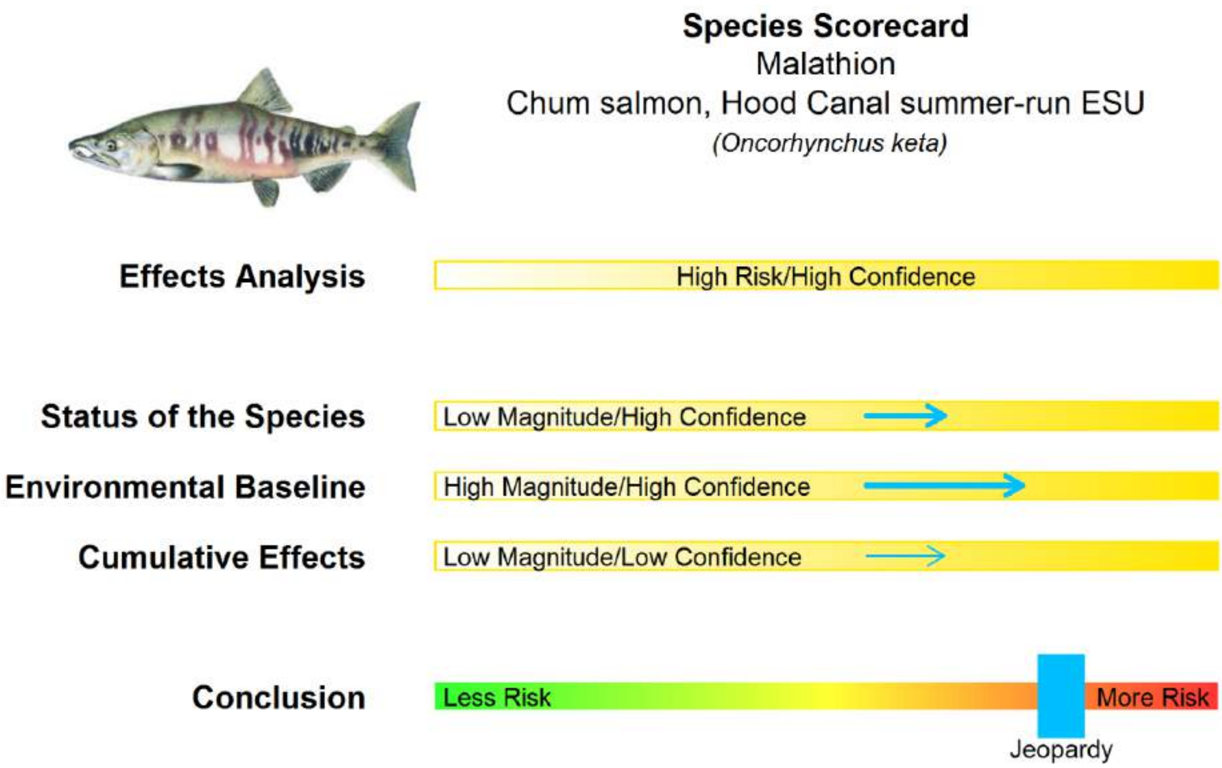

Figure 4. Species Score Card; Chum salmon, Hood Canal summer-run ESU; Malathion

<u>Effects Analysis: High risk/High confidence</u>

- Salmon occupying freshwater and nearshore areas likely experience reduced abundance and productivity.
- Anticipated effects include death, reduced cholinesterase activity, reduced prey abundance, impaired swimming, and reduced productivity.

<u>Status of the Species: Increased risk of jeopardy; Low magnitude/ High confidence</u>

- Stable to increasing abundance trend, increasing population productivity
- Threatened species; 6 of 15 populations extirpated or nearly extirpated
- Proposed action may hinder attainment of some recovery goals

<u>Environmental Baseline: Minimal increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures anticipated in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures likely
- Anticipated hydrologic effects in freshwater areas may affect species

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species as a whole based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in freshwater and nearshore areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Malathion is likely to jeopardize the continued existence of this species: Jeopardy</u>

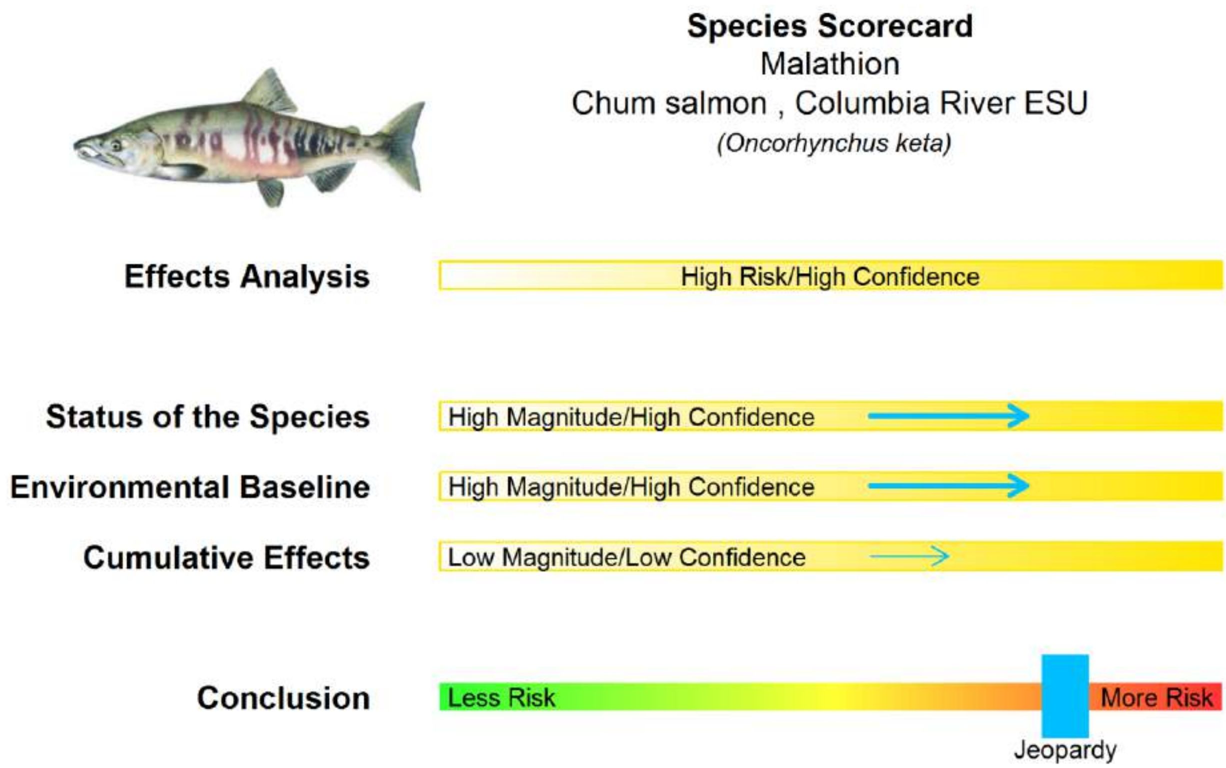

Figure 5. Species Score Card; Chum salmon, Columbia River ESU; Malathion

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater and nearshore areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Declining abundance trends, high risk of extinction
- Threatened species; 7 of 16 populations are functionally extinct
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Minimal increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures anticipated in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas that may affect species

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Malathion is likely to jeopardize the continued existence of this species: Jeopardy</u>

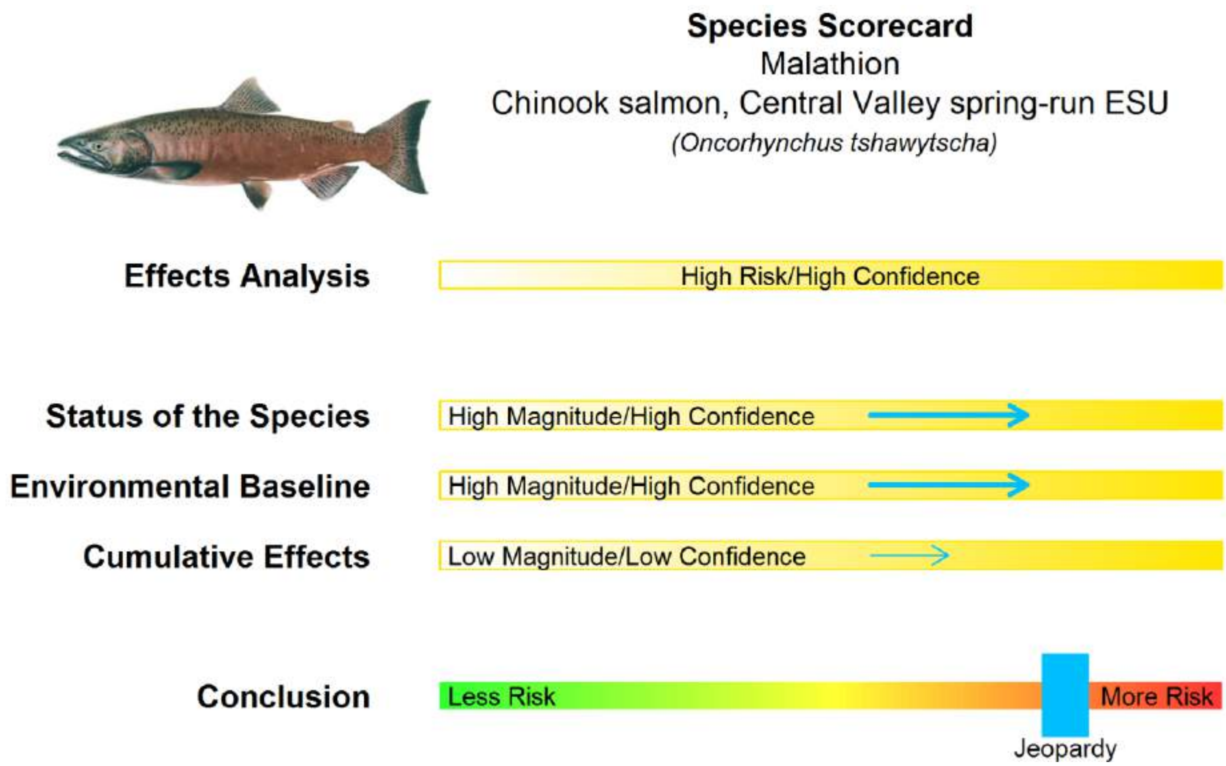

Figure 6. Species Score Card; Chinook salmon, Central Valley spring-run ESU; Malathion

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Stable to declining abundance trends, low abundances and fragmented populations
- Threatened species
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Malathion is likely to jeopardize the continued existence of this species: Jeopardy</u>

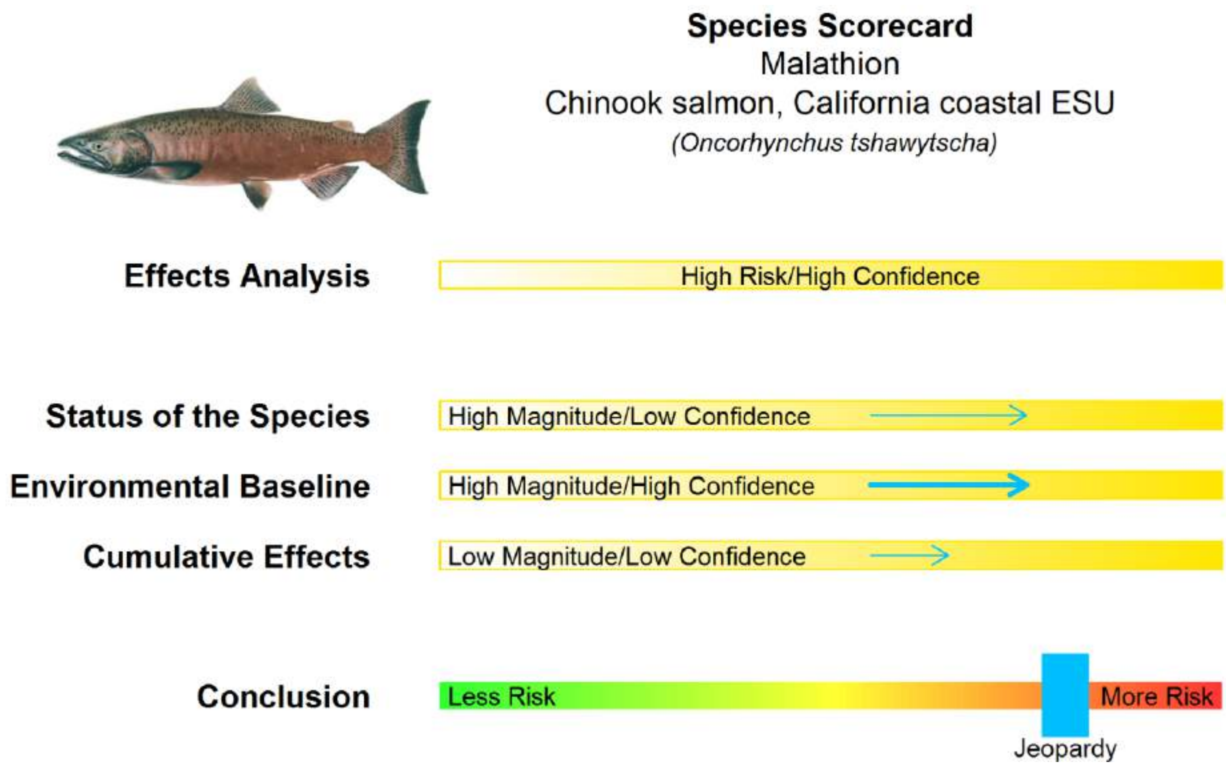

Figure 7. Species Score Card; Chinook salmon, California coastal ESU; Malathion

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Minimal increased risk of jeopardy; High magnitude/ Low confidence</u>

- One population with greater than 1000 spawners, declining trends in abundance
- Threatened
- Some recovery criteria not met, yet reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Malathion is likely to jeopardize the continued existence of this species: Jeopardy</u>

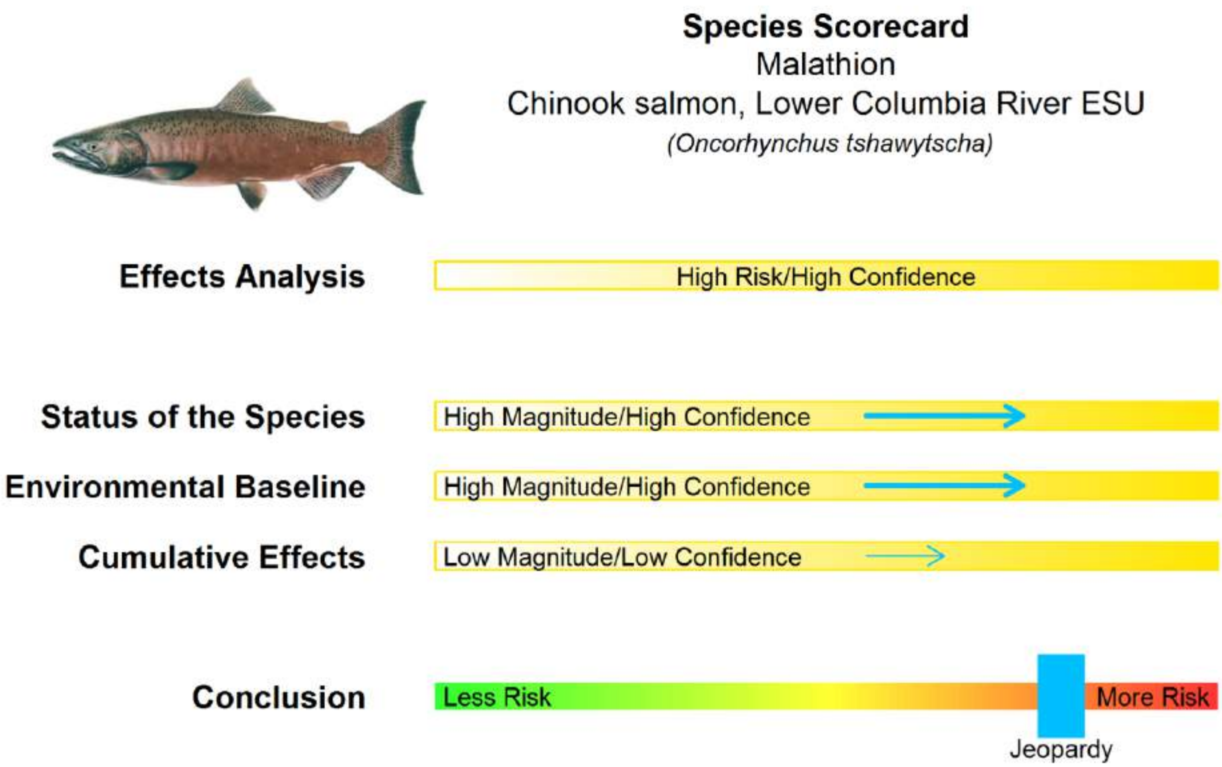

Figure 8. Species Score Card; Chinook salmon, Lower Columbia River ESU; Malathion

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Declining trends in abundance, one self-sustaining population, low genetic diversity
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>**Malathion is likely to jeopardize the continued existence of this species: Jeopardy**</u>

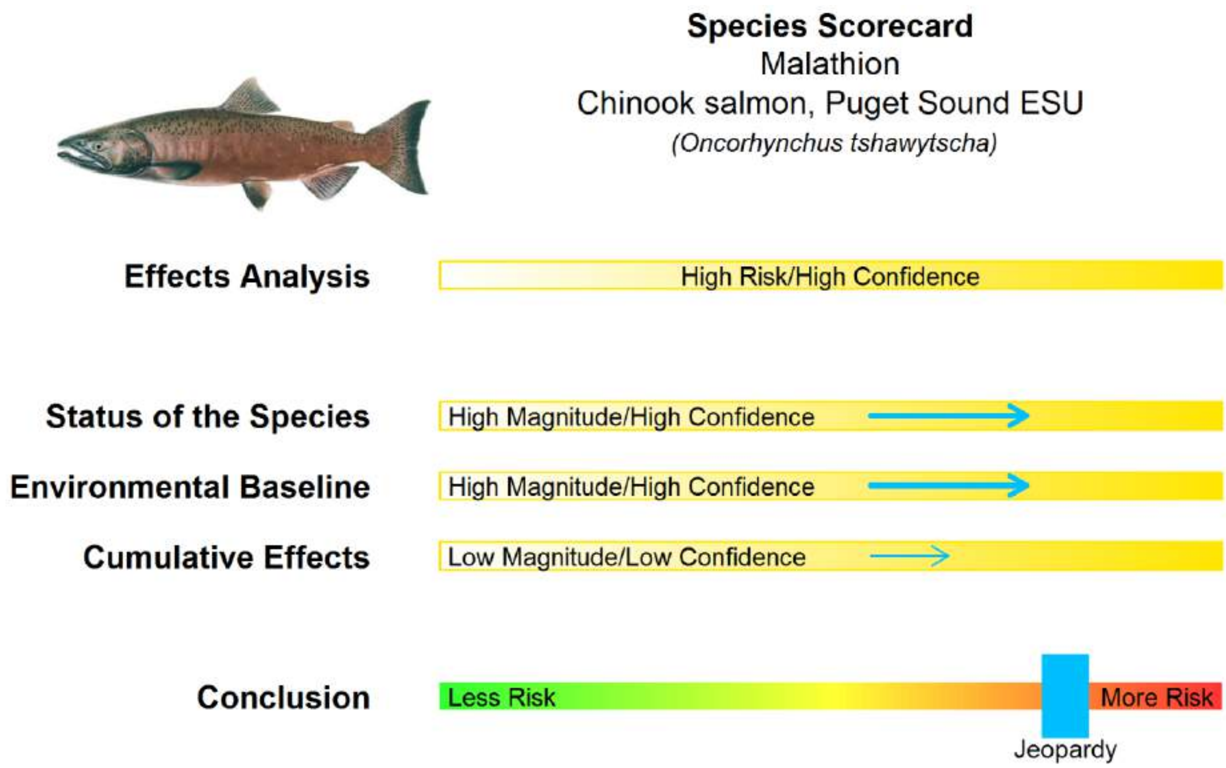

Figure 9. Species Score Card; Chinook salmon, Puget Sound ESU; Malathion

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Half of the populations declining and half increasing in abundance
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Malathion is likely to jeopardize the continued existence of this species: Jeopardy</u>

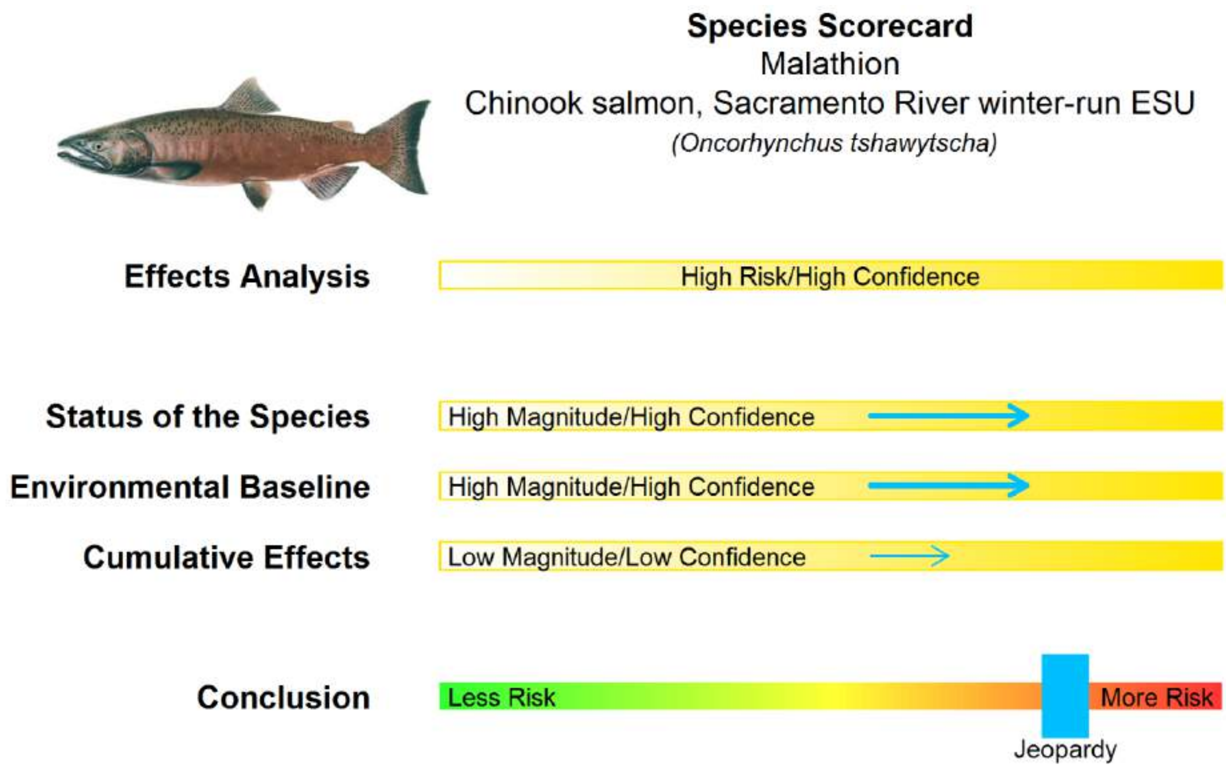

Figure 10. Species Score Card; Chinook salmon, Sacramento River winter-run ESU; Malathion

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- One extant population, declining abundance trends, hatchery-supported
- Endangered species
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Malathion is likely to jeopardize the continued existence of this species: Jeopardy</u>

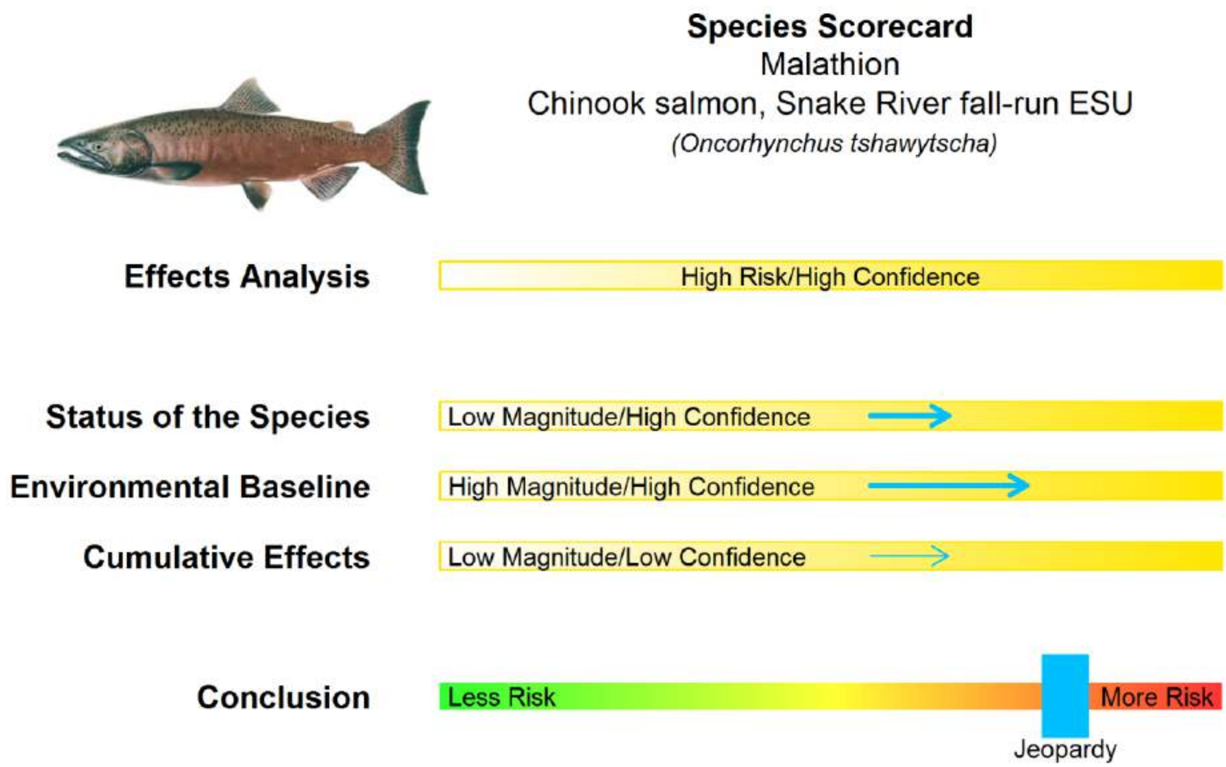

Figure 11. Species Score Card; Chinook salmon, Snake River fall-run ESU; Malathion

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; Low magnitude/ High confidence</u>

- Stable to increasing abundance trends, moderate extinction risk, hatchery supported
- Threatened species
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they spend a portion of their lives. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Malathion is likely to jeopardize the continued existence of this species: Jeopardy</u>

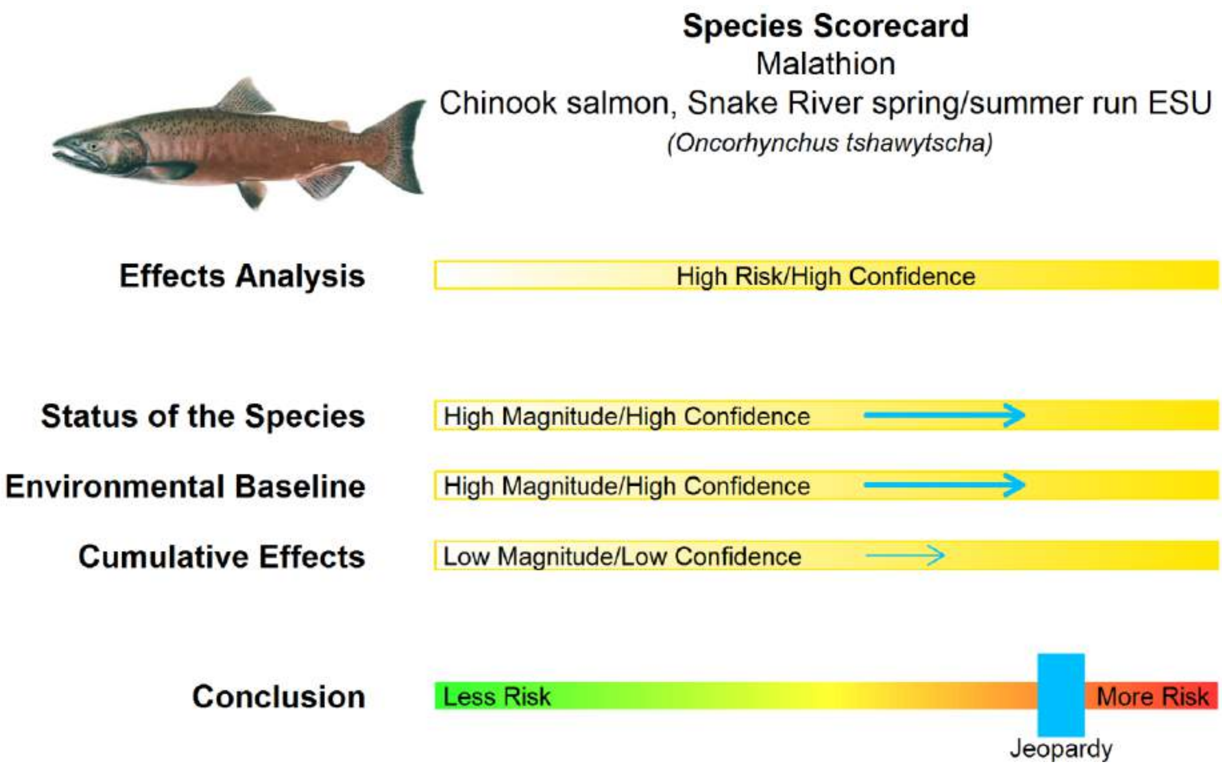

Figure 12. Species Score Card; Chinook salmon, Snake River spring/summer run ESU; Malathion

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Increased risk of jeopardy; Low magnitude/ High confidence

- Decreasing abundance trends, high extinction risk, moderate genetic diversity
- Threatened species
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Malathion is likely to jeopardize the continued existence of this species: Jeopardy

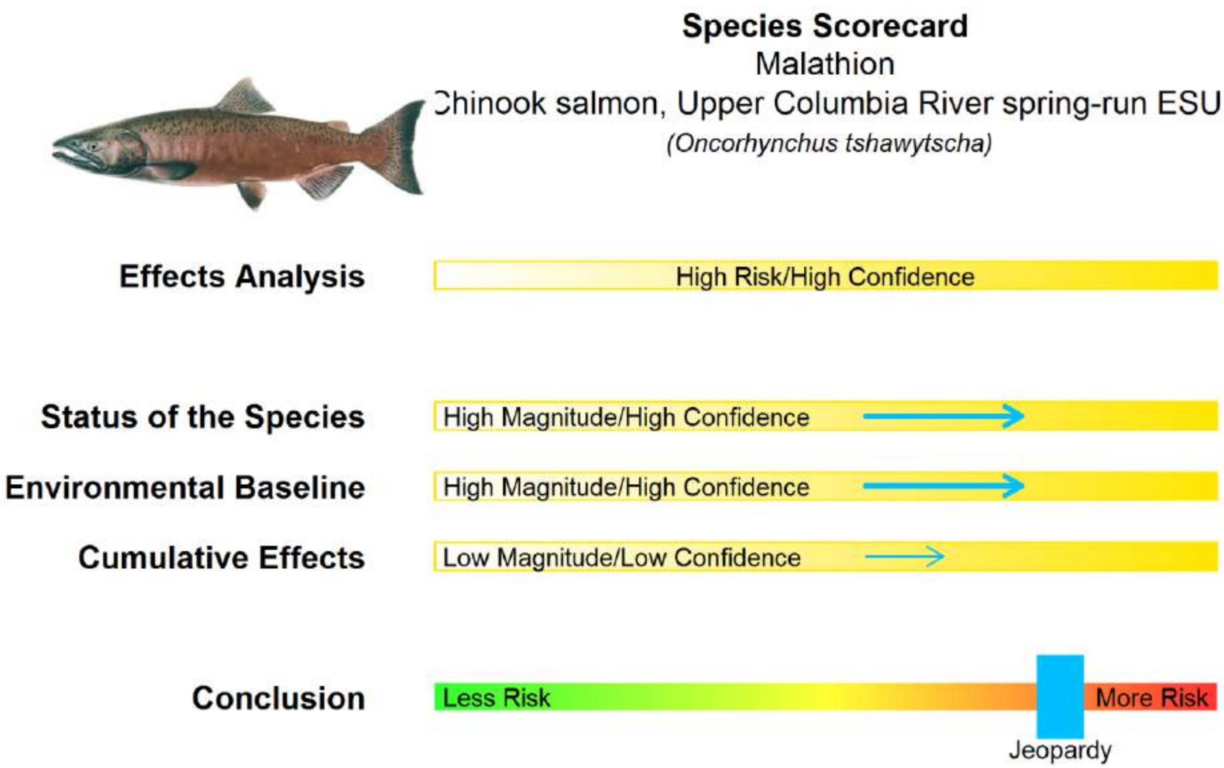

Figure 13. Species Score Card; Chinook salmon, Upper Columbia River spring-run ESU; Malathion

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence

- Decreasing abundance trends, independent populations not replacing themselves
- Endangered species (all independent population experiencing low abundance)
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Malathion is likely to jeopardize the continued existence of this species: Jeopardy

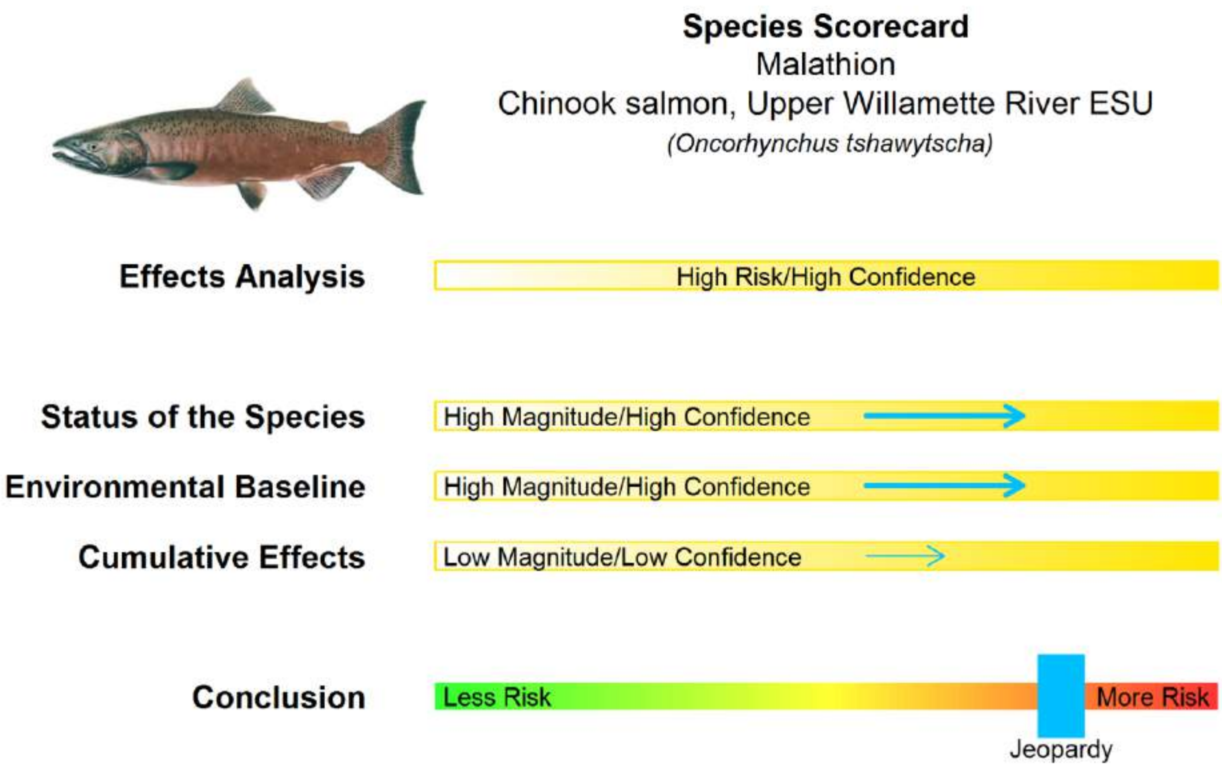

Figure 14. Species Score Card; Chinook salmon, Upper Willamette River ESU; Malathion

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; How magnitude/ High confidence</u>

- Decreasing abundance trends, 1 of 7 remaining naturally reproducing populations
- Threatened species
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy</u>

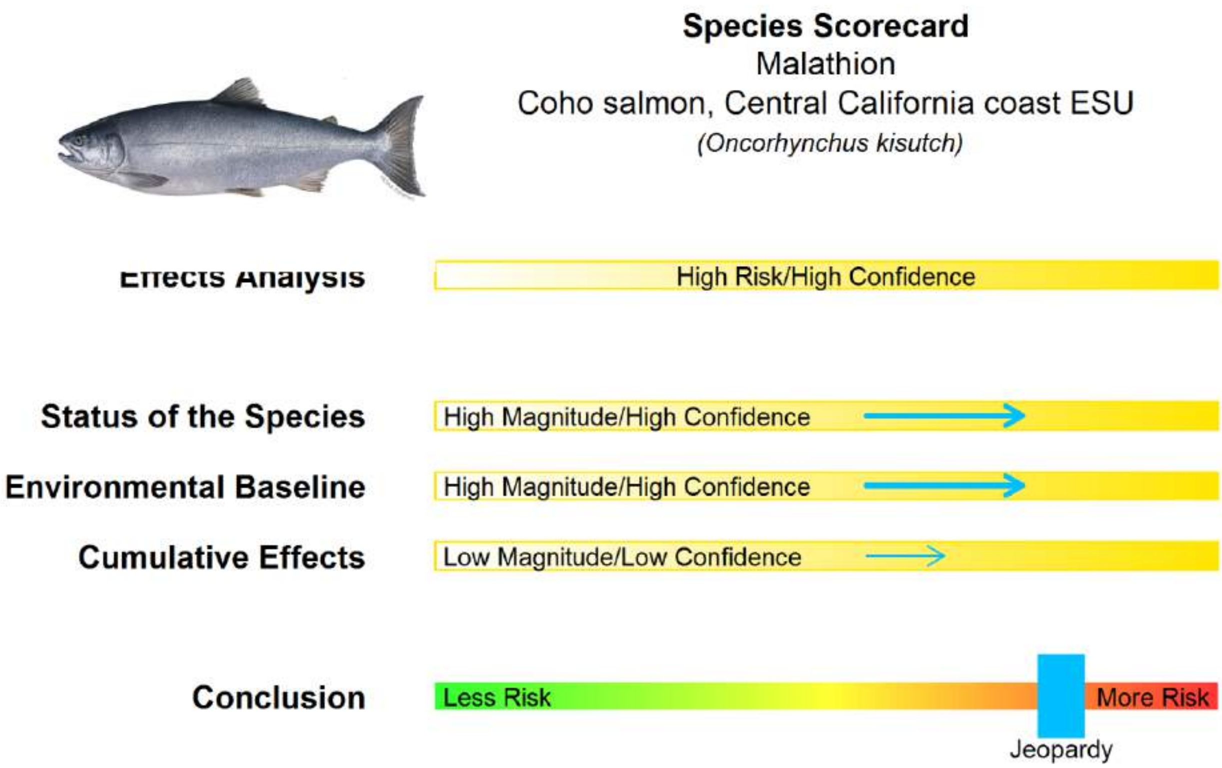

Figure 15. Species Score Card; Coho salmon, Central California coast ESU; Malathion

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; How magnitude/ High confidence</u>

- Stable population trend, fragmented populations, supported by hatchery propogation
- Endangered species (low abundances)
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Malathion is likely to jeopardize the continued existence of this species: Jeopardy</u>

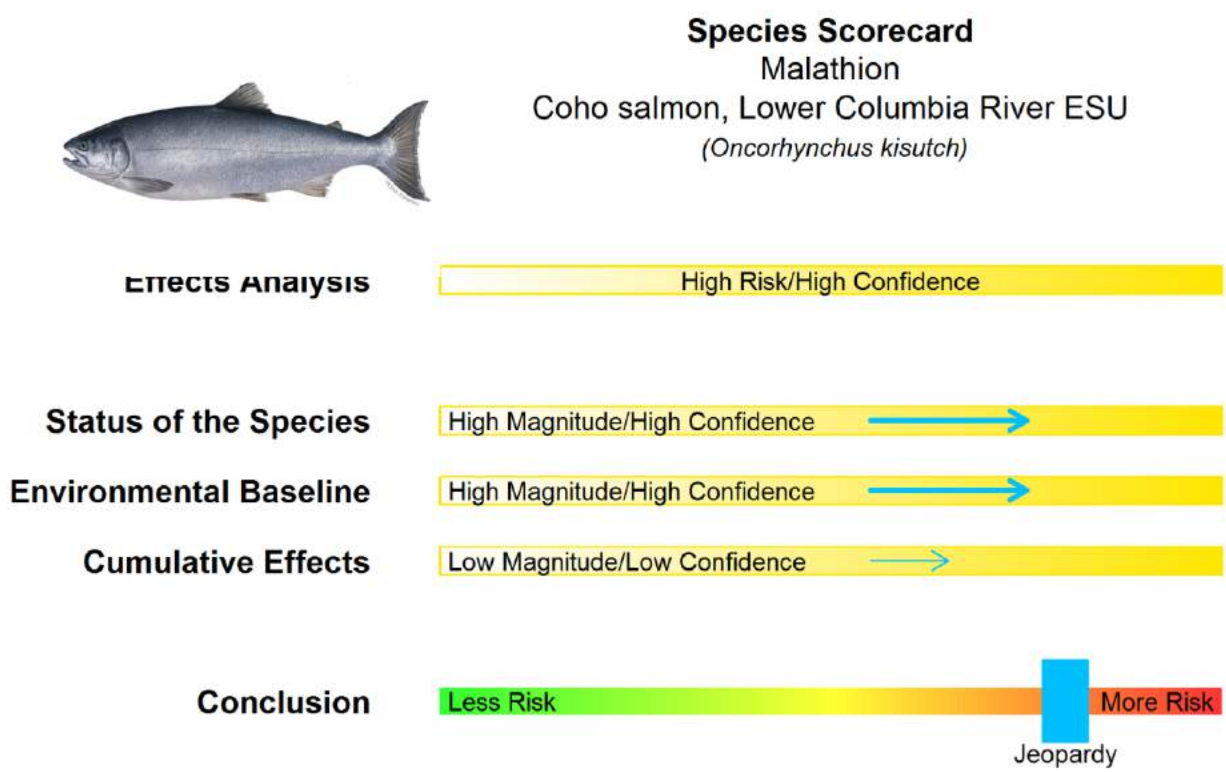

Figure 16. Species Score Card; Coho salmon, Lower Columbia River ESU; Malathion

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Increased risk of jeopardy; How magnitude/ High confidence

- Negative long/short term lambda projections; 2/25 populations exhibit natural production. Diveristy at high risk category.
- Endangered species (90% reduction in abundance of all independent populations)
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Malathion is likely to jeopardize the continued existence of this species: Jeopardy

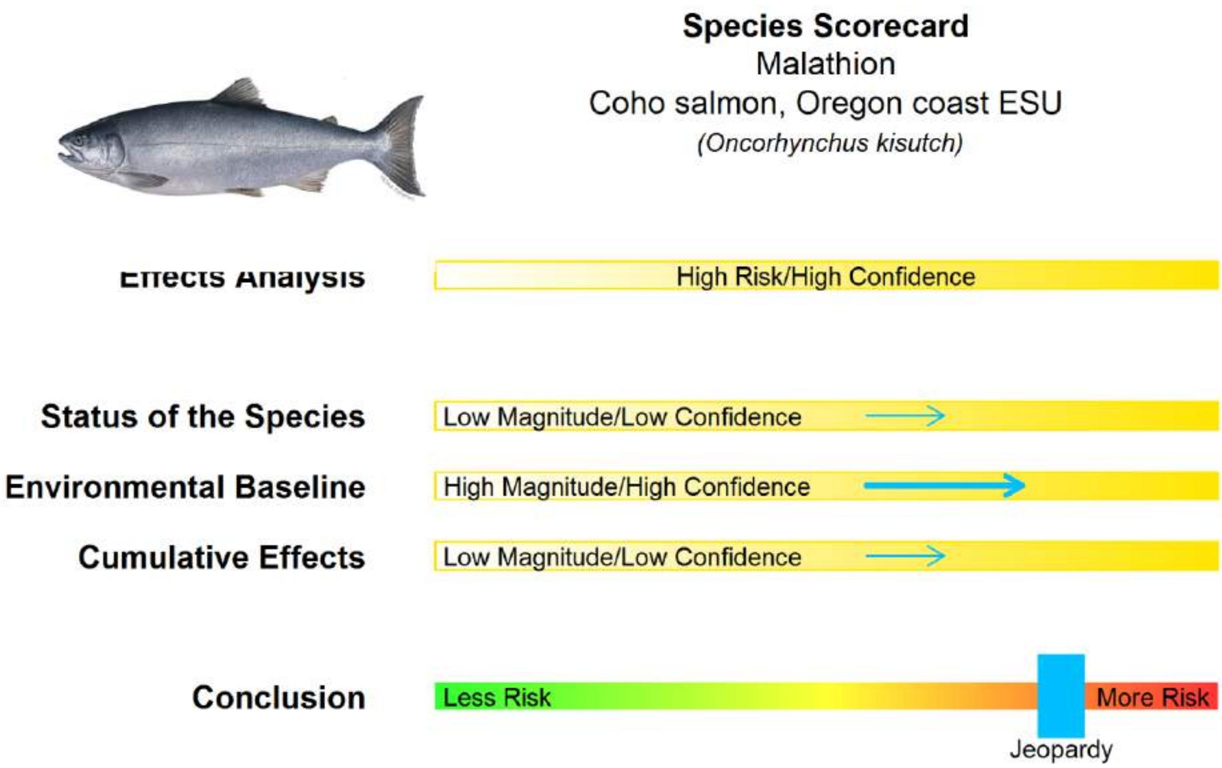

Figure 17. Species Score Card; Coho salmon, Oregon coast ESU; Malathion

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Variable abundances with periods of severe declines. Negative long term trends negative
- Threatened (Severe reductions in ESU abundance compared to historical estimates)
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Chlorpyrifos is likely to jeopardize the continued existence of this species: Jeopardy

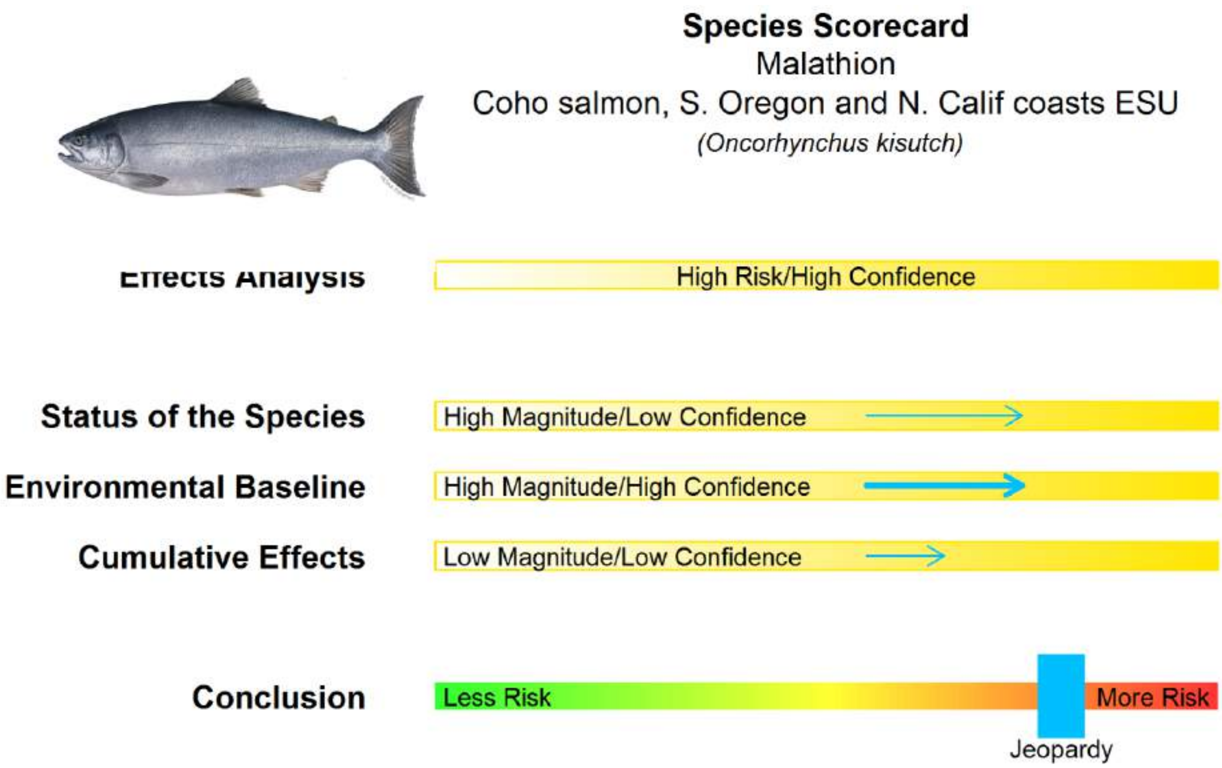

Figure 18. Species Score Card; Coho salmon, S. Oregon and N. Calif coasts ESU; Malathion

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Increased risk of jeopardy; High magnitude/ Low confidence

- Limited data on population abundance, thus trend data unavailable
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Malathion is likely to jeopardize the continued existence of this species: Jeopardy

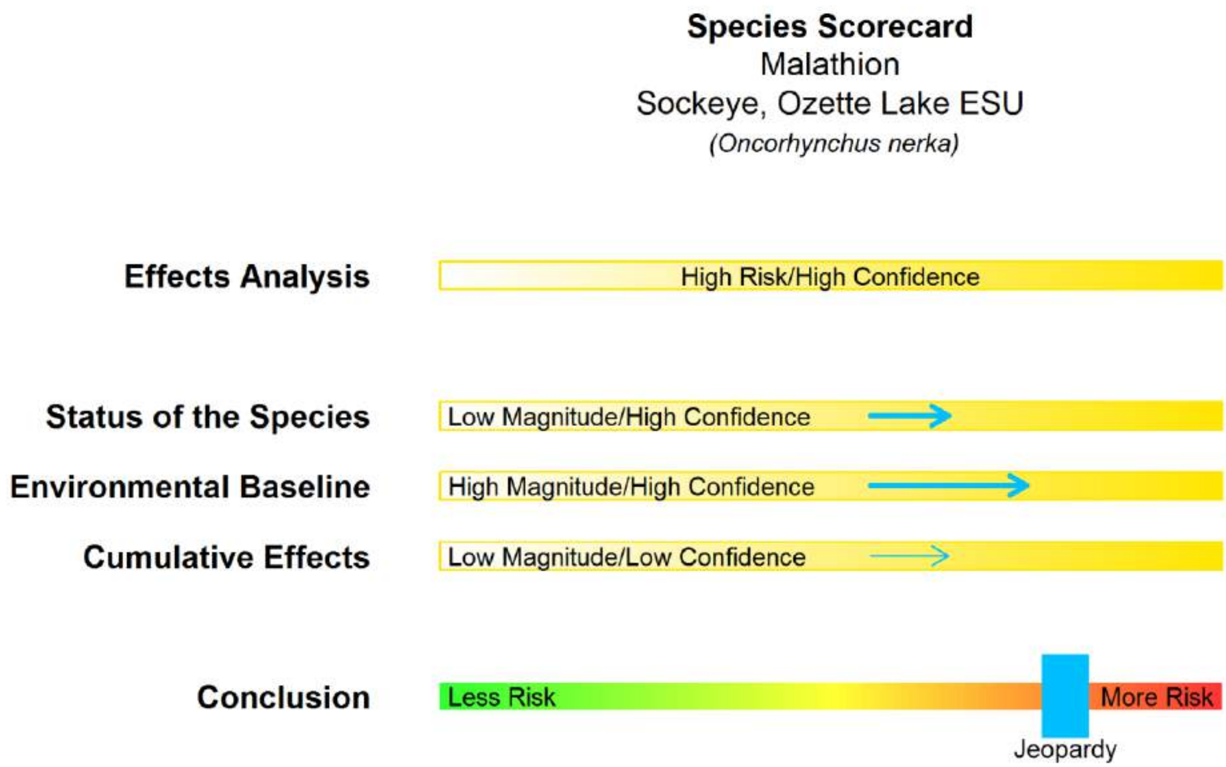

Figure 19. Species Score Card; Sockeye, Ozette Lake ESU; Malathion

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ High confidence</u>

- Stable productivity rates; low genetic diversity and low resilience to future perturbations
- Threatened (abundance only 1% of historical levels)
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations predicted for freshwater habitats. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Malathion is likely to jeopardize the continued existence of this species: Jeopardy</u>

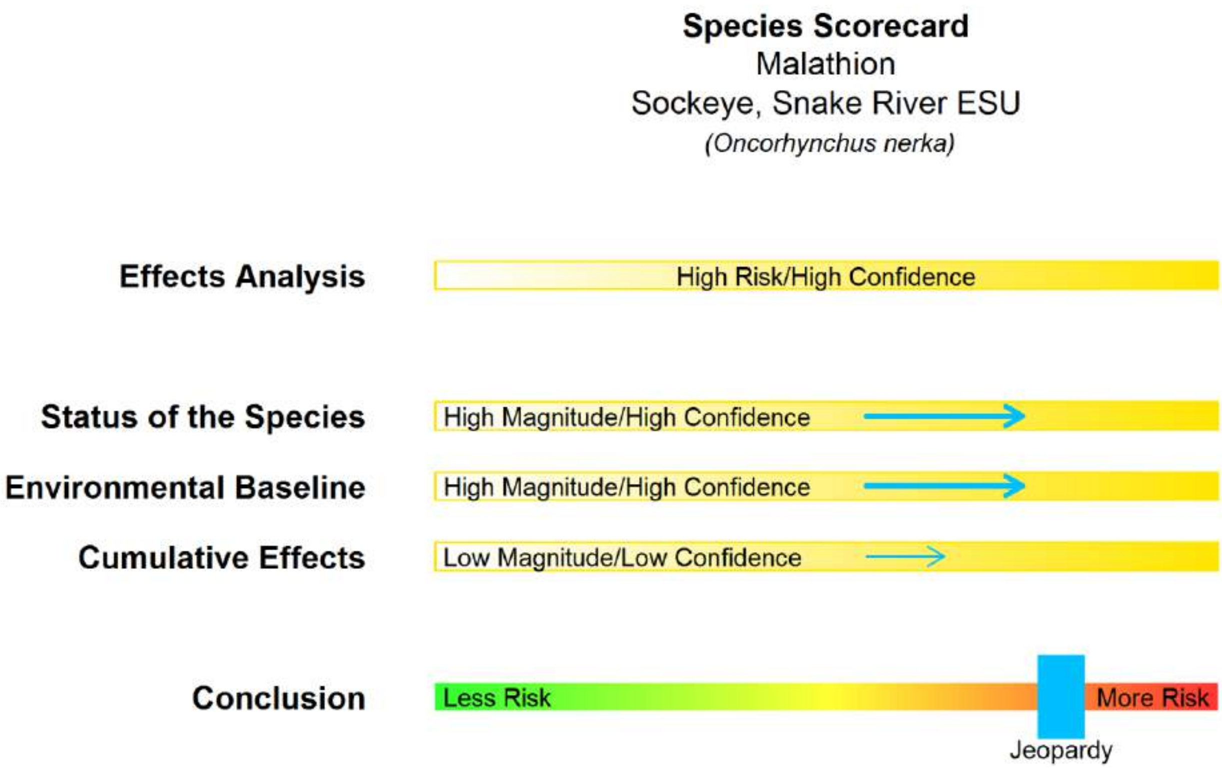

Figure 20. Species Score Card; Sockeye, Snake River ESU; Malathion

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- One population remaining supported by hatchery propagation. Increasing abundance, well below sustainable natural production. Low resilience to perturbations.
- Endangered (abundance only 1% of historical levels)
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>**Malathion is likely to jeopardize the continued existence of this species: Jeopardy**</u>

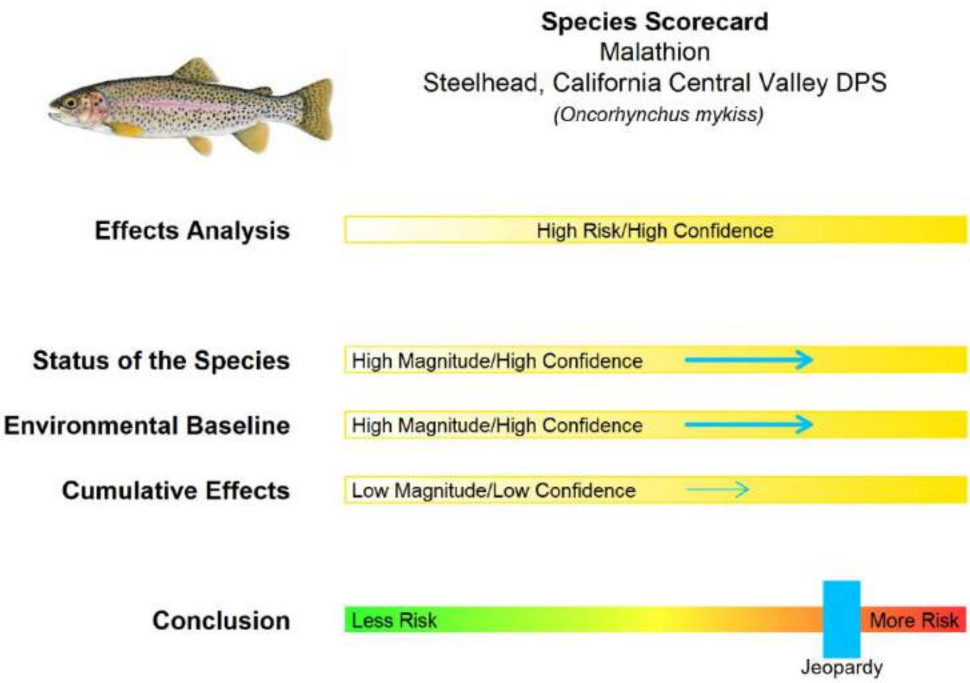

Figure 21. Species Score Card; Steelhead, California Central Valley distinct Population Segment (DPS); Malathion

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence

- Long-term trend of declining abundances and reduced genetic diversity. Populations supplemented by hatchery propogation.
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Malathion is likely to jeopardize the continued existence of this species: Jeopardy

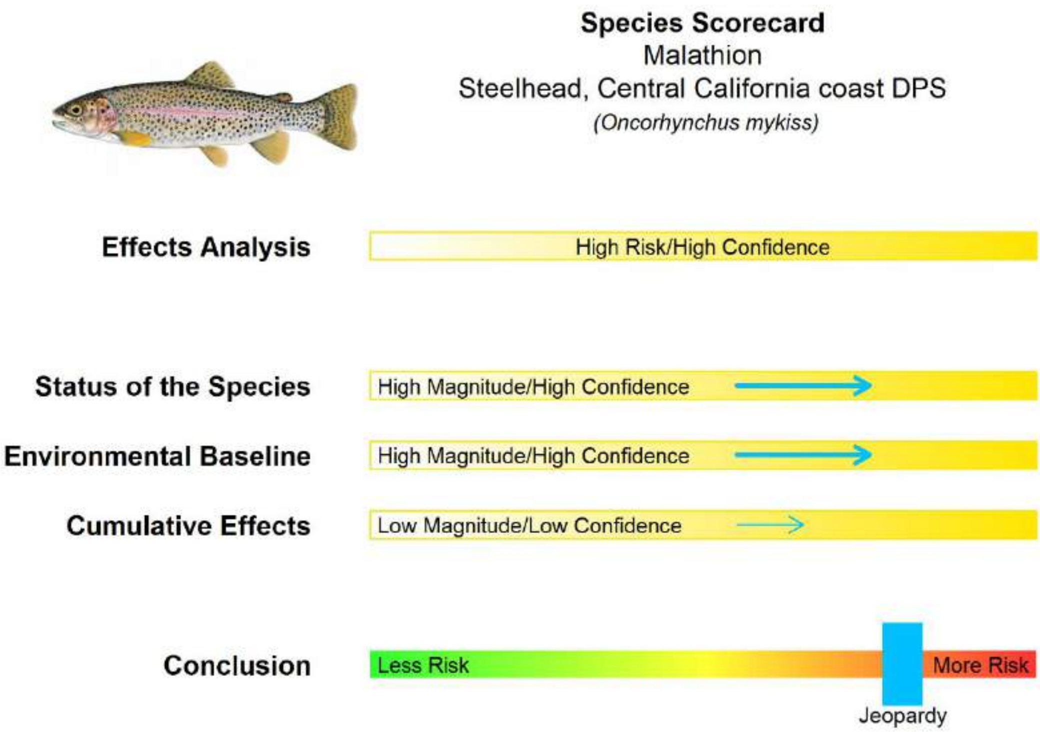

Figure 22. Species Score Card; Steelhead, Central California coast DPS; Malathion

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence

- 5-year population trend uncertain. Population abundance supplemented by hatchery propagation. Populations likely not viable, and have lost spatial structure.
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Malathion is likely to jeopardize the continued existence of this species: Jeopardy

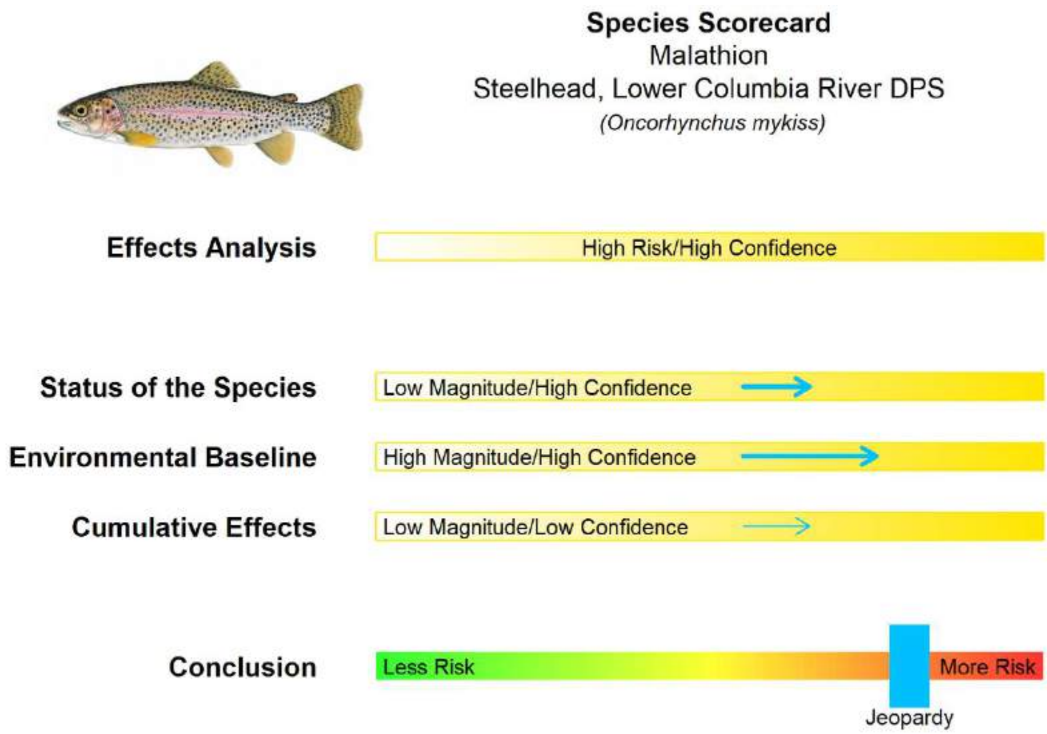

Figure 23. Species Score Card; Steelhead, Lower Columbia River DPS; Malathion

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ High confidence

- 5-year population trend stable. Populations exhibit low genetic diversity and impacted by a loss of available habitat.
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Malathion is likely to jeopardize the continued existence of this species: Jeopardy

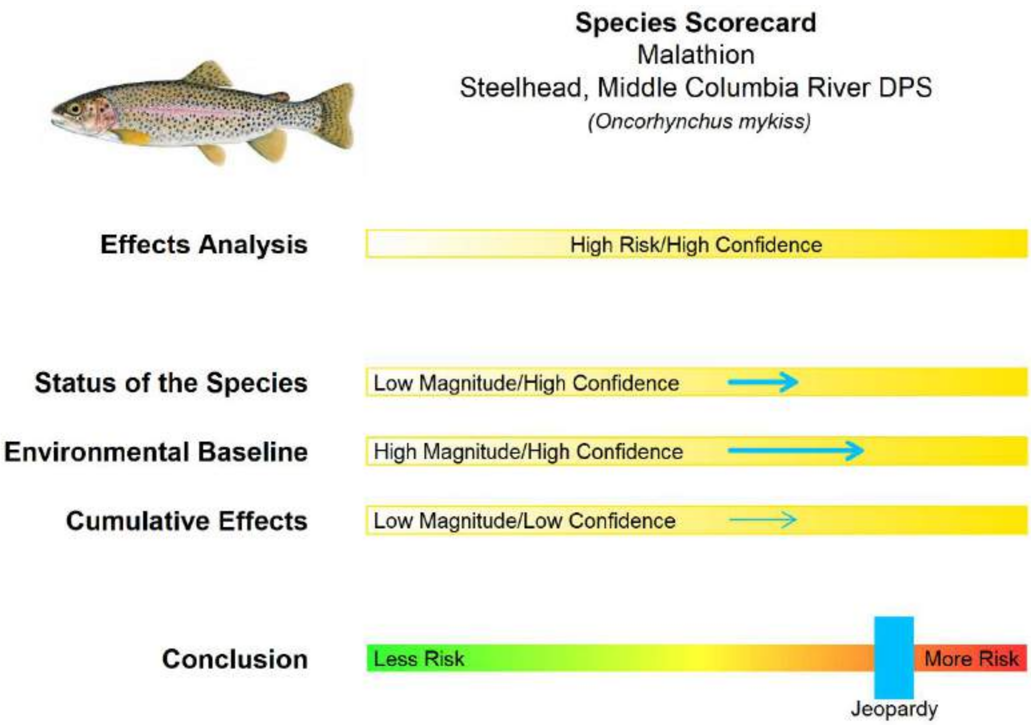

Figure 24. Species Score Card; Steelhead, Middle Columbia River DPS; Malathion

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ High confidence

- 5-year population trend stable to improving; abundances remain low compared to historical numbers
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Malathion is likely to jeopardize the continued existence of this species: Jeopardy

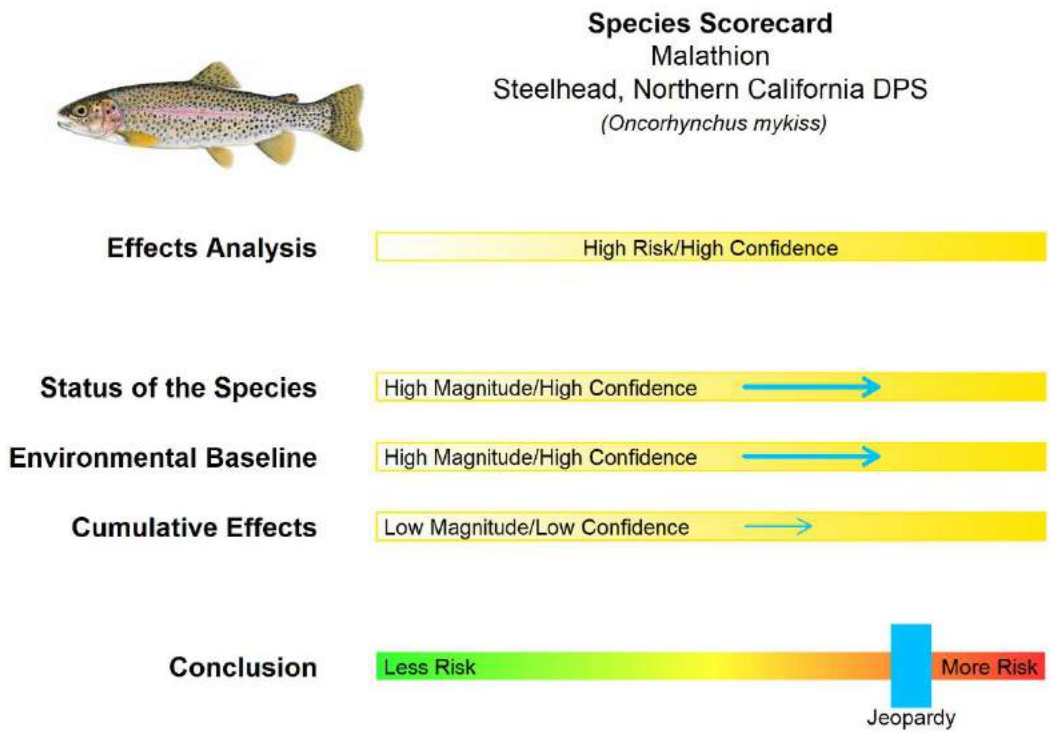

Figure 25. Species Score Card; Steelhead, Northern California DPS; Malathion

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Icreased risk of jeopardy; High magnitude/ High confidence</u>

- Variable 5-year population abundance trends; Population supplemented by hatchery propagation. Populations exhibit low abundances and productivity.
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Malathion is likely to jeopardize the continued existence of this species: Jeopardy</u>

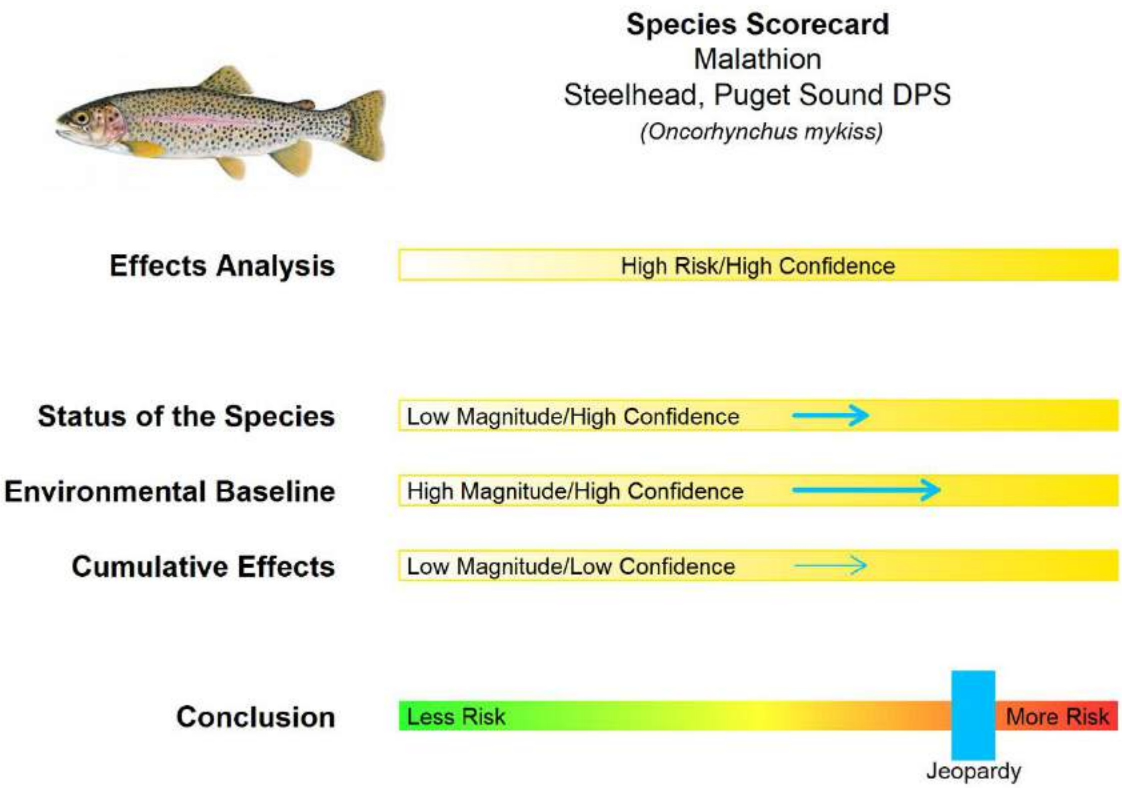

Figure 26. Species Score Card; Steelhead, Puget Sound DPS; Malathion

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ High confidence

- 5-year population trend stable, but populations have reduced genetic diversity
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Malathion is likely to jeopardize the continued existence of this species: Jeopardy

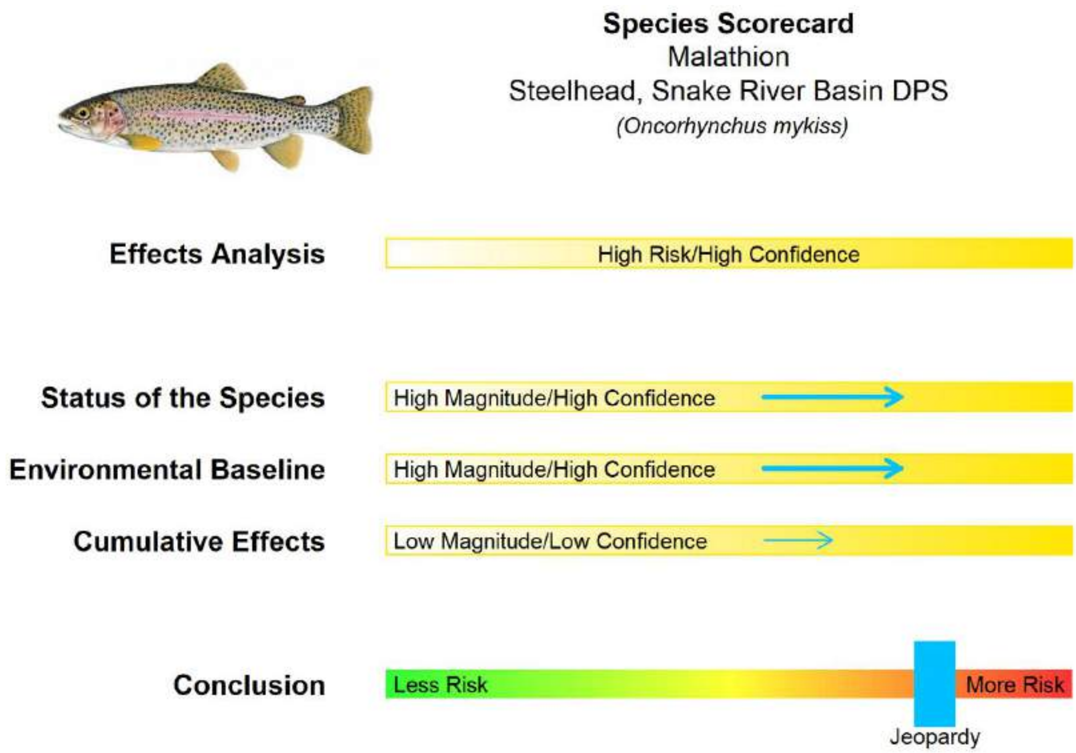

Figure 27. Species Score Card; Steelhead, Snake River Basin DPS; Malathion

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- 5-year population trend stable to improving, but still in moderate danger of extinction. Overall abundances remain below thresholds necessary for recovery.
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>**Malathion is likely to jeopardize the continued existence of this species: Jeopardy**</u>

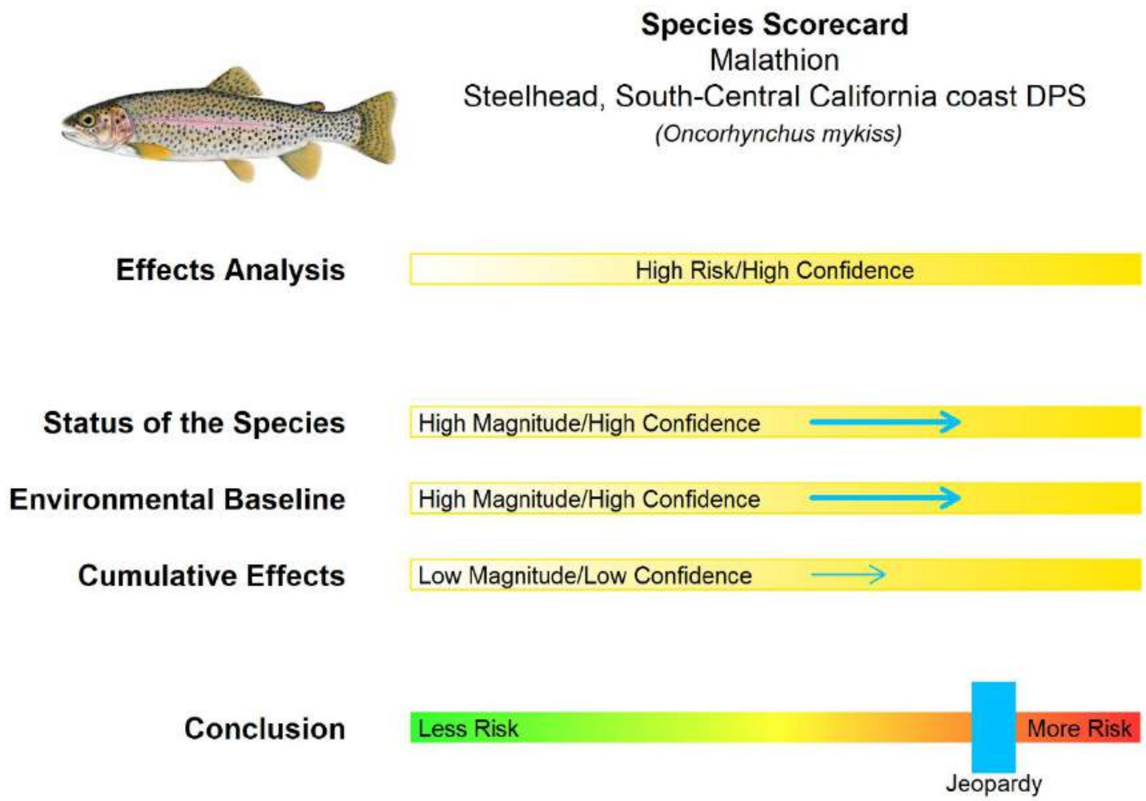

Figure 28. Species Score Card; Steelhead, South-Central California coast DPS; Malathion

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- 5-year population trend declining, depressed abundances.
- Threatened
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Malathion is likely to jeopardize the continued existence of this species: Jeopardy</u>

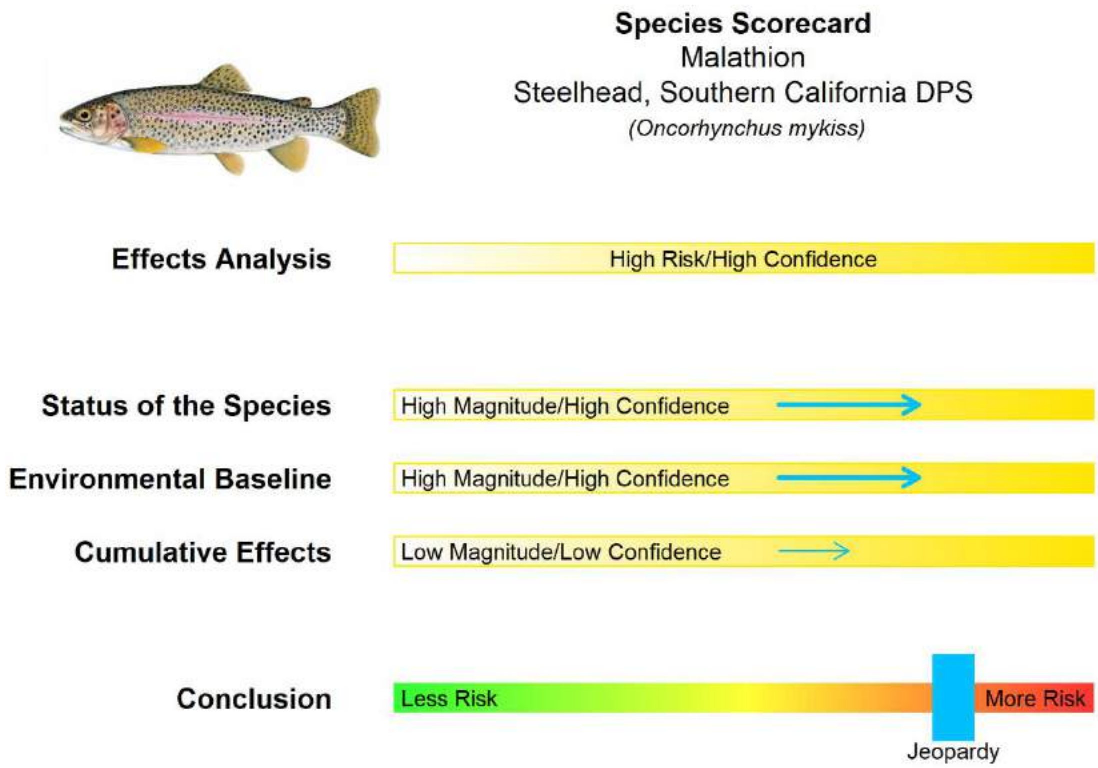

Figure 29. Species Score Card; Steelhead, Southern California DPS; Malathion

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- 5-year population trend uncertain (large annual variations); supplemented by hatchery propagation; fragmented distributions.
- Endangered; Populations at extreme southern end of species' range
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Malathion is likely to jeopardize the continued existence of this species: Jeopardy</u>

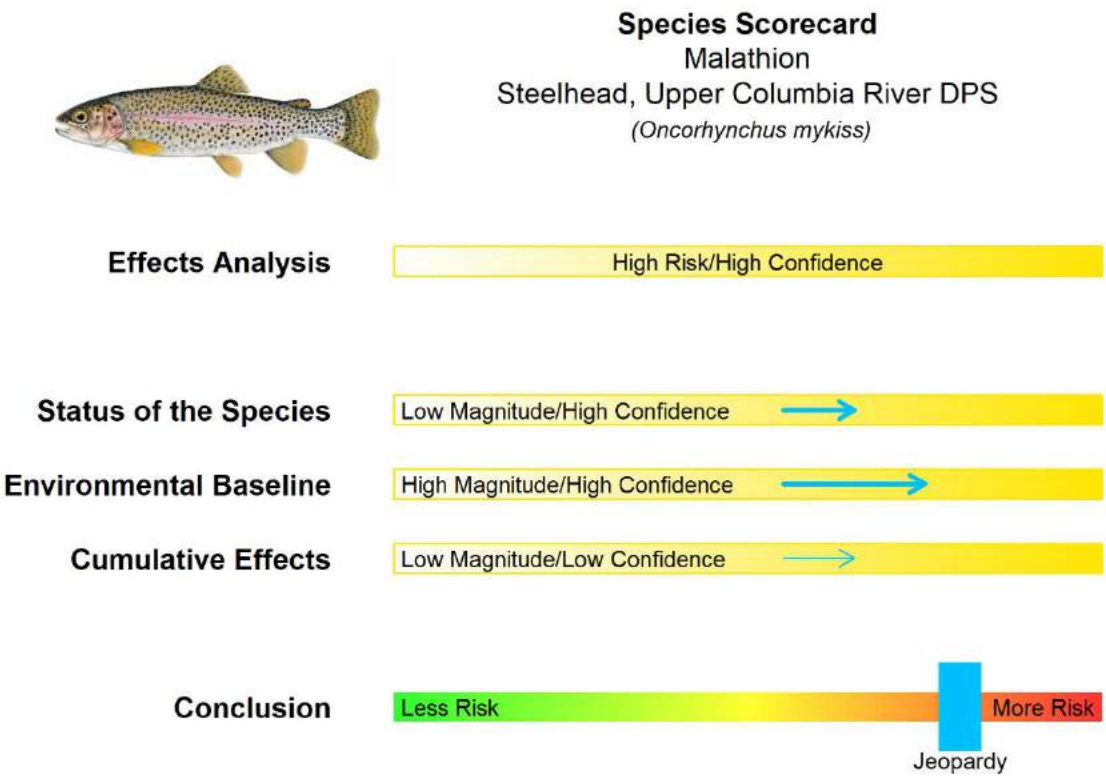

Figure 30. Species Score Card; Steelhead, Upper Columbia River DPS; Malathion

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- 5-year population trend improving, but low genetic diversity.
- Threatened;
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Malathion is likely to jeopardize the continued existence of this species: Jeopardy</u>

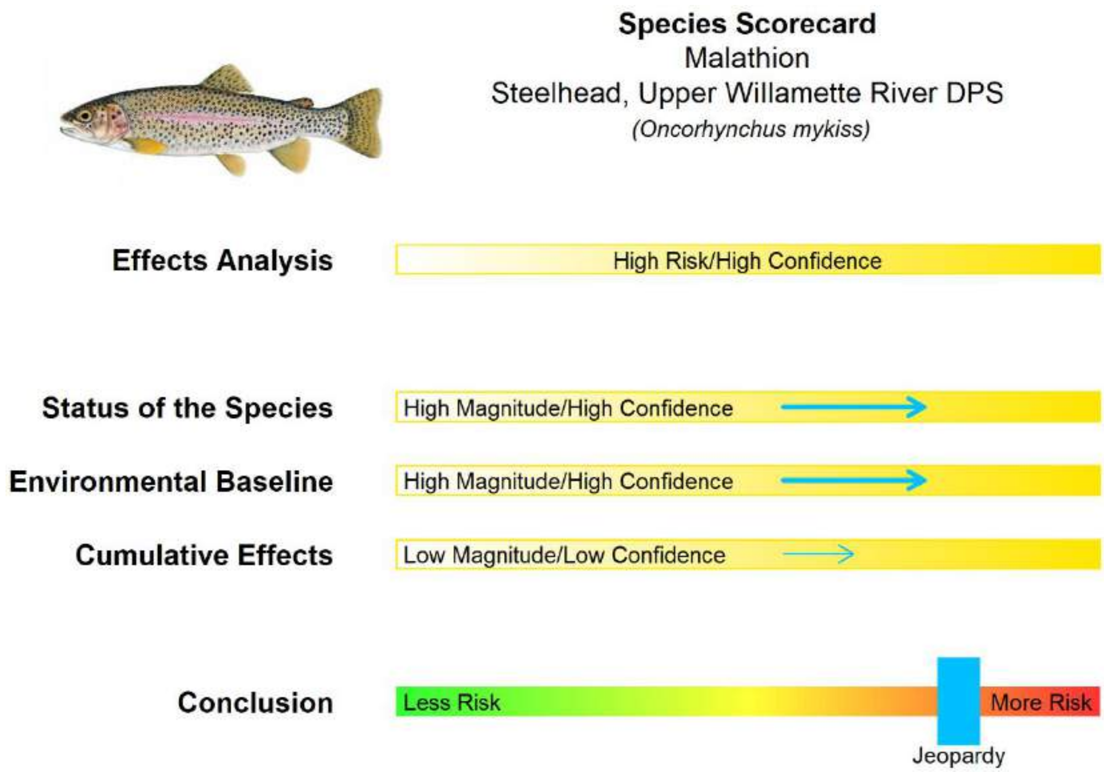

Figure 31. Species Score Card; Steelhead, Upper Willamette River DPS; Malathion

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence

- 5-year population trend declining, large fluctuations in abundances.
- Threatened;
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Malathion is likely to jeopardize the continued existence of this species: Jeopardy

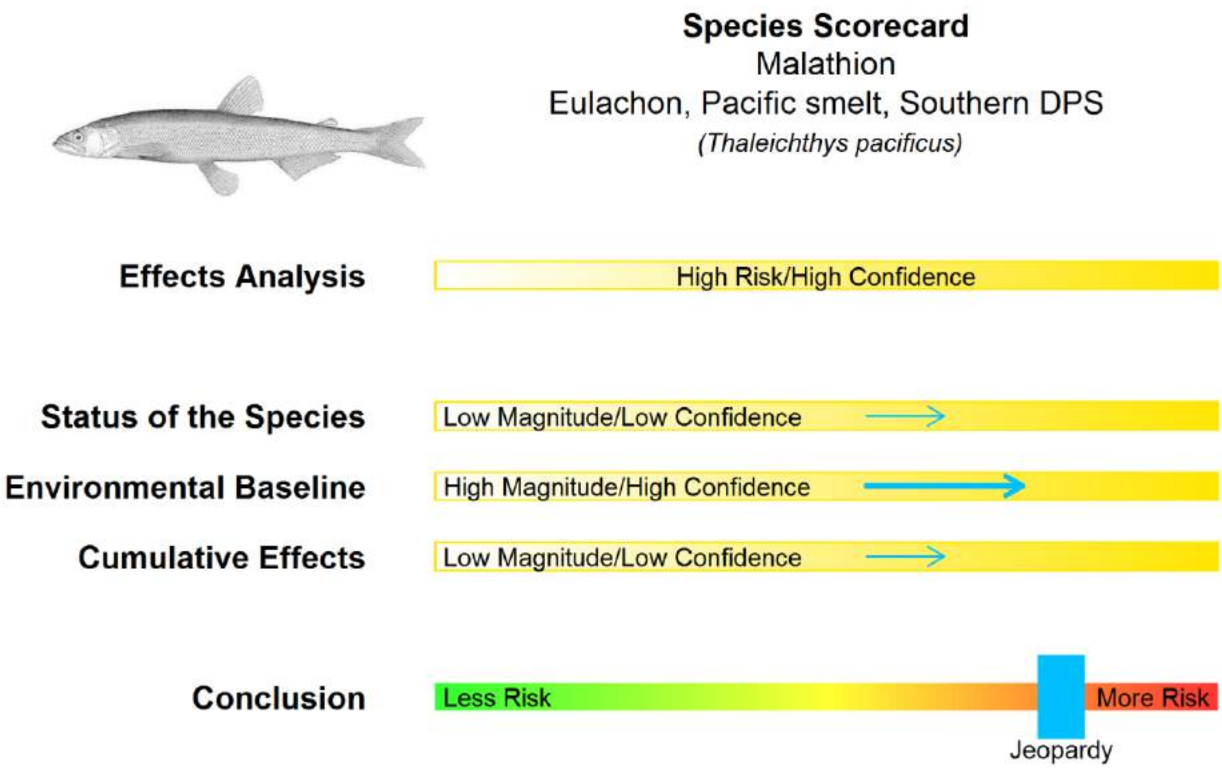

Figure 32. Species Score Card; Eulachon, Pacific smelt, Southern DPS; Malathion

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ High confidence

- Population abundance improving, especially in the 2013–2015 return years; in upcoming return years population declines may be widespread from poor ocean conditions
- Threatened; severely depressed abundance mid-late 1990s to late 2000s;
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Malathion is likely to jeopardize the continued existence of this species: Jeopardy

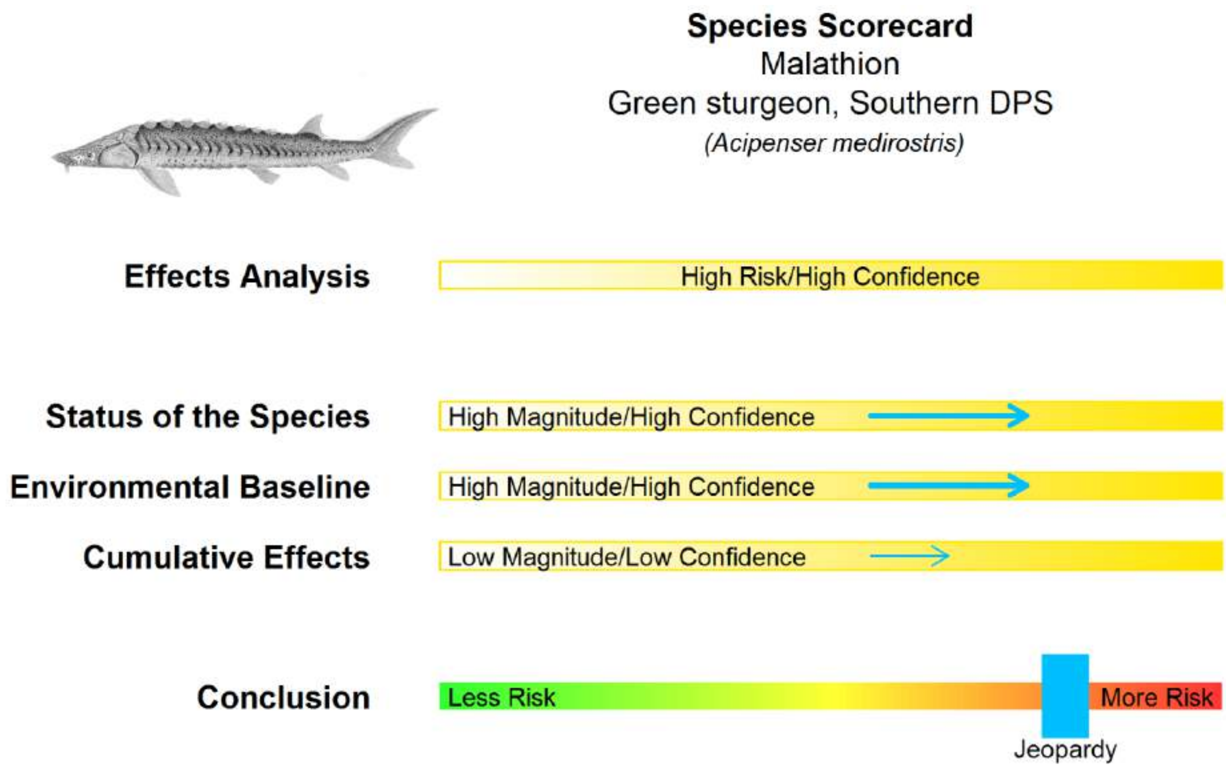

Figure 33. Species Score Card; Green sturgeon, Southern DPS; Malathion

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence

- Small population size, little population data, few remaining spawning sites
- Threatened;
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Increased risk of jeopardy; High magnitude/ High confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Malathion is likely to jeopardize the continued existence of this species: Jeopardy

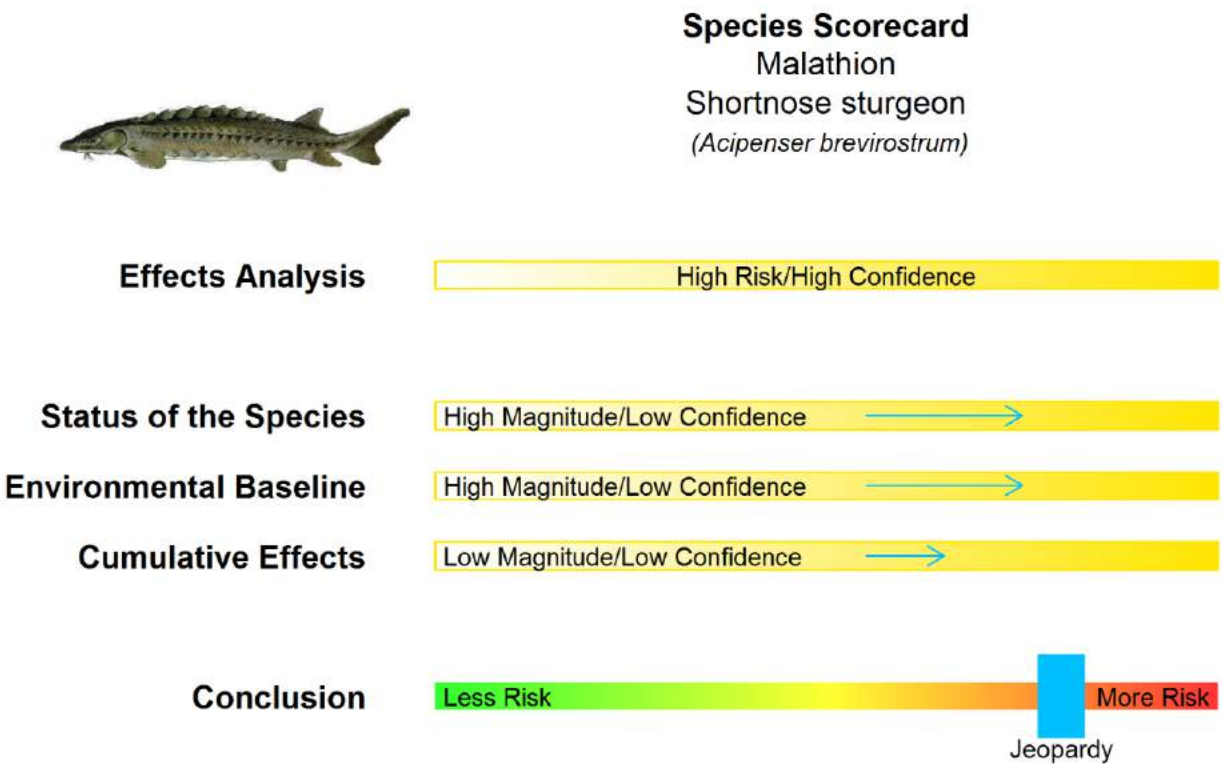

Figure 34. Species Score Card; Shortnose sturgeon; Malathion

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ low confidence</u>

- Stable to increasing populations, fragmented populations, only 12 known spawning sites
- Endangered;
- Recovery criteria not identified

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ Low confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>**Malathion is likely to jeopardize the continued existence of this species: Jeopardy**</u>

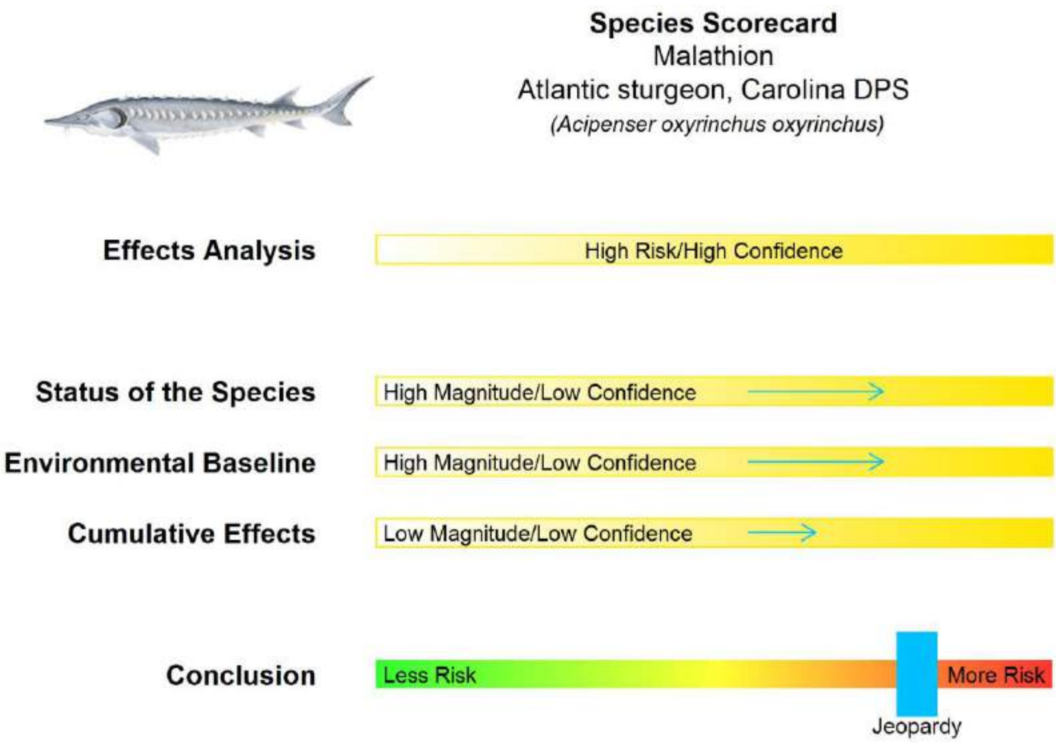

Figure 35. Species Score Card; Atlantic sturgeon, Carolina DPS; Malathion

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Increased risk of jeopardy; High magnitude/ low confidence

- <3% of historical abundance
- Endangered;
- Recovery criteria not identified

Environmental Baseline: Increased risk of jeopardy; High magnitude/ Low confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Malathion is likely to jeopardize the continued existence of this species: Jeopardy

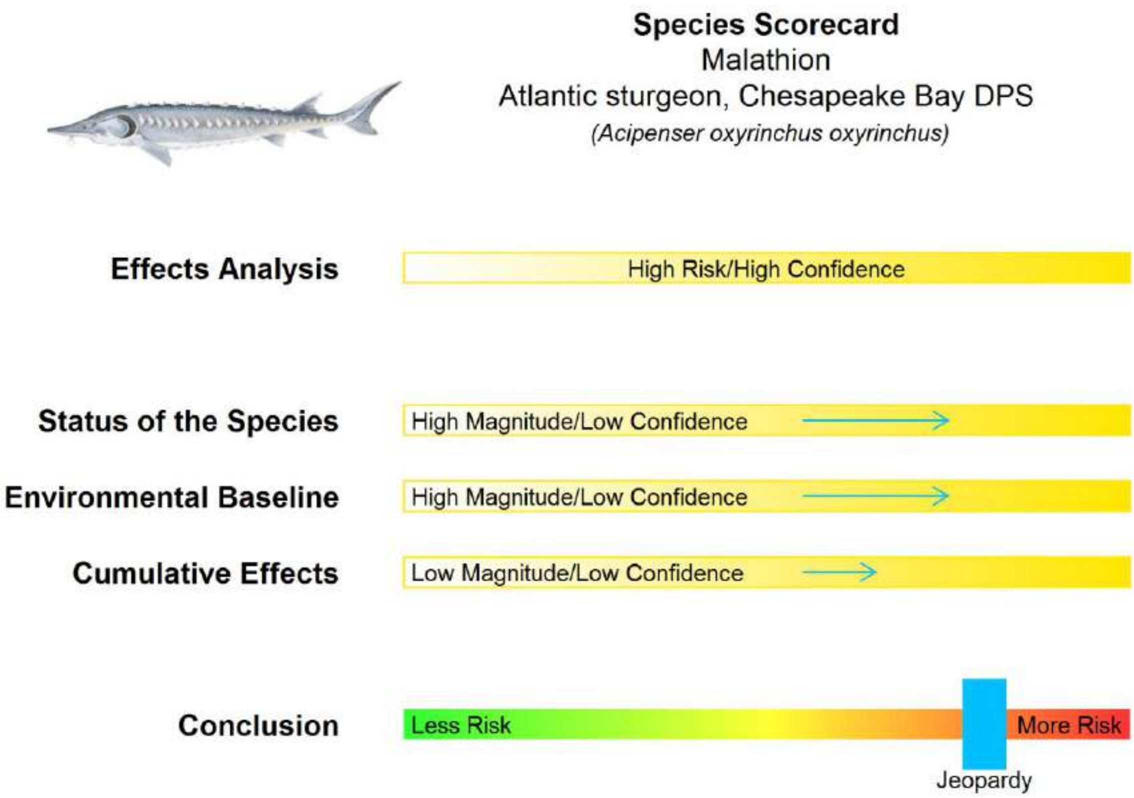

Figure 36. Species Score Card; Atlantic sturgeon, Chesapeake Bay DPS; Malathion

Effects Analysis: High risk/High confidence

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

Status of the Species: Increased risk of jeopardy; High magnitude/ low confidence

- 4% of historical abundance, unknown population growth rate
- Endangered;
- Recovery criteria not identified

Environmental Baseline: Increased risk of jeopardy; High magnitude/ Low confidence

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

Malathion is likely to jeopardize the continued existence of this species: Jeopardy

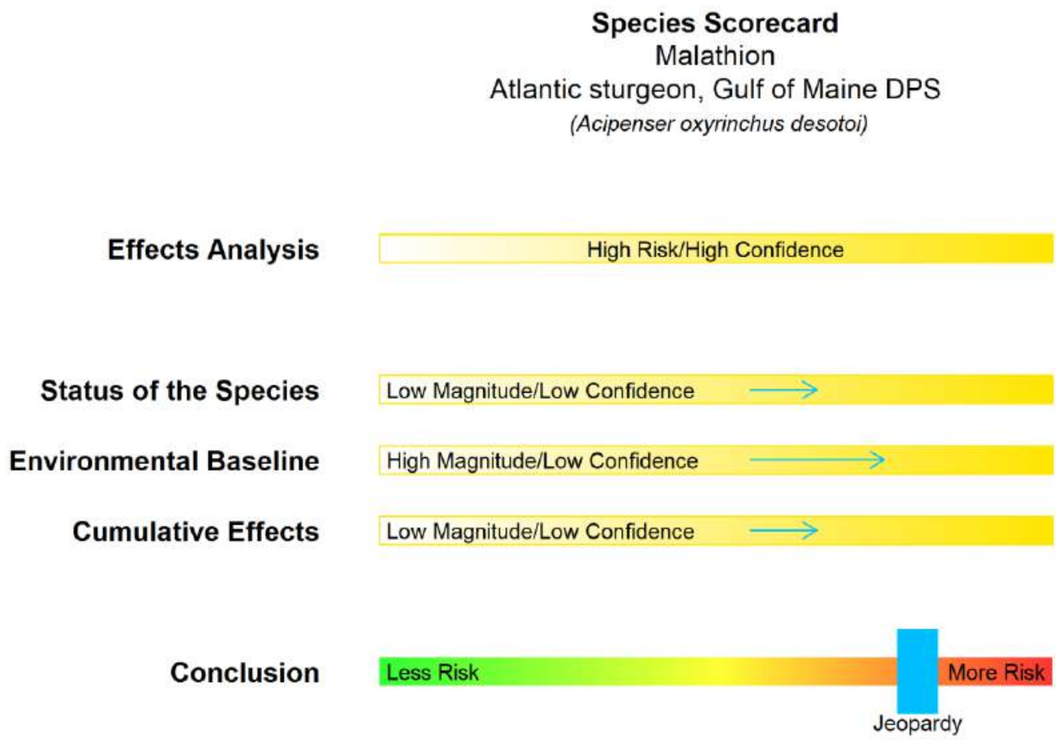

Figure 37. Species Score Card; Atlantic sturgeon, Gulf of Maine DPS; Malathion

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: minimal increased risk of jeopardy; Low magnitude/ low confidence</u>

- 10% of historical abundance, unknown population growth rate, range expanding
- Threatened;
- Recovery criteria not identified

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ Low confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Malathion is likely to jeopardize the continued existence of this species: Jeopardy</u>

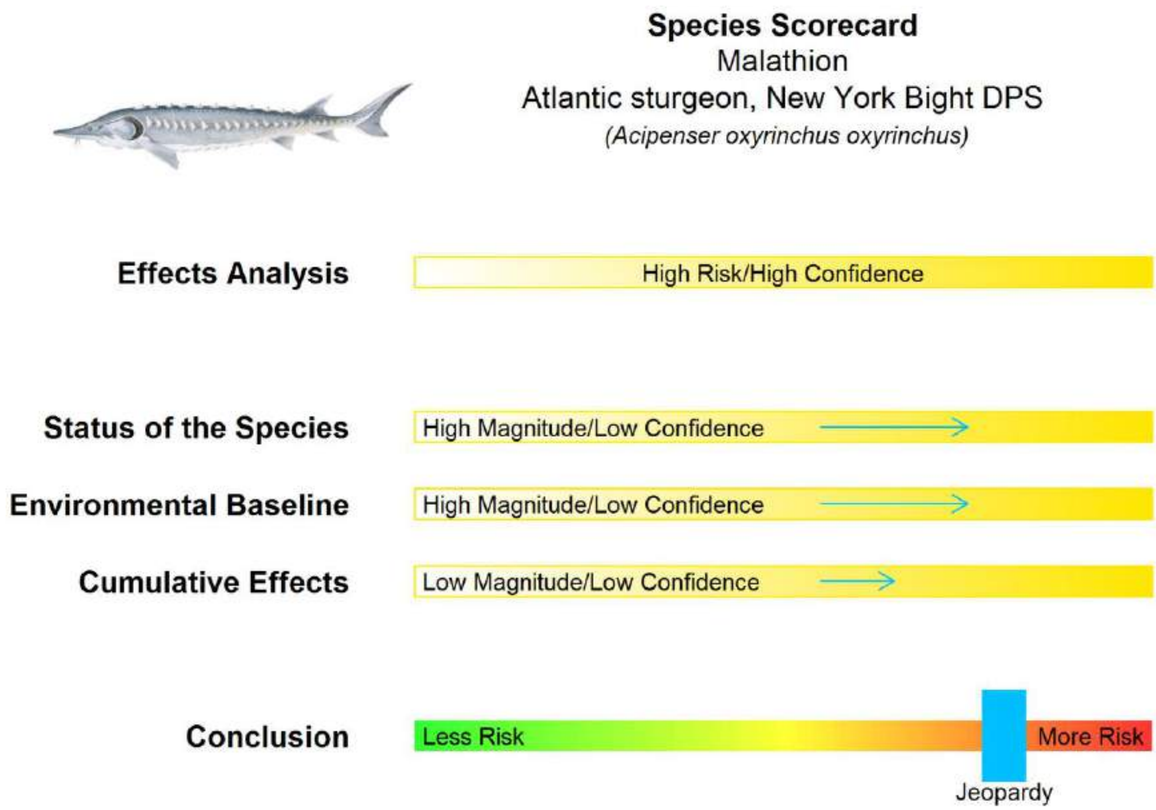

Figure 38. Species Score Card; Atlantic sturgeon, New York Bight DPS; Malathion

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ low confidence</u>

- 4% of historical abundance, unknown population growth rate
- Endangered;
- Recovery criteria not identified

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ Low confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Malathion is likely to jeopardize the continued existence of this species: Jeopardy</u>

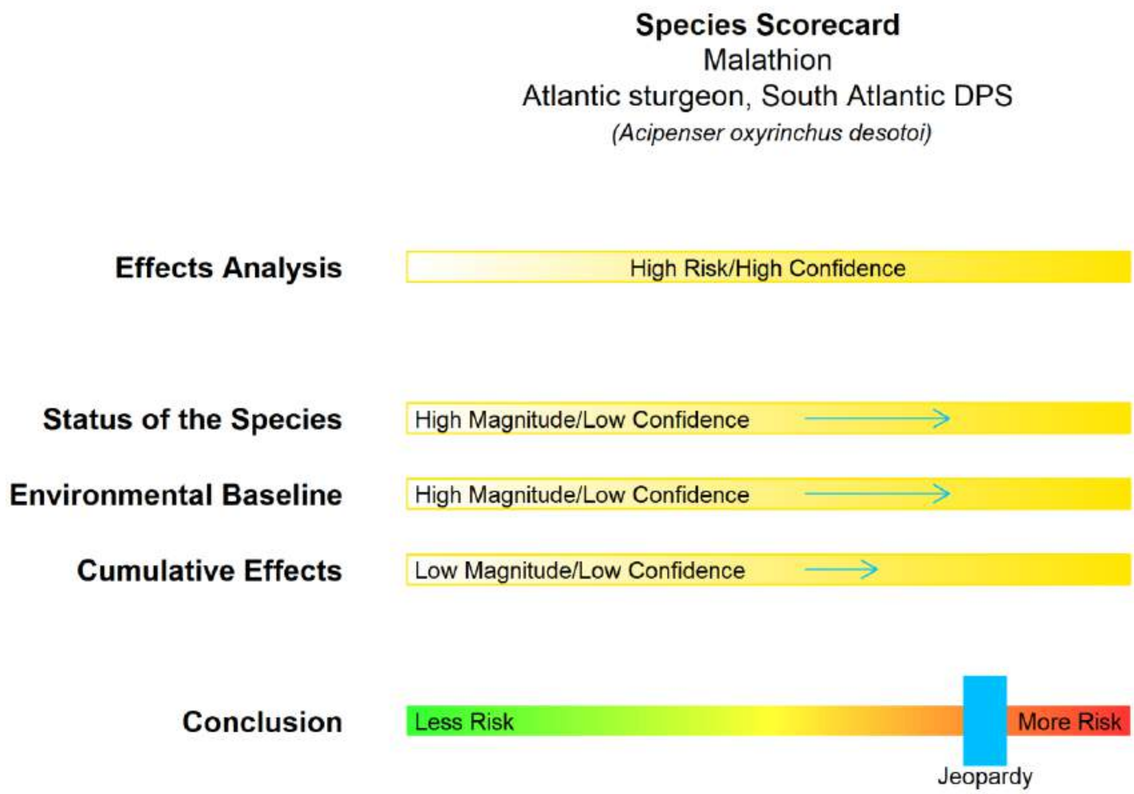

Figure 39. Species Score Card; Atlantic sturgeon, South Atlantic DPS; Malathion

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ low confidence</u>

- <6% of historical abundance
- Endangered;
- Recovery criteria not identified

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ Low confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>Malathion is likely to jeopardize the continued existence of this species: Jeopardy</u>

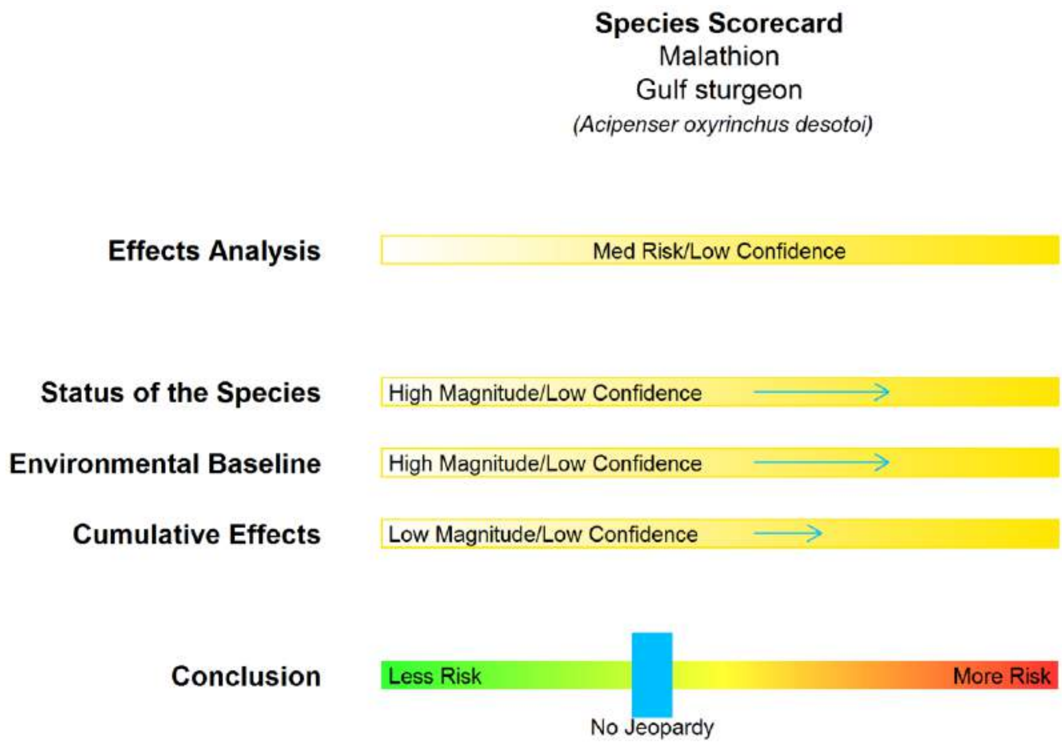

Figure 40. Species Score Card; Gulf sturgeon; Malathion

<u>Effects Analysis: Medium risk/Low confidence</u>

- Reduced abundance may occur in estuarine areas
- Potential effects include death, reduced cholinesterase activity, reduced growth and prey abundance, and impaired swimming.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ Low confidence</u>

- Eastern range populations stable to increasing, western population lower abundances and more uncertainty, minimal growth rate data
- Threatened;
- Recovery criteria not identified

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ Low confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures not anticipated to affect species
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In estuarine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in these estuarine areas where they rear. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

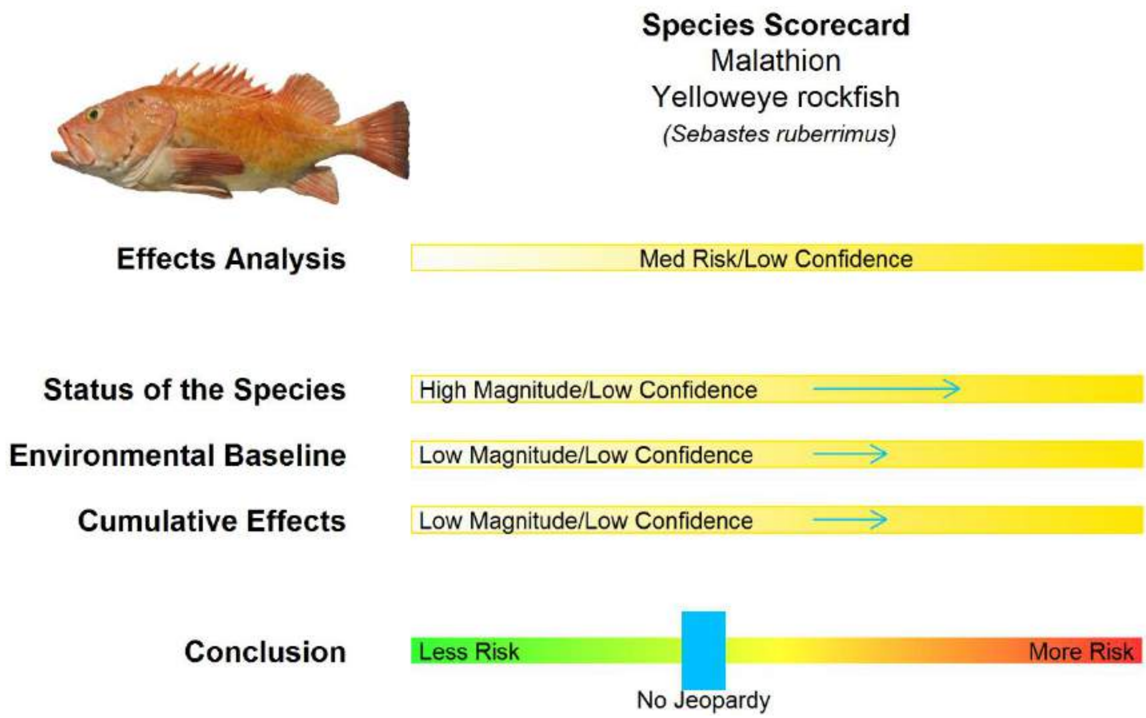

Figure 41. Species Score Card; Yelloweye rockfish; Malathion

<u>Effects Analysis: Medium risk/Low confidence</u>

- Reduced abundance may occur in marine areas
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ Low confidence</u>

- Historically low abundance, fragmented populations, altered population age structure
- Threatened;
- Recovery criteria not identified

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures unanticipated in marine waters
- Environmental mixtures at toxic concentrations unanticipated in marine habitats

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures not anticipated

<u>Conclusion:</u> In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations and species use of deep water habitats. The species is most at risk while in shallow surface, marine areas. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

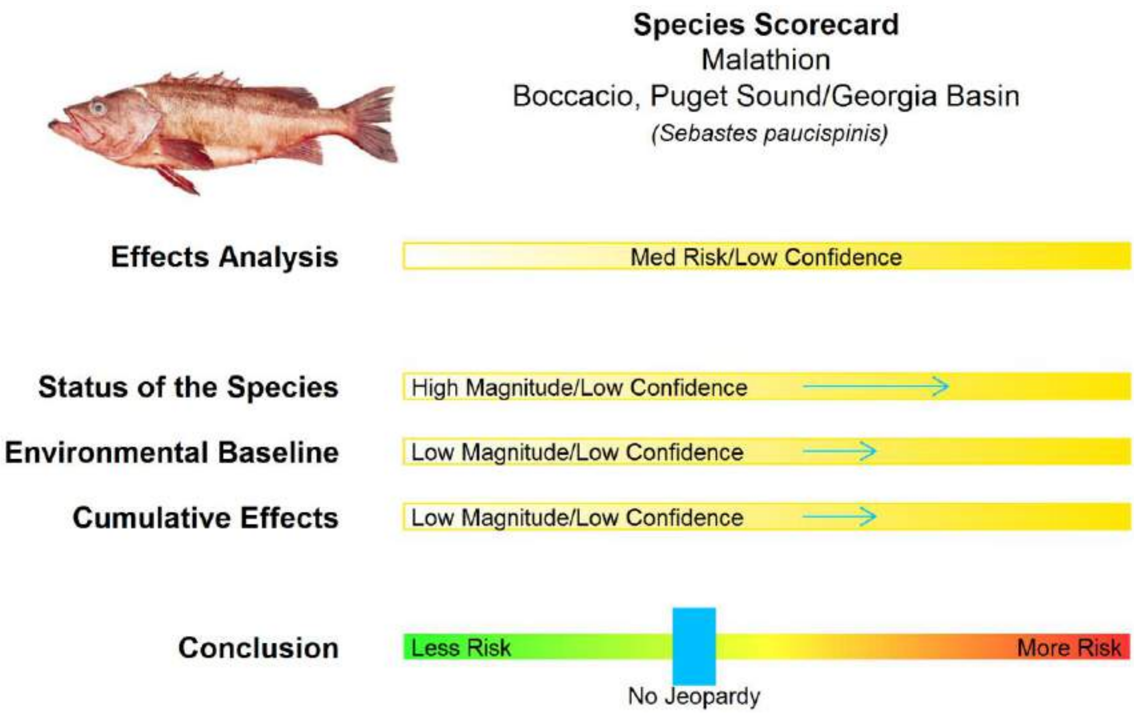

Figure 42. Species Score Card; Boccacio, Puget Sound/Georgia Basin; Malathion

Effects Analysis: Medium risk/Low confidence

- Reduced abundance may occur in marine areas
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Increased risk of jeopardy; High magnitude/ Low confidence

- There are no estimates of historical or current abundance across the DPS's full range; Indices suggest declining abundance trends
- Threatened;
- Recovery criteria not identified

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures unanticipated in marine waters
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures not anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas where they rear. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy

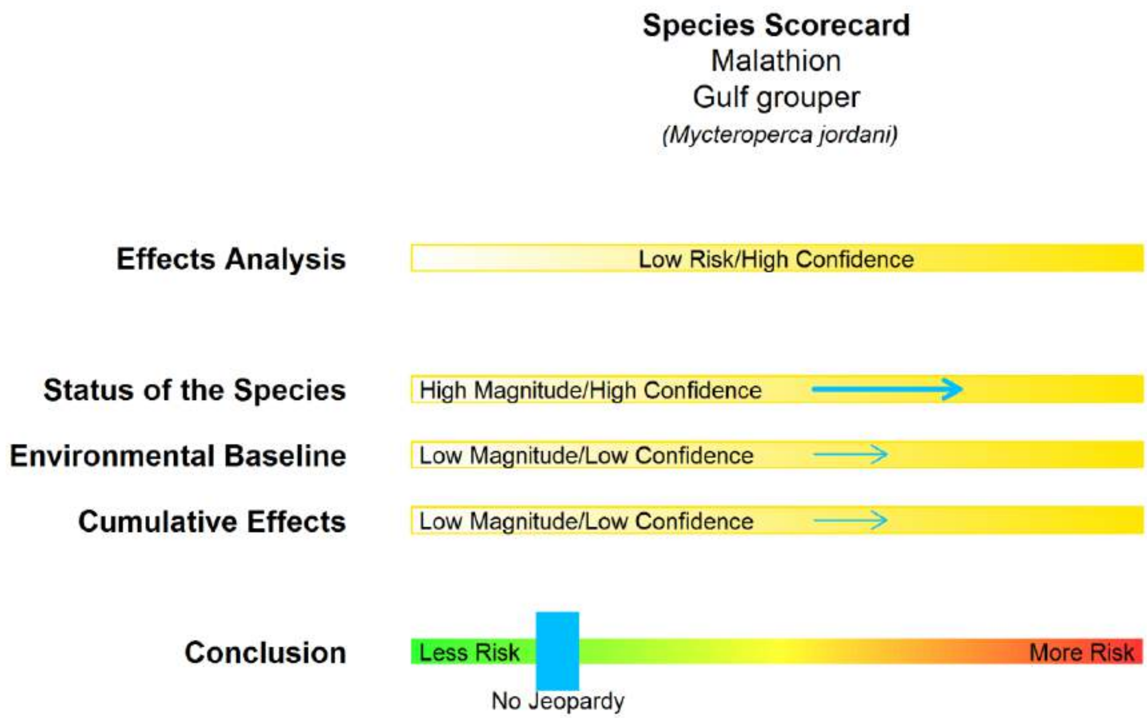

Figure 43. Species Score Card; Gulf grouper; Malathion

Effects Analysis: Low risk/High confidence

- Reduced abundance not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence

- Abundance levels less than 1% of their historical levels
- Endangered;
- Recovery criteria not identified

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures unanticipated in marine waters
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures not anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy

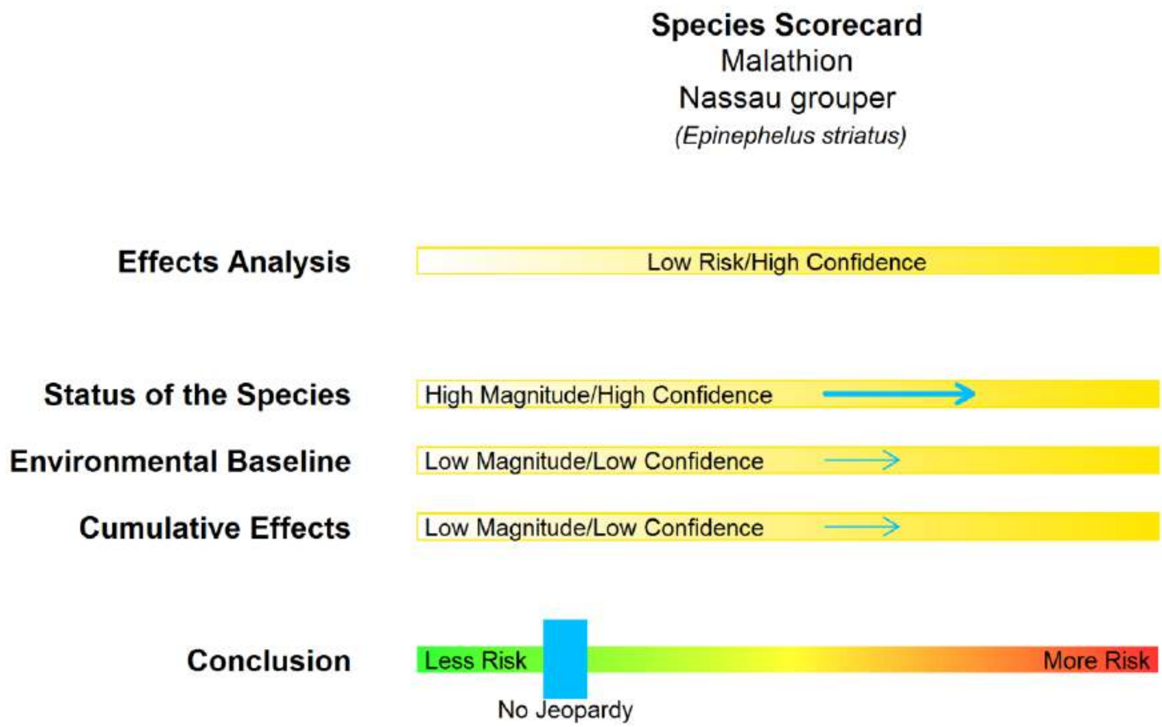

Figure 44. Species Score Card; Nassau grouper; Malathion

<u>Effects Analysis: Low risk/High confidence</u>

- Reduced abundance not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- The species has pathcy abundance with declining abundance trends. Throughout its range reductions in the size and number of spawning aggregations;
- Threatened;
- Recovery criteria not identified

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures unanticipated in marine waters
- Environmental mixtures not anticipated at toxic concentrations in marine habitats

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures not anticipated in marine waters

<u>Conclusion:</u> In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>**Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy**</u>

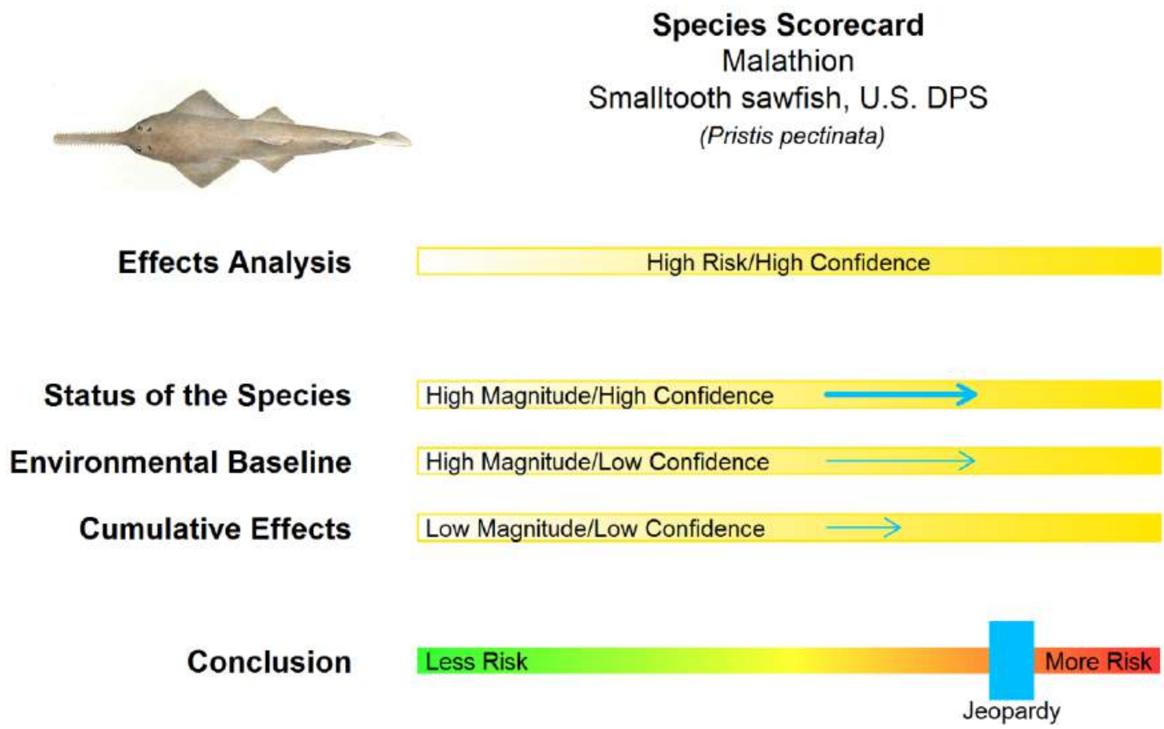

Figure 45. Species Score Card; Smalltooth sawfish, U.S. DPS; Malathion

<u>Effects Analysis: High risk/High confidence</u>

- Reduced abundance and productivity anticipated in freshwater and estuarine areas
- Anticipated effects include death, reduced cholinesterase activity, reduced growth and prey abundance, impaired swimming, and reduced reproduction.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Stable abundance, low population growth rates, <5% of historical abundance
- Endangered;
- Recovery criteria not met and reduced likelihood of attaining recovery goals

<u>Environmental Baseline: Increased risk of jeopardy; High magnitude/ Low confidence</u>

- Elevated temperatures occur in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated
- Anticipated hydrologic effects in freshwater areas

<u>Conclusion:</u> In freshwater habitats, we find a high likelihood of exposure and effects to the species based on high confidence in exposure concentrations. The species is most at risk while in these freshwater areas where they rear, reproduce, and migrate. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action.

<u>**Malathion is likely to jeopardize the continued existence of this species: Jeopardy**</u>

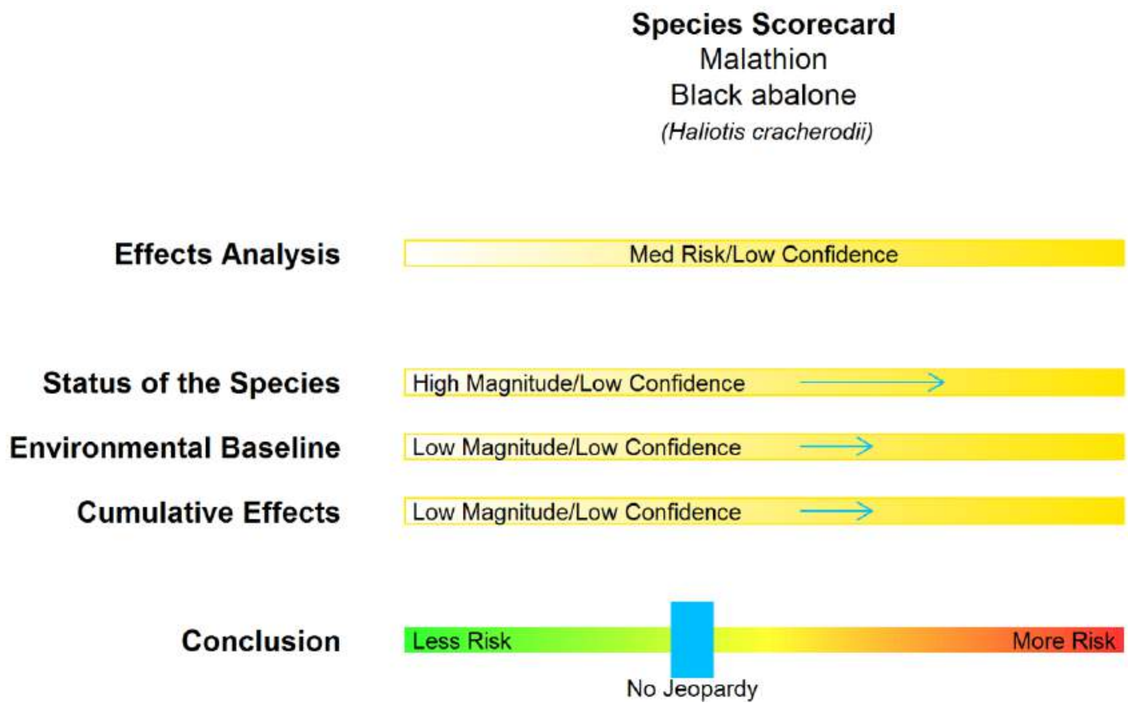

Figure 46. Species Score Card; Black abalone; Malathion

Effects Analysis: Medium risk/Low confidence

- Reduced abundance may occur in marine areas
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Increased risk of jeopardy; High magnitude/ Low confidence

- 5% of historical abundance, declining population trend
- Endangered;
- Recovery criteria not identified

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures unanticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures not anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in the surface areas. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy

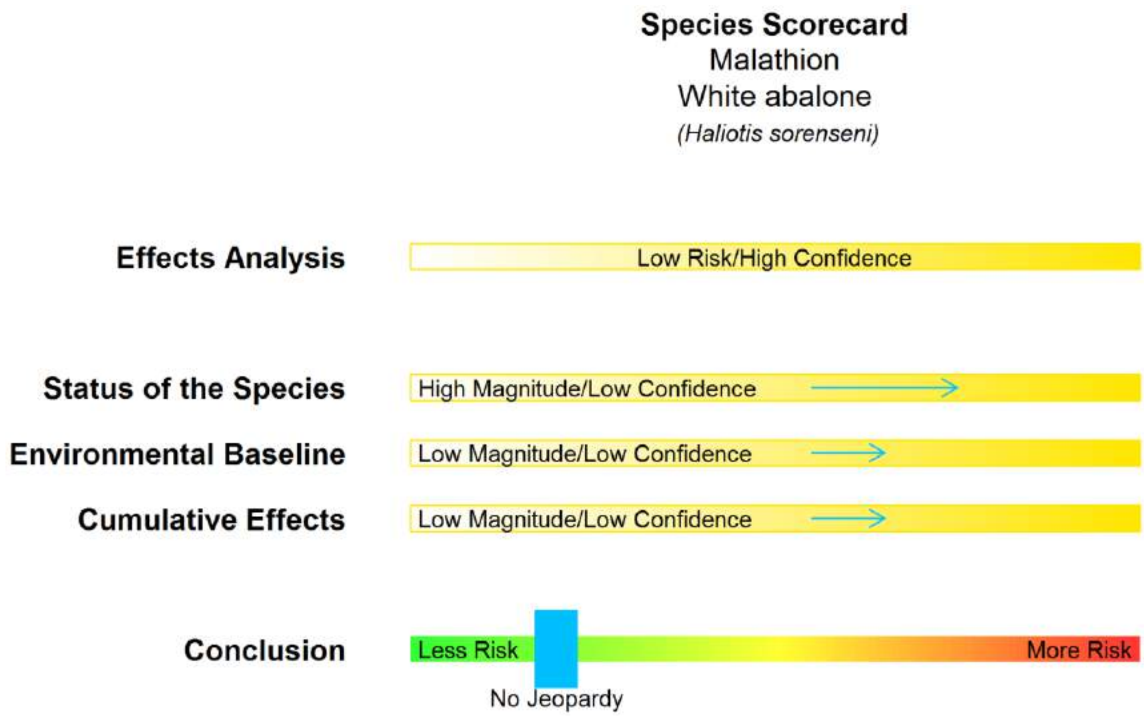

Figure 47. Species Score Card; White abalone; Malathion

Effects Analysis: Low risk/High confidence

- Reduced abundance unlikely to occur in marine areas
- Potential effects to some individual include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Increased risk of jeopardy; High magnitude/ Low confidence

- Declining population trend, lack of recruitment, no current estimated population size
- Endangered;
- Recovery criteria not met

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures unanticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures not anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on high confidence in minimal exposure to the stressor of the action. The species is most at risk while in the surface areas. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy

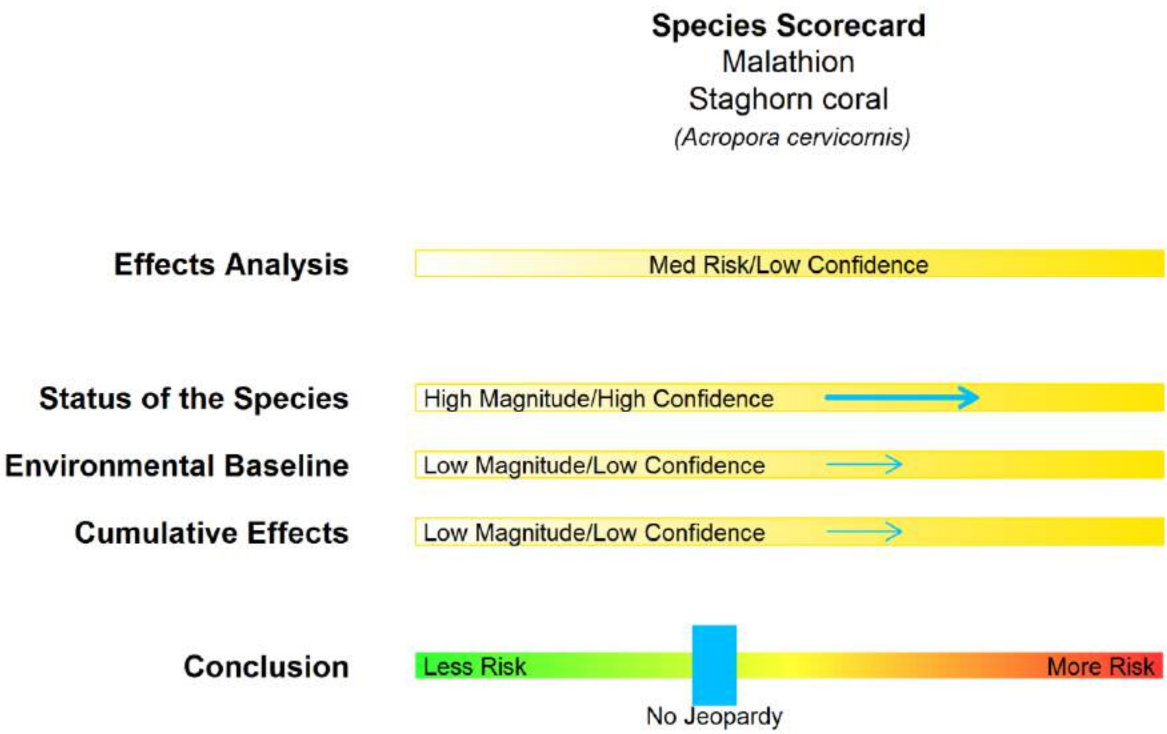

Figure 48. Species Score Card; Staghorn coral; Malathion

<u>Effects Analysis: Medium risk/Low confidence</u>

- Reduced abundance unlikely to occur in marine areas
- Potential effects to colonies include death and reduced settling of juveniles.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- Severe reductions in abundance in portions of range. Populations remain stable at depressed levels;
- Threatened;
- Recovery criteria not met.

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters

<u>Conclusion:</u> In marine habitats, we find a small likelihood of exposure and effects to the species based on high confidence in minimal exposure to the stressor of the action. Additionally, a maximum of 8% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

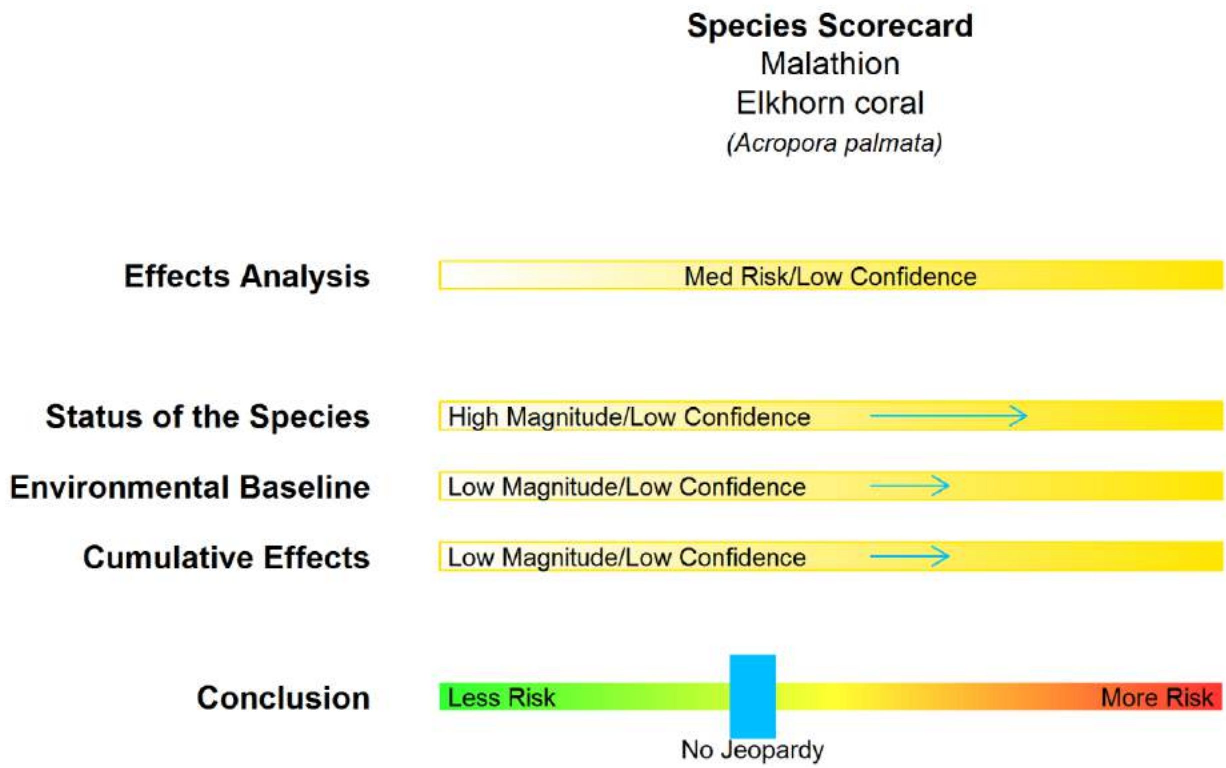

Figure 49. Species Score Card; Elkhorn coral; Malathion

<u>Effects Analysis: Medium risk/Low confidence</u>

- Reduced abundance unlikely to occur in marine areas
- Potential effects to colonies include death and reduced settling of juveniles.

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ Low confidence</u>

- Low abundance, large declines over past decades. Genetically depauparate populations in Caribbean. In eastern Caribbean, population is doing better and is genetically richer.
- Threatened;
- Recovery criteria not met.

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters

<u>Conclusion:</u> In marine habitats, we find a small likelihood of exposure and effects to the species based on high confidence in minimal exposure to the stressor of the action. Additionally, a maximum of 8% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>**Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy**</u>

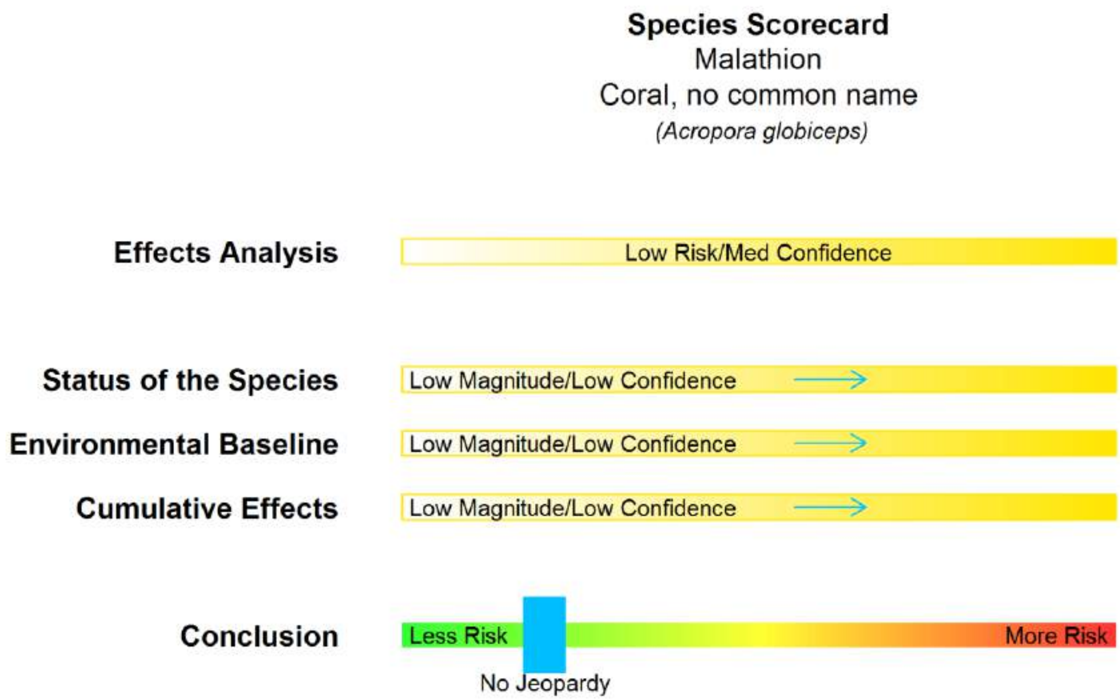

Figure 50. Species Score Card; Coral, Acropora globiceps; Malathion

<u>Effects Analysis: Low risk/Medium confidence</u>

- Reduced abundance unlikely to occur in marine areas
- Potential effects to colonies include death and reduced settling of juveniles.

<u>Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Range is extensive throughout the Indo-Pacific region. Less than 5 % of the population is within the range of the action area. Over-all status unknown. Growth rates of decline or increase are unknown.
- Threatened;
- Recovery criteria not developed

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters

<u>Conclusion:</u> In marine habitats, we find a small likelihood of exposure and effects to the species based on medium confidence in minimal exposure to the stressors of the action. Additionally, a maximum of 5% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

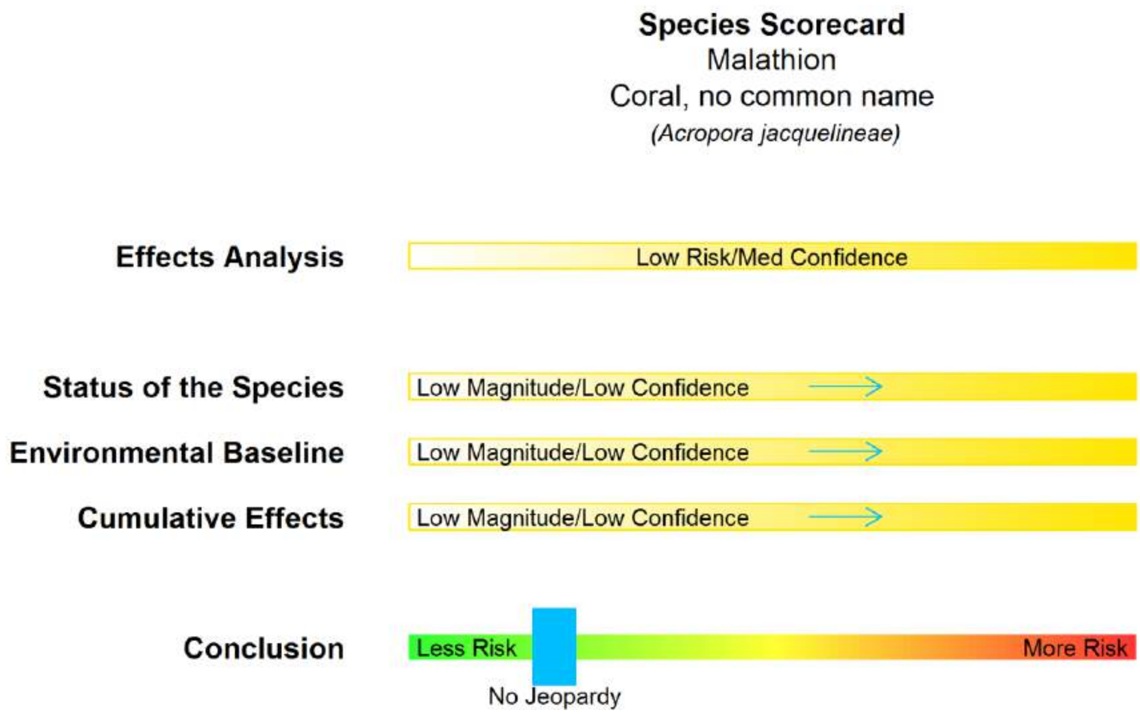

Figure 51. Species Score Card; Coral, Acropora jacquelineae; Malathion

<u>Effects Analysis: Low risk/Medium confidence</u>

- Reduced abundance unlikely to occur in marine areas
- Potential effects to colonies include death and reduced settling of juveniles.

<u>Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Range is extensive throughout the Indo-Pacific region. Less than 5 % of the population is within the range of the action area. Over-all status unknown. Growth rates of decline or increase are unknown.
- Threatened;
- Recovery criteria not developed

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters

<u>Conclusion:</u> In marine habitats, we find a small likelihood of exposure and effects to the species based on medium confidence in minimal exposure to the stressors of the action. Additionally, a maximum of 5% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

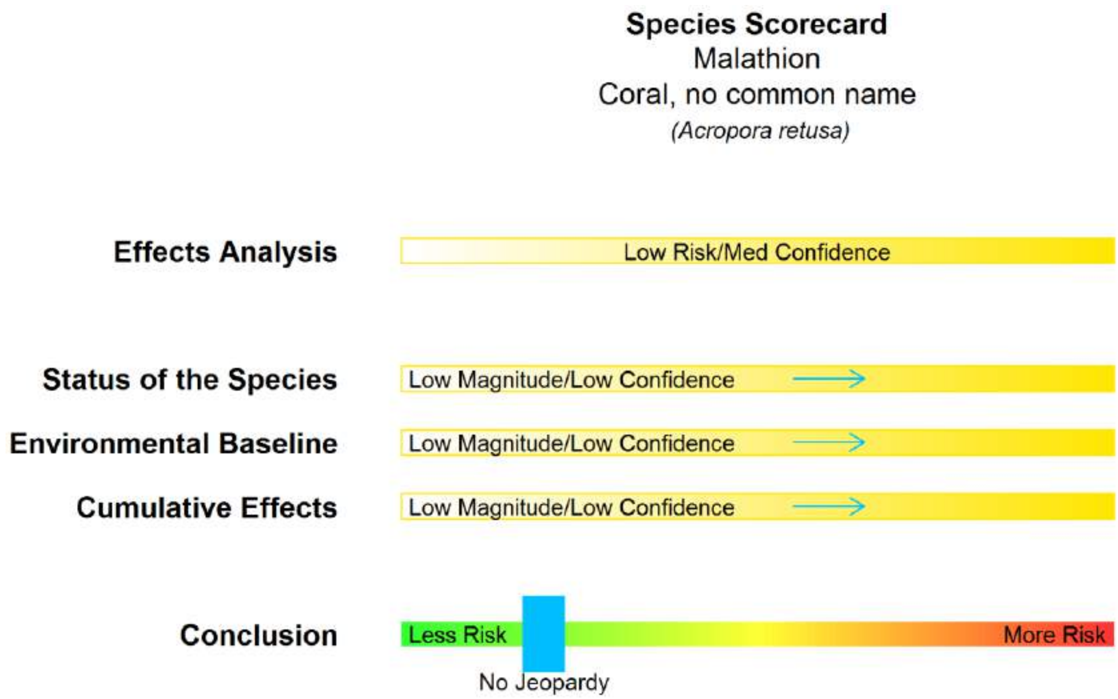

Figure 52. Species Score Card; Coral, Acropora retusa; Malathion

Effects Analysis: Low risk/Medium confidence

- Reduced abundance unlikely to occur in marine areas
- Potential effects to colonies include death and reduced settling of juveniles.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Range is extensive throughout the Indo-Pacific region. Less than 5 % of the population is within the range of the action area. Over-all status unknown. Growth rates of decline or increase are unknown.
- Threatened;
- Recovery criteria not developed

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on medium confidence in minimal exposure to the stressors of the action. Additionally, a maximum of 5% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy

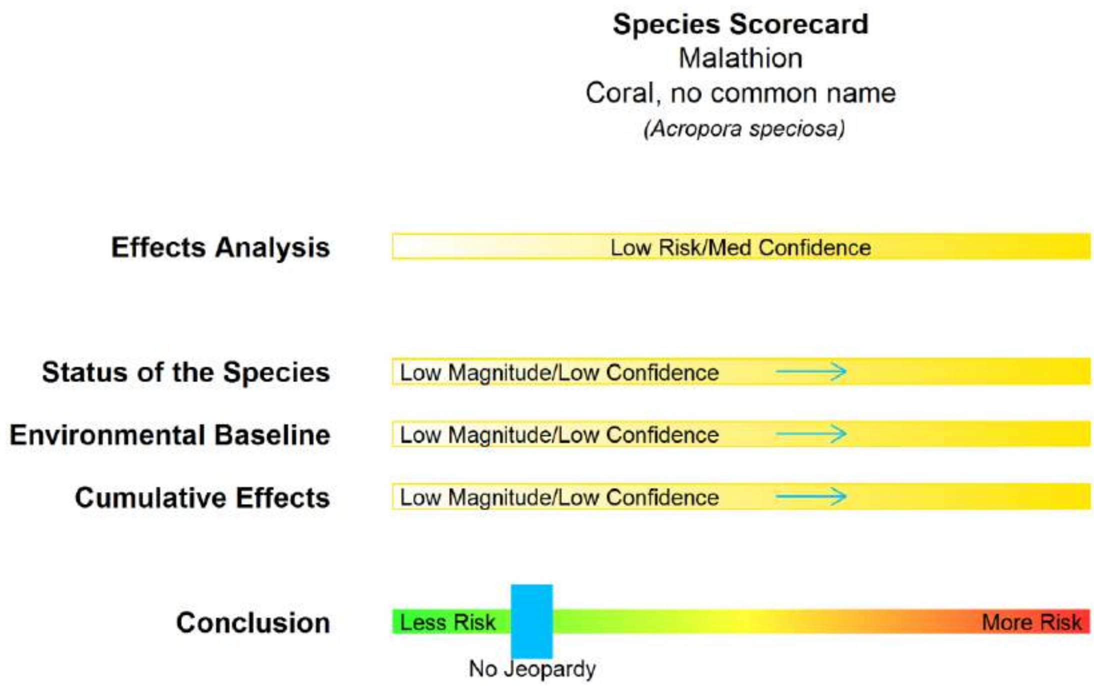

Figure 53. Species Score Card; Coral, Acropora speciosa; Malathion

Effects Analysis: Low risk/Medium confidence

- Reduced abundance unlikely to occur in marine areas
- Potential effects to colonies include death and reduced settling of juveniles.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Range is extensive throughout the Indo-Pacific region. Less than 5 % of the population is within the range of the action area. Over-all status unknown. Growth rates of decline or increase are unknown.
- Threatened;
- Recovery criteria not developed

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on medium confidence in minimal exposure to the stressors of the action. Additionally, a maximum of 5% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy

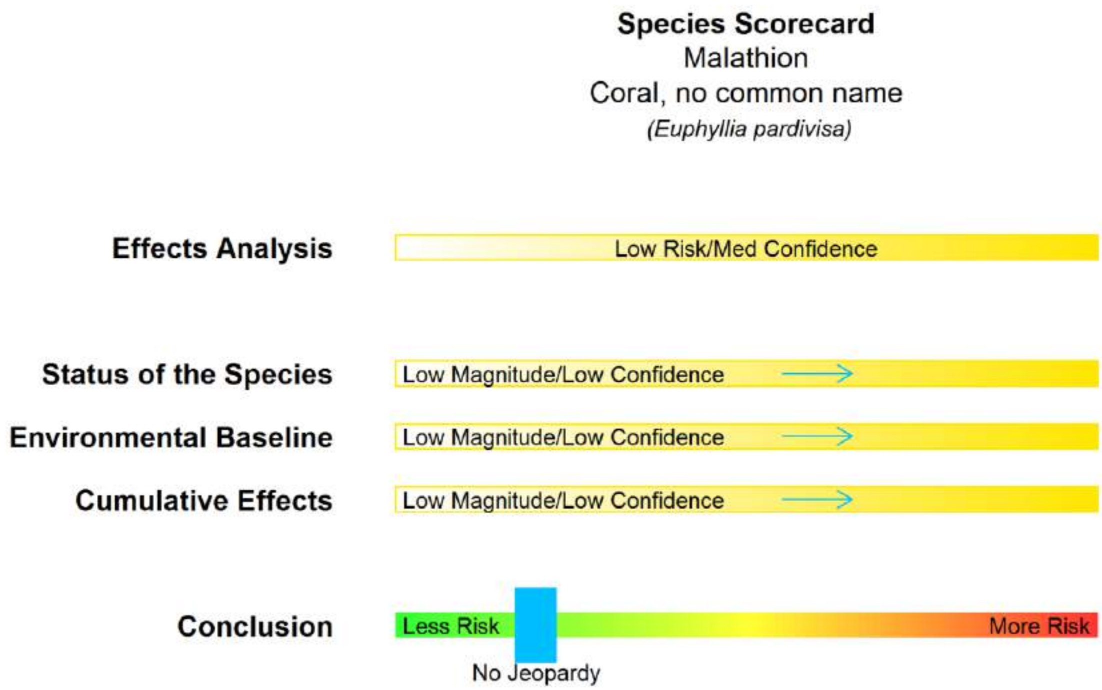

Figure 54. Species Score Card; Coral, Euphyllia pardivisa; Malathion

<u>Effects Analysis: Low risk/Medium confidence</u>

- Reduced abundance unlikely to occur in marine areas
- Potential effects to colonies include death and reduced settling of juveniles.

<u>Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Range is extensive throughout the Indo-Pacific region. Less than 5 % of the population is within the range of the action area. Over-all status unknown. Growth rates of decline or increase are unknown.
- Threatened;
- Recovery criteria not developed

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters

<u>Conclusion:</u> In marine habitats, we find a small likelihood of exposure and effects to the species based on medium confidence in minimal exposure to the stressors of the action. Additionally, a maximum of 5% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

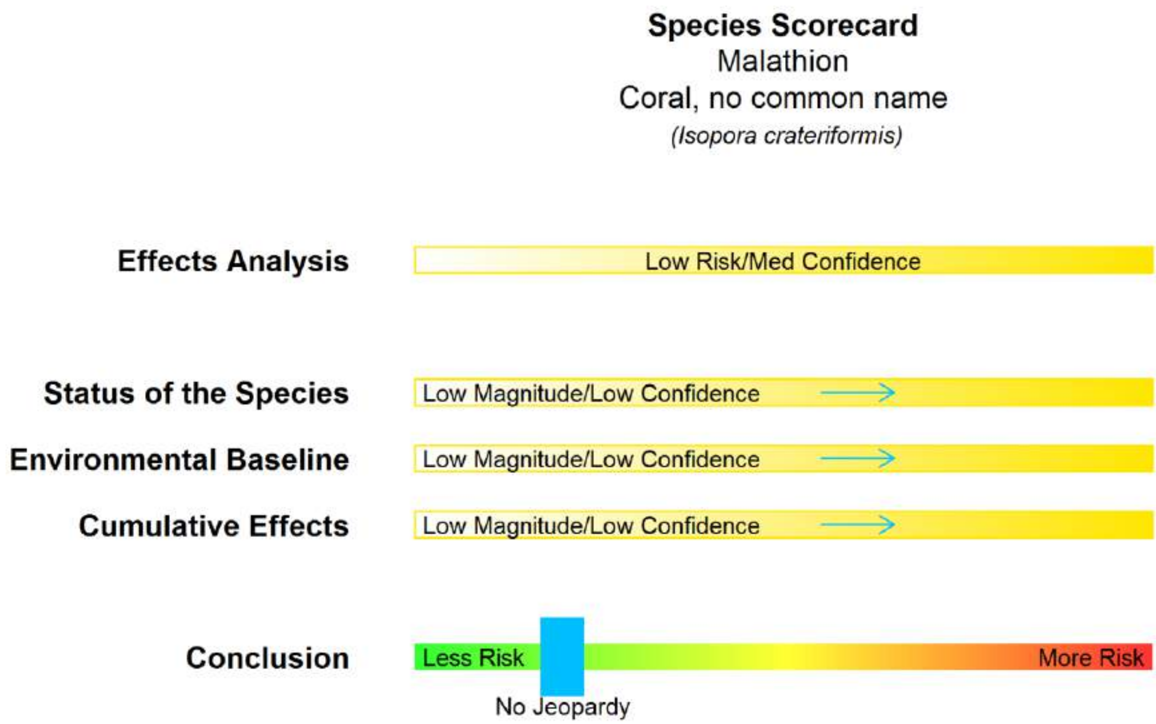

Figure 55. Species Score Card; Coral, Isopora crateriformis; Malathion

Effects Analysis: Low risk/Medium confidence

- Reduced abundance unlikely to occur in marine areas
- Potential effects to colonies include death and reduced settling of juveniles.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Range is extensive throughout the Indo-Pacific region. Less than 5 % of the population is within the range of the action area. Over-all status unknown. Growth rates of decline or increase are unknown.
- Threatened;
- Recovery criteria not developed

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on medium confidence in minimal exposure to the stressors of the action. Additionally, a maximum of 5% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy

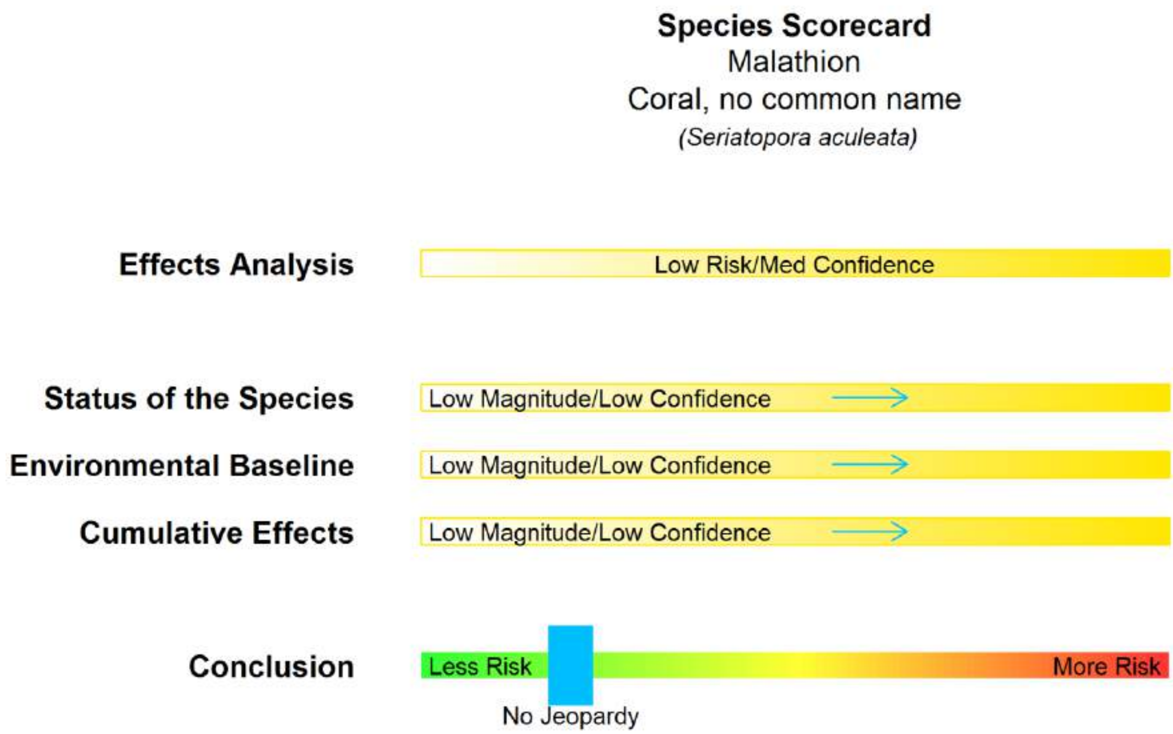

Figure 56. Species Score Card; Coral, Seriatopora aculeata; Malathion

<u>Effects Analysis: Low risk/Medium confidence</u>

- Reduced abundance unlikely to occur in marine areas
- Potential effects to colonies include death and reduced settling of juveniles.

<u>Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Range is extensive throughout the Indo-Pacific region. Less than 5 % of the population is within the range of the action area. Over-all status unknown. Growth rates of decline or increase are unknown.
- Threatened;
- Recovery criteria not developed

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters

<u>Conclusion:</u> In marine habitats, we find a small likelihood of exposure and effects to the species based on medium confidence in minimal exposure to the stressors of the action. Additionally, a maximum of 5% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

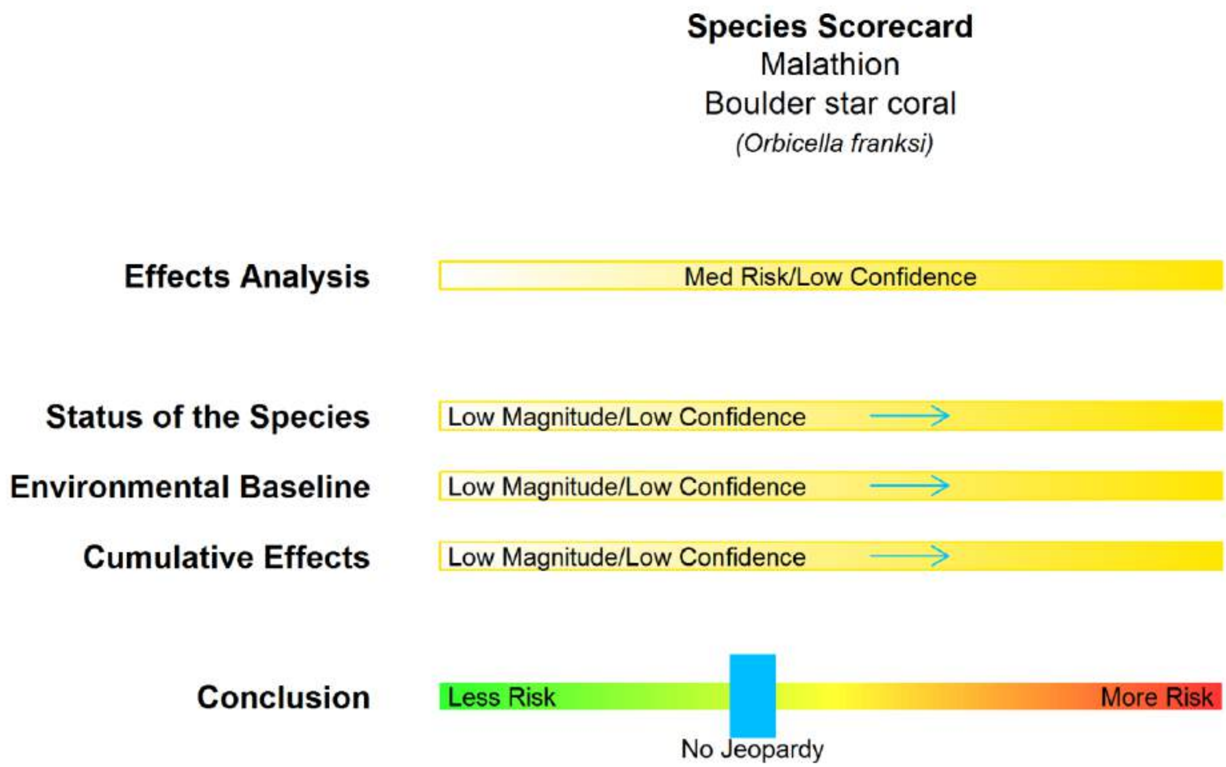

Figure 57. Species Score Card; Boulder star coral; Malathion

Effects Analysis: Medium risk/Low confidence

- Reduced abundance unlikely to occur in marine areas
- Potential effects to some colonies include death and reduced settling of juveniles.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Reductions in abundance, population is currently stable
- Threatened;
- Recovery criteria not developed

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on medium confidence in minimal exposure to the stressors of the action. Additionally, a maximum of 5% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy

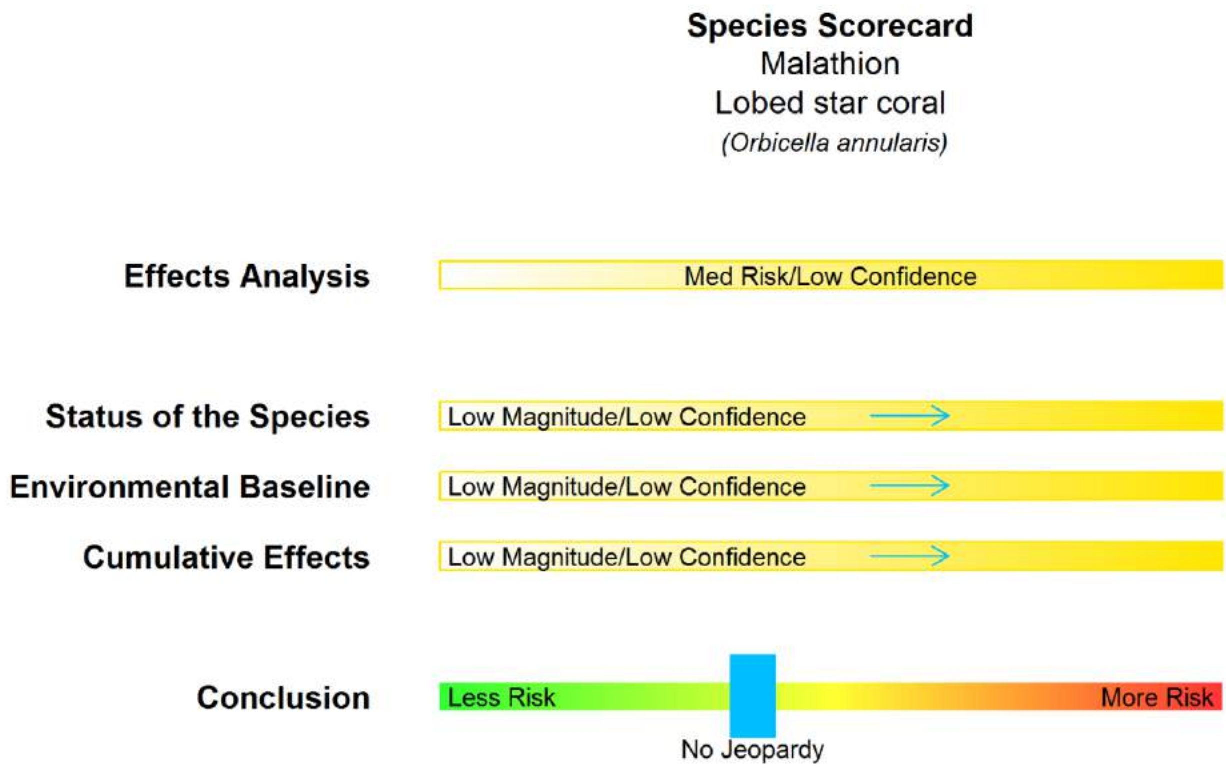

Figure 58. Species Score Card; Lobed star coral; Malathion

<u>Effects Analysis: Medium risk/Low confidence</u>

- Reduced abundance unlikely to occur in marine areas
- Potential effects to some colonies include death and reduced settling of juveniles.

<u>Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- 60% decline 2001-2012 due to bleaching. Most were considered "partial" mortalities to the colony. Abundance is stable.
- Threatened;
- Recovery criteria not developed

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters

<u>Conclusion:</u> In marine habitats, we find a small likelihood of exposure and effects to the species based on medium confidence in minimal exposure to the stressors of the action. Additionally, a maximum of 8% of the species’ range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species’ numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

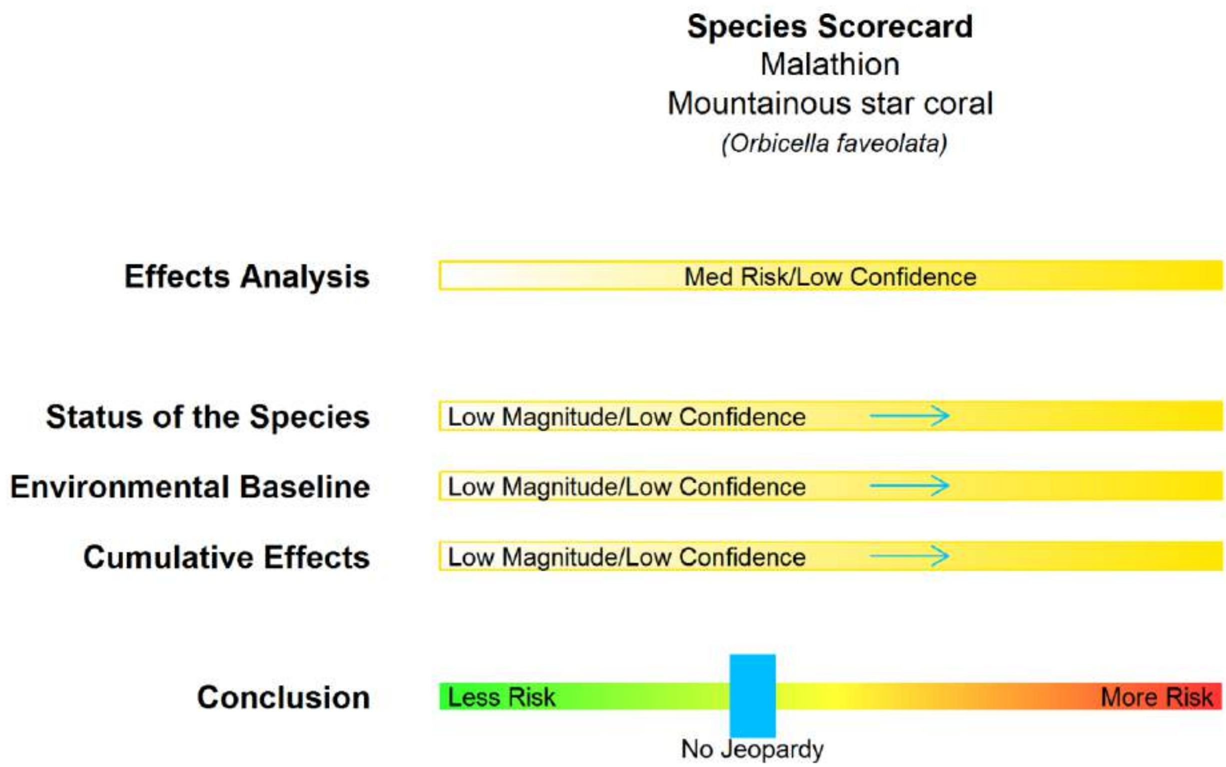

Figure 59. Species Score Card; Mountainous star coral; Malathion

<u>Effects Analysis: Medium risk/Low confidence</u>

- Reduced abundance unlikely to occur in marine areas
- Potential effects to some colonies include death and reduced settling of juveniles.

<u>Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Some areas have shown major declines due to warming induced bleaching and disease; however this species is considered abundant.
- Threatened;
- Recovery criteria not developed

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters

<u>Conclusion:</u> In marine habitats, we find a small likelihood of exposure and effects to the species based on medium confidence in minimal exposure to the stressors of the action. Additionally, a maximum of 8% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

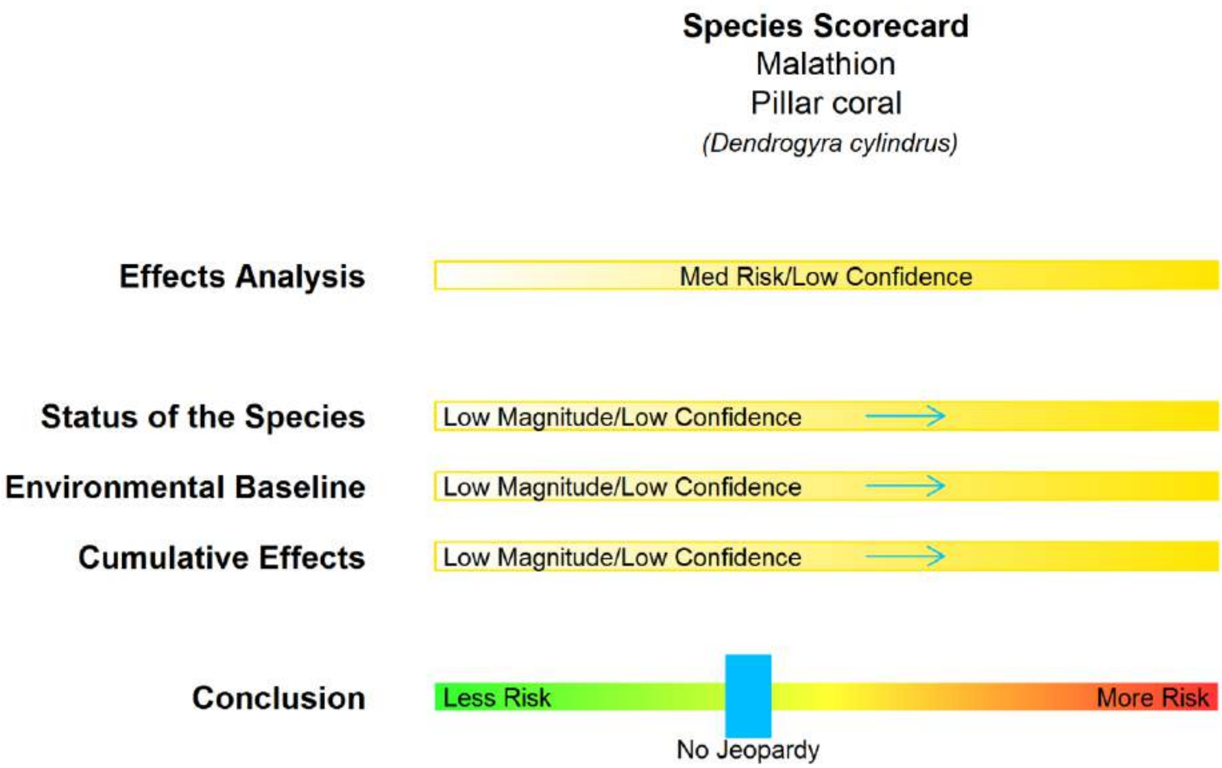

Figure 60. Species Score Card; Pillar coral; Malathion

Effects Analysis: Medium risk/Low confidence

- Reduced abundance unlikely to occur in marine areas
- Potential effects to some colonies include death and reduced settling of juveniles.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Uncommon, rarely found in aggregations - yet little evidence of population declines over years of monitoring. Unknown trends in abundance or productivity
- Threatened;
- Recovery criteria not developed

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on medium confidence in minimal exposure to the stressors of the action. Additionally, a maximum of 8% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy

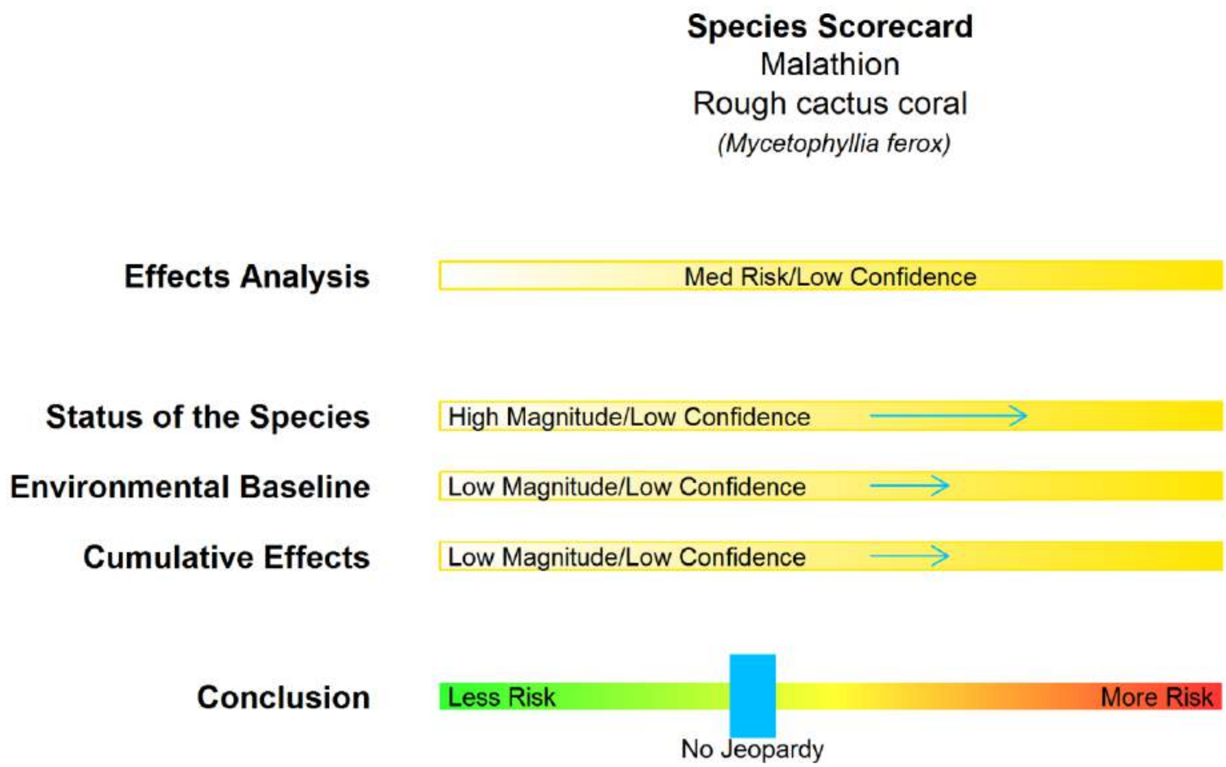

Figure 61. Species Score Card; Rough cactus coral; Malathion

Effects Analysis: Medium risk/Low confidence

- Reduced abundance unlikely to occur in marine areas
- Potential effects to some colonies include death and reduced settling of juveniles.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Uncommon to rare. Species saw declines since the 1970's. Highly affected by disease. Unknown trends in abundance or productivity
- Threatened;
- Recovery criteria not developed

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures anticipated in marine waters
- Environmental mixtures not anticipated to reach toxic concentration in marine habitats

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on medium confidence in minimal exposure to the stressors of the action. Additionally, a maximum of 8% of the species' range is in U.S. jurisdiction. The species is most at risk where colonies are proximate to river and stream mouths. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy

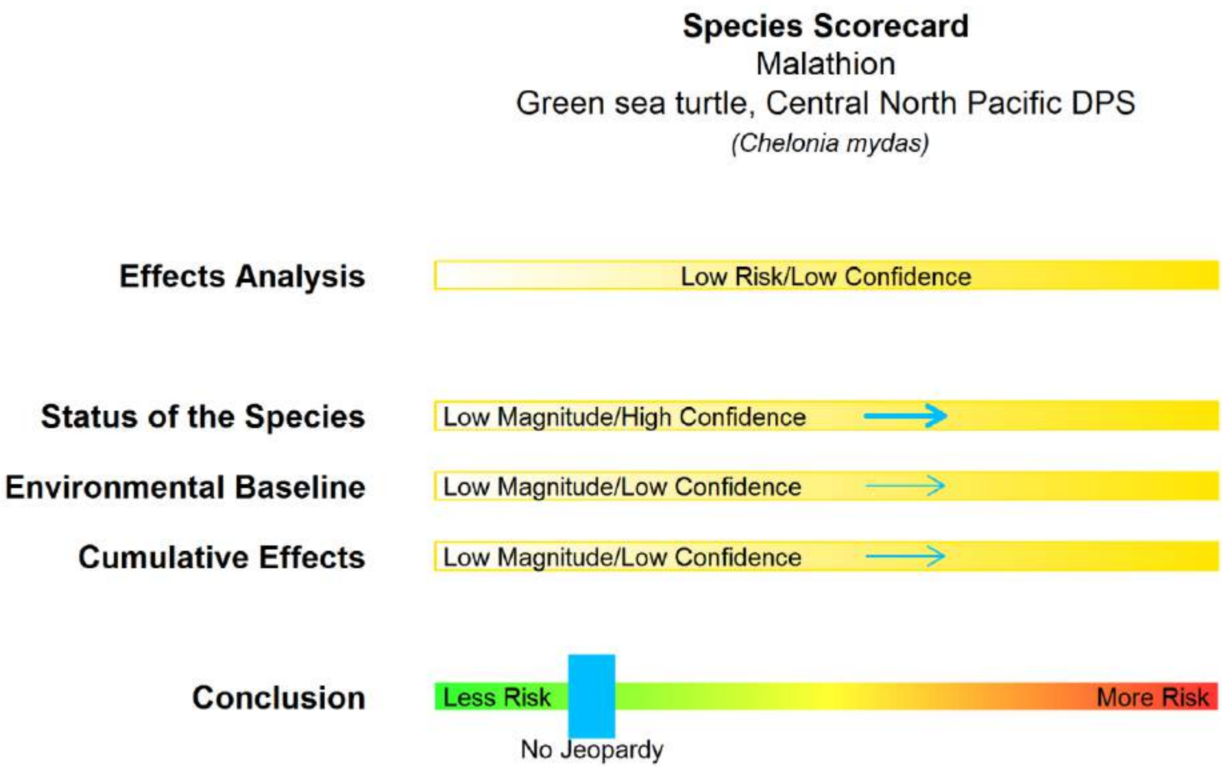

Figure 62. Species Score Card; Green sea turtle, Central North Pacific DPS; Malathion

Effects Analysis: Low risk/Low confidence

- Reduced abundance not anticipated
- Potential effects may include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ High confidence

- Population nesting abundance is increasing at estimated rate of 4.8% annually. DPS has low level of genetic diversity. Population considered resilient.
- Threatened;
- Recovery criteria not met

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy

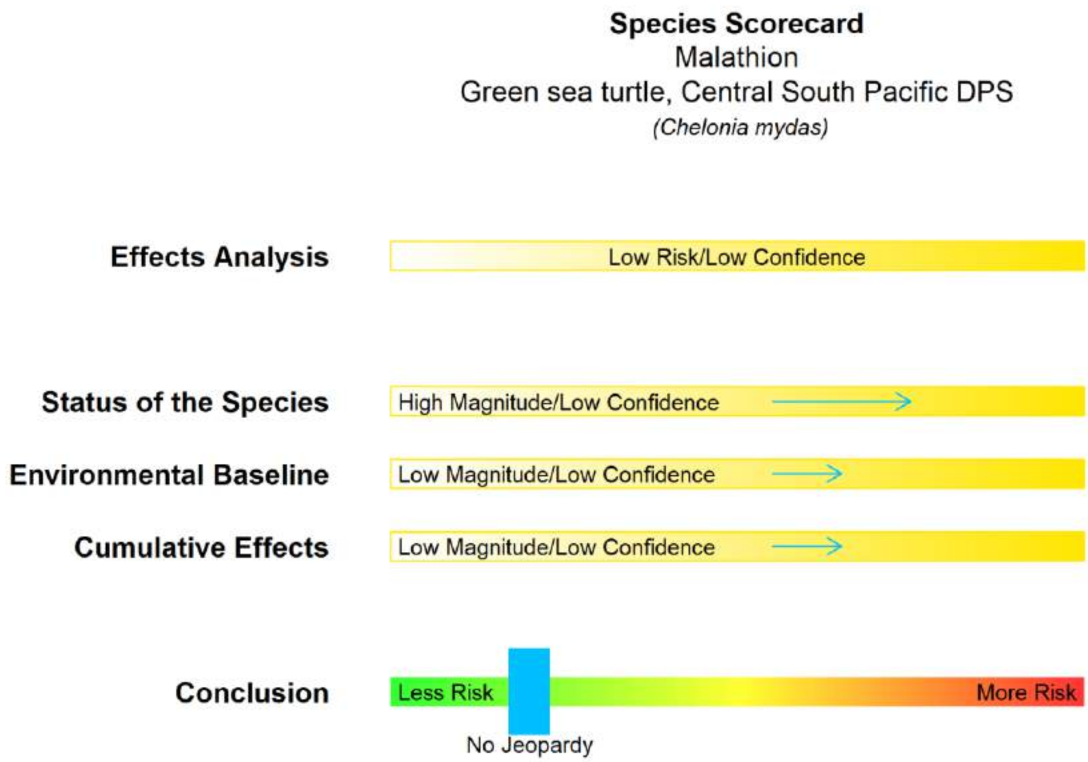

Figure 63. Species Score Card; Green sea turtle, Central South Pacific DPS; Malathion

Effects Analysis: Low risk/Low confidence

- Reduced abundance not anticipated
- Potential effects may include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Increased risk of jeopardy; High magnitude/ Low confidence

- Nesting abundance considered low, 59 known sites; Unknown population trends; Existing data suggest steep declines due to illegal harvest of eggs. Nesting areas typically outside of the action area (US, territories, protectorates, etc.)
- Endangered;
- Recovery criteria not met

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy

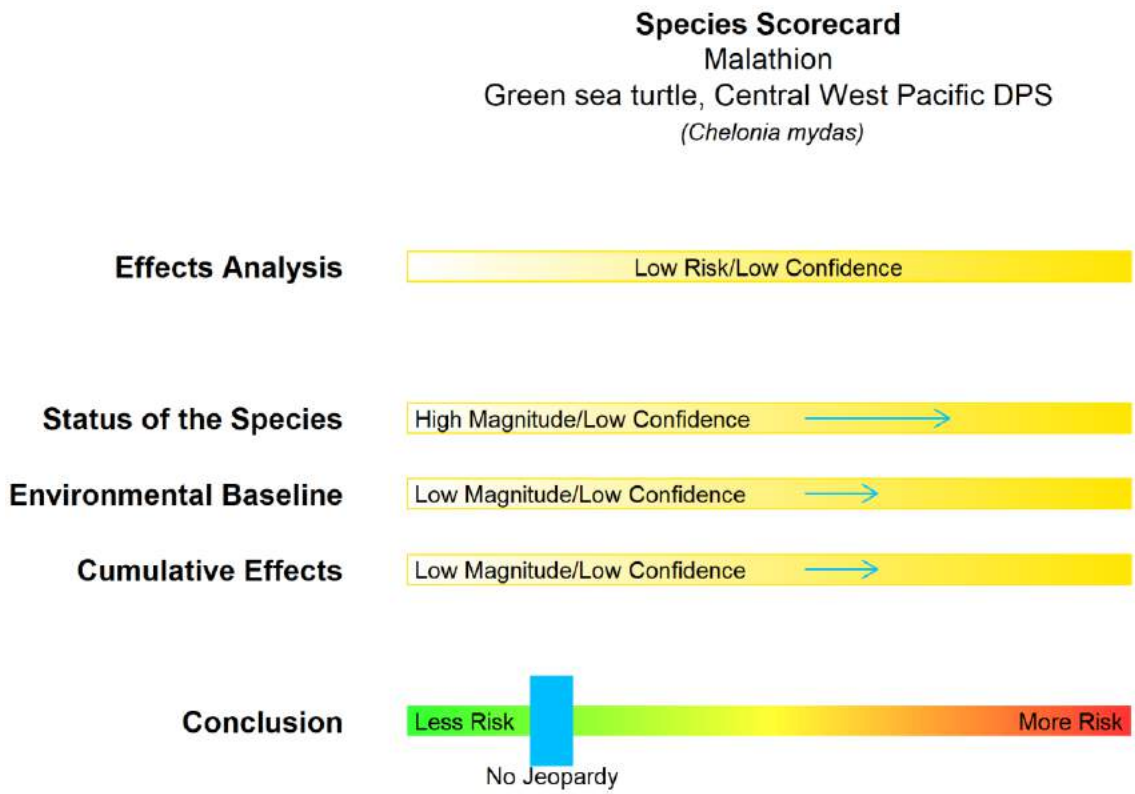

Figure 64. Species Score Card; Green sea turtle, Central West Pacific DPS; Malathion

Effects Analysis: Low risk/Low confidence

- Reduced abundance not anticipated
- Potential effects may include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Increased risk of jeopardy; High magnitude/ Low confidence

- No available population trend data; Most of species' range outside of action area.
- Endangered;
- Recovery criteria not met

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy

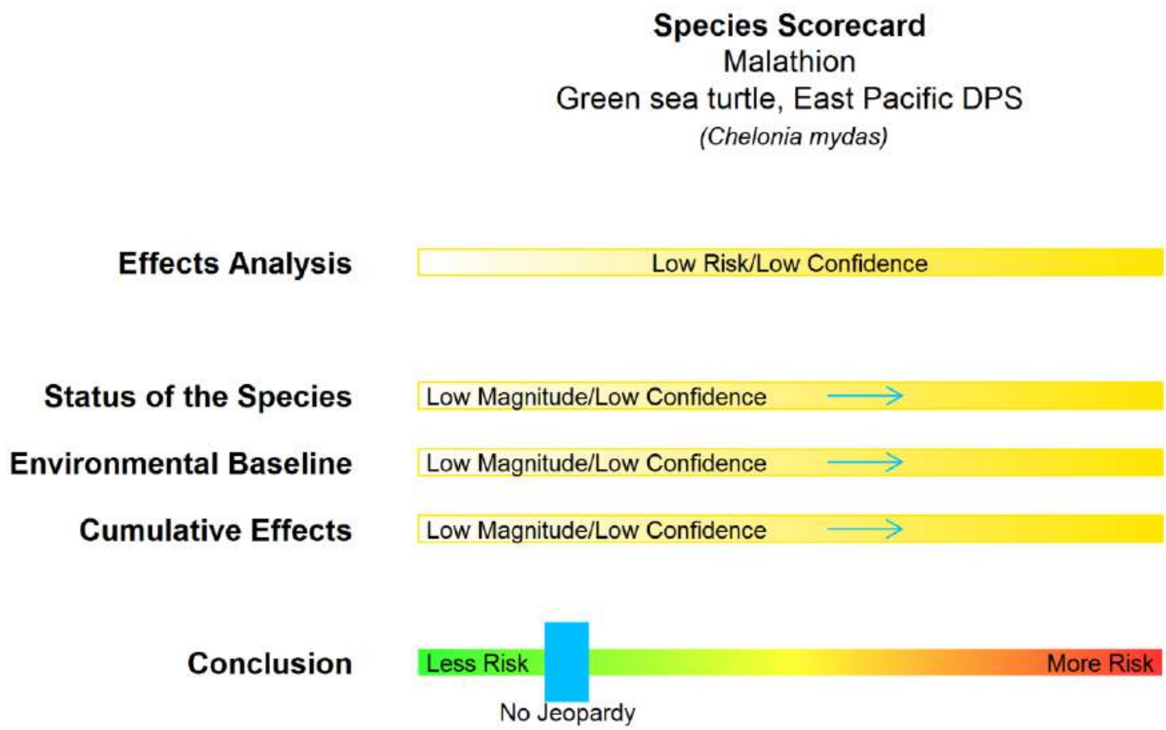

Figure 65. Species Score Card; Green sea turtle, East Pacific DPS; Malathion

Effects Analysis: Low risk/Low confidence

- Reduced abundance not anticipated
- Potential effects may include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- 39 nesting sites with an estimated 20,062 nesting females.; The largest nesting site is at Colola, Mexico, which hosts 58% of the nesting females for the DPS where monitoring data suggest the population is increasing.
- Threatened;
- Recovery criteria not met

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas and rivers/streams. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy

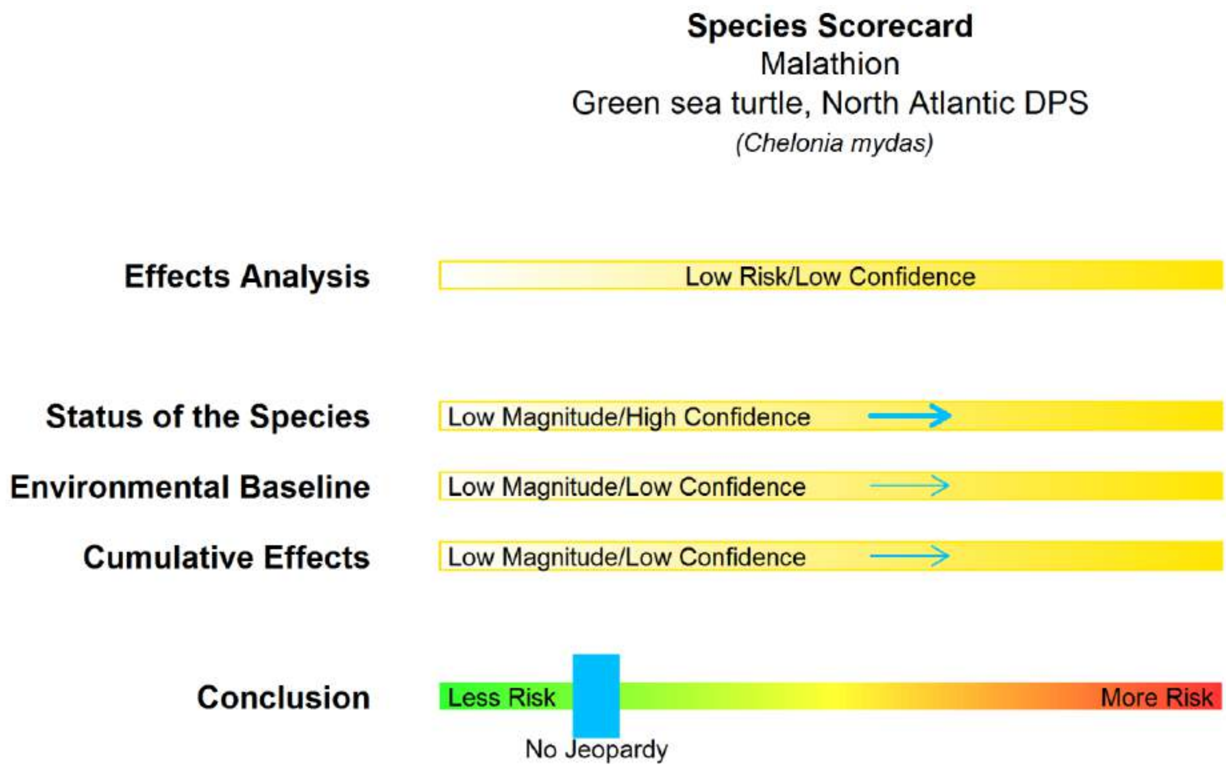

Figure 66. Species Score Card; Green sea turtle, North Atlantic DPS; Malathion

Effects Analysis: Low risk/Low confidence

- Reduced abundance not anticipated
- Potential effects may include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ High confidence

- Population shows increasing trend.
- Threatened;
- Recovery criteria not met

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in freshwater habitats that affect species

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas and rivers/streams. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy

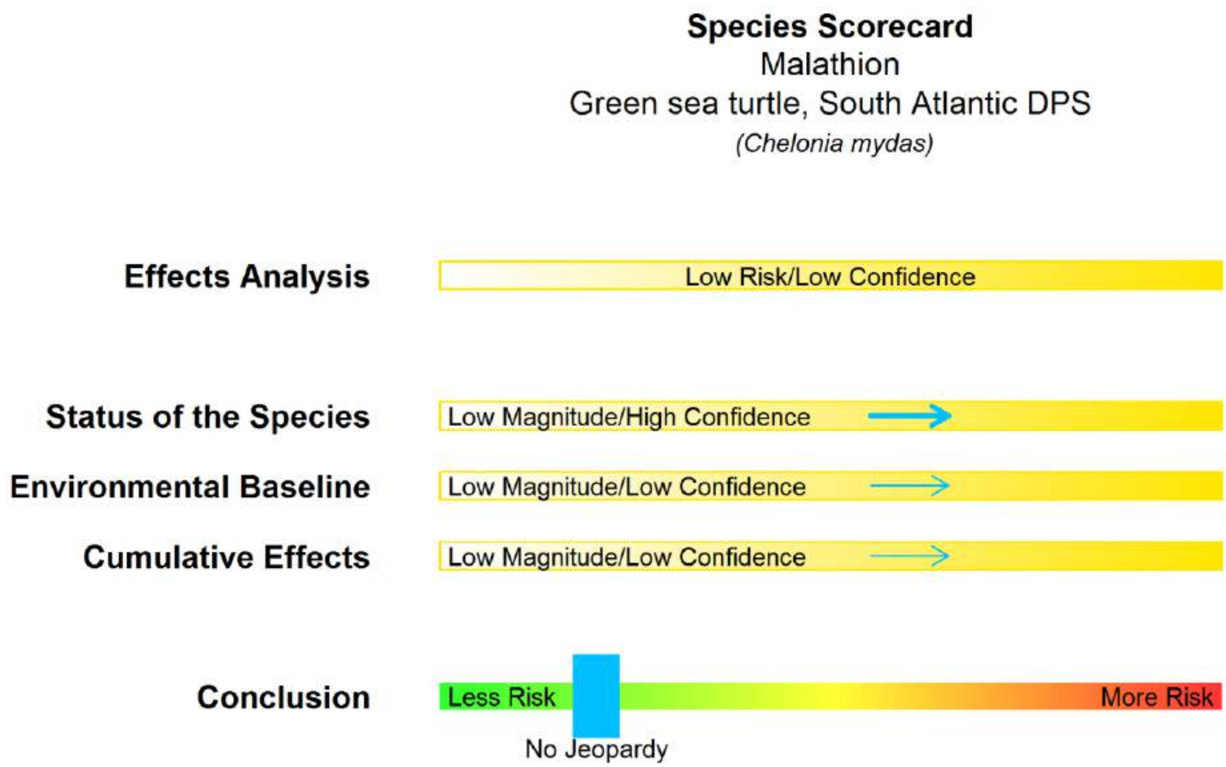

Figure 67. Species Score Card; Green sea turtle, South Atlantic DPS; Malathion

<u>Effects Analysis: Low risk/Low confidence</u>

- Reduced abundance not anticipated
- Potential effects may include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

<u>Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ High confidence</u>

- Sparse data available, suggests population is increasing; Most of DPS range outside of the action area;
- Threatened;
- Recovery criteria not all met

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in freshwater habitats that affect species

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters

<u>Conclusion:</u> In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas and rivers/streams. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>**Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy**</u>

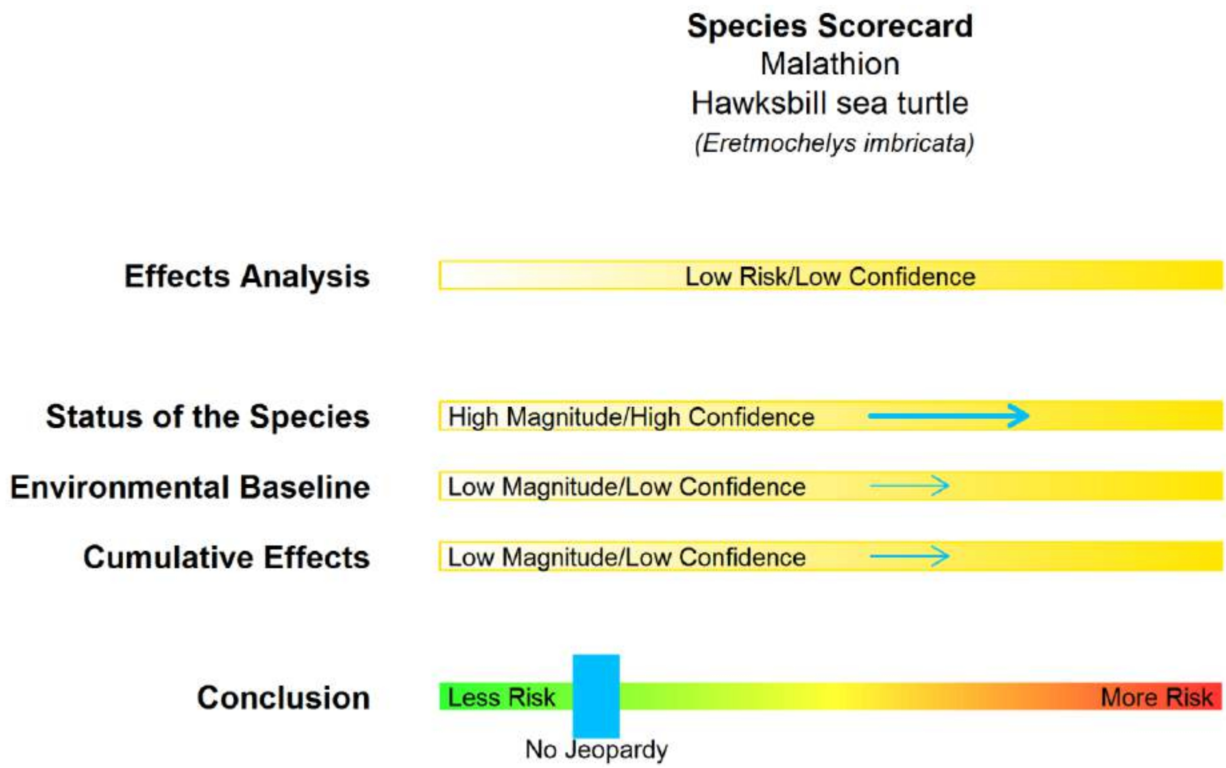

Figure 68. Species Score Card; Hawksbill sea turtle; Malathion

Effects Analysis: Low risk/Low confidence

- Reduced abundance not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence

- Population abundance improving in Atlantic and Indian Ocean; abundance declining in Pacific Ocean over the last 20 - 100 years. 68% of nesting sites exhibited declines.
- Endangered;
- Recovery criteria not met

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in marine waters yet effects uncertain

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas and rivers/streams. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy

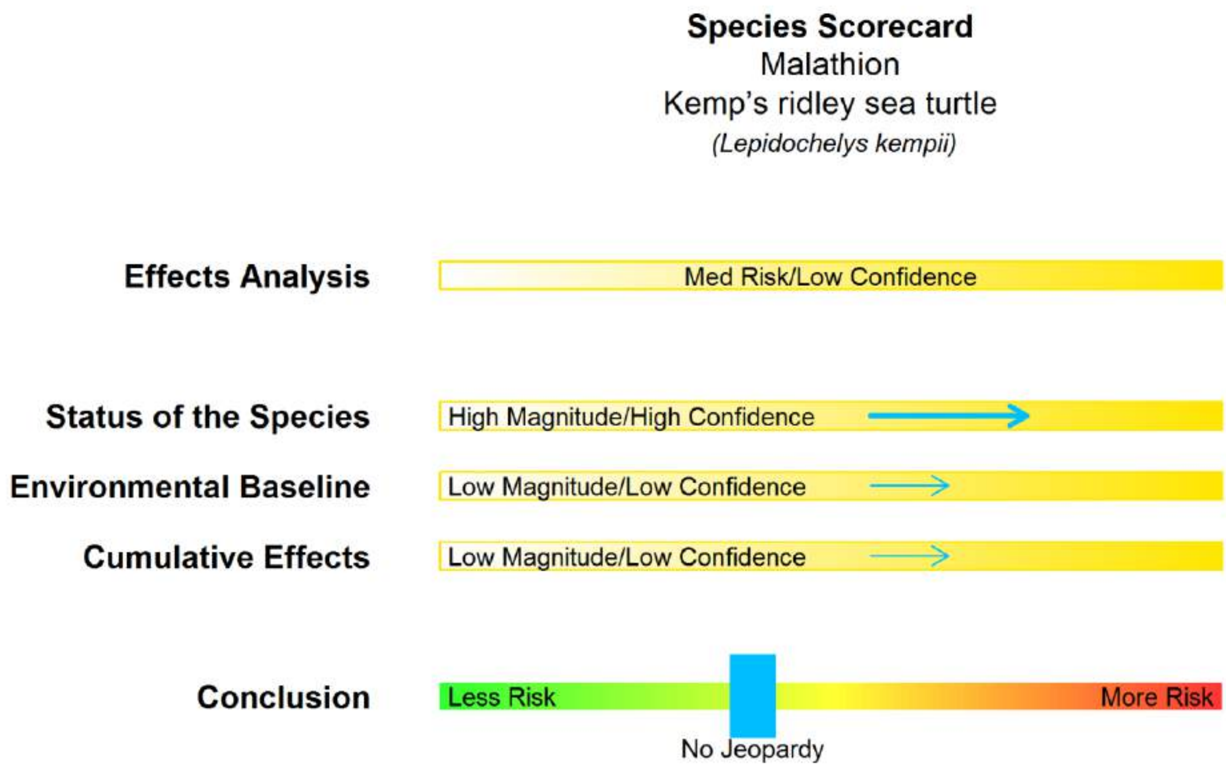

Figure 69. Species Score Card; Kemp's ridley sea turtle; Malathion

Effects Analysis: Medium risk/Low confidence

- Reduced abundance not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Minimal increased risk of jeopardy; High magnitude/ High confidence

- Abundance trends negative;
- Endangered;
- Recovery criteria not met

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in marine waters yet effects uncertain

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas and rivers/streams. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy

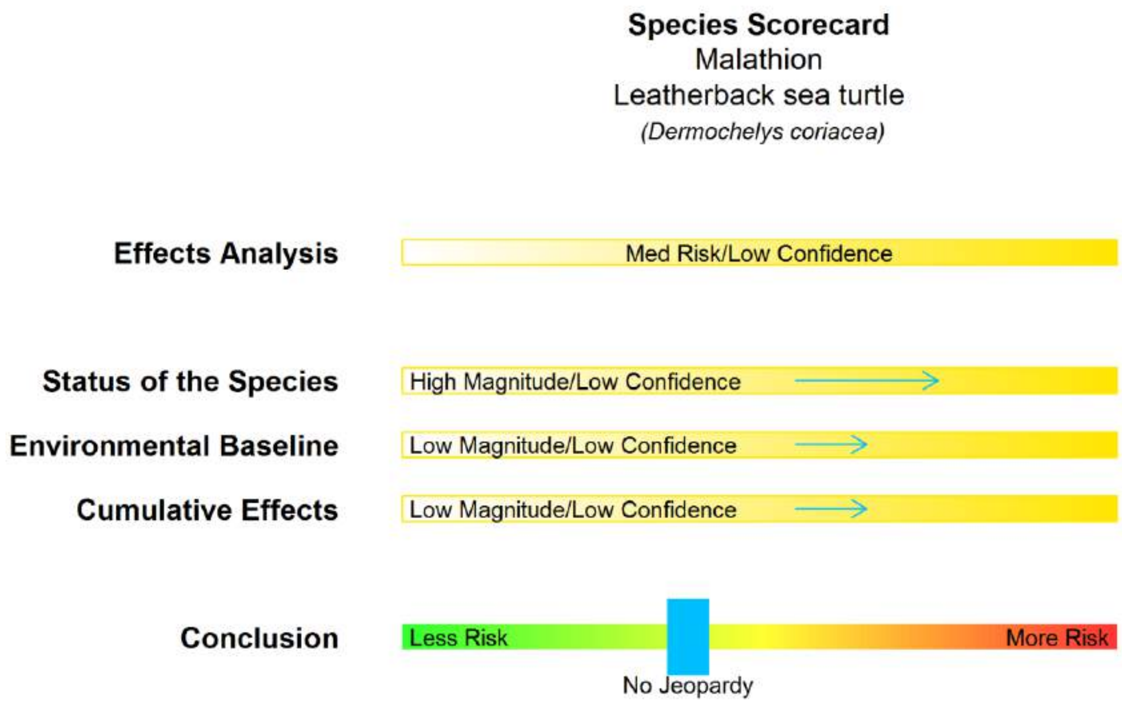

Figure 70. Species Score Card; Leatherback sea turtle; Malathion

<u>Effects Analysis: Medium risk/Low confidence</u>

- Reduced abundance not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

<u>Status of the Species: Minimal increased risk of jeopardy; High magnitude/ Low confidence</u>

- Pacific population declined from 81,000 in to less than 3,000 with a continued rate of loss of approximately 6 %. Atlantic population is stable and showing signs of increasing growth of between 4-5.6% and 9-13% in Florida and the U.S. Virgin Islands, respectively.
- Endangered;
- Recovery criteria not met

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in marine waters yet effects uncertain

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters

<u>Conclusion:</u> In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas and rivers/streams. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

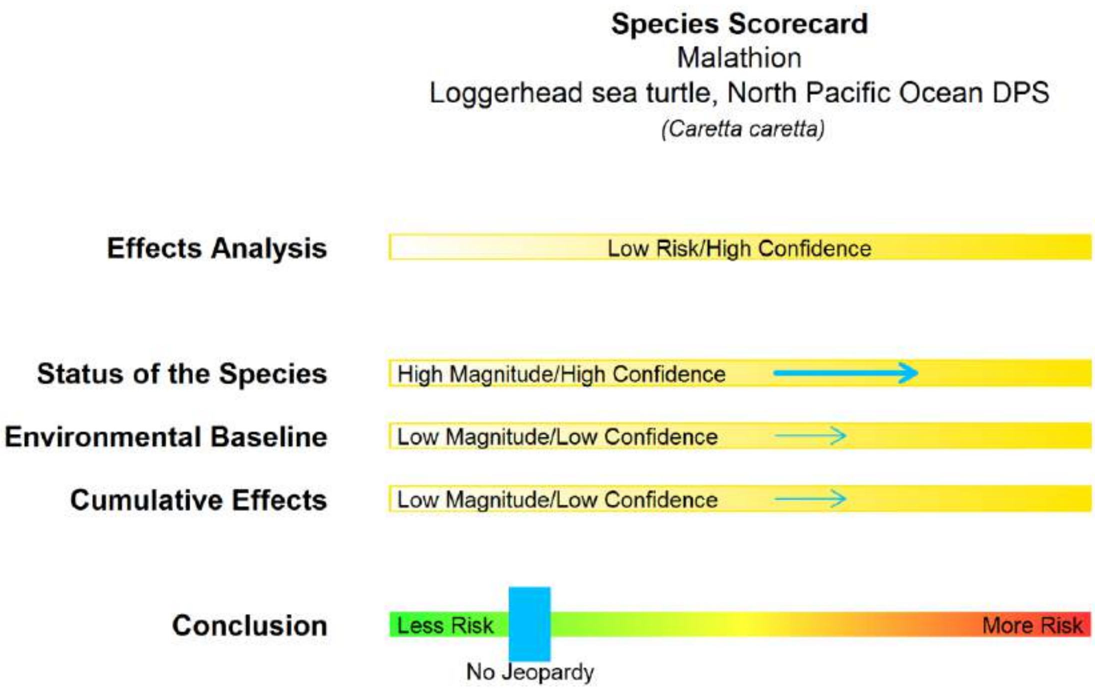

Figure 71. Species Score Card; Loggerhead sea turtle, North Pacific Ocean DPS; Malathion

Effects Analysis: Low risk/High confidence

- Reduced abundance not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Population growth rate estimated at 0.032. Population depressed compared to historical numbers.
- Threatened; Population has declined an estimated 80% in past 20 years.
- Recovery criteria not met

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in marine waters yet effects uncertain

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters but effects uncertain

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas and rivers/streams. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy

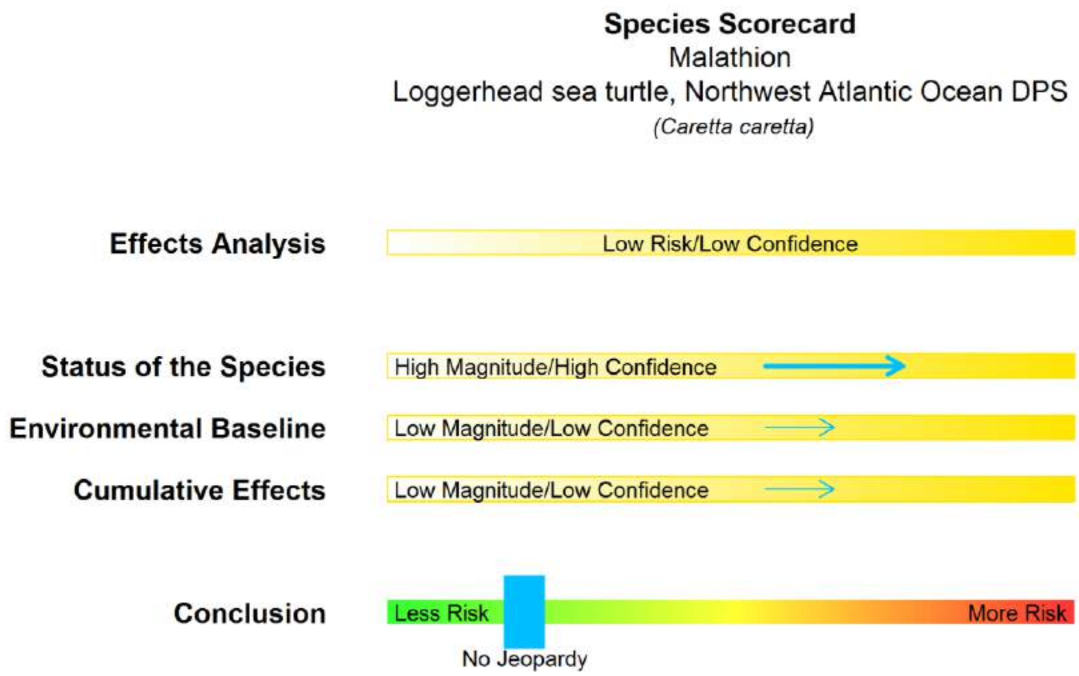

Figure 72. Species Score Card; Loggerhead sea turtle, Northwest Atlantic Ocean DPS; Malathion

Effects Analysis: Low risk/Low confidence

- Reduced abundance not anticipated
- Potential effects may include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence

- All sub-populations exhibiting negative population growth rates;
- Threatened;
- Recovery criteria not met;

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in marine waters yet effects uncertain

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters but effects uncertain

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas and rivers/streams. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy

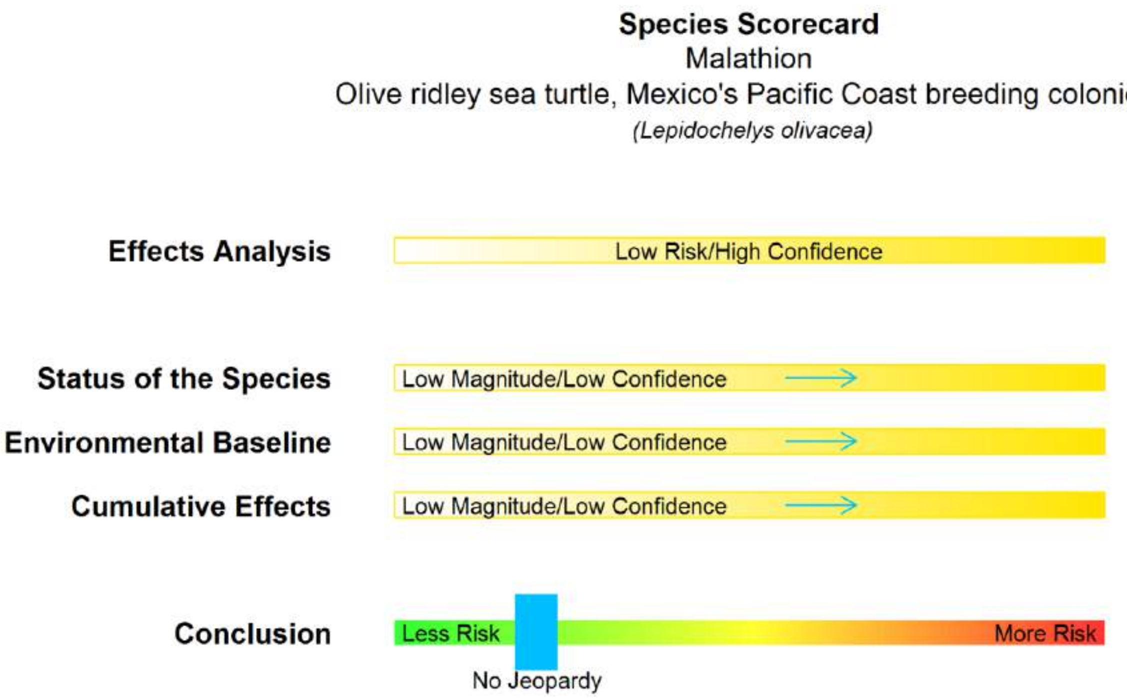

Figure 73. Species Score Card; Olive ridley sea turtle, Mexico's Pacific Coast breeding colonies; Malathion

<u>Effects Analysis: Low risk/High confidence</u>

- Reduced abundance not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

<u>Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- 50% decline in a population abundance since the 1960's; 80% reductions in some nesting populations in the Western Atlantic Ocean since 1967;
- Threatened;
- Recovery criteria not met;

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in marine waters yet effects uncertain

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters but effects uncertain

<u>Conclusion:</u> In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas and rivers/streams. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

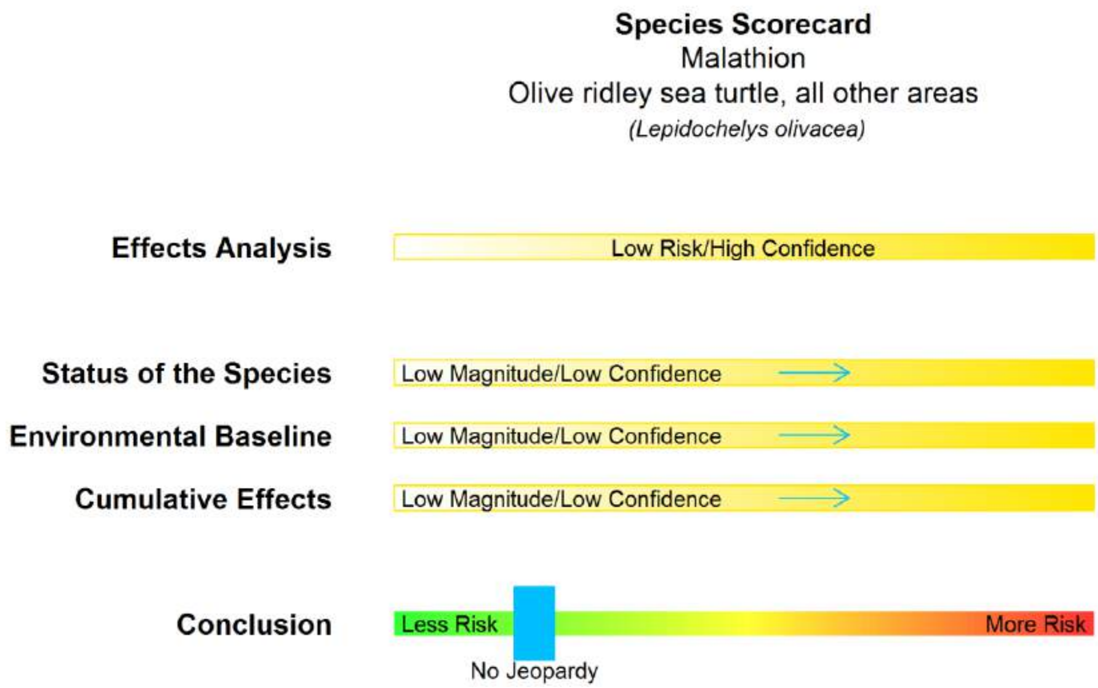

Figure 74. Species Score Card; Olive ridley sea turtle, all other areas; Malathion

Effects Analysis: Low risk/High confidence

- Reduced abundance not anticipated
- Potential effects include death; reduced cholinesterase activity, growth, and prey abundance; and impaired swimming.

Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Some nesting populations are stable or increasing, but most remain severely depressed. Populations are outside of the action area.
- Threatened;
- Recovery criteria not met;

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect turtles
- Environmental mixtures anticipated in marine waters yet effects uncertain

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters but effects uncertain

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk while in shallow areas and rivers/streams. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy

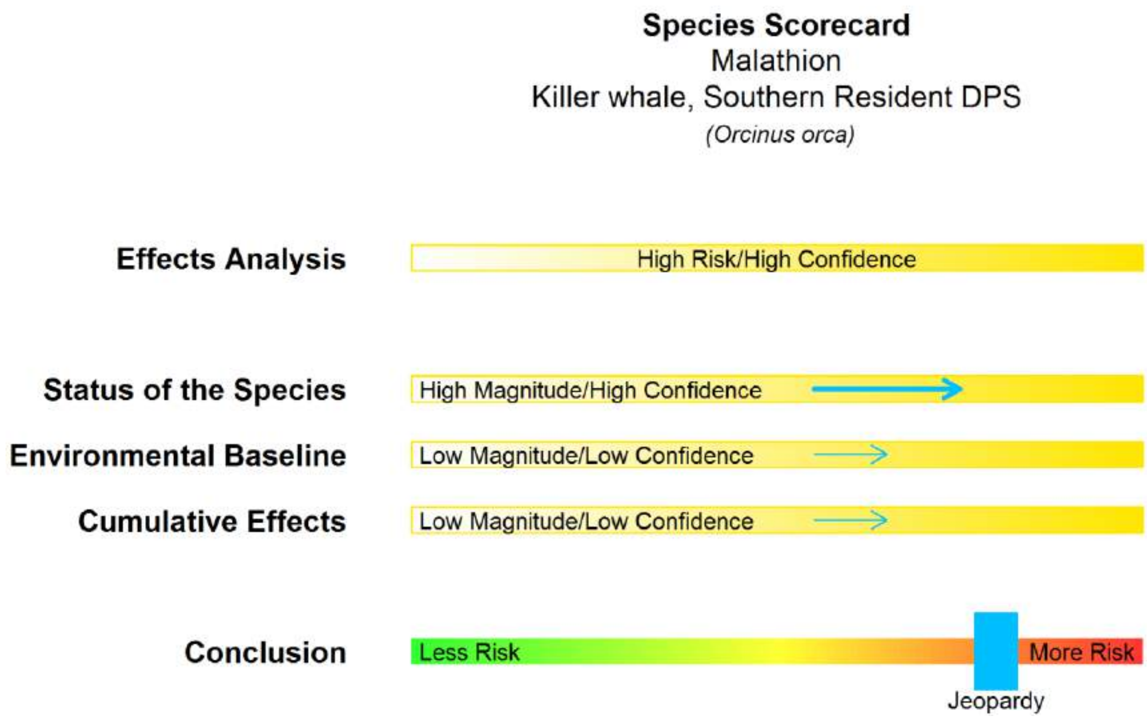

Figure 75. Species Score Card; Killer whale, Southern Resident DPS; Malathion

Effects Analysis: High risk/High confidence

- Reduced abundance anticipated based on effects to prey (Chinook salmon)
- Anticipated effects include reduced availability of Chinook salmon and other fish prey leading to reduced growth, chronic lack of food;

Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence

- Stable to declining populations in past decade, unstable population structure
- Endangered, very small population size (n=76 individuals);
- Recovery criteria not met and reduced likelihood of attaining recovery goals

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/Low confidence

- Elevated temperatures may occur in marine habitats;
- Environmental mixtures anticipated in marine habitats with high uncertainty of toxicity

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures may occur in marine waters

Conclusion: In freshwater habitats, we find a high likelihood of exposure and effects to orca whales' prey base. We have high confidence in exposure concentrations predicted for freshwater habitats. The species prey is most at risk while spawning, rearing, and migrating in freshwaters. Reductions of species' numbers, reproduction, or distribution are anticipated over the 15-year action due to continuous reductions in prey.

Malathion is likely to jeopardize the continued existence of this species: Jeopardy

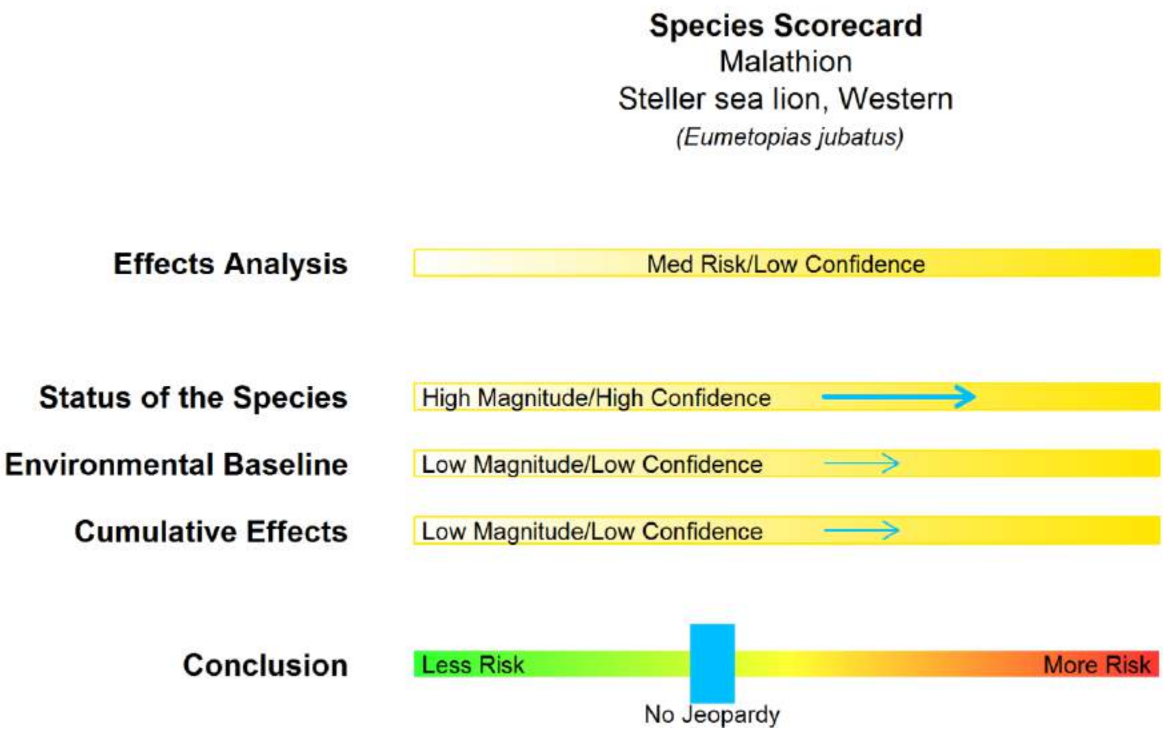

Figure 76. Species Score Card; Steller sea lion, Western; Malathion

Effects Analysis: Medium risk/Low confidence

- Reduced abundance not anticipated
- Potential effects include reduced prey abundance

Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence

- 30% of 1950s historical abundance, stable to slight negative population trend;
- Endangered;
- Recovery criteria not met;

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters unanticipated to affect sea lions
- Environmental mixtures anticipated in marine waters yet effects uncertain

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters but effects uncertain

Conclusion: In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk from reductions in prey. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy

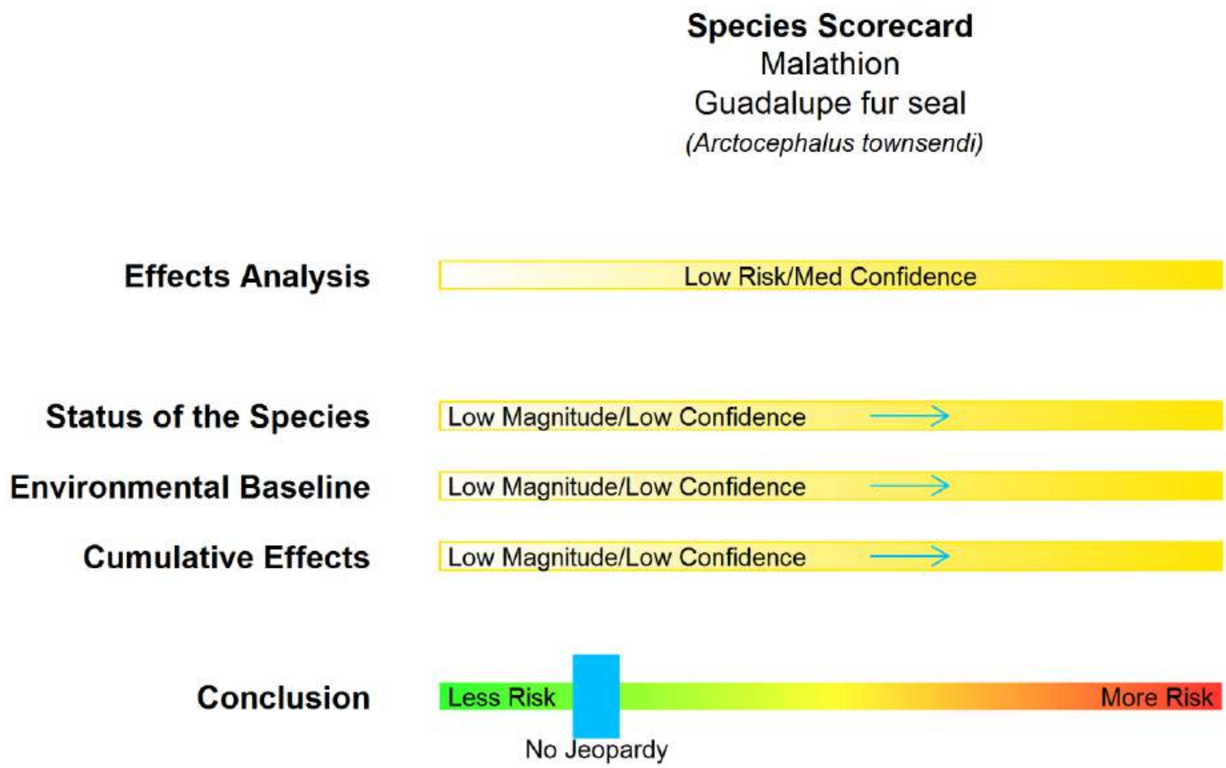

Figure 77. Species Score Card; Guadalupe fur seal; Malathion

<u>Effects Analysis: Low risk/Medium confidence</u>

- Reduced abundance not anticipated
- Potential effects include reduced prey abundance

<u>Status of the Species: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- 5% of historical abundance, increasing abundance trend;
- Threatened;
- No recovery criteria established;

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures in marine waters not anticipated to affect sea lions
- Environmental mixtures anticipated in marine waters yet effects uncertain

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters but effects uncertain

<u>Conclusion:</u> In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk from reductions in prey. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

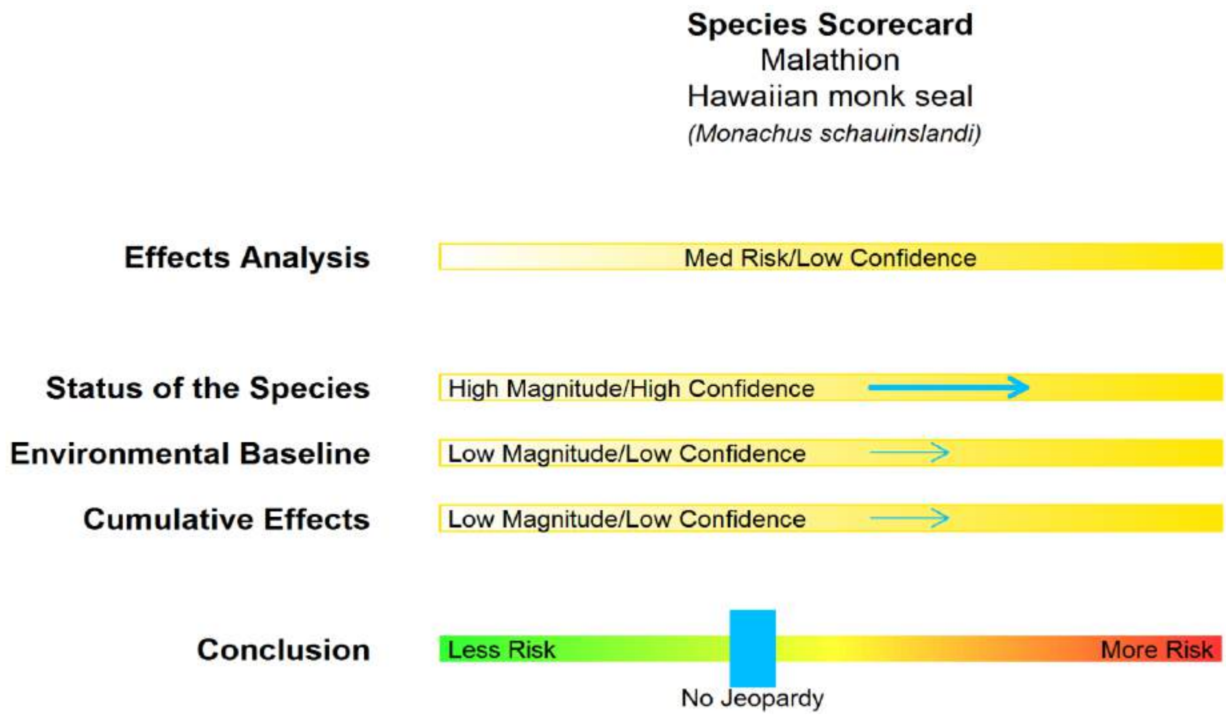

Figure 78. Species Score Card; Hawaiian monk seal; Malathion

<u>Effects Analysis: Medium risk/Low confidence</u>

- Reduced abundance not anticipated
- Potential effects include reduced prey abundance

<u>Status of the Species: Increased risk of jeopardy; High magnitude/ High confidence</u>

- <40% of 1958 abundance, two populations have increasing trends, six populations have declining trends, very low genetic diversity
- Endangered;
- Recovery criteria not met

<u>Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Elevated temperatures in marine waters not anticipated to affect sea lions
- Environmental mixtures anticipated in marine waters yet effects uncertain

<u>Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence</u>

- Future elevated temperatures anticipated in marine waters but effects uncertain

<u>Conclusion:</u> In marine habitats, we find a small likelihood of exposure and effects to the species based on low confidence in exposure concentrations. The species is most at risk from reductions in prey. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

<u>Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy</u>

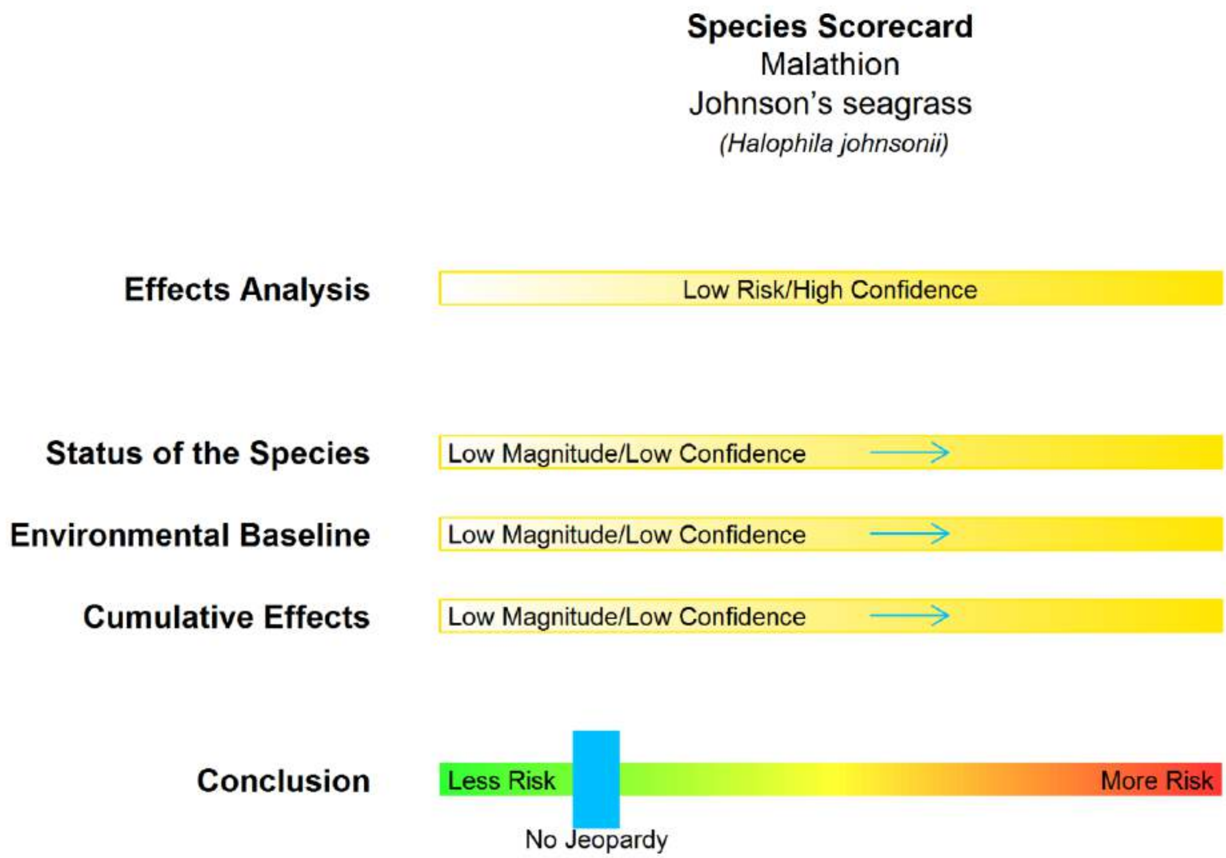

Figure 79. Species Score Card; Johnson's seagrass; Malathion

Effects Analysis: Low risk/High confidence

- Reduced abundance not anticipated

Status of the Species: Increased risk of jeopardy; Low magnitude/ Low confidence

- No trend data on abundance
- Threatened;
- Recovery criteria not met

Environmental Baseline: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Elevated temperatures in marine waters not anticipated to affect seagrass
- Environmental mixtures anticipated in marine waters yet effects uncertain

Cumulative Effects: Minimal increased risk of jeopardy; Low magnitude/ Low confidence

- Future elevated temperatures anticipated in marine waters but effects uncertain

Conclusion: In marine habitats, we find a high likelihood of exposure and a low likelihood of effects to the species based on low confidence in exposure concentrations and low toxicity. The species is most at risk from direct toxicity. Reductions of species' numbers, reproduction, or distribution are not anticipated over the 15-year action.

Malathion is not likely to jeopardize the continued existence of this species: No Jeopardy

CHAPTER 22

INTEGRATION AND SYNTHESIS FOR DESIGNATED CRITICAL HABITAT

CHLORPYRIFOS

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22 Chlorpyrifos

22.1 Introduction

The integration and synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action to the environmental baseline and the cumulative effects to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of Endangered Species Act (ESA)-listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated critical habitat for the conservation of an ESA-listed species. These assessments are made in full consideration of the Status of the Species.

We treat the information from the status of the species, environmental baseline, and cumulative effects, as "risk modifiers," in that the effects described in the effects analysis section may be modified by the condition of the species; the condition of environmental baseline, and the anticipated cumulative effects. The key questions addressed include:

- Status of Designated Critical Habitat:
  - Are the PBFs impaired or degraded?
- Environmental Baseline:
  - Are freshwater temperatures elevated?
  - Are pesticide environmental mixtures present, or anticipated based on current land use?
- Cumulative Effects:
  - Will future temperatures impair species aquatic habitats?
  - Will future hydrologic flows impair freshwater species habitats?
  - How might changes in ocean conditions affect the species habitat?

As detailed in the environmental baseline and cumulative effects chapters, adverse toxic responses to exposures to these OP pesticides are heightened with increases in temperature. In addition, exposures to other pesticides in the environment can cause additive or synergistic responses when simultaneously exposed to any of these OPs. Altered hydraulic flows can cause migratory blockages. Lower hydraulic flows can also result in increases in water temperatures and reductions in dissolved oxygen levels. These conditions can put stress on aquatic species and increases toxic responses when exposed to these pesticides.

Once each of the above sections is evaluated i.e., questions answered, the effects of the action and the risk modifiers are depicted graphically on a "scorecard." First, we assign a magnitude of influence (small or large) indicated graphically with one of two lengths of arrows. The shorter of the two arrows indicates a low magnitude, while the longer of the two arrows indicates a high magnitude as a risk modifier. The direction an arrow is pointed indicates the directionality of the risk modifier. For example, an environmental baseline arrow pointing towards more risk may indicate that environmental mixtures and elevated temperatures occur in the Environmental Baseline, which further stresses the species in question. We also assign a level of confidence in our selection of the small and large magnitude, indicated by a bold arrow (high confidence) or an un-bolded arrow (low confidence). The final arrow representing the influence on risk is graphically depicted on each of the designated critical habitat scorecards.

Figure 1. Example of arrows to represent direction, magnitude, and confidence of risk modifiers

Conclusion Section:
We combine the effects analysis conducted in chapters 15 – 17 with the baseline status of the species habitat, and cumulative effects to determine whether the action could reasonably be expected to appreciably diminish the conservation value of designated critical habitat. We state our conclusion as to whether the action is likely to destroy or adversely modify each of the species designated critical habitats.

A scorecard is generated for each species designated critical habitat. The effects of the proposed action is considered based on magnitude and confidence of the three arrows. Next, an adverse modification or no adverse modification vertical blue bar is placed on the horizontal risk bar i.e., the colored bar beginning with green (less risk) to red (more risk) (***Figure 2***) to depict our conclusion.

Figure 2: Example conclusion graphic

22.2 Designated Critical Habitat Scorecards (Chlorpyrifos)

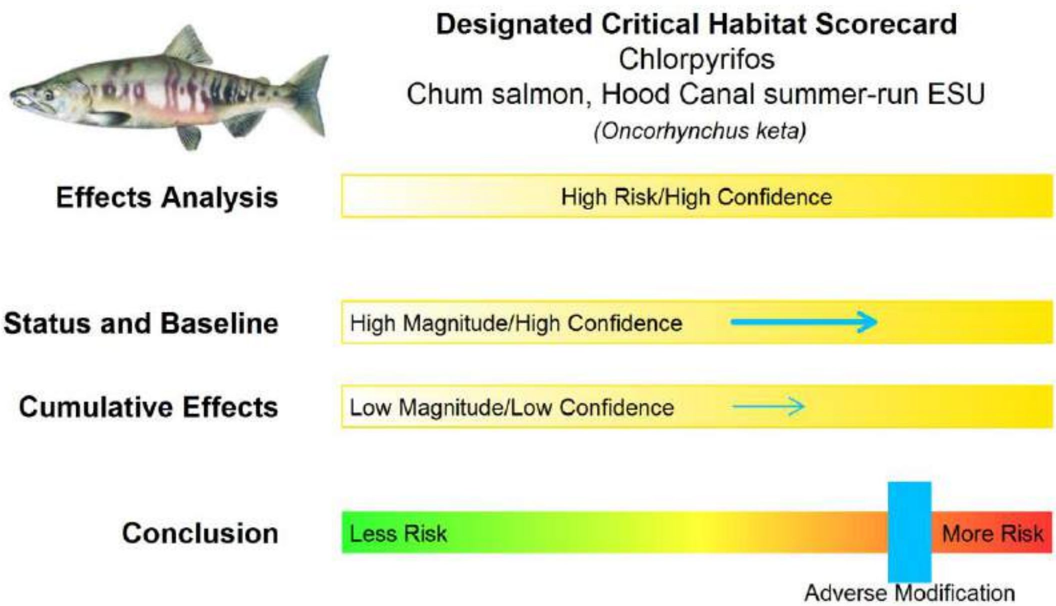

Figure 3. Designated Critical Habitat Scorecard; Chum salmon, Hood Canal summer-run Evolutionarily Significant Unit (ESU); Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning and rearing PBFs are degraded
- Migration and rearing PBFs are impaired by loss of floodplain habitat necessary for juvenile growth and development
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- All 12 watersheds of high or medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Sixteen use site categories, totaling more than 437,951 acres (over 31% of critical habitat) currently overlap. Chlorpyrifos may be applied anywhere in this species' critical habitat for mosquito control and other wide area uses. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

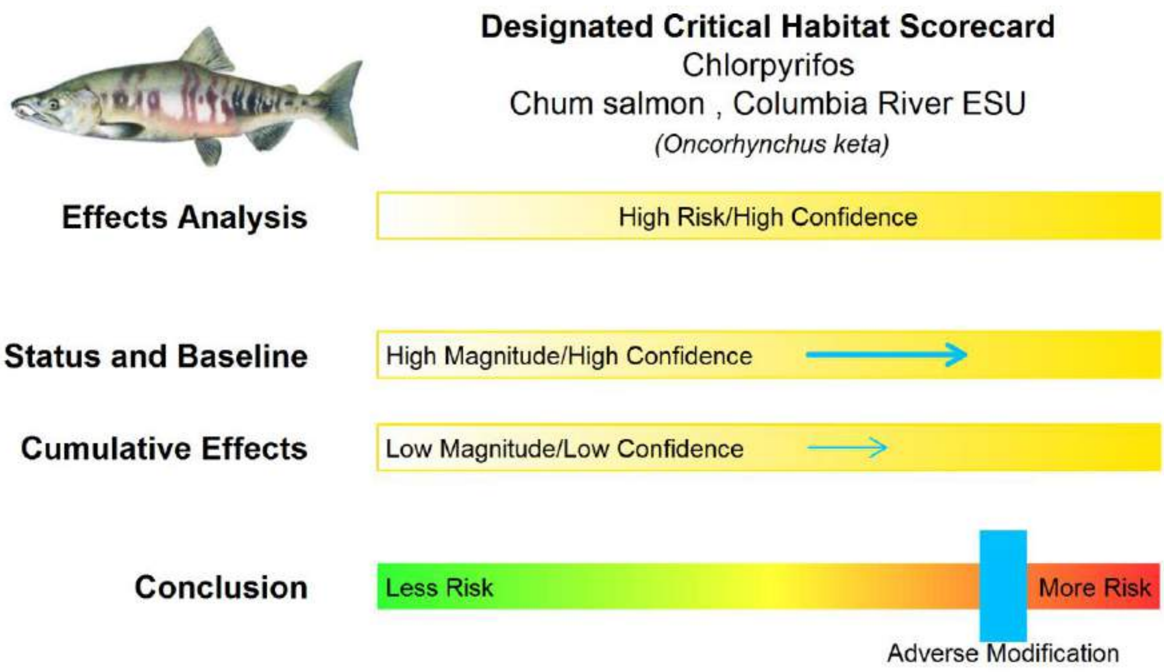

Figure 4. Designated Critical Habitat Scorecard; Chum salmon, Columbia River ESU; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Rearing PBFs (water quality and cover) are degraded
- Migration PBFs significantly impacted by dams
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- All 19 watersheds of high or medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Fourteen use site categories, totaling more than 852,477 acres (over 58% of critical habitat) currently overlap. Chlorpyrifos may be applied anywhere in this species' critical habitat for mosquito control and other wide area uses. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

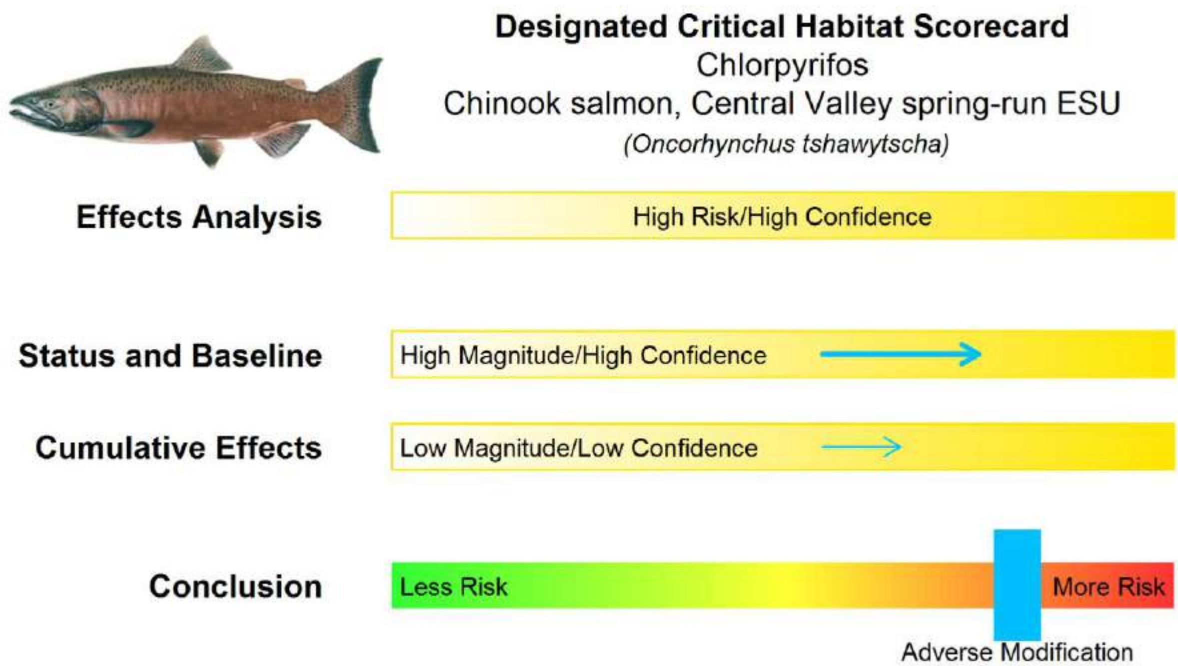

Figure 5. Designated Critical Habitat Scorecard; Chinook salmon, Central Valley spring-run ESU; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning and rearing PBFs are degraded by elevated temperatures, lost access to historic spawning sites, and loss of floodplain habitat
- Migration PBFs degraded by loss of cover and water diversions
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 38 watersheds, 28 are of high and 3 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Sixteen use site categories, totaling more than 2,211,697 acres (over 65% of critical habitat) currently overlap. Chlorpyrifos may be applied anywhere in this species' critical habitat for mosquito control and other wide area uses. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

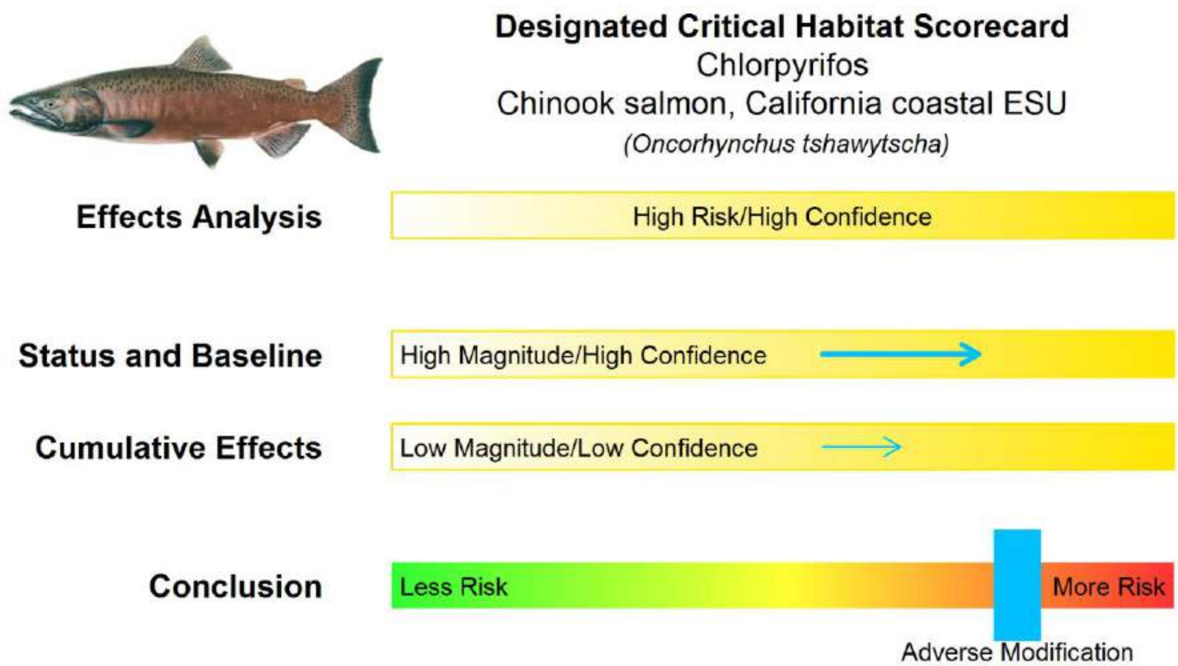

Figure 6. Designated Critical Habitat Scorecard; Chinook salmon, California coastal ESU; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning PBFs are degraded by timber harvest
- Rearing and migration PBFs impacted by dams and invasive species.
- Estuarine PBFs degraded by water quality and saltwater mixing
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 45 watersheds, 27 are of high and 10 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Fifteen use site categories, totaling more than 899410 acres (over 16% of critical habitat) currently overlap. Chlorpyrifos may be applied anywhere in this species' critical habitat for mosquito control and other wide area uses. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

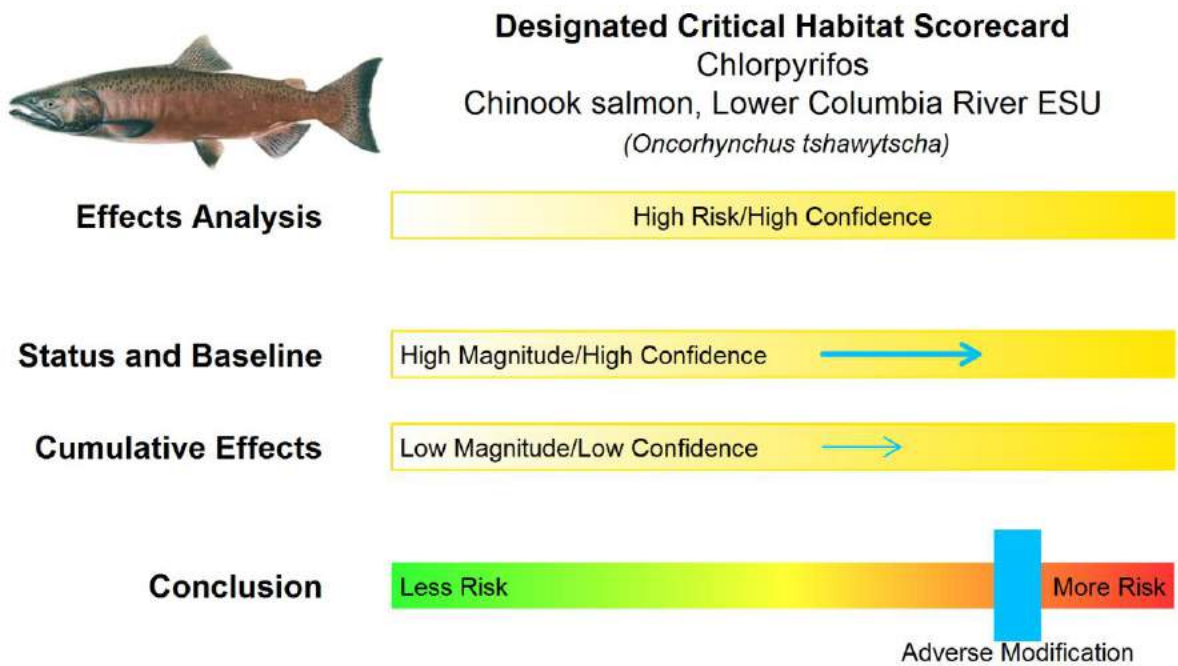

Figure 7. Designated Critical Habitat Scorecard; Chinook salmon, Lower Columbia River ESU; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning and rearing PBFs are degraded by timber harvest, agriculture, urbanization, loss of floodplain habitat, and reduced natural cover
- Migration PBFs impacted by dams
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of occupied watersheds, 31 are of high and 13 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Seventeen use site categories, totaling more than 1,949,214 acres (over 62% of critical habitat) currently overlap. Chlorpyrifos may be applied anywhere in this species' critical habitat for mosquito control and other wide area uses. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

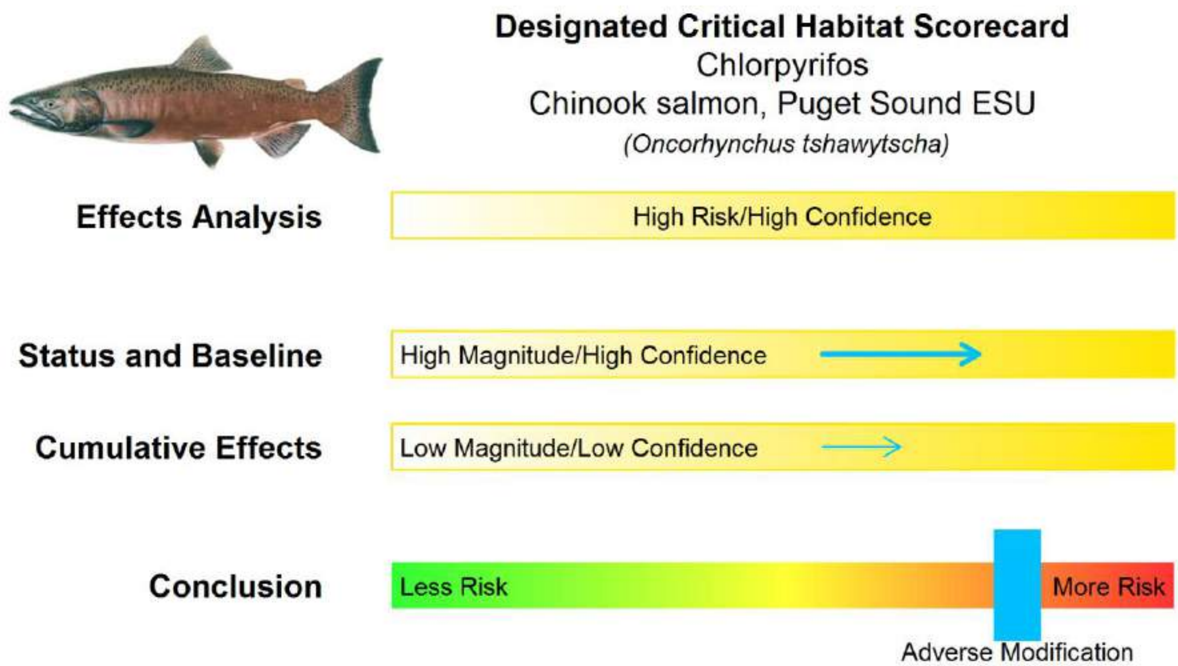

Figure 8. Designated Critical Habitat Scorecard; Chinook salmon, Puget Sound ESU; Chlorpyrifos

<u>Effects Analysis: High risk/High confidence</u>

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

<u>Status and Baseline: Increased risk; High magnitude/High confidence</u>

- Spawning, rearing and migration PBFs are degraded by forestry, agriculture, urbanization, and loss of habitat
- Estuarine PBFs degraded by water quality, altered salinity, and lack of natural cover
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 61 watersheds, 40 are of high and 9 are of medium conservation value

<u>Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence</u>

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

<u>Conclusion:</u> We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Sixteen use site categories, totaling more than 4,249,639 acres (over 45% of critical habitat) currently overlap. Chlorpyrifos may be applied anywhere in this species' critical habitat for mosquito control and other wide area uses. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

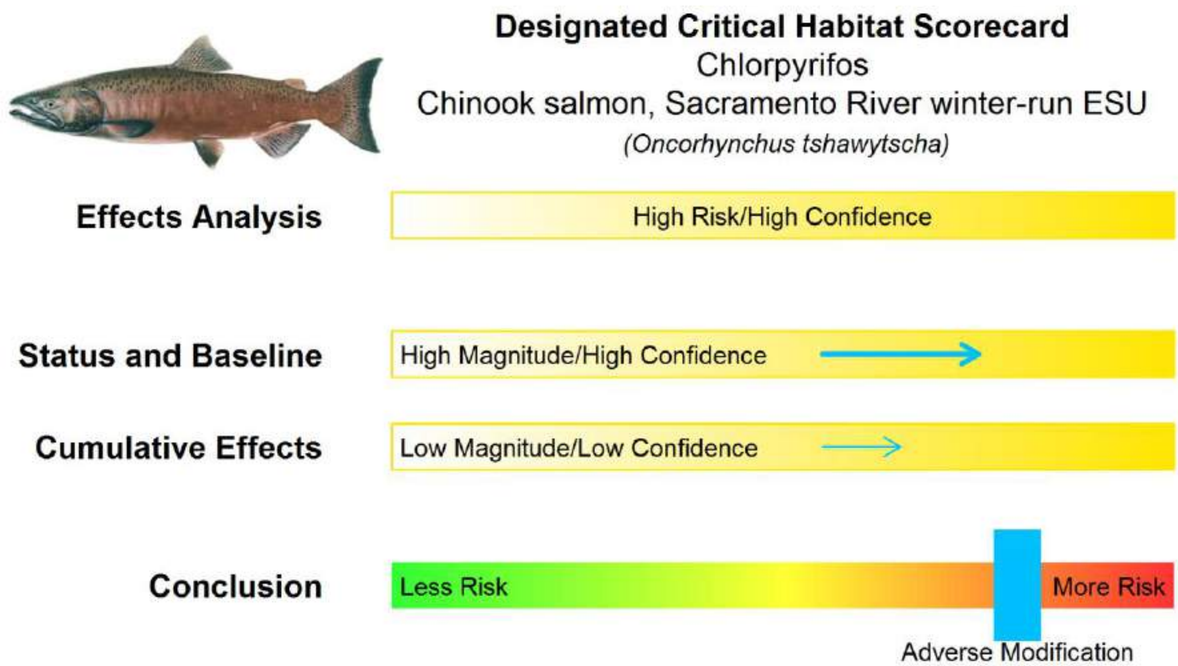

Figure 9. Designated Critical Habitat Scorecard; Chinook salmon, Sacramento River winter-run ESU; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning and rearing PBFs are degraded by elevated temperatures and loss of habitat
- Migration PBFs degraded by lack of natural cover and water diversions
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- The entire Sacramento river and delta are considered of high conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Sixteen use site categories, totaling more than 1,060,503 acres (over 71% of critical habitat) currently overlap. Chlorpyrifos may be applied anywhere in this species' critical habitat for mosquito control and other wide area uses. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

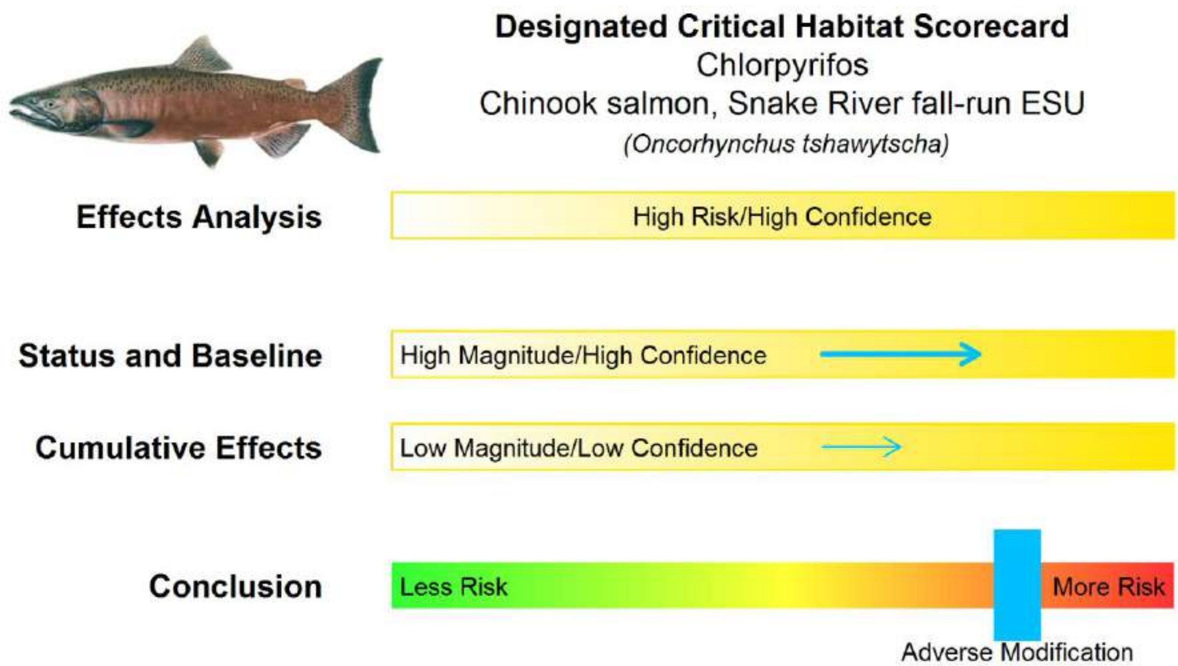

Figure 10. Designated Critical Habitat Scorecard; Chinook salmon, Snake River fall-run ESU; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning, rearing and migration PBFs are degraded by loss of habitat, impaired stream flows, barriers to fish passage, and poor water quality
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- The entire river corridor is considered of high conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Seventeen use site categories, totaling more than 5,462,029 acres (over 66% of critical habitat) currently overlap. Chlorpyrifos may be applied anywhere in this species' critical habitat for mosquito control and other wide area uses. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

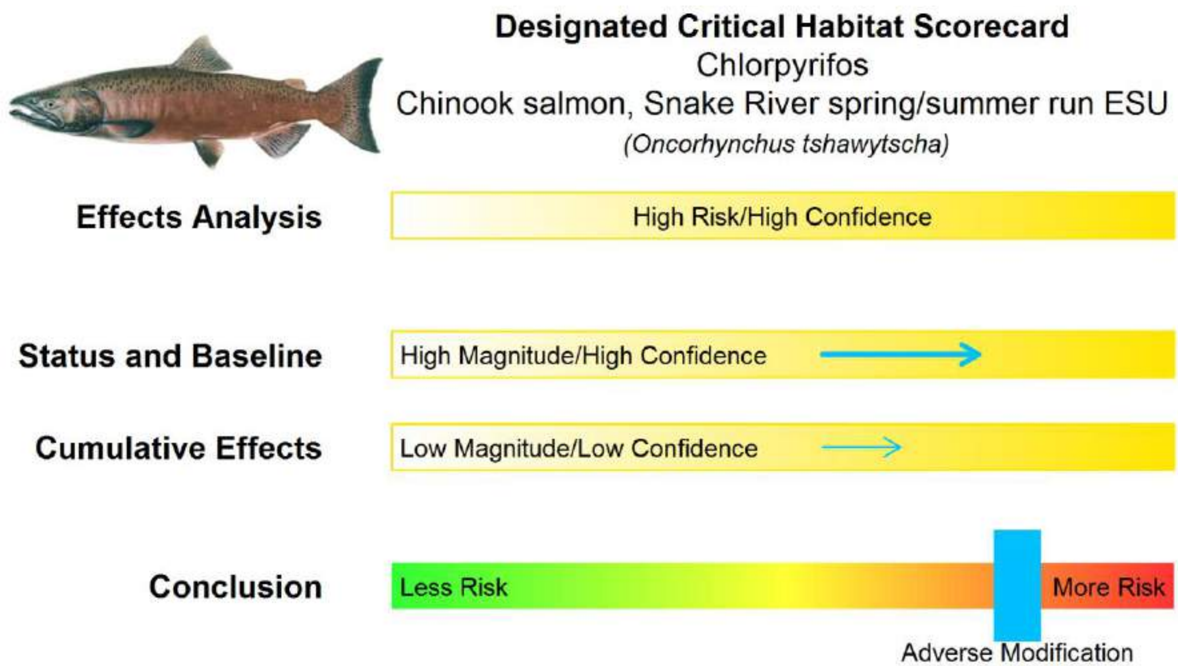

Figure 11. Designated Critical Habitat Scorecard; Chinook salmon, Snake River spring/summer run ESU; Chlorpyrifos

<u>Effects Analysis: High risk/High confidence</u>

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

<u>Status and Baseline: Increased risk; High magnitude/High confidence</u>

- Spawning, rearing and migration PBFs are degraded by loss of habitat, altered stream flows, barriers to fish passage, dams, loss of cover, and poor water quality
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- The entire river corridor is considered of high conservation value

<u>Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence</u>

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

<u>Conclusion:</u> We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Seventeen use site categories, totaling more than 7,267,721 acres (over 50% of critical habitat) currently overlap. Chlorpyrifos may be applied anywhere in this species' critical habitat for mosquito control and other wide area uses. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

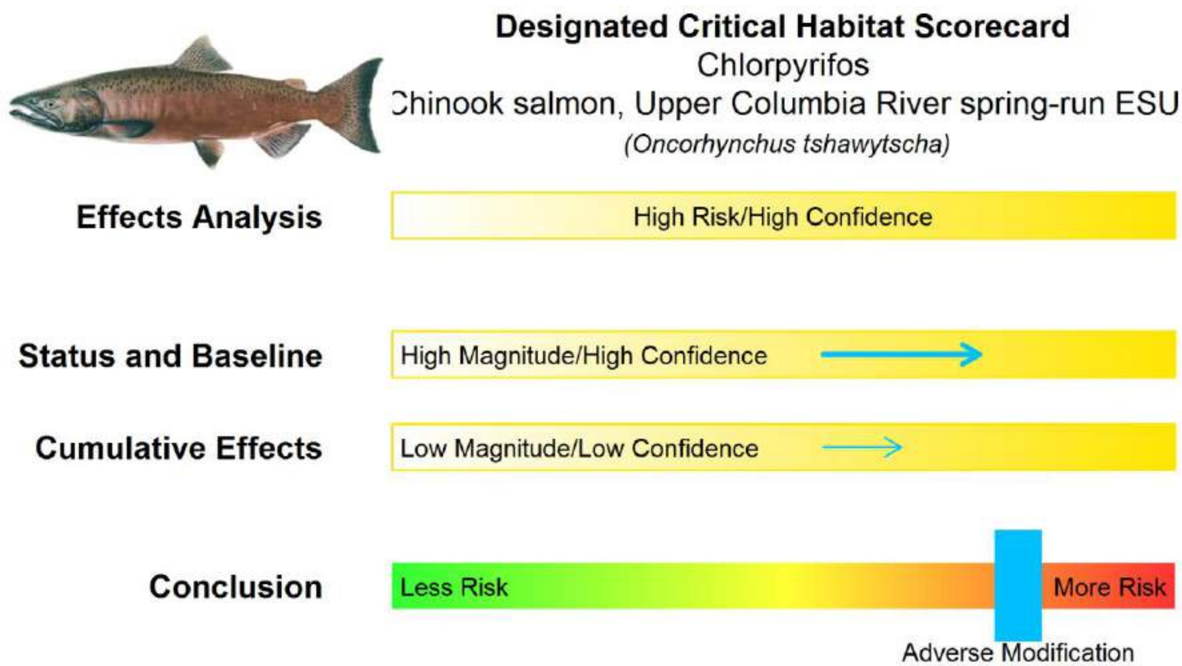

Figure 12. Designated Critical Habitat Scorecard; Chinook salmon, Upper Columbia River spring-run ESU; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning and rearing PBFs are degraded by urbanization and irrigation water diversions
- Migration PBFs degraded by numerous dams
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of occupied watersheds, 26 are of high and 5 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Seventeen use site categories, totaling more than 1,512,434 acres (over 48% of critical habitat) currently overlap. Chlorpyrifos may be applied anywhere in this species' critical habitat for mosquito control and other wide area uses. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

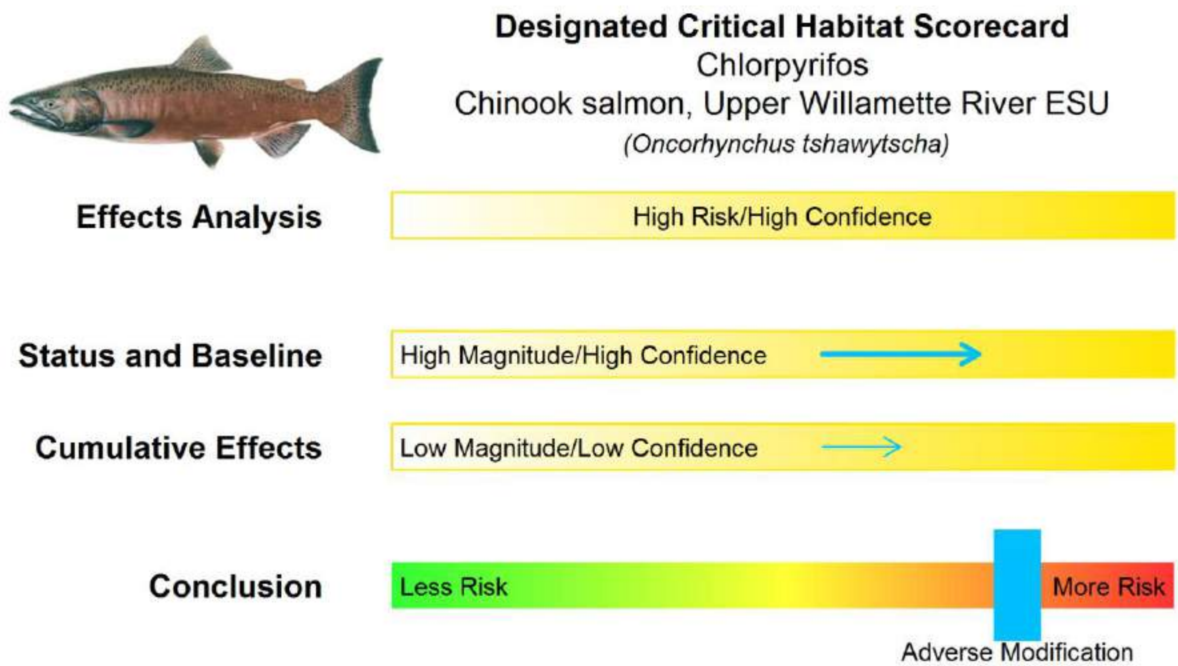

Figure 13. Designated Critical Habitat Scorecard; Chinook salmon, Upper Willamette River ESU; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Migration, rearing, and estuary PBFs are degraded by dams, water management, loss of riparian vegetation, and quality of floodplain habitat
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 59 assessed watersheds, 22 are of high and 18 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Seventeen use site categories, totaling more than 2,564,130 acres (over 74% of critical habitat) currently overlap. Chlorpyrifos may be applied anywhere in this species' critical habitat for mosquito control and other wide area uses. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

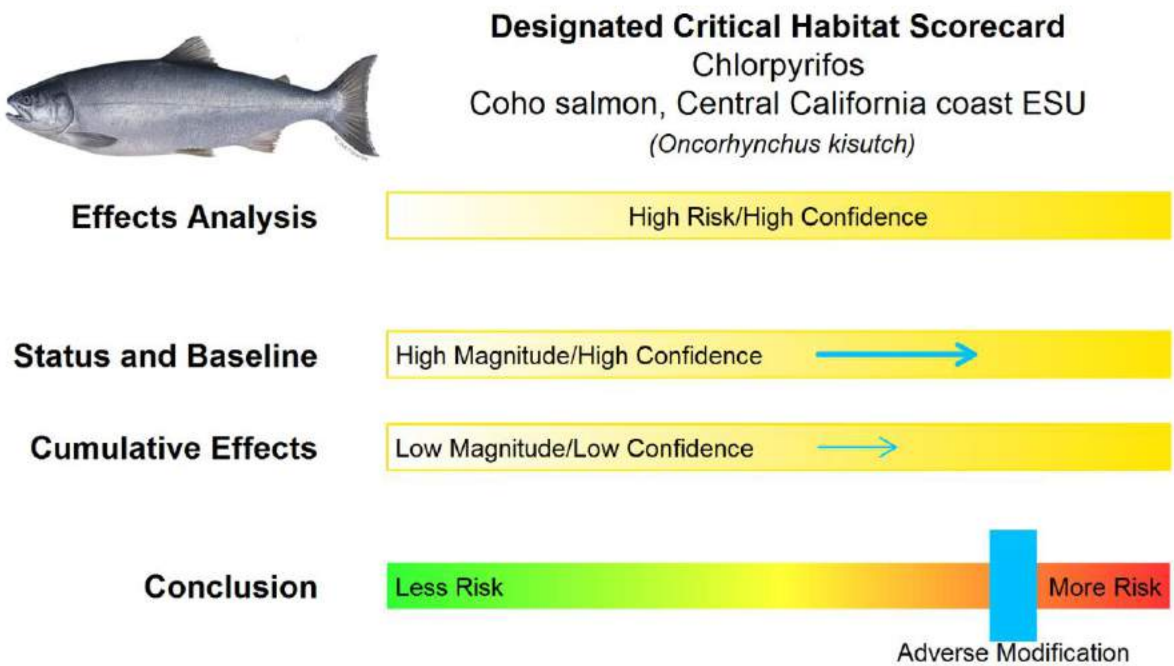

Figure 14. Designated Critical Habitat Scorecard; Coho salmon, Central California coast ESU; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Degradation in quality and quantity of PBFs, especially in southern end of range
- Rearing PBFs degraded by loss of suitable incubation substrate and loss of habitat
- Elevated temperatures anticipated in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats may impact PBFs

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Sixteen use site categories, totaling more than 1,351,070 acres (over 35% of critical habitat) currently overlap. Chlorpyrifos may be applied anywhere in this species' critical habitat for mosquito control and other wide area uses. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

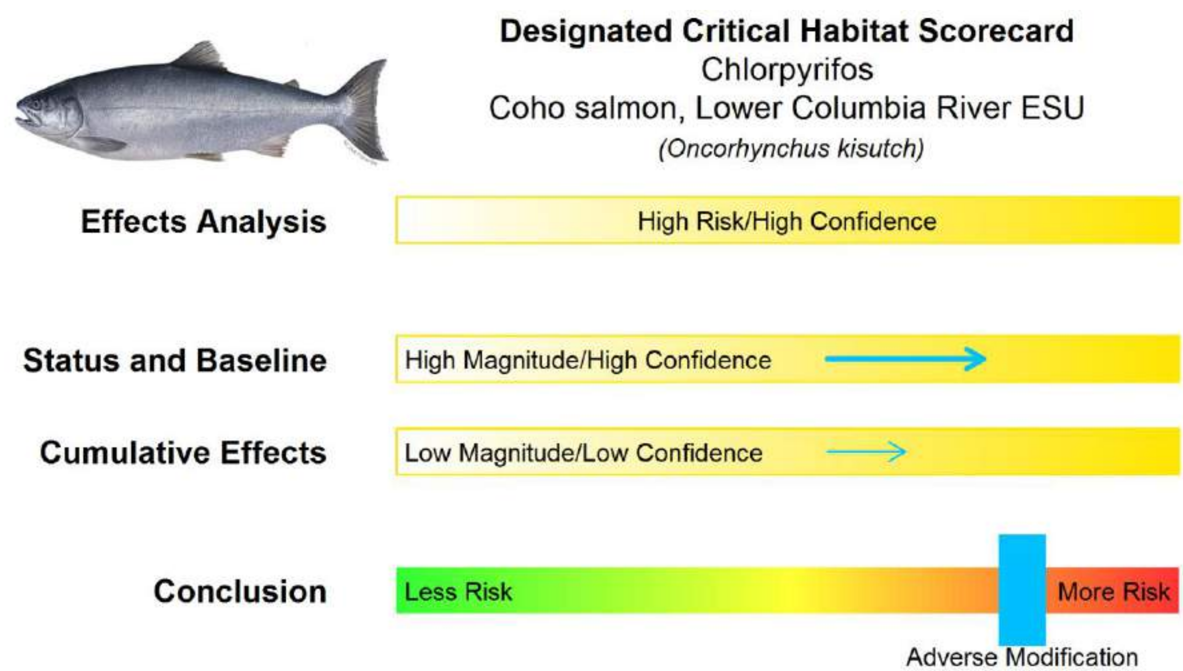

Figure 15. Designated Critical Habitat Scorecard; Coho salmon, Lower Columbia River ESU; Chlorpyrifos

<u>Effects Analysis: High risk/High confidence</u>

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

<u>Status and Baseline: Increased risk; High magnitude/High confidence</u>

- Spawning and rearing PBFs are degraded by timber harvest, agriculture, urbanization, loss of floodplain habitat, and reduced natural cover
- Migration PBFs impacted by dams
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats

<u>Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence</u>

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

<u>Conclusion:</u> We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Seventeen use site categories, totaling more than 2,903,477 acres (over 62% of critical habitat) currently overlap. Chlorpyrifos may be applied anywhere in this species' critical habitat for mosquito control and other wide area uses. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

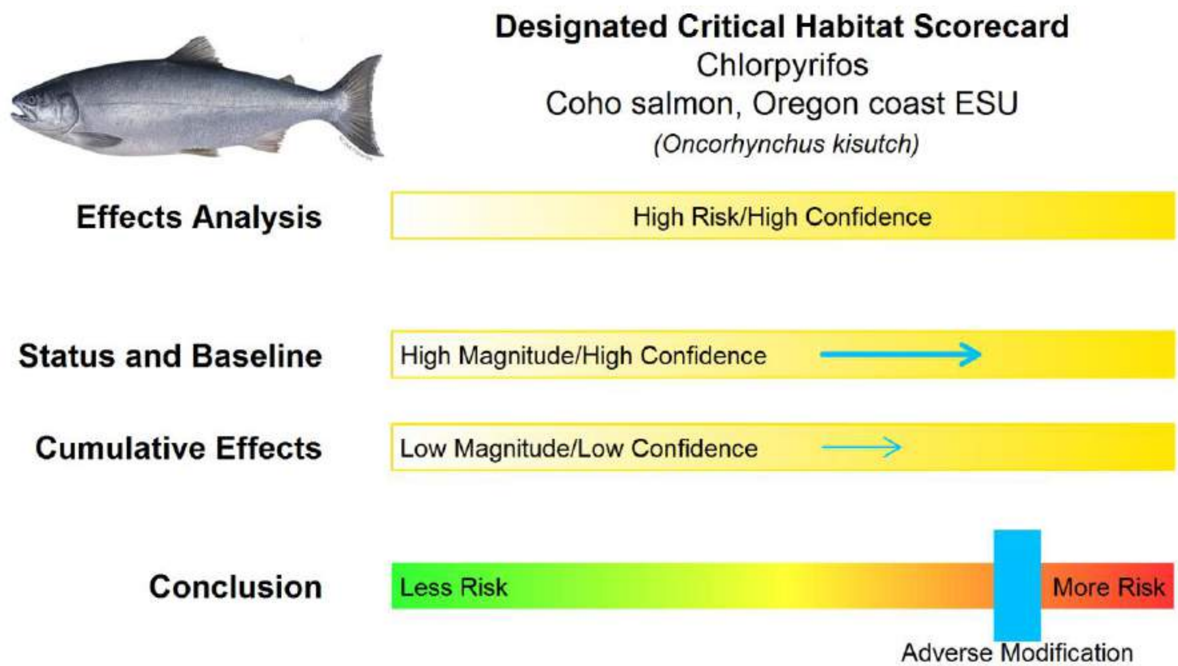

Figure 16. Designated Critical Habitat Scorecard; Coho salmon, Oregon coast ESU; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Rearing PBFs are degraded by elevated water temperature
- All PBFs degraded by reduced water quality from contaminants and excess nutrients
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 80 assessed watersheds, 45 are of high and 27 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Sixteen use site categories, totaling more than 4,171,280 acres (over 66% of critical habitat) currently overlap. Chlorpyrifos may be applied anywhere in this species' critical habitat for mosquito control and other wide area uses. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

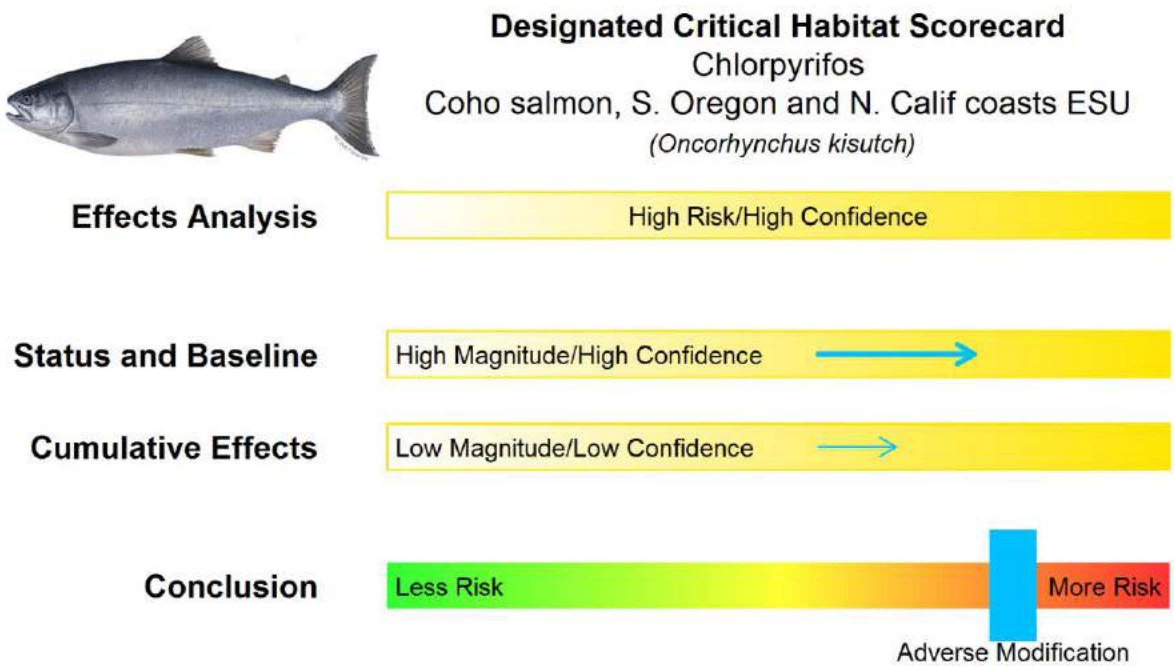

Figure 17. Designated Critical Habitat Scorecard; Coho salmon, S. Oregon and N. Calif coasts ESU; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning PBFs are degraded by logging
- Rearing and migration PBFs degraded by loss of riparian vegetation and loss of floodplain habitat
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Fifteen use site categories, totaling more than 6,444,382 acres (over 46% of critical habitat) currently overlap. Chlorpyrifos may be applied anywhere in this species' critical habitat for mosquito control and other wide area uses. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

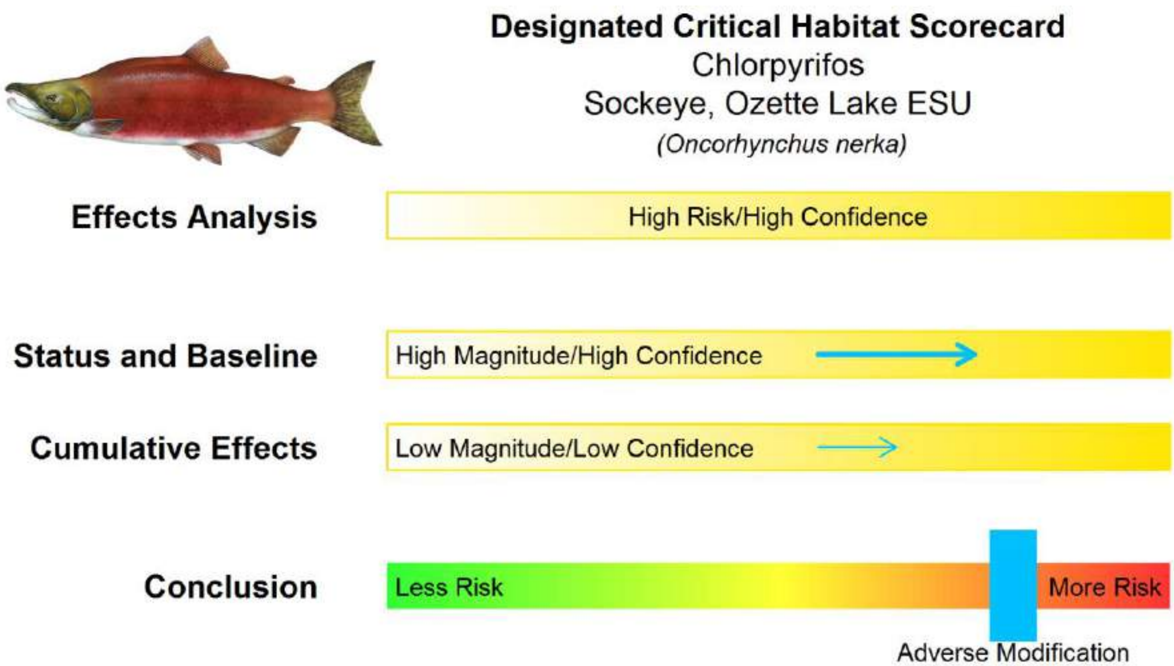

Figure 18. Designated Critical Habitat Scorecard; Sockeye, Ozette Lake ESU; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Rearing PBFs are degraded by excessive predation, invasive species, and loss of habitat
- Spawning and migration PBFs are degraded by low water levels, loss of suitable spawning habitat, and low summer water flows
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- The entire watershed is of high conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Six use site categories, totaling more than 25,949 acres (over 45% of critical habitat) currently overlap. Chlorpyrifos may be applied anywhere in this species' critical habitat for mosquito control and other wide area uses. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

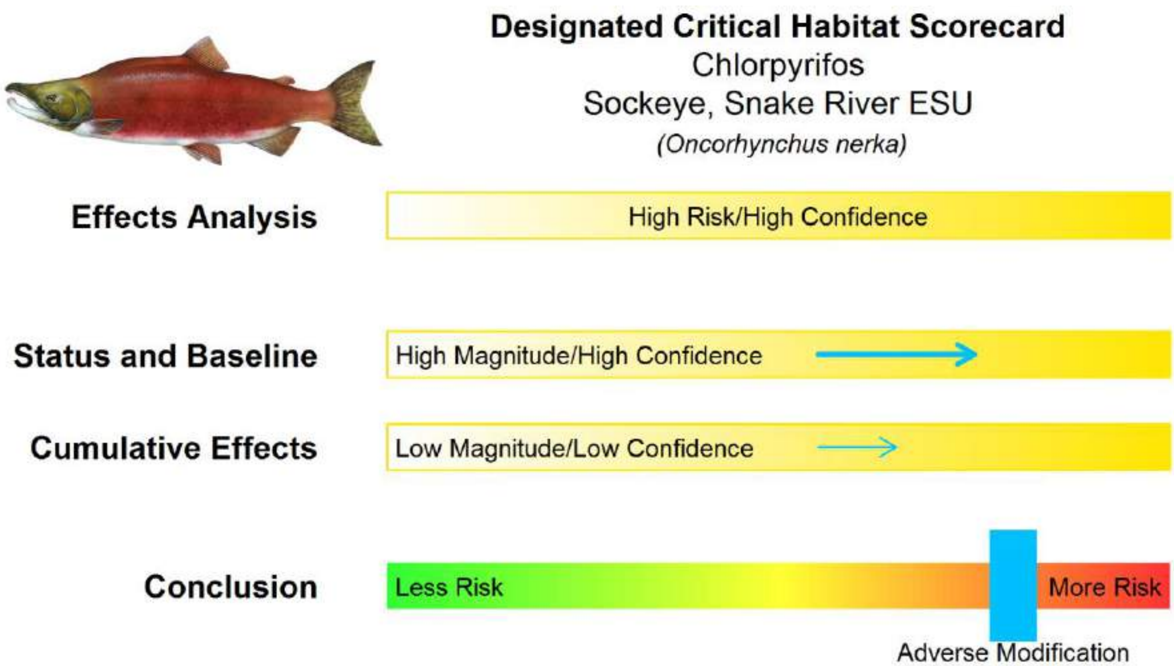

Figure 19. Designated Critical Habitat Scorecard; Sockeye, Snake River ESU; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Rearing and migration PBFs are degraded by impaired water quality from adjacent land uses
- Migration PBFs are degraded by multiple dams
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- All occupied and used areas of the watershed are of high conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Seventeen use site categories, totaling more than 1,710,031 acres (over 54% of critical habitat) currently overlap. Chlorpyrifos may be applied anywhere in this species' critical habitat for mosquito control and other wide area uses. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

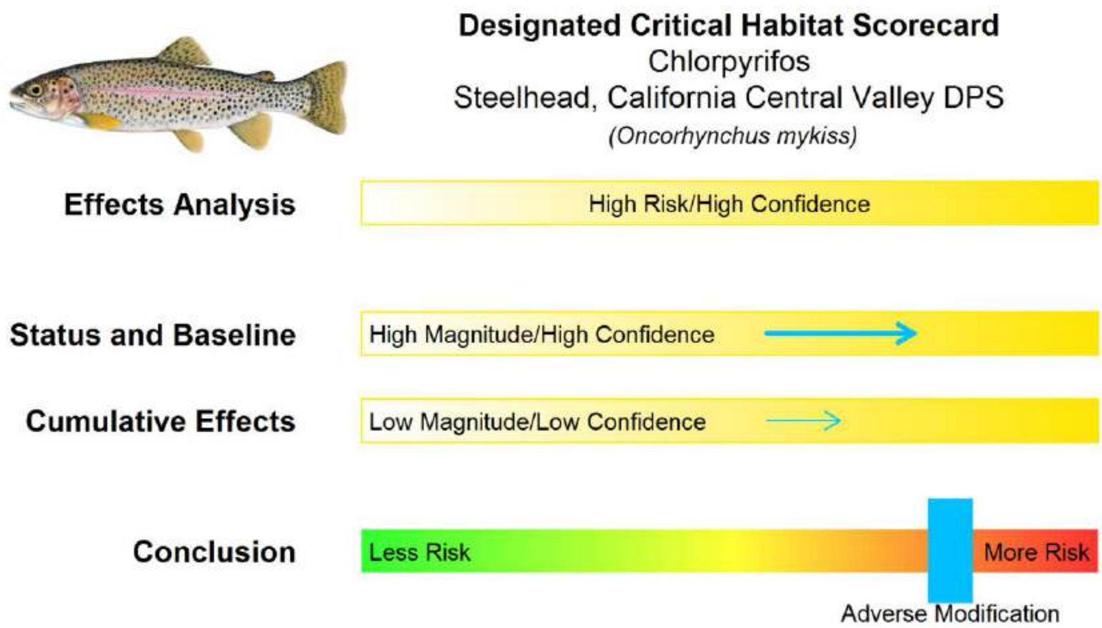

Figure 20. Designated Critical Habitat Scorecard; Steelhead, California Central Valley Distinct Population Segment (DPS); Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning physical and biological features (PBFs) are degraded by altered water flows and temperature
- Rearing and migration PBFs are degraded by altered riverine habitat, dense urbanization and agriculture, poor water quality, and water diversions
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 67 occupied watersheds, 37 are of high and 18 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Seventeen use site categories, totaling more than 4,080,477 acres (over 75% of critical habitat) currently overlap. Chlorpyrifos may be applied anywhere in this species' critical habitat for mosquito control and other wide area uses. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

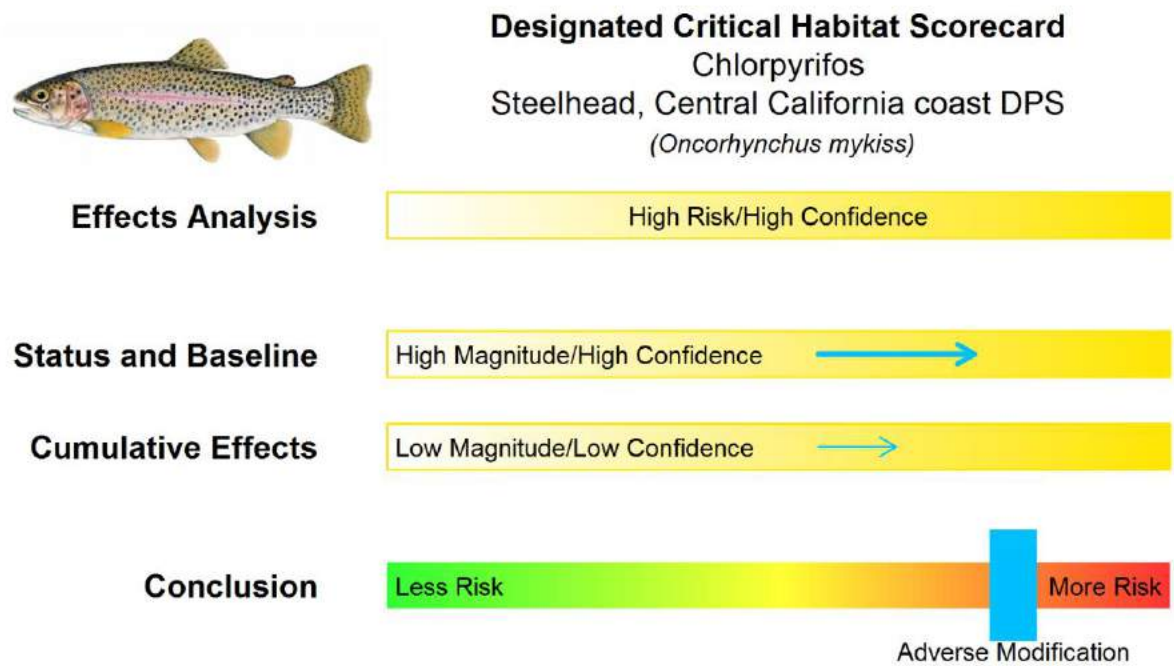

Figure 21. Designated Critical Habitat Scorecard; Steelhead, Central California coast DPS; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning and rearing PBFs are degraded by sedimentation and elevated temperature
- All PBFs are degraded by loss of habitat, low summer flows, erosion, and contaminants
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 47 occupied watersheds, 19 are of high and 15 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Sixteen use site categories, totaling more than 3,314,460 acres (over 45% of critical habitat) currently overlap. Chlorpyrifos may be applied anywhere in this species' critical habitat for mosquito control and other wide area uses. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

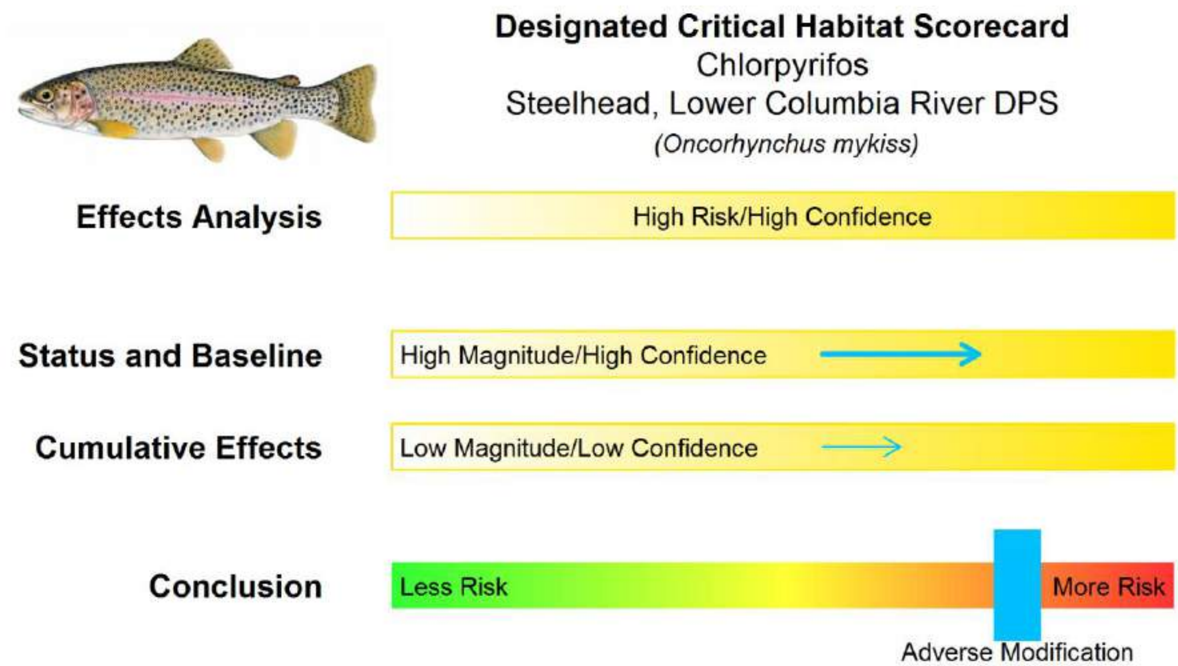

Figure 22. Designated Critical Habitat Scorecard; Steelhead, Lower Columbia River DPS; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Rearing PBFs are degraded by agricultural runoff and lack of available prey
- Spawning, rearing and migration PBFs are degraded by timber harvests, dams, and loss of floodplain habitat
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 41 occupied watersheds, 28 are of high and 11 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Seventeen use site categories, totaling more than 2,323,028 acres (over 63% of critical habitat) currently overlap. Chlorpyrifos may be applied anywhere in this species' critical habitat for mosquito control and other wide area uses. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

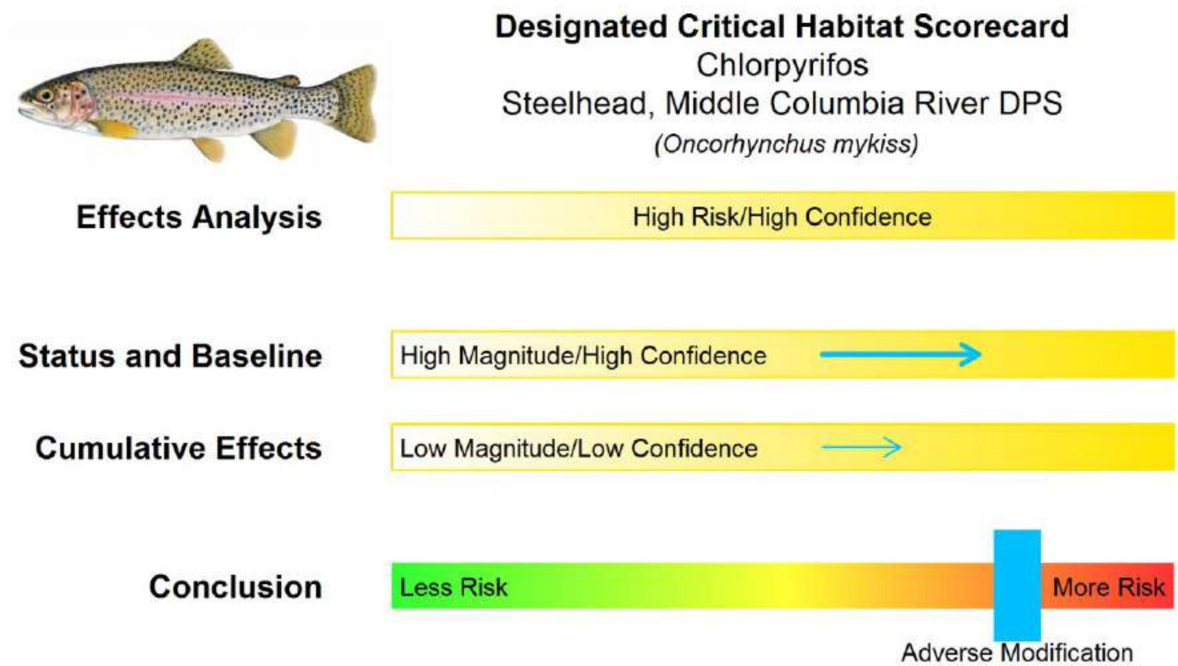

Figure 23. Designated Critical Habitat Scorecard; Steelhead, Middle Columbia River DPS; Chlorpyrifos

<u>Effects Analysis: High risk/High confidence</u>

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

<u>Status and Baseline: Increased risk; High magnitude/High confidence</u>

- Rearing PBFs are degraded by water quality, reduced invertebrate prey, and loss of riparian vegetation
- Migration PBFs are degraded by several dams
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 106 assessed watersheds, 73 are of high and 24 are of medium conservation value

<u>Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence</u>

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

<u>Conclusion:</u> We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Seventeen use site categories, totaling more than 5,920,763 acres (over 45% of critical habitat) currently overlap. Chlorpyrifos may be applied anywhere in this species' critical habitat for mosquito control and other wide area uses. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

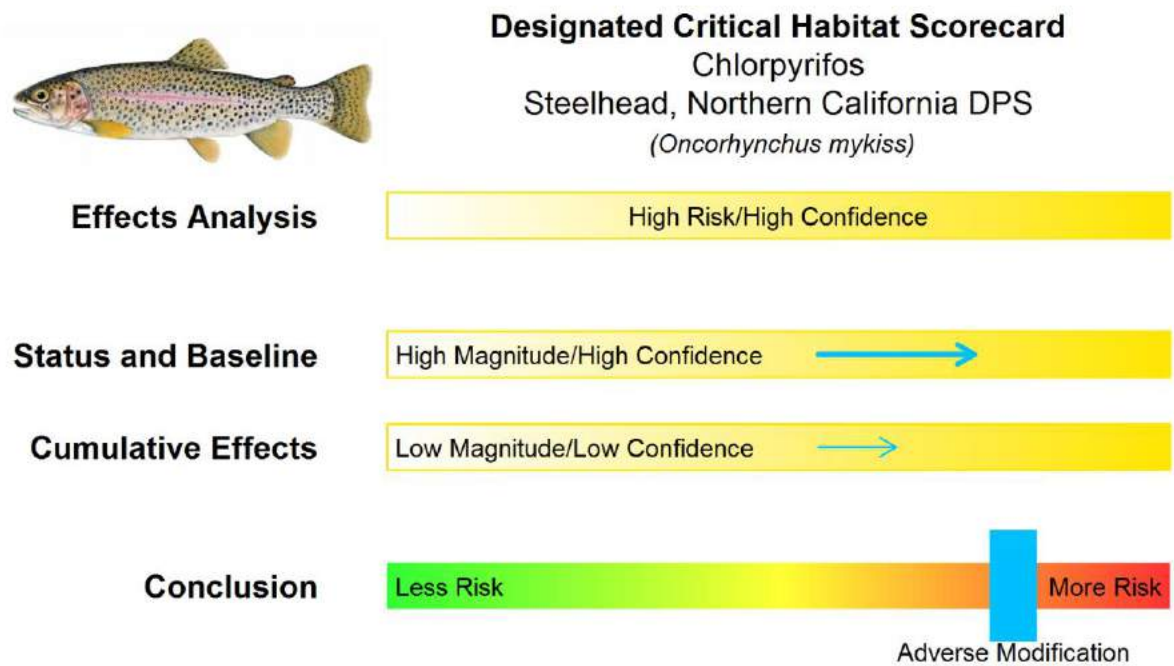

Figure 24. Designated Critical Habitat Scorecard; Steelhead, Northern California DPS; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Rearing PBFs are degraded by loss of riparian vegetation and elevated temperature
- Spawning PBFs are degraded by lack of quality substrate and sedimentation
- Migration PBFs are degraded by bridges, culverts, and forest road construction
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 50 assessed watersheds, 27 are of high and 14 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Fourteen use site categories, totaling more than 1,019,525 acres (over 21% of critical habitat) currently overlap. Chlorpyrifos may be applied anywhere in this species' critical habitat for mosquito control and other wide area uses. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

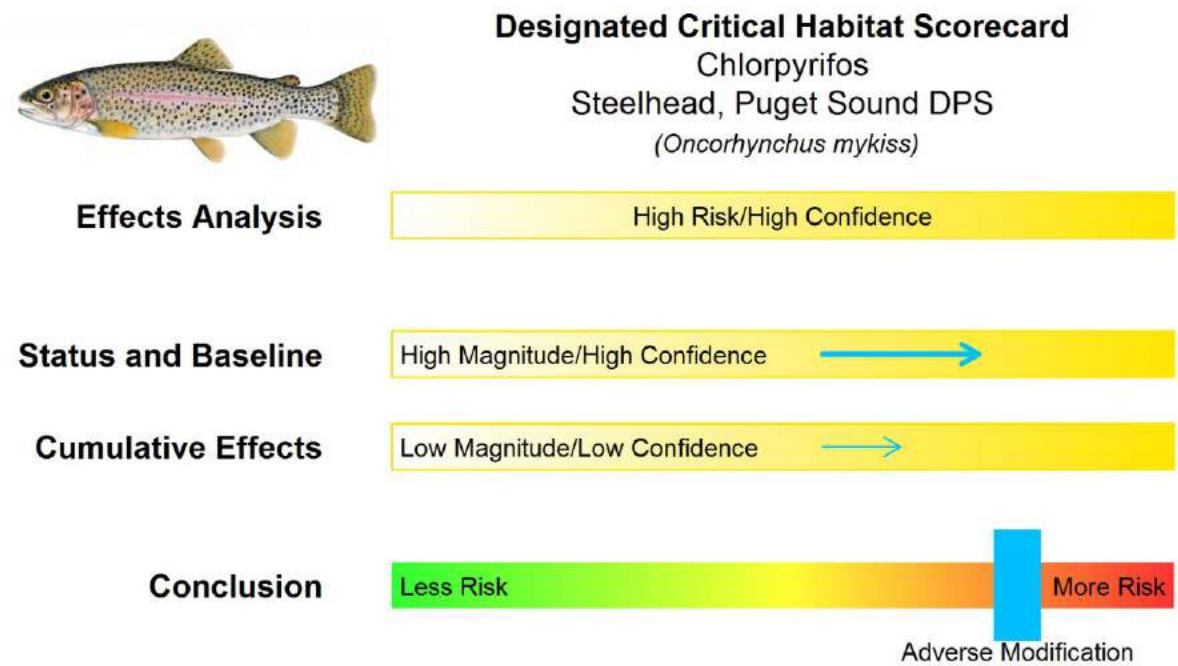

Figure 25. Designated Critical Habitat Scorecard; Steelhead, Puget Sound DPS; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Rearing, migration and spawning PBFs are degraded by forestry, agriculture, urbanization, loss of floodplain habitat, and poor water quality
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Most watersheds are of high or medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Sixteen use site categories, totaling more than 3,819,637 acres (over 63% of critical habitat) currently overlap. Chlorpyrifos may be applied anywhere in this species' critical habitat for mosquito control and other wide area uses. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

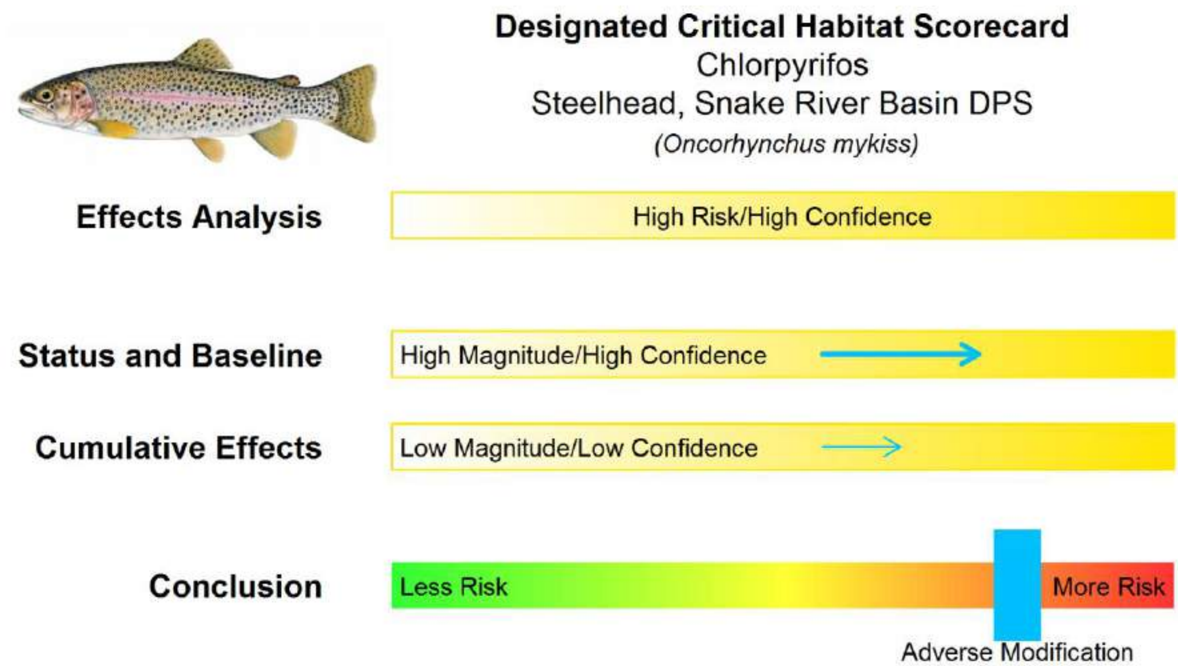

Figure 26. Designated Critical Habitat Scorecard; Steelhead, Snake River Basin DPS; Chlorpyrifos

<u>Effects Analysis: High risk/High confidence</u>

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

<u>Status and Baseline: Increased risk; High magnitude/High confidence</u>

- Rearing PBFs are degraded by agricultural runoff, reduced invertebrate prey, loss of riparian vegetation, and elevated temperature
- Migration PBFs are degraded by several dams
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of assessed watersheds, 229 are of high and 41 are of medium conservation value

<u>Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence</u>

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

<u>Conclusion:</u> We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Seventeen use site categories, totaling more than 9,136,811 acres (over 52% of critical habitat) currently overlap. Chlorpyrifos may be applied anywhere in this species' critical habitat for mosquito control and other wide area uses. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

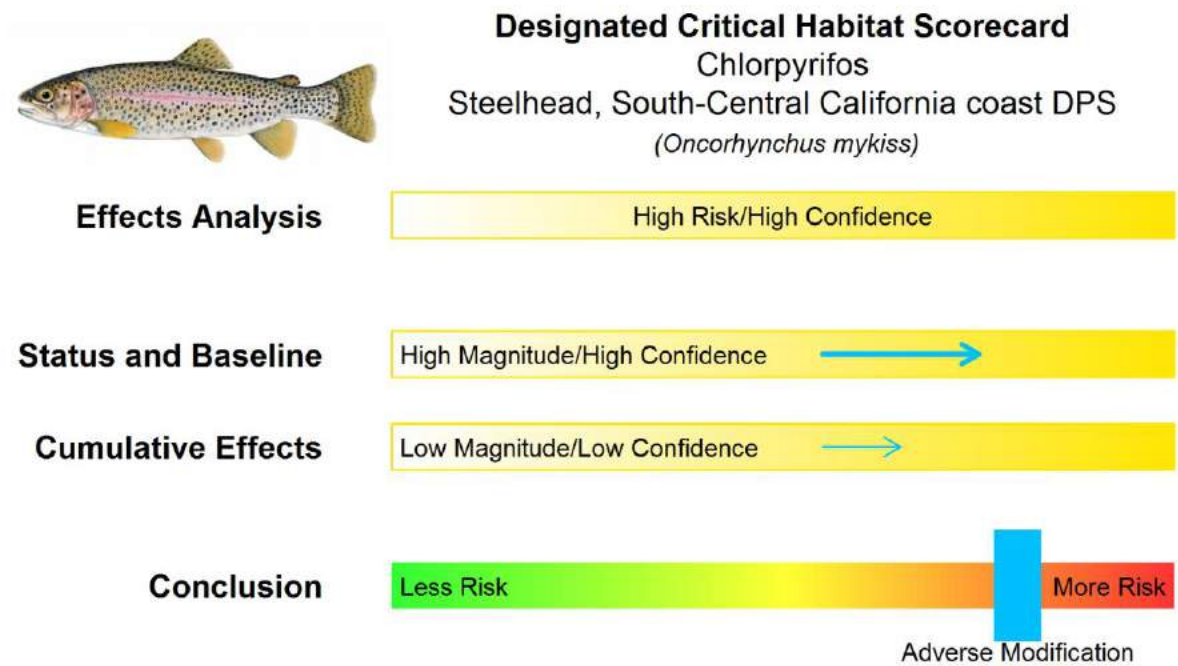

Figure 27. Designated Critical Habitat Scorecard; Steelhead, South-Central California coast DPS; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Rearing and migration PBFs are degraded by elevated temperatures and contaminants from urban and agricultural runoff
- Estuarine PBFs are degraded by altered habitat and contaminated runoff
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 29 occupied watersheds, 12 are of high and 11 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Seventeen use site categories, totaling more than 1,409,107 acres (over 44% of critical habitat) currently overlap. Chlorpyrifos may be applied anywhere in this species' critical habitat for mosquito control and other wide area uses. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

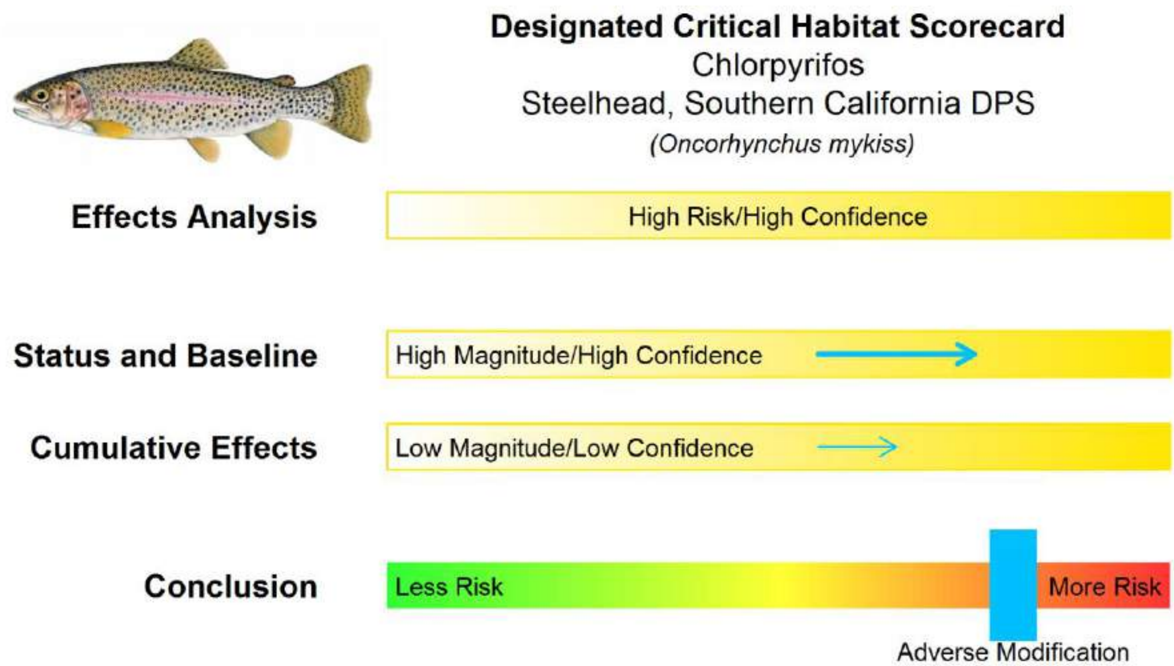

Figure 28. Designated Critical Habitat Scorecard; Steelhead, Southern California DPS; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- All PBFs are degraded by pollutants in urban and agricultural runoff, elevated temperatures, erosion, and low water flows
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 29 freshwater and estuarine watersheds, 21 are of high and 5 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Seventeen use site categories, totaling more than 765,006 acres (over 35% of critical habitat) currently overlap. Chlorpyrifos may be applied anywhere in this species' critical habitat for mosquito control and other wide area uses. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

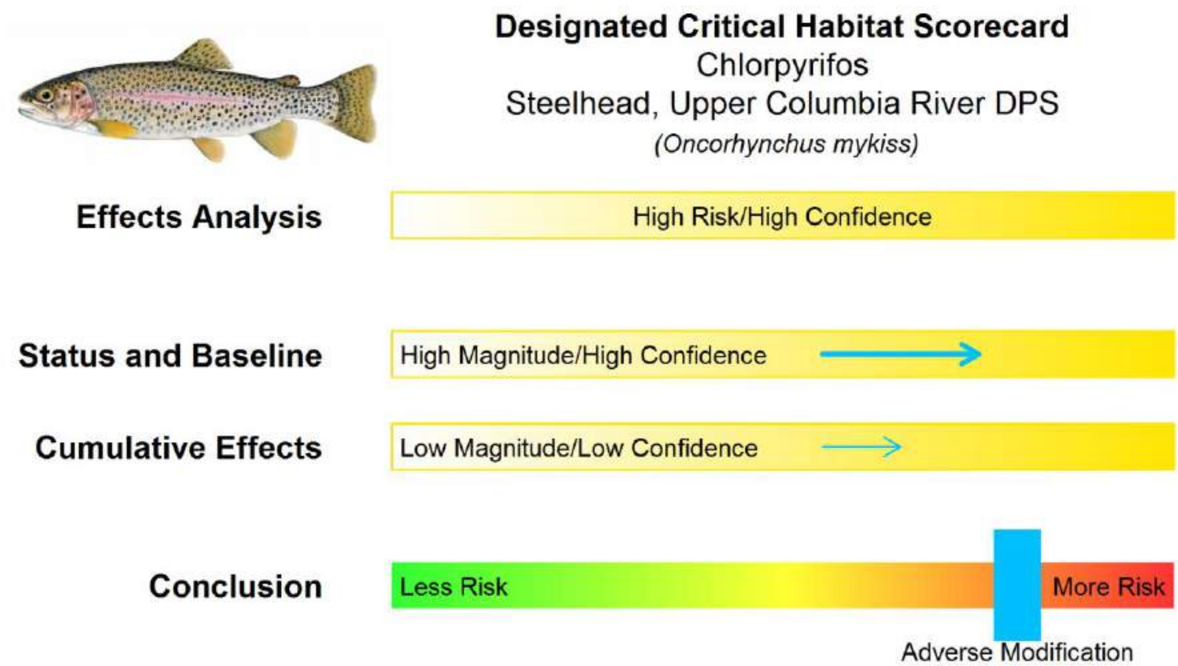

Figure 29. Designated Critical Habitat Scorecard; Steelhead, Upper Columbia River DPS; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Rearing PBFs are degraded by agricultural runoff and lack of available prey
- Migration PBFs are degraded by several dams
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 41 occupied watersheds, 31 are of high and 7 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Seventeen use site categories, totaling more than 2,017,023 acres (over 44% of critical habitat) currently overlap. Chlorpyrifos may be applied anywhere in this species' critical habitat for mosquito control and other wide area uses. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

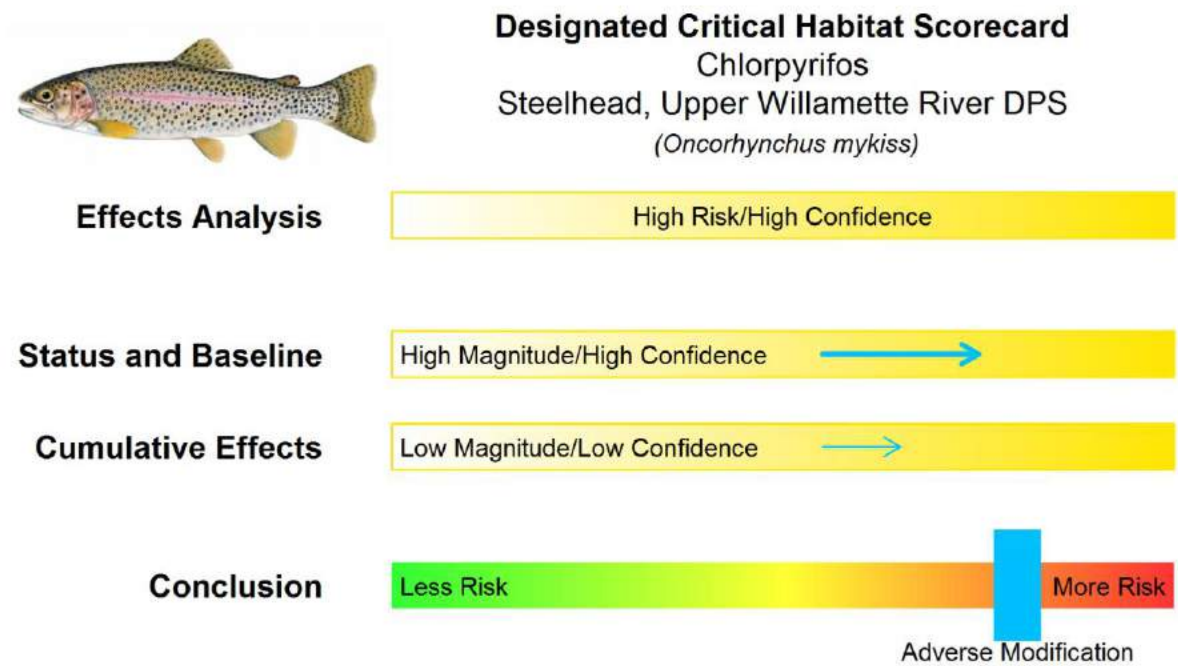

Figure 30. Designated Critical Habitat Scorecard; Steelhead, Upper Willamette River DPS; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Rearing PBFs are degraded by agricultural runoff and lack of available prey
- Migration PBFs are degraded by dams and elevated temperatures
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of assessed watersheds, 14 are of high and 6 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Seventeen use site categories, totaling more than 1,685,690 acres (over 75% of critical habitat) currently overlap. Chlorpyrifos may be applied anywhere in this species' critical habitat for mosquito control and other wide area uses. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

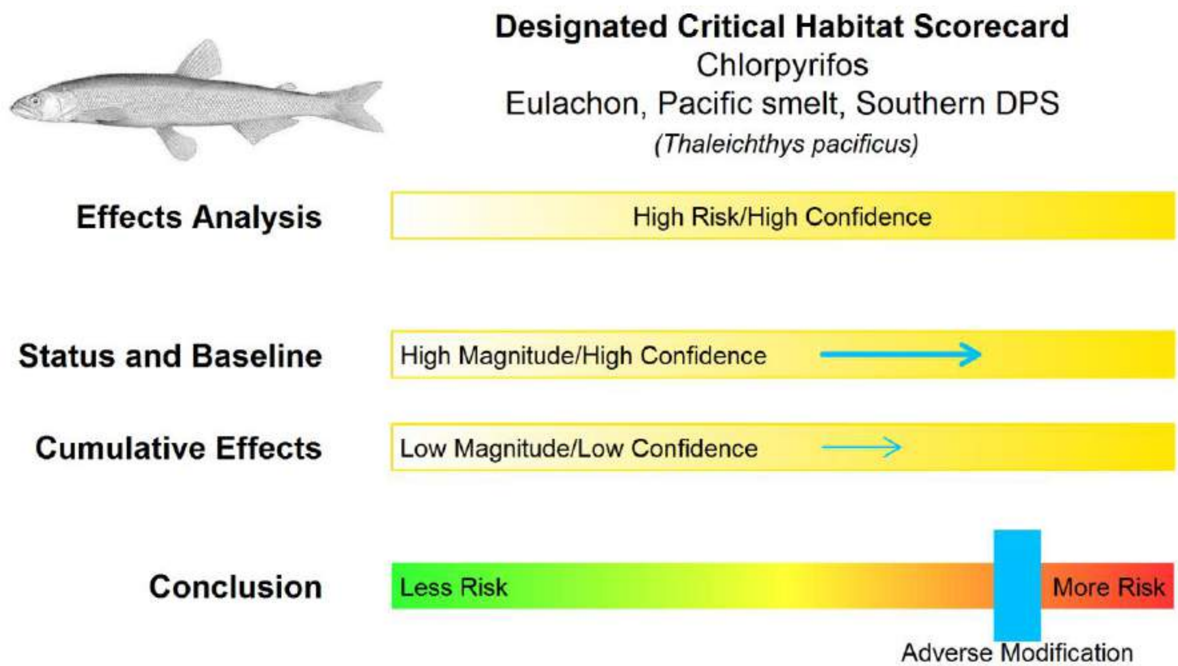

Figure 31. Designated Critical Habitat Scorecard; Eulachon, Pacific smelt, Southern DPS; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat.
- We find high confidence of high risk due to expected exposures predicted in habitats.

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning, incubation, and rearing PBFs are degraded.
- Dams block flow and access to historical spawning grounds and are cause for degraded spawning substrates below.
- Elevated temperatures prevalent in freshwater habitats.
- Environmental mixtures anticipated in freshwater habitats may affect prey.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely. Global climate change a threat, particularly in eulachon's southern range where ocean warming may be most severe, altering prey, spawning, and rearing success.
- Anticipated hydrologic changes in freshwater areas may affect PBFs.

Conclusion: We find a high likelihood of exposure and effects to designated critical habitat. Critical habitat is most at risk in areas where there is extensive overlap with use sites. Chlorpyrifos may be applied anywhere in this species critical habitat for mosquito control and other wide area uses. Sixteen use site categories, totaling more than 420,163 acres (over 23 percent of acres) are currently present. Anticipated reductions in prey and degradation of water quality will reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

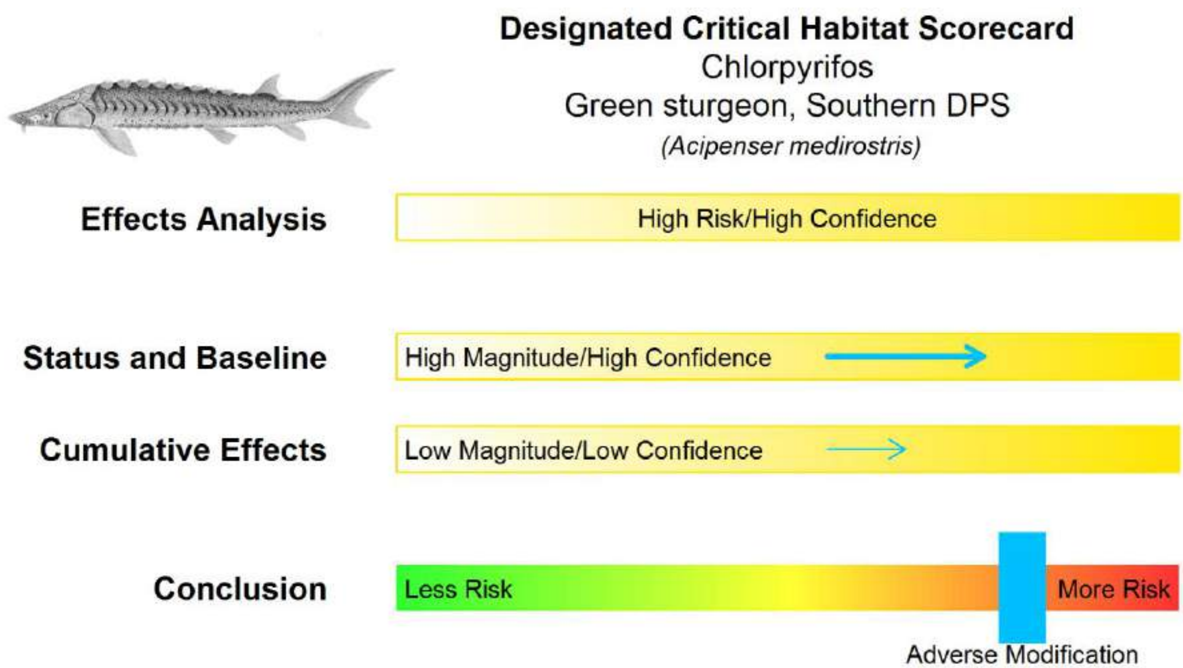

Figure 32. Designated Critical Habitat Scorecard; Green sturgeon, Southern DPS; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reductions in prey species and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat.
- We find high confidence of high risk due to expected exposures predicted in habitats.

Status and Baseline: Increased risk; High magnitude/High confidence

- Insufficient freshwater flow rates in spawning areas.
- Contaminants (e.g., pesticides).
- Impassable barriers limit spawning to limited sections in Sacramento River.
- Elevated water temperatures.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely. Global climate change may threaten PBFs.
- Anticipated hydrologic changes in freshwater areas may further affect PBFs.

Conclusion: We find a high likelihood of exposure and effects to designated critical habitat. Critical habitat is most at risk in areas where there is extensive overlap with use sites. Chlorpyrifos may be applied anywhere in this species critical habitat for mosquito control and other wide area uses. Seventeen use site categories, totaling more than 5,076,959 acres (over 49 percent of acres) are currently present. Anticipated reductions in prey and degradation of water quality will reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

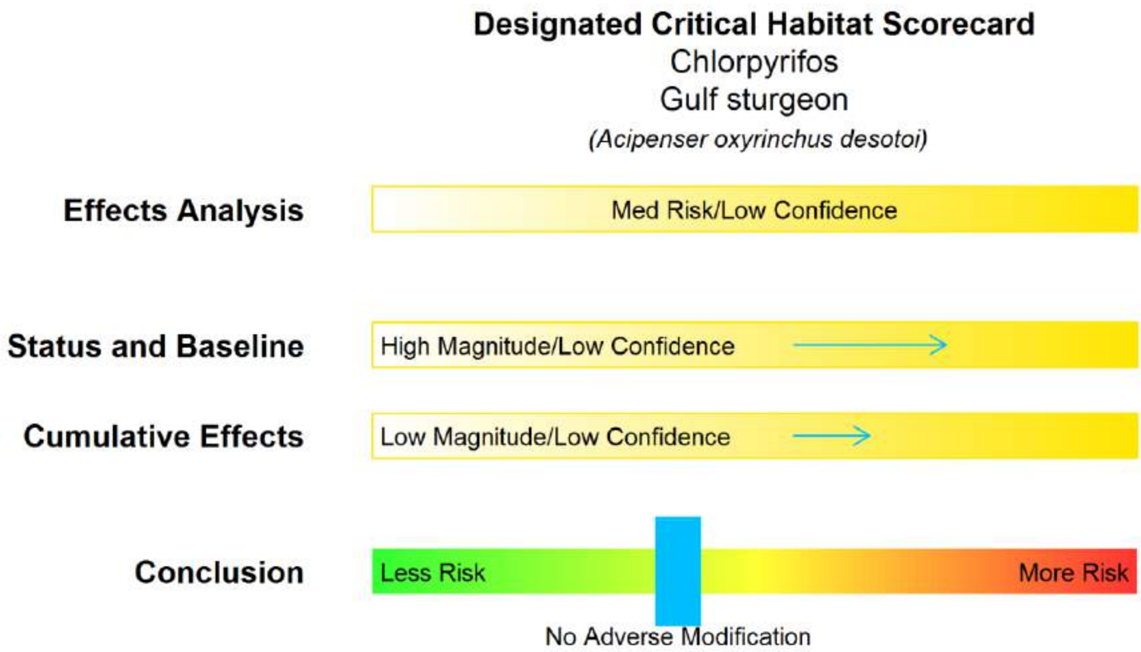

Figure 33. Designated Critical Habitat Scorecard; Gulf sturgeon; Chlorpyrifos

Effects Analysis: Medium risk/Low confidence

- Reductions in prey species and degradation of water quality in marine habitats are not anticipated to reduce the overall conservation value of designated critical habitat.
- We find low confidence of medium risk due to exposures predicted in their marine habitats.

Status and Baseline: Increased risk; High magnitude/Low confidence

- Construction of water control structures, such as dams and sills exacerbated habitat loss.
- Dredging.
- Groundwater extraction, irrigation, and altered flows.
- Poor water quality.
- Contaminants, primarily from industrial sources.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Global climate change may threaten PBFs.

Conclusion: We have low confidence in EECs predicted for the marine habitats. We find that the overall risk is medium and the confidence associated with that risk is low. We do not anticipate reductions in prey and degradation of water quality will reduce conservation values throughout the marine portion of this species designated critical habitat over the 15-year action.

Chlorpyrifos is not likely to adversely modify designated critical habitat: No Adverse Modification

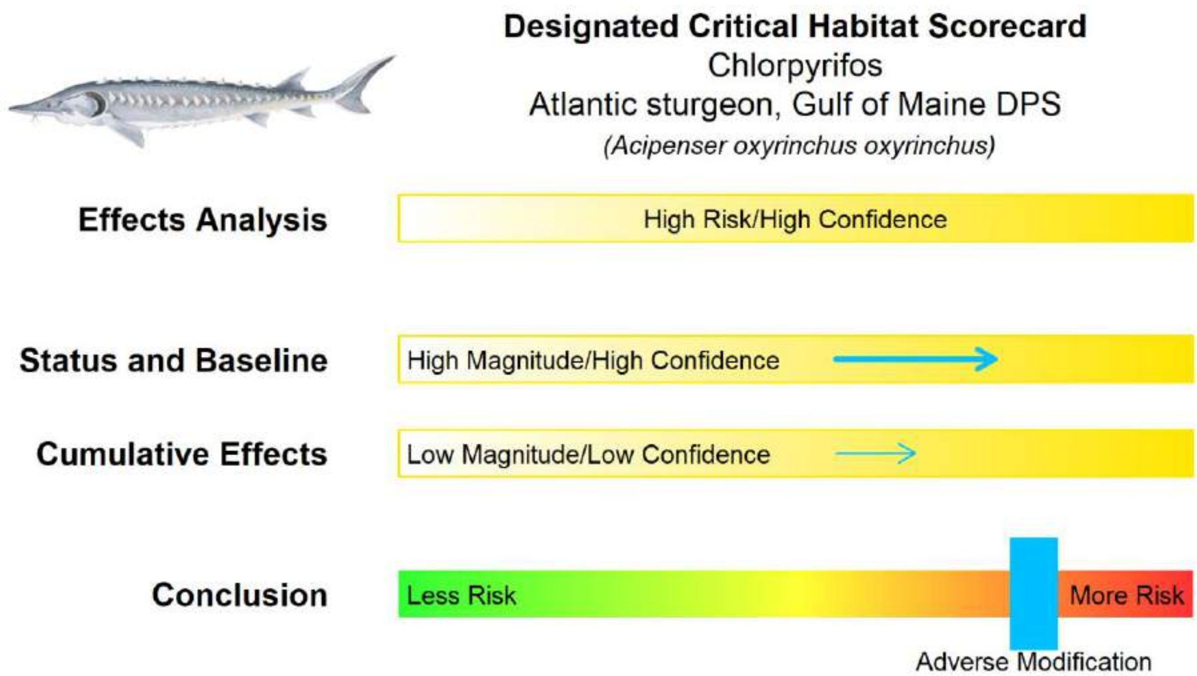

Figure 34. Designated Critical Habitat Scorecard; Atlantic sturgeon, Gulf of Maine DPS; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reductions in prey species and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat.
- We find high confidence of high risk due to expected exposures predicted in habitats.

Status and Baseline: Increased risk; High magnitude/High confidence

- Contaminants (e.g., pesticides).
- Impassable barriers limit spawning to limited sections
- Elevated water temperatures.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely. Global climate change may threaten PBFs.
- Anticipated hydrologic changes in freshwater areas may further affect PBFs.

Conclusion: We find a high likelihood of exposure and effects to designated critical habitat. Critical habitat is most at risk in areas where there is extensive overlap with use sites. Chlorpyrifos may be applied anywhere in this species critical habitat for mosquito control and other wide area uses. Anticipated reductions in prey and degradation of water quality will reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

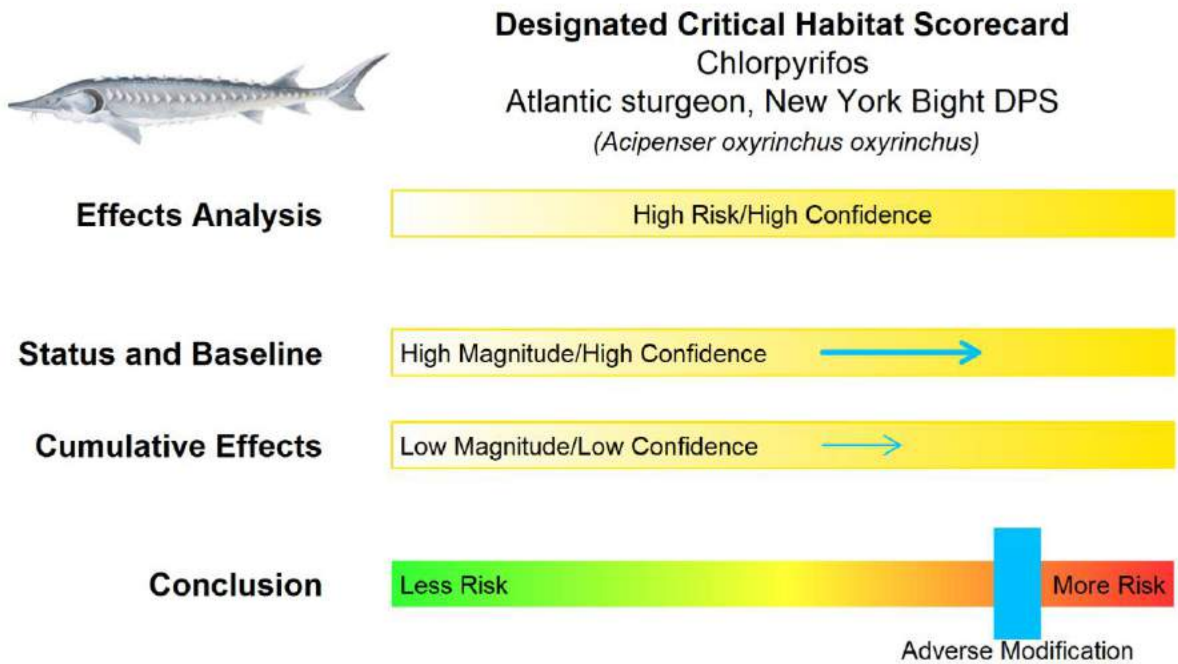

Figure 35. Designated Critical Habitat Scorecard; Atlantic sturgeon, New York Bight DPS; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reductions in prey species and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat.
- We find high confidence of high risk due to expected exposures predicted in habitats.

Status and Baseline: Increased risk; High magnitude/High confidence

- Contaminants (e.g., pesticides).
- Impassable barriers limit spawning to limited sections
- Elevated water temperatures.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely. Global climate change may threaten PBFs.
- Anticipated hydrologic changes in freshwater areas may further affect PBFs.

Conclusion: We find a high likelihood of exposure and effects to designated critical habitat. Critical habitat is most at risk in areas where there is extensive overlap with use sites. Chlorpyrifos may be applied anywhere in this species critical habitat for mosquito control and other wide area uses. Anticipated reductions in prey and degradation of water quality will reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

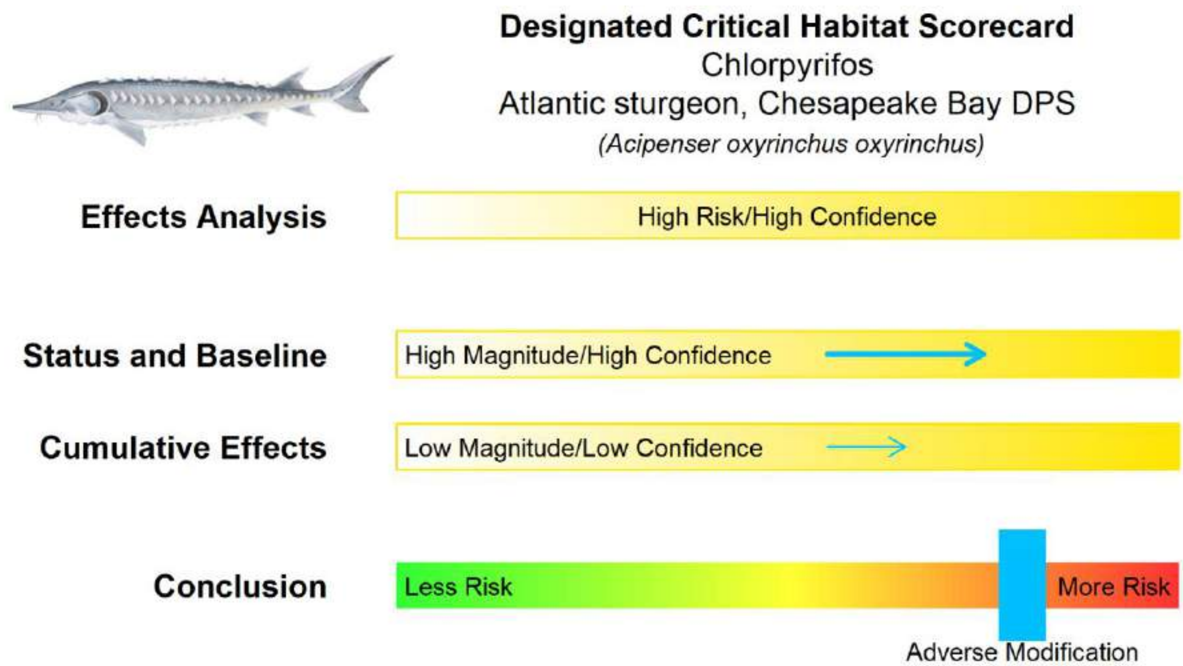

Figure 36. Designated Critical Habitat Scorecard; Atlantic sturgeon, Chesapeake Bay DPS; Chlorpyrifos

<u>Effects Analysis: High risk/High confidence</u>

- Reductions in prey species and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat.
- We find high confidence of high risk due to expected exposures predicted in habitats.

<u>Status and Baseline: Increased risk; High magnitude/High confidence</u>

- Contaminants (e.g., pesticides).
- Impassable barriers limit spawning to limited sections
- Elevated water temperatures.

<u>Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence</u>

- Future elevated temperatures likely. Global climate change may threaten PBFs.
- Anticipated hydrologic changes in freshwater areas may further affect PBFs.

<u>Conclusion:</u> We find a high likelihood of exposure and effects to designated critical habitat. Critical habitat is most at risk in areas where there is extensive overlap with use sites. Chlorpyrifos may be applied anywhere in this species critical habitat for mosquito control and other wide area uses. Anticipated reductions in prey and degradation of water quality will reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

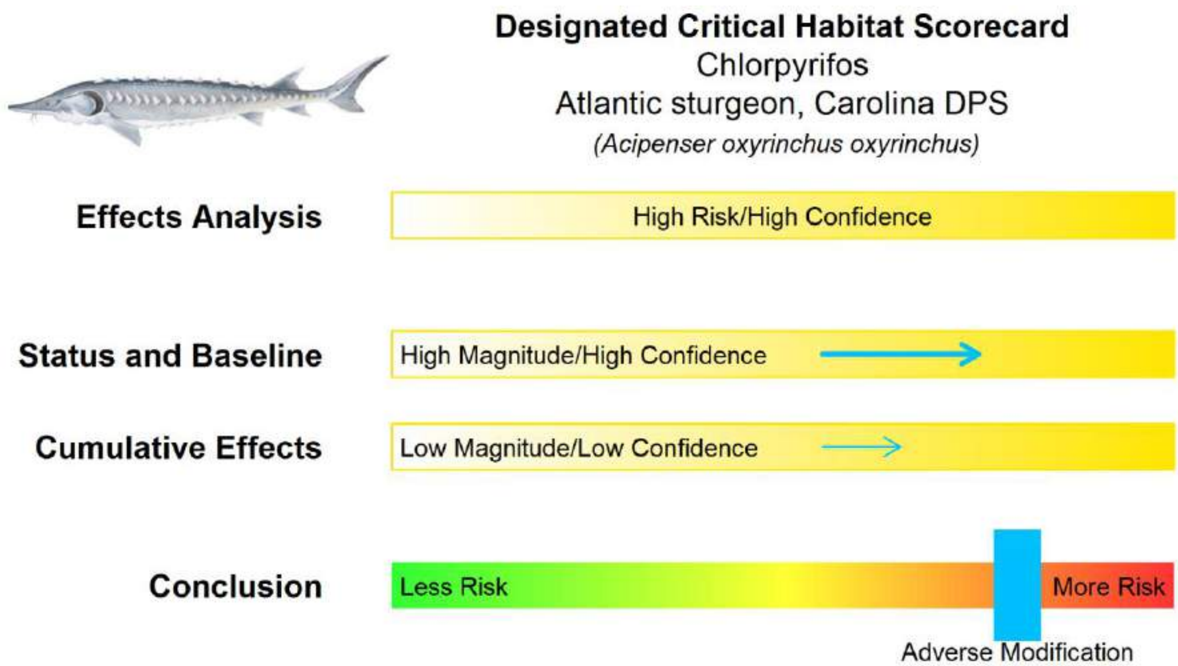

Figure 37. Designated Critical Habitat Scorecard; Atlantic sturgeon, Carolina DPS; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reductions in prey species and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat.
- We find high confidence of high risk due to expected exposures predicted in habitats.

Status and Baseline: Increased risk; High magnitude/High confidence

- Contaminants (e.g., pesticides).
- Impassable barriers limit spawning to limited sections
- Elevated water temperatures.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely. Global climate change may threaten PBFs.
- Anticipated hydrologic changes in freshwater areas may further affect PBFs.

Conclusion: We find a high likelihood of exposure and effects to designated critical habitat. Critical habitat is most at risk in areas where there is extensive overlap with use sites. Chlorpyrifos may be applied anywhere in this species critical habitat for mosquito control and other wide area uses. Anticipated reductions in prey and degradation of water quality will reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

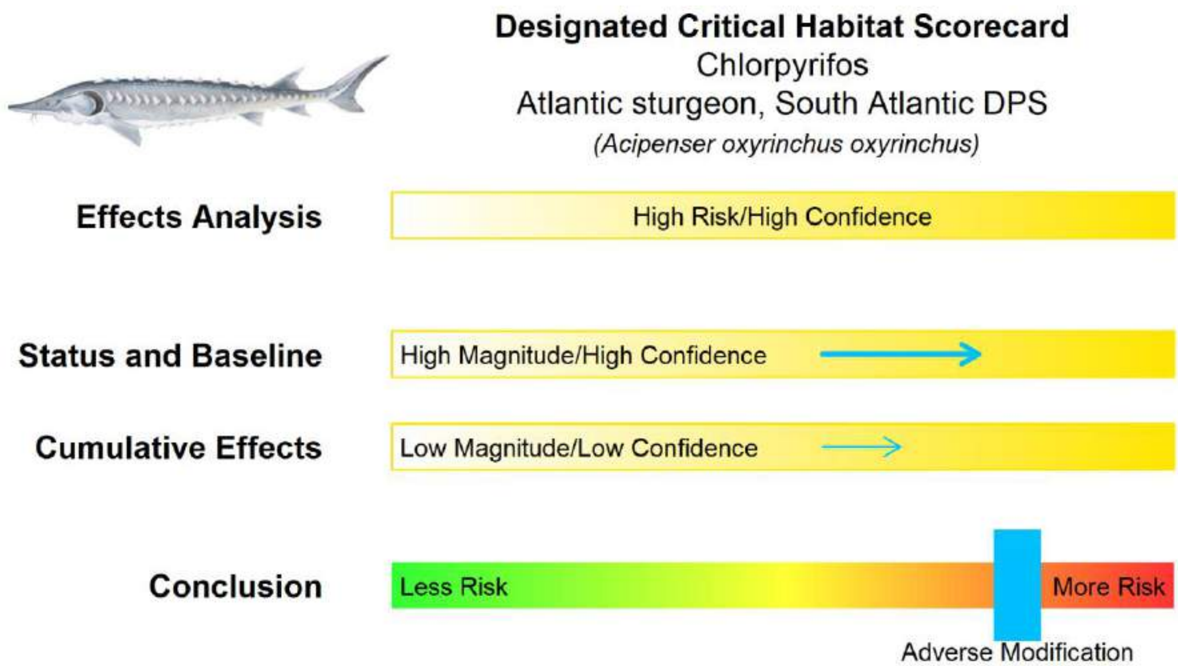

Figure 38. Designated Critical Habitat Scorecard; Atlantic sturgeon, South Carolina DPS; Chlorpyrifos

<u>Effects Analysis: High risk/High confidence</u>

- Reductions in prey species and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat.
- We find high confidence of high risk due to expected exposures predicted in habitats.

<u>Status and Baseline: Increased risk; High magnitude/High confidence</u>

- Contaminants (e.g., pesticides).
- Impassable barriers limit spawning to limited sections
- Elevated water temperatures.

<u>Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence</u>

- Future elevated temperatures likely. Global climate change may threaten PBFs.
- Anticipated hydrologic changes in freshwater areas may further affect PBFs.

<u>Conclusion:</u> We find a high likelihood of exposure and effects to designated critical habitat. Critical habitat is most at risk in areas where there is extensive overlap with use sites. Chlorpyrifos may be applied anywhere in this species critical habitat for mosquito control and other wide area uses. Anticipated reductions in prey and degradation of water quality will reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

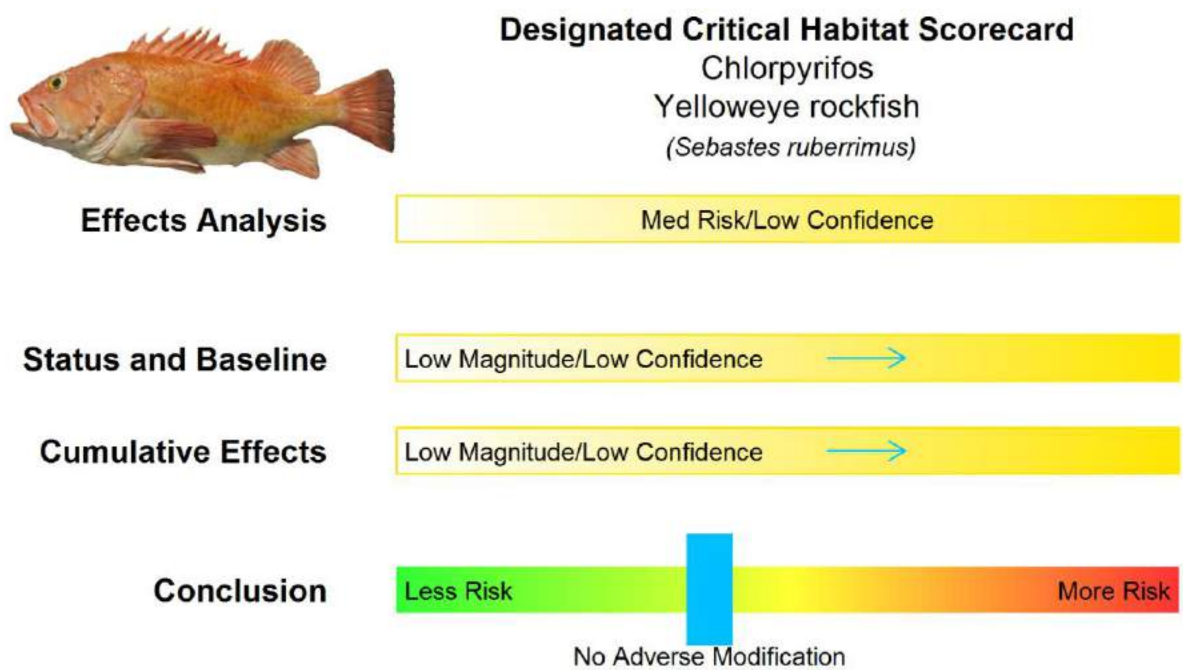

Figure 39. Designated Critical Habitat Scorecard; Yelloweye rockfish; Chlorpyrifos

<u>Effects Analysis: Medium risk/Low confidence</u>

- Reductions in prey species and degradation of water quality in marine habitats are not anticipated to reduce the overall conservation value of designated critical habitat.
- We find low confidence of medium risk due to exposures predicted in their marine habitats.

<u>Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence</u>

- Adverse environmental factors have led to prey reductions and recruitment failures.

<u>Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence</u>

- Changes in ocean conditions brought about by climate change may threaten PBFs.

<u>Conclusion:</u> We have low confidence in EECs predicted for the marine habitats. We find that the overall risk is medium and the confidence associated with that risk is low. We do not anticipate reductions in prey and degradation of water quality will reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is not likely to adversely modify designated critical habitat: No Adverse Modification

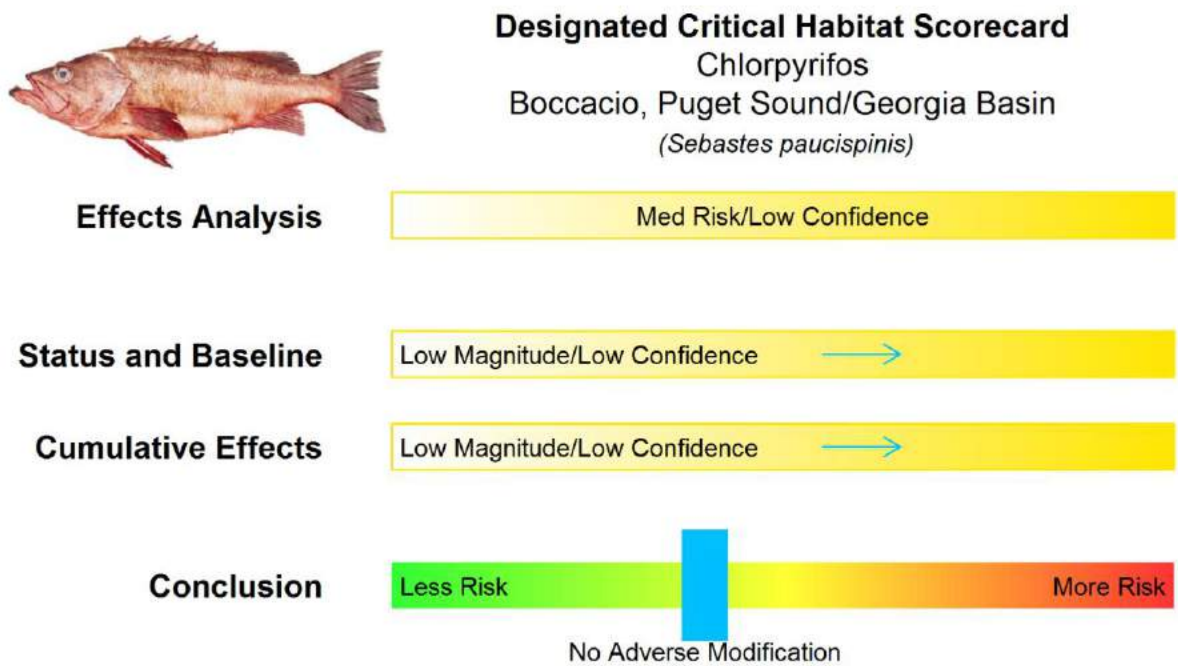

Figure 40. Designated Critical Habitat Scorecard; Boccacio, Puget Sound/Georgia Basin; Chlorpyrifos

Effects Analysis: Medium risk/Low confidence

- Reductions in prey species and degradation of water quality in marine habitats are not anticipated to reduce the overall conservation value of designated critical habitat.
- We find low confidence of medium risk due to exposures predicted in their marine habitats.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Adverse environmental factors have led to prey reductions and recruitment failures.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions brought about by climate change may threaten PBFs.

Conclusion: We have low confidence in EECs predicted for the marine habitats. We find that the overall risk is medium and the confidence associated with that risk is low. We do not anticipate reductions in prey and degradation of water quality will reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is not likely to adversely modify designated critical habitat: No Adverse Modification

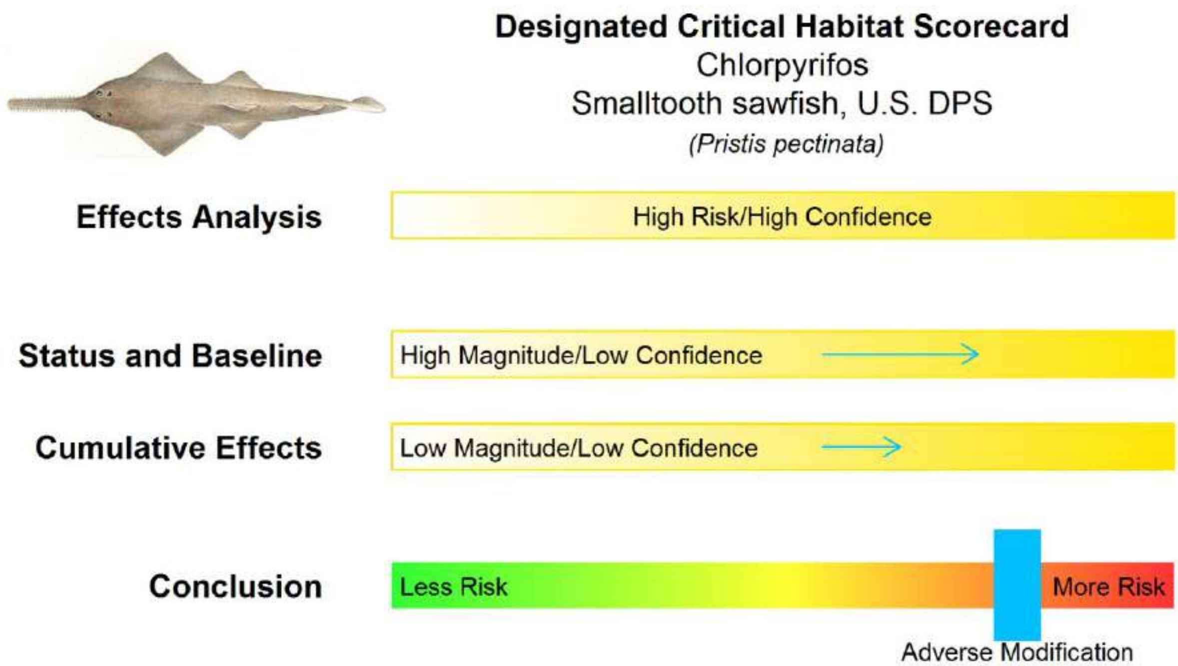

Figure 41. Designated Critical Habitat Scorecard; Smalltooth sawfish, U.S. DPS; Chlorpyrifos

Effects Analysis: High risk/High confidence

- Reductions in prey species are likely to reduce the overall conservation value of designated critical habitat.
- We find high confidence of high risk due to expected exposures predicted in habitats.

Status and Baseline: Increased risk; High magnitude/Low confidence

- Loss and degradation of female pupping sites and juvenile rearing habitats.
- Point and non-point contaminants.
- Marine Debris.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future losses in vegetated shallow water habitats from developmental pressures and global climate change may further threaten PBFs.

Conclusion: We find a high likelihood of exposure and effects to designated critical habitat. Critical habitat is most at risk in areas where there is extensive overlap with use sites. Chlorpyrifos may be applied anywhere in this species critical habitat for mosquito control and other wide area uses. Thirteen use site categories, totaling more than 543,533 acres (over 15 percent of acres) are currently present in land adjacent to designated critical habitat. Anticipated reductions in prey will reduce conservation values throughout designated critical habitat over the 15-year action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

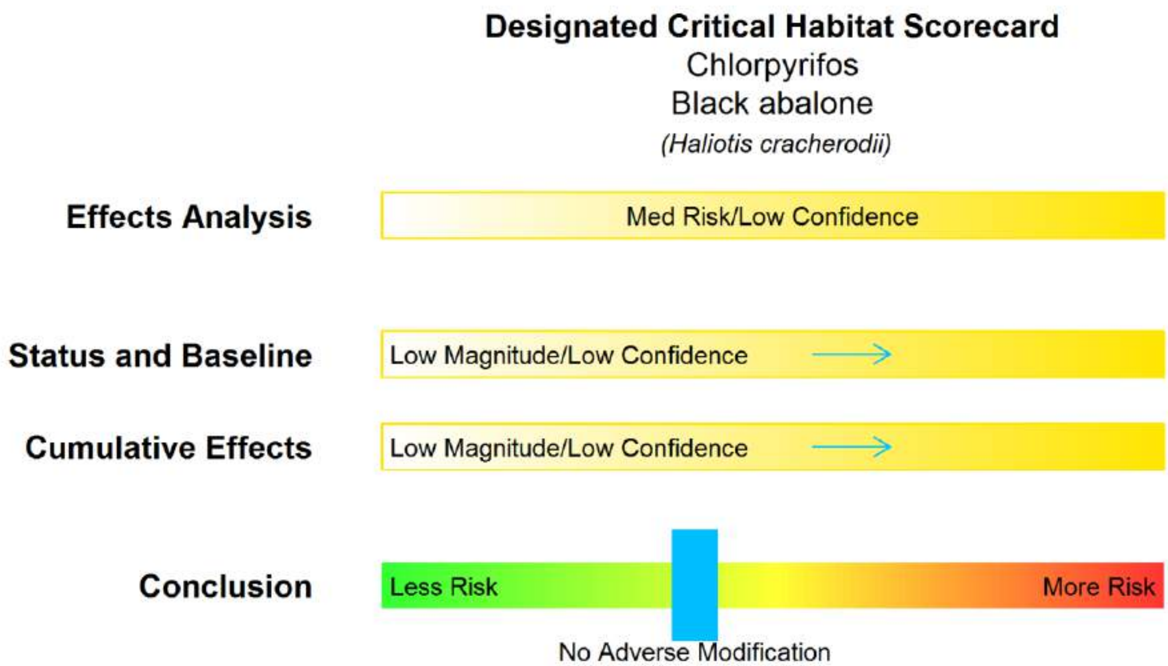

Figure 42. Designated Critical Habitat Scorecard; Black abalone; Chlorpyrifos

Effects Analysis: Medium risk/Low confidence

- We do not anticipate reductions in prey species and degradation of water quality in marine nearshore and inter-tidal habitats to reduce the overall conservation value of designated critical habitat.
- We find low confidence of medium risk due to exposures predicted.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Habitat destruction.
- Disease.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Developmental pressures could reduce available habitat and create competition for space with other marine invertebrates.
- Changes in ocean conditions (ocean acidification) may threaten PBFs.

Conclusion: The stressors of the action may negatively affect relevant physical and biological features within nearshore habitats. However, we have low confidence in the EECs predicted for the marine nearshore habitats. We do not anticipate that the stressors of the action will reduce the overall conservation value of the designated critical habitat of Black Abalone. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.

Chlorpyrifos is not likely to adversely modify designated critical habitat: No Adverse Modification

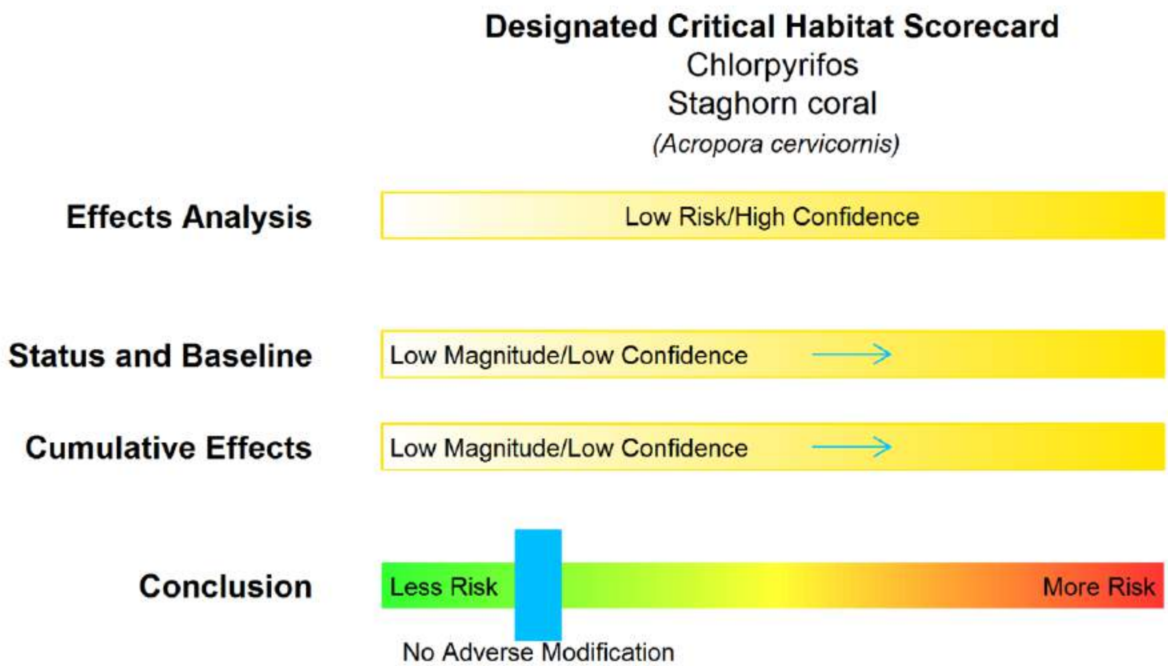

Figure 43. Designated Critical Habitat Scorecard; Staghorn coral; Chlorpyrifos

Effects Analysis: Low risk/High confidence

- We do not anticipate reductions in PBFs or reductions in the overall conservation value of designated critical habitat.
- We find high confidence of low risk due to exposures predicted and PBFs identified.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Disease (white band).
- Habitat destruction.
- Bleaching (temperature variations).
- Sedimentation.
- Algal overgrowth (nutrification).

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions (e.g. increased water temperature and acidification) may threaten PBFs.

Conclusion: There are no physical and biological features identified in Staghorn Coral designated critical habitat that could be affected by the proposed action. We find that the overall risk is low and the confidence associated with that risk is high over the 15-year duration of the action.

Chlorpyrifos is not likely to adversely modify designated critical habitat: No Adverse Modification

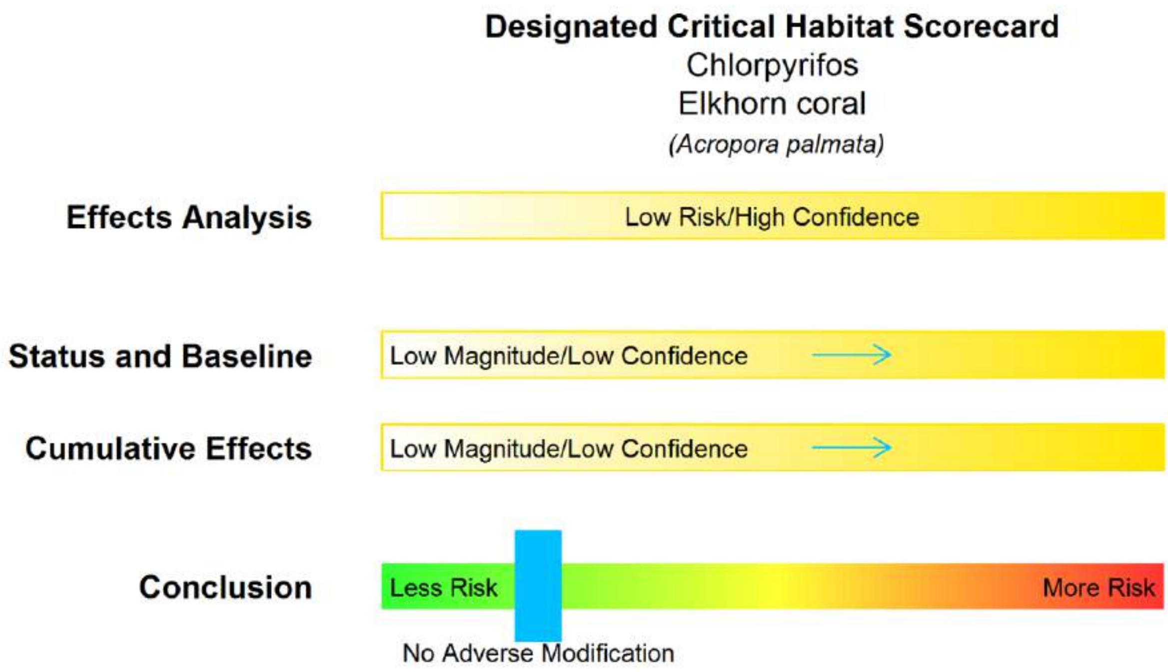

Figure 44. Designated Critical Habitat Scorecard; Elkhorn coral; Chlorpyrifos

Effects Analysis: Low risk/High confidence

- We do not anticipate reductions in PBFs or reductions in the overall conservation value of designated critical habitat.
- We find high confidence of low risk due to exposures predicted and PBFs identified.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Disease (white band).
- Habitat destruction.
- Bleaching (temperature variations).
- Sedimentation.
- Algal overgrowth (nutrification).

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions (e.g. increased water temperature and acidification) brought about by climate change may threaten PBFs.

Conclusion: There are no physical and biological features identified in Staghorn Coral designated critical habitat that could be affected by the proposed action. We find that the overall risk is low and the confidence associated with that risk is high over the 15-year duration of the action.

Chlorpyrifos is not likely to adversely modify designated critical habitat: No Adverse Modification

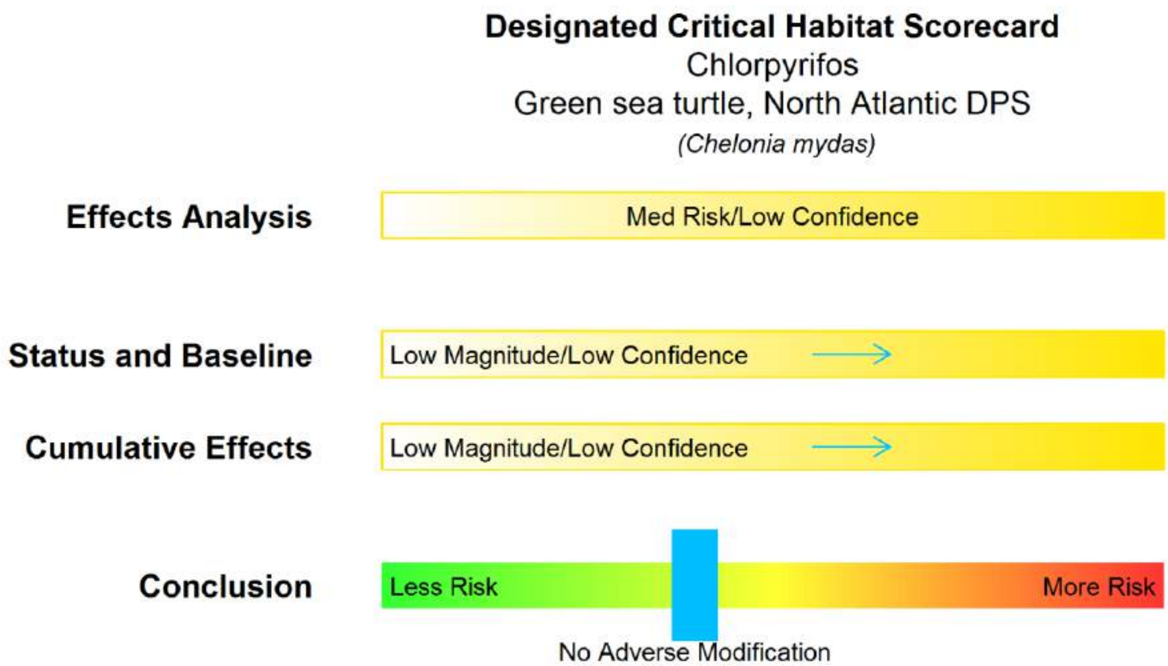

Figure 45. Designated Critical Habitat Scorecard; Green sea turtle, North Atlantic DPS; Chlorpyrifos

Effects Analysis: Medium risk/Low confidence

- We do not anticipate reductions in water quality in marine and nearshore habitats to reduce the overall conservation value of designated critical habitat.
- We find low confidence of medium risk due to exposures predicted.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Disease.
- Point and non-point pollution.
- Marine debris continues to build in critical habitat.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions brought about by climate change may threaten PBFs.
- Increased coastal construction may threaten PBFs.

Conclusion: The stressors of the action may negatively affect relevant physical and biological features within marine and nearshore habitats. However, we have low confidence in the EECs predicted for the marine nearshore habitats. We do not anticipate that the stressors of the action will reduce the overall conservation value of the designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.

Chlorpyrifos is not likely to adversely modify designated critical habitat: No Adverse Modification

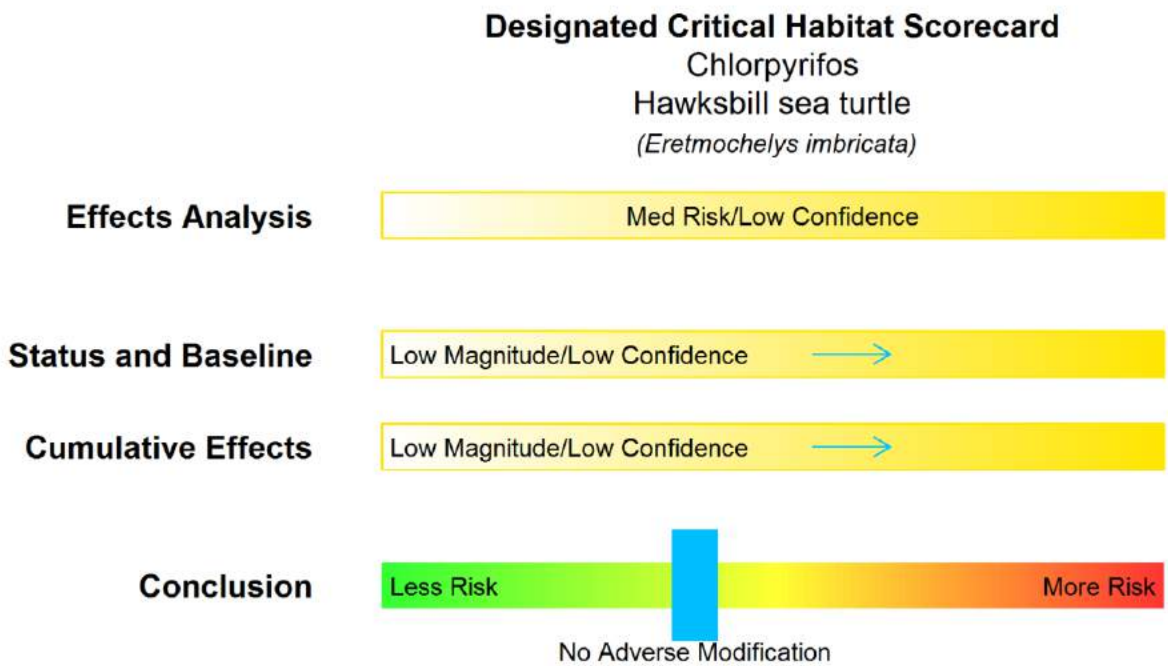

Figure 46. Designated Critical Habitat Scorecard; Hawksbill sea turtle; Chlorpyrifos

Effects Analysis: Medium risk/Low confidence

- We do not anticipate reductions in water quality in marine and nearshore habitats to reduce the overall conservation value of designated critical habitat.
- We find low confidence of medium risk due to exposures predicted.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Disease.
- Point and non-point pollution.
- Marine debris.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions brought about by climate change may threaten PBFs.
- Increased coastal construction may threaten PBFs.

Conclusion: The stressors of the action may negatively affect relevant physical and biological features within marine and nearshore habitats. However, we have low confidence in the EECs predicted for the marine nearshore habitats. We do not anticipate that the stressors of the action will reduce the overall conservation value of the designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.

Chlorpyrifos is not likely to adversely modify designated critical habitat: No Adverse Modification

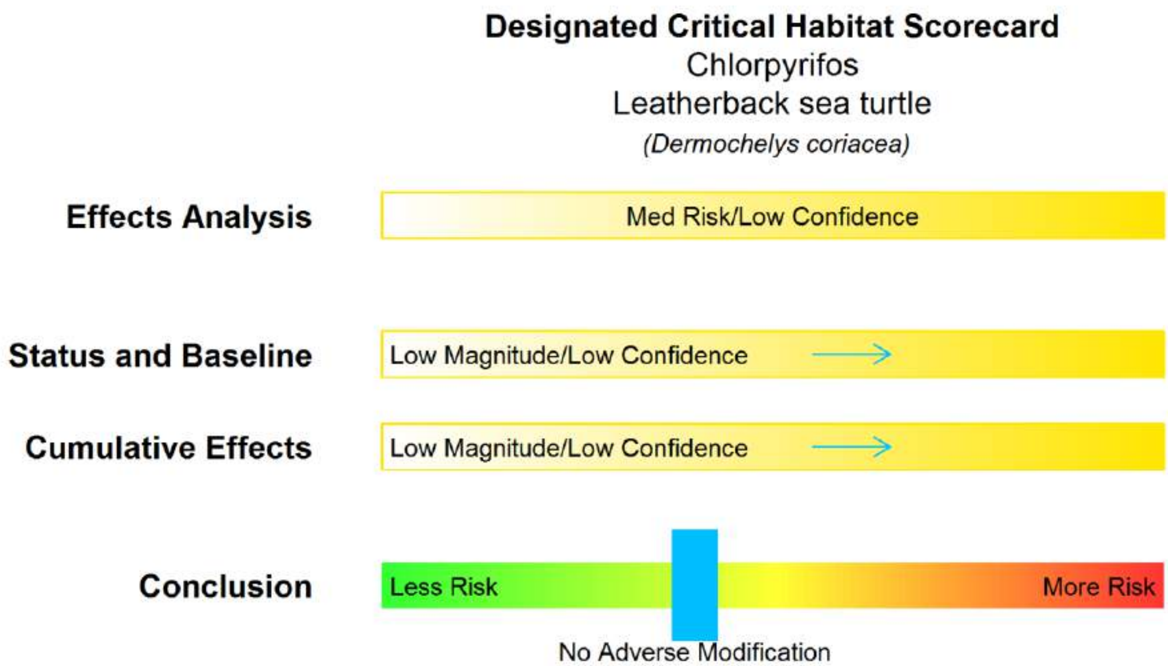

Figure 47. Designated Critical Habitat Scorecard; Leatherback sea turtle; Chlorpyrifos

<u>Effects Analysis: Medium risk/Low confidence</u>

- We do not anticipate reductions in prey in marine and nearshore habitats to reduce the overall conservation value of designated critical habitat.
- We find low confidence of medium risk due to exposures predicted.

<u>Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence</u>

- Disease.
- Point and non-point pollution.
- Marine debris.

<u>Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence</u>

- Changes in ocean conditions brought about by climate change may threaten PBFs.
- Increased coastal construction may threaten PBFs.

<u>Conclusion:</u> The stressors of the action may negatively affect relevant physical and biological features within marine and nearshore habitats. However, we have low confidence in the EECs predicted for the marine nearshore habitats. We do not anticipate that the stressors of the action will reduce the overall conservation value of the designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.

Chlorpyrifos is not likely to adversely modify designated critical habitat: No Adverse Modification

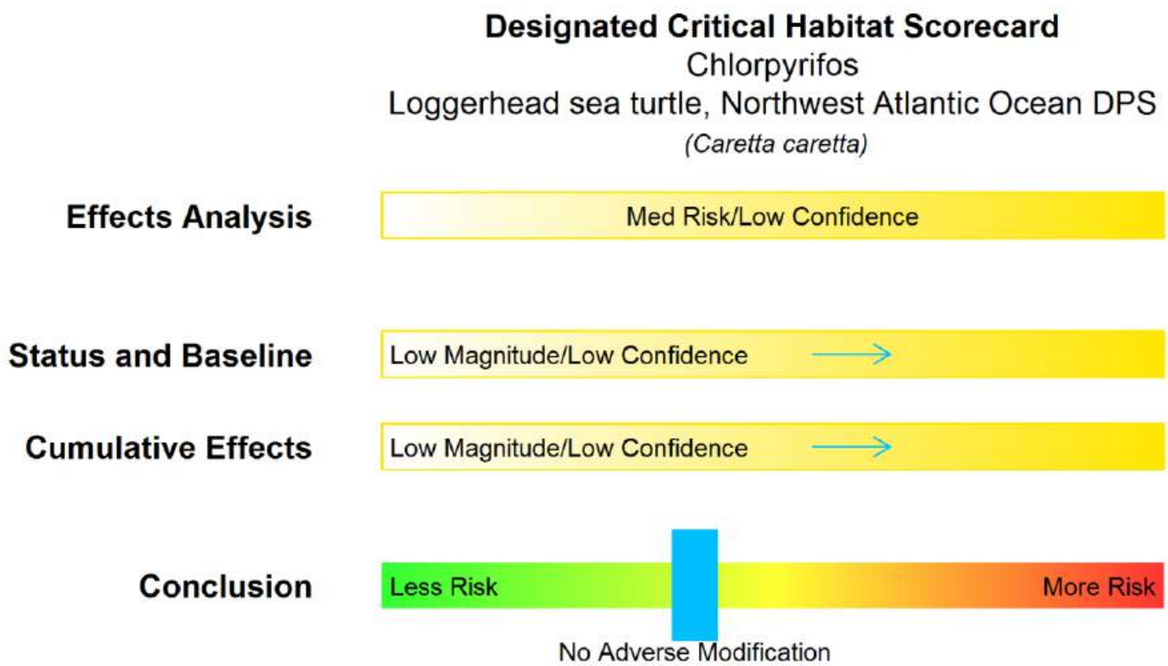

Figure 48. Designated Critical Habitat Scorecard; Loggerhead sea turtle, Northwest Atlantic Ocean DPS; Chlorpyrifos

Effects Analysis: Medium risk/Low confidence

- We do not anticipate reductions in prey in marine and nearshore habitats to reduce the overall conservation value of designated critical habitat.
- We find low confidence of medium risk due to exposures predicted.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Point and non-point pollution.
- Marine debris.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions brought about by climate change may threaten PBFs.
- Increased coastal construction may threaten PBFs.

Conclusion: The stressors of the action may negatively affect relevant physical and biological features within marine and nearshore habitats. However, we have low confidence in the EECs predicted for the marine nearshore habitats. We do not anticipate that the stressors of the action will reduce the overall conservation value of the designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.

Chlorpyrifos is not likely to adversely modify designated critical habitat: No Adverse Modification

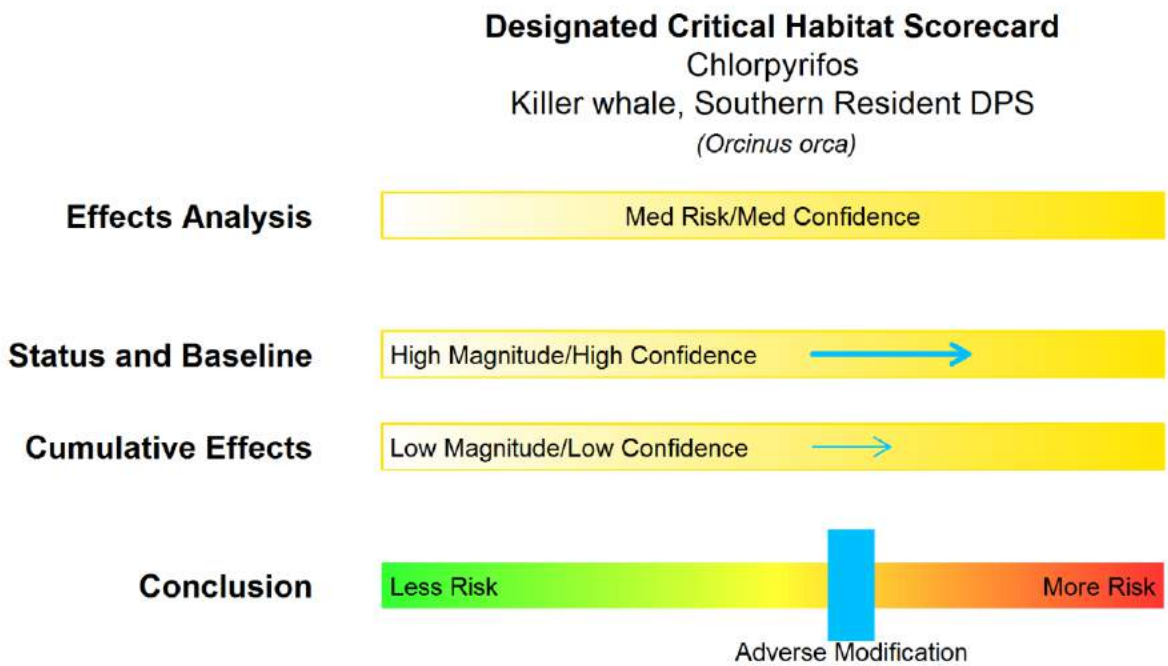

Figure 49. Designated Critical Habitat Scorecard; Killer whale, Southern Resident DPS; Chlorpyrifos

Effects Analysis: Medium risk/Medium confidence

- Reductions in prey species availability are likely to reduce (indirectly) the overall conservation value of designated critical habitat.
- We find medium confidence of medium risk due to expected exposures predicted in habitats.

Status and Baseline: Increased risk; High magnitude/High confidence

- Depleted prey throughout designated critical habitat.
- Point and non-point contaminants.
- Noise disturbance.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions brought about by climate change may threaten PBFs.
- Altered hydrology and affects to prey brought about by climate change.
- Increased stresses (e.g., temperature) to freshwater habitats critical to prey.

Conclusion: We do not anticipate stressors of the action will directly affect physical and biological features (PBFs). Reductions in suitable prey and degradation of water quality are unlikely throughout designated critical habitat of Southern Resident Killer Whale from this action. However, indirectly, prey species (Chinook salmon) will be adversely affected by exposures anticipated in their freshwater habitats. The likelihood and magnitude of toxic effects will reduce the overall conservation value of designated critical habitat by reducing the recruitment and availability of this important prey. We find that the overall risk is medium and the confidence associated with that risk is medium over the 15-year duration of the action.

Chlorpyrifos is likely to adversely modify designated critical habitat: Adverse Modification

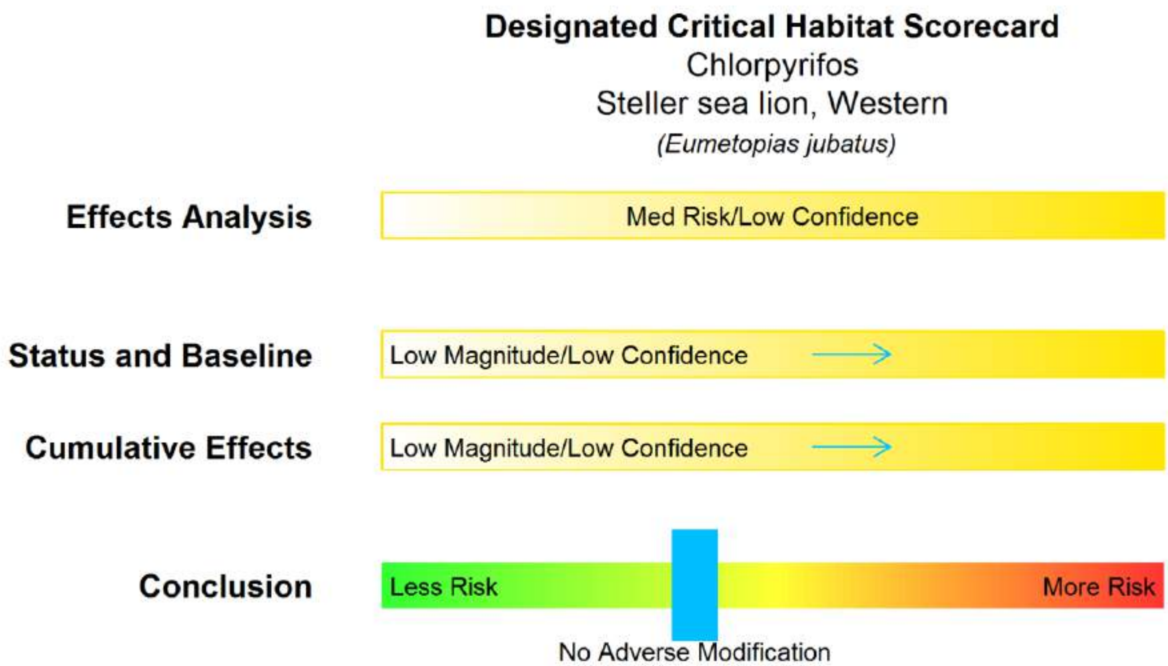

Figure 50. Designated Critical Habitat Scorecard; Steller sea lion, Western; Chlorpyrifos

Effects Analysis: Medium risk/Low confidence

- We do not anticipate reductions in prey in marine and nearshore habitats to reduce the overall conservation value of designated critical habitat.
- We find low confidence of medium risk due to exposures predicted.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Point and non-point contaminants/pollution.
- Habitat degradation.
- Oil and gas exploration.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions brought about by climate change may threaten PBFs.
- Increased coastal construction/activities may threaten PBFs.

Conclusion: The stressors of the action may negatively affect a relevant physical and biological feature within nearshore designated critical habitat of Steller Sea Lion (Western DPS). However, we have low confidence in the EECs predicted for the marine nearshore habitats. The likelihood and magnitude of toxic effects are not likely to reduce the overall conservation value of designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.

Chlorpyrifos is not likely to adversely modify designated critical habitat: No Adverse Modification

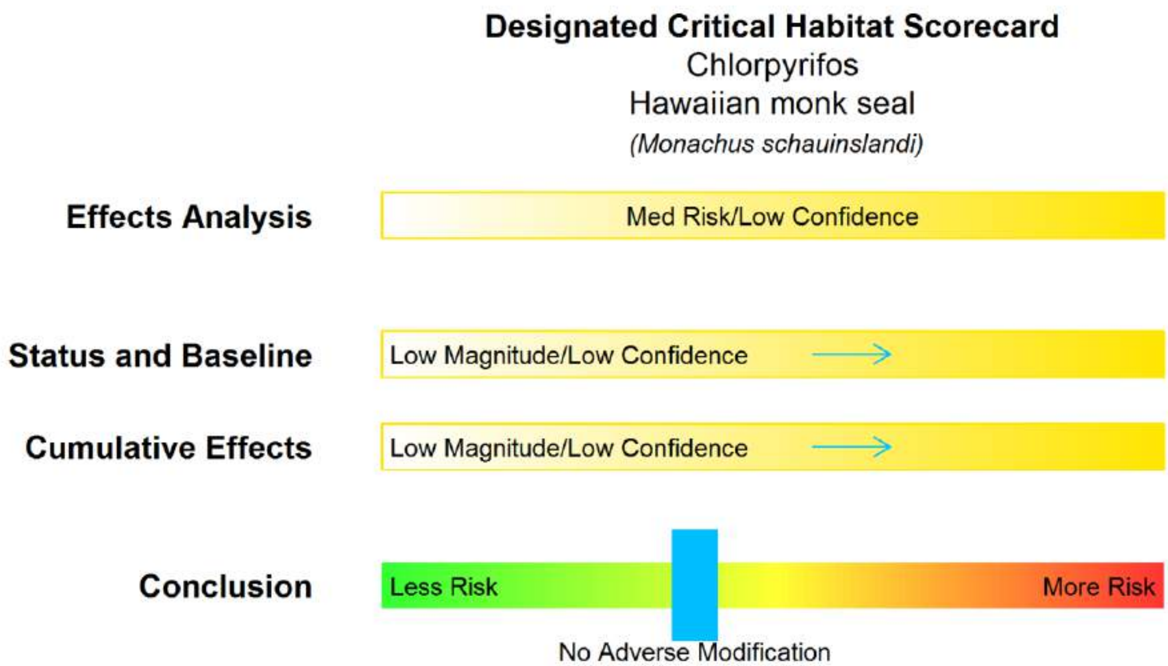

Figure 51. Designated Critical Habitat Scorecard; Hawaiian monk seal; Chlorpyrifos

Effects Analysis: Medium risk/Low confidence

- We do not anticipate reductions in prey in marine and nearshore habitats to reduce the overall conservation value of designated critical habitat.
- We find low confidence of medium risk due to exposures predicted.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Limitations in food.
- Marine debris (entanglement).
- Habitat degradation.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions brought about by climate change may threaten PBFs.
- Increased coastal construction/activities may threaten PBFs.

Conclusion: The stressors of the action may negatively affect a relevant physical and biological feature within nearshore designated critical habitat of Hawaiian Monk Seal. However, we have low confidence in the EECs predicted for the marine nearshore habitats. The likelihood and magnitude of toxic effects are not likely to reduce the overall conservation value of the marine portion of their designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.

Chlorpyrifos is not likely to adversely modify designated critical habitat: No Adverse Modification

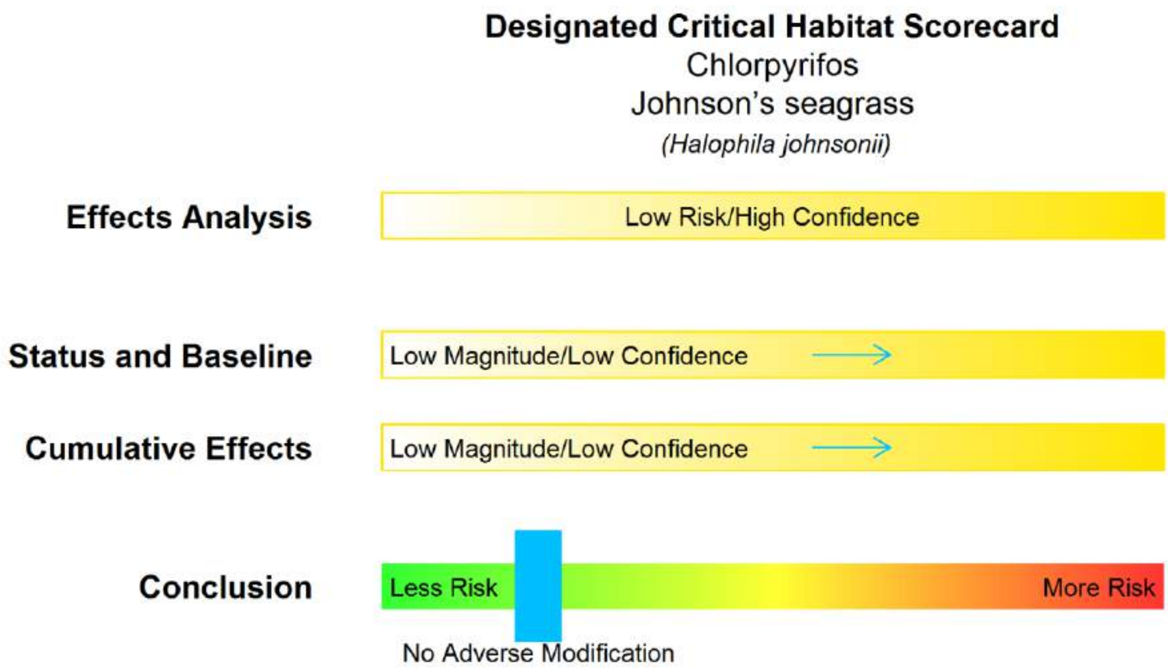

Figure 52. Designated Critical Habitat Scorecard; Johnson's seagrass; Chlorpyrifos

<u>Effects Analysis: Low risk/High confidence</u>

- We do not anticipate reductions in PBFs or reductions in the overall conservation value of designated critical habitat.
- We find high confidence of low risk due to exposures predicted and PBFs identified.

<u>Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence</u>

- Degraded water quality.
- Habitat destruction
- Siltation due to land-use practices.
- Algal overgrowth (nutrification).

<u>Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence</u>

- Changes in ocean conditions brought about by climate change may threaten PBFs.

<u>Conclusion:</u> Water quality is a physical and biological features identified in Johnson's seagrass designated critical habitat. However, we do not anticipate exposures from the stressors of the action to be sufficient to reduce conservation values of this PBF. We find that the overall risk is low and the confidence associated with that risk is high over the 15-year duration of the action.

Chlorpyrifos is not likely to adversely modify designated critical habitat: No Adverse Modification

CHAPTER 23

INTEGRATION AND SYNTHESIS FOR DESIGNATED CRITICAL HABITAT

DIAZINON

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23 Diazinon

23.1 Introduction

The integration and synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action to the environmental baseline and the cumulative effects to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of an Endangered Species Act (ESA)-listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated critical habitat for the conservation of an ESA-listed species. These assessments are made in full consideration of the status of the species.

We treat the information from the status of the species, environmental baseline, and cumulative effects, as "risk modifiers," in that the effects described in the effects analysis section may be modified by the condition of the species; the condition of environmental baseline, and the anticipated cumulative effects. The key questions addressed include:

- Status of Designated Critical Habitat:
    - Are the PBFs impaired or degraded?
- Environmental Baseline:
    - Are freshwater temperatures elevated?
    - Are pesticide environmental mixtures present, or anticipated based on current land use?
- Cumulative Effects:
    - Will future temperatures impair species aquatic habitats?
    - Will future hydrologic flows impair freshwater species habitats?
    - How might changes in ocean conditions affect the species habitat?

As detailed in the Environmental Baseline and Cumulative Effects chapters, adverse toxic responses to exposures to these OP pesticides are heightened with increases in temperature. In addition, exposures to other pesticides in the environment can cause additive or synergistic responses when simultaneously exposed to any of these OPs. Altered hydraulic flows can cause migratory blockages. Lower hydraulic flows can also result in increases in water temperatures and reductions in dissolved oxygen levels. These conditions can put stress on aquatic species and increases toxic responses when exposed to these pesticides.

Once each of the above sections is evaluated i.e., questions answered, the effects of the action and the risk modifiers are depicted graphically on a "scorecard." First, we assign a magnitude of influence (small or large) indicated graphically with one of two lengths of arrows. The shorter of the two arrows indicates a low magnitude, while the longer of the two arrows indicates a high magnitude as a risk modifier. The direction an arrow is pointed indicates the directionality of the risk modifier. For example, an environmental baseline arrow pointing towards more risk may indicate that environmental mixtures and elevated temperatures occur in the Environmental Baseline, which further stresses the species in question. We also assign a level of confidence in our selection of the small and large magnitude, indicated by a bold arrow (high confidence) or an un-bolded arrow (low confidence). The final arrow representing the influence on risk is graphically depicted on each of the designated critical habitat scorecards.

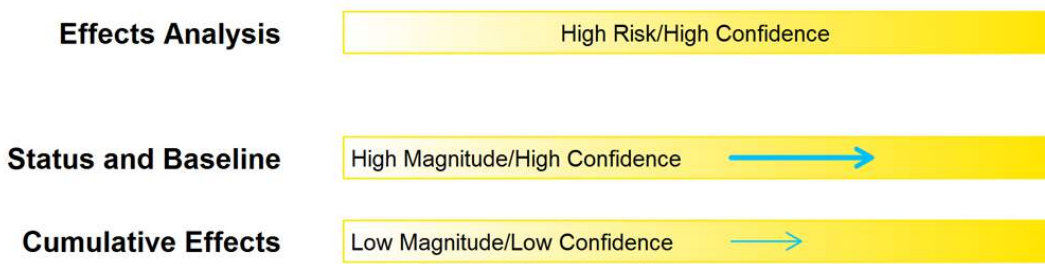

Figure 1. Example of arrows to represent direction, magnitude, and confidence of risk modifiers

Conclusion Section:
We combine the effects analysis conducted in chapters 15 – 17 with the baseline status of the species habitat, and cumulative effects to determine whether the action could reasonably be expected to appreciably diminish the conservation value of designated critical habitat. We state our conclusion as to whether the action is likely to destroy or adversely modify each of the species designated critical habitats.

A scorecard is generated for each species designated critical habitat. The effects of the proposed action is considered based on magnitude and confidence of the three arrows. Next, an adverse modification or no adverse modification vertical blue bar is placed on the horizontal risk bar i.e., the colored bar beginning with green (less risk) to red (more risk) (***Figure 2***) to depict our conclusion.

Figure 2: Example conclusion graphic

23.2 Designated Critical Habitat Scorecards (Diazinon)

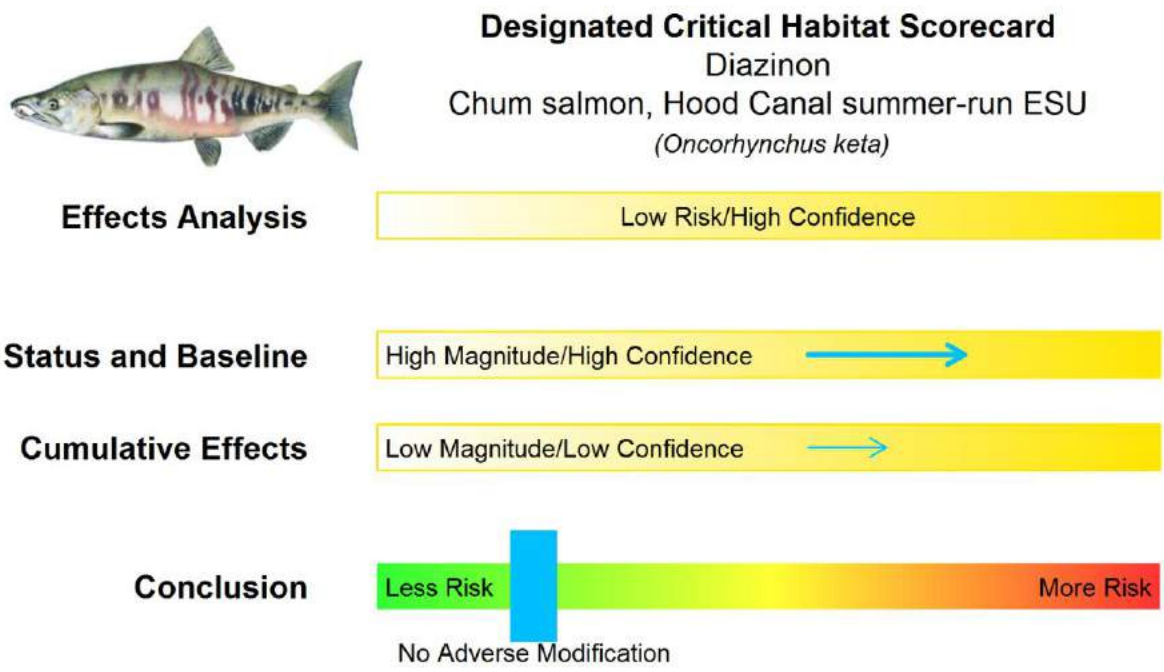

Figure 3. Designated Critical Habitat Scorecard; Chum salmon, Hood Canal summer-run Evolutionarily Significant Unit (ESU); Diazinon

Effects Analysis: Low risk/High confidence

- Reductions in prey and degradation of water quality are not likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature may increase adverse effects
- We find high confidence of low risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning and rearing PBFs are degraded
- Migration and rearing PBFs are impaired by loss of floodplain habitat necessary for juvenile growth and development
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- All 12 watersheds of high or medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a low risk to this species' designated critical habitat due to minimal overlap with diazinon use sites. Reductions in prey and degradation of water quality are not anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

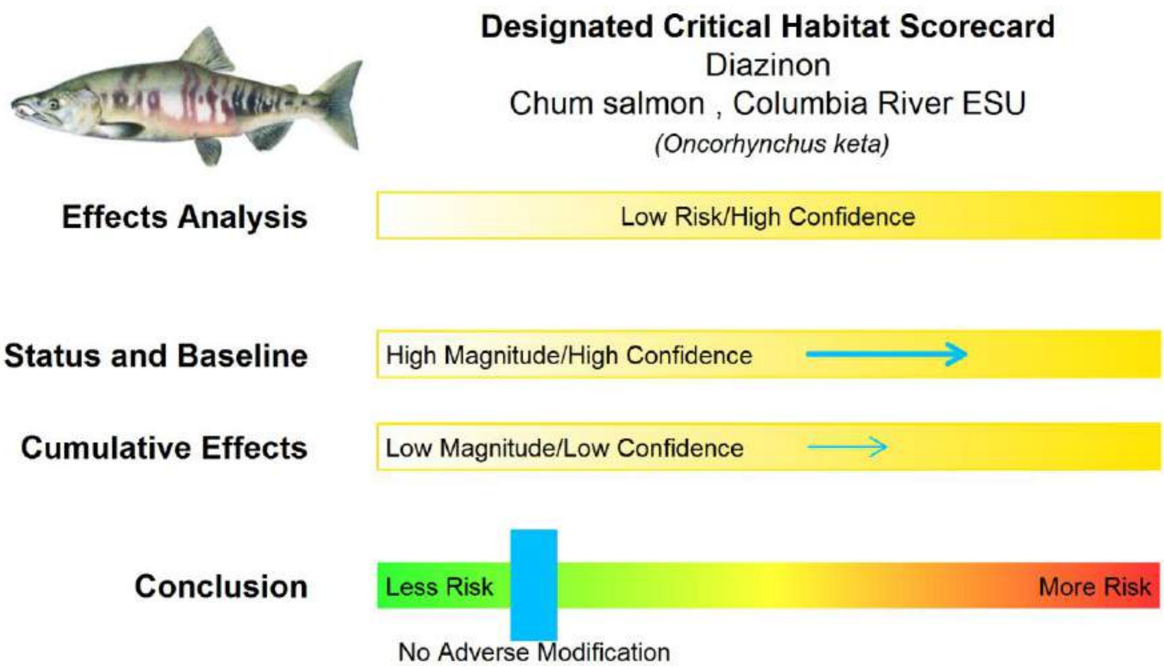

Figure 4. Designated Critical Habitat Scorecard; Chum salmon, Columbia River ESU; Diazinon

<u>Effects Analysis: Low risk/High confidence</u>

- Reductions in prey and degradation of water quality are not likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature may increase adverse effects
- We find high confidence of low risk due to expected exposures in freshwater habitats

<u>Status and Baseline: Increased risk; High magnitude/High confidence</u>

- Rearing PBFs (water quality and cover) are degraded
- Migration PBFs significantly impacted by dams
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- All 19 watersheds of high or medium conservation value

<u>Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence</u>

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

<u>Conclusion:</u> We find high confidence of a low risk to this species' designated critical habitat due to minimal overlap with diazinon use sites. Reductions in prey and degradation of water quality are not anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

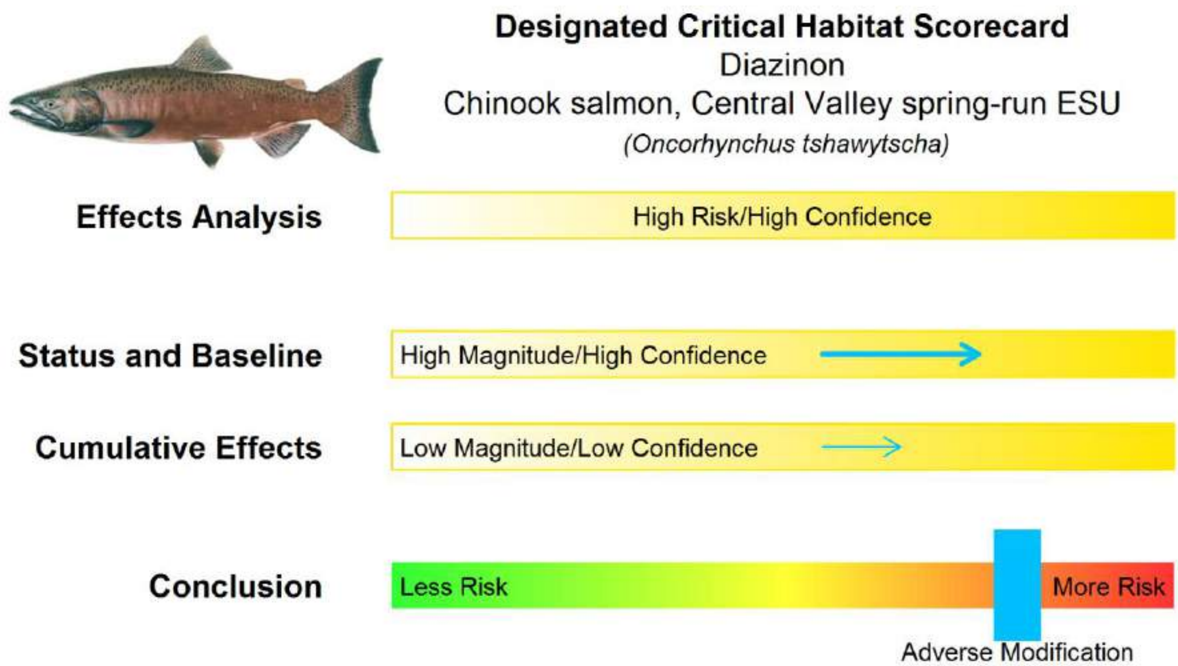

Figure 5. Designated Critical Habitat Scorecard; Chinook salmon, Central Valley spring-run ESU; Diazinon

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning and rearing PBFs are degraded by elevated temperatures, lost access to historic spawning sites, and loss of floodplain habitat
- Migration PBFs degraded by loss of cover and water diversions
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 38 watersheds, 28 are of high and 3 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Three use site categories, totaling more than 332,480 acres (over 10% of critical habitat) currently overlap. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Diazinon is likely to adversely modify designated critical habitat: Adverse Modification

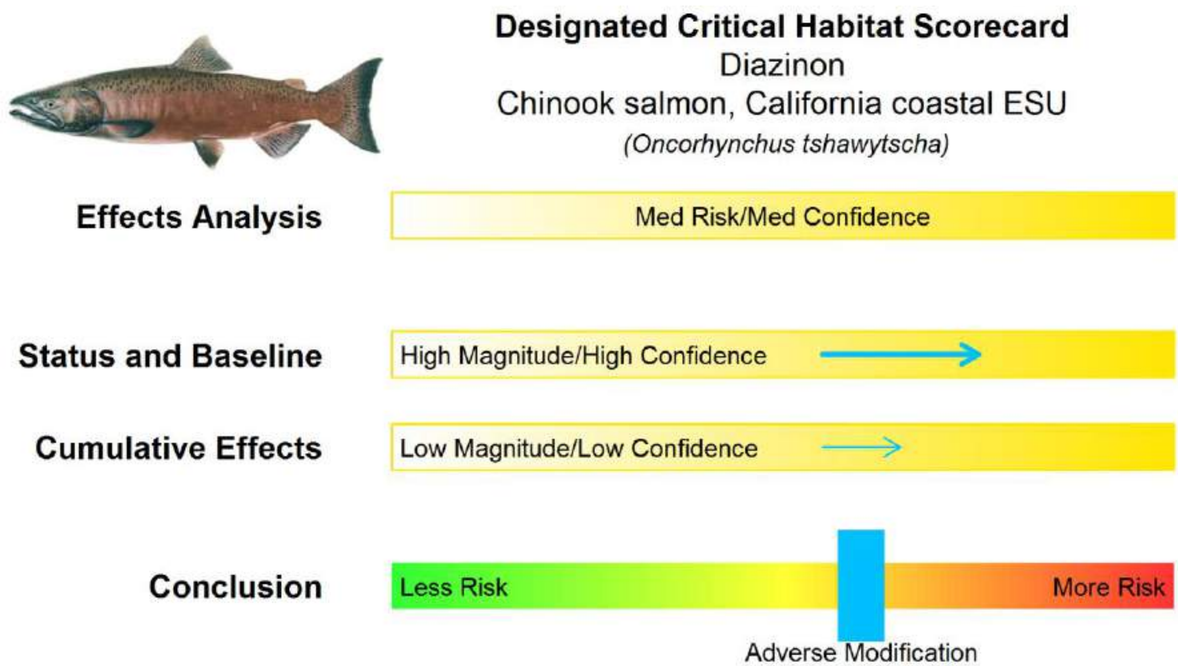

Figure 6. Designated Critical Habitat Scorecard; Chinook salmon, California coastal ESU; Diazinon

Effects Analysis: Medium risk/Medium confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find medium confidence of medium risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning PBFs are degraded by timber harvest
- Rearing and migration PBFs impacted by dams and invasive species.
- Estuarine PBFs degraded by water quality and saltwater mixing
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 45 watersheds, 27 are of high and 10 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find medium confidence of a medium risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Three use site categories, totaling more than 46,855 acres (over 1% of critical habitat) currently overlap. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Diazinon is likely to adversely modify designated critical habitat: Adverse Modification

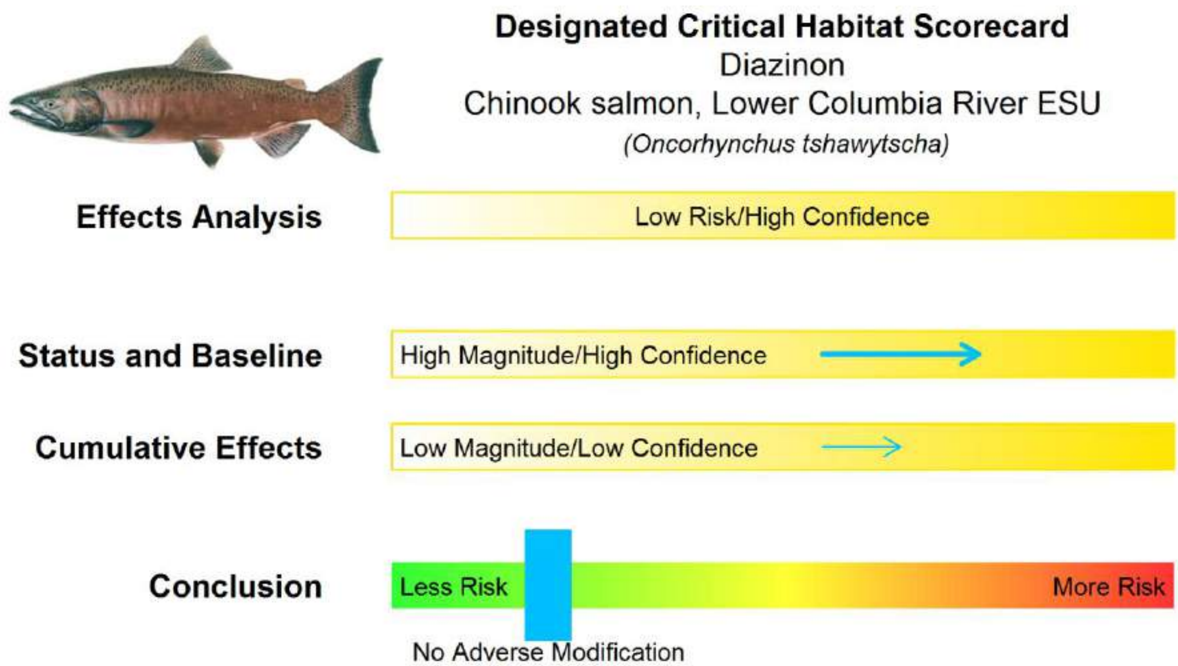

Figure 7. Designated Critical Habitat Scorecard; Chinook salmon, Lower Columbia River ESU; Diazinon

Effects Analysis: Low risk/High confidence

- Reductions in prey and degradation of water quality are not likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature may increase adverse effects
- We find high confidence of low risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning and rearing PBFs are degraded by timber harvest, agriculture, urbanization, loss of floodplain habitat, and reduced natural cover
- Migration PBFs impacted by dams
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of occupied watersheds, 31 are of high and 13 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a low risk to this species' designated critical habitat due to minimal overlap with diazinon use sites. Reductions in prey and degradation of water quality are not anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

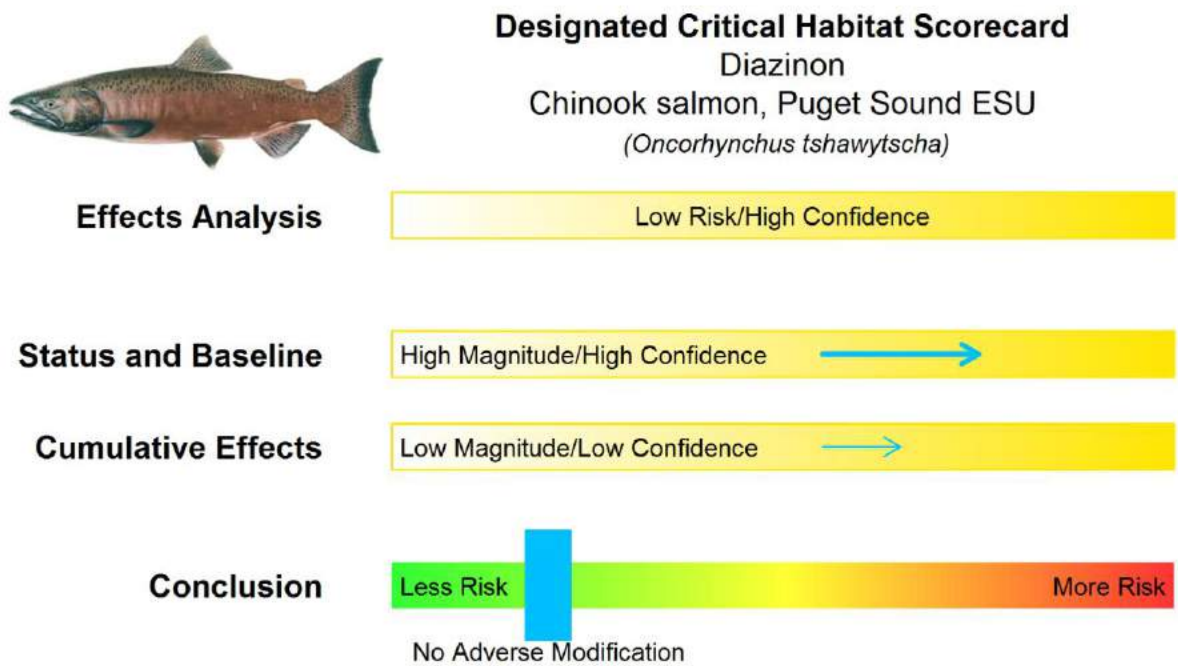

Figure 8. Designated Critical Habitat Scorecard; Chinook salmon, Puget Sound ESU; Diazinon

Effects Analysis: Low risk/High confidence

- Reductions in prey and degradation of water quality are not likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature may increase adverse effects
- We find high confidence of low risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning, rearing and migration PBFs are degraded by forestry, agriculture, urbanization, and loss of habitat
- Estuarine PBFs degraded by water quality, altered salinity, and lack of natural cover
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 61 watersheds, 40 are of high and 9 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a low risk to this species' designated critical habitat due to minimal overlap with diazinon use sites. Reductions in prey and degradation of water quality are not anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

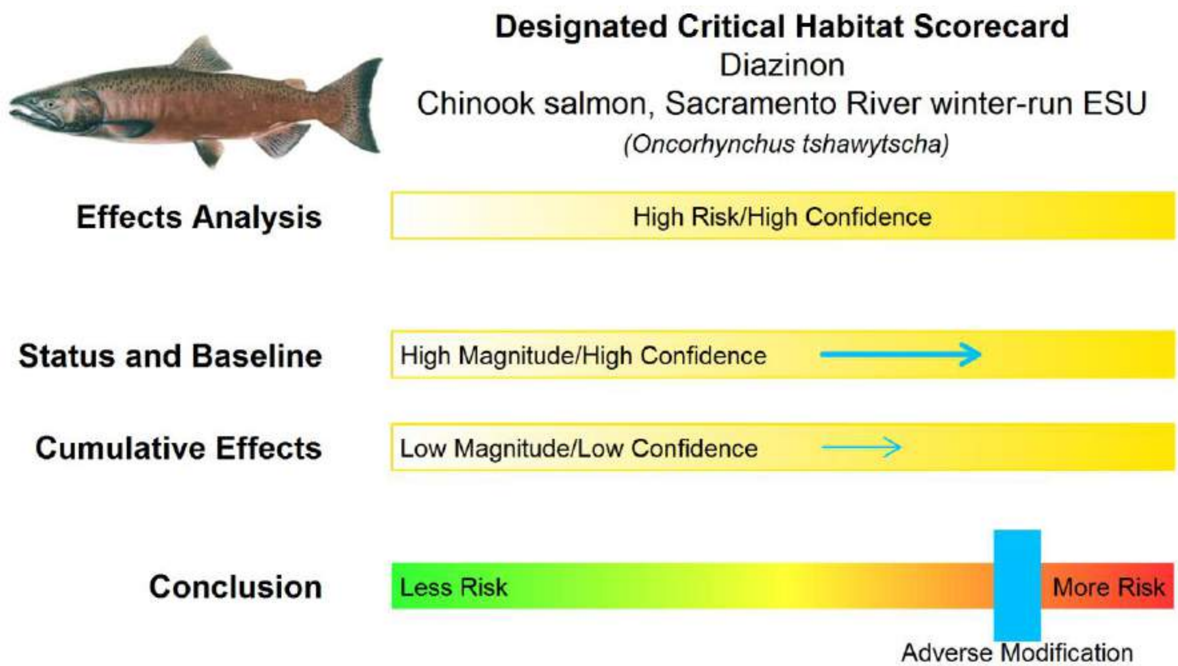

Figure 9. Designated Critical Habitat Scorecard; Chinook salmon, Sacramento River winter-run ESU; Diazinon

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning and rearing PBFs are degraded by elevated temperatures and loss of habitat
- Migration PBFs degraded by lack of natural cover and water diversions
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- The entire Sacramento river and delta are considered of high conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Three use site categories, totaling more than 106,617 acres (over 8% of critical habitat) currently overlap. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Diazinon is likely to adversely modify designated critical habitat: Adverse Modification

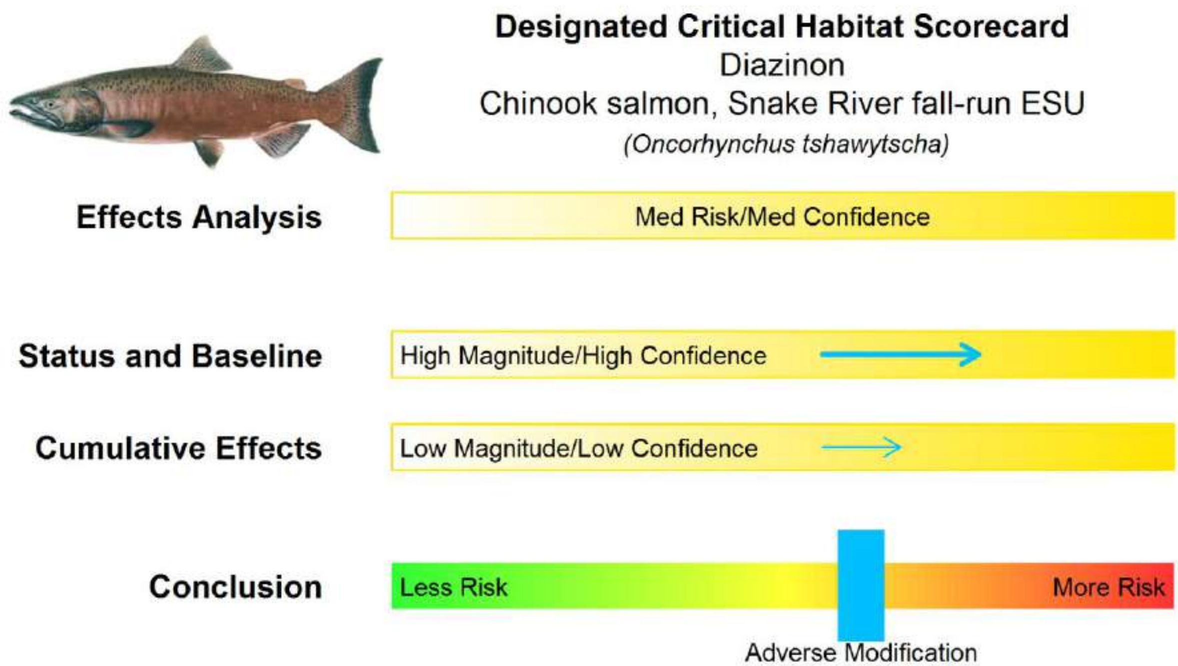

Figure 10. Designated Critical Habitat Scorecard; Chinook salmon, Snake River fall-run ESU; Diazinon

Effects Analysis: Medium risk/Medium confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find medium confidence of medium risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning, rearing and migration PBFs are degraded by loss of habitat, impaired stream flows, barriers to fish passage, and poor water quality
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- The entire river corridor is considered of high conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find medium confidence of a medium risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Three use site categories, totaling more than 251,769 acres (over 4% of critical habitat) currently overlap. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Diazinon is likely to adversely modify designated critical habitat: Adverse Modification

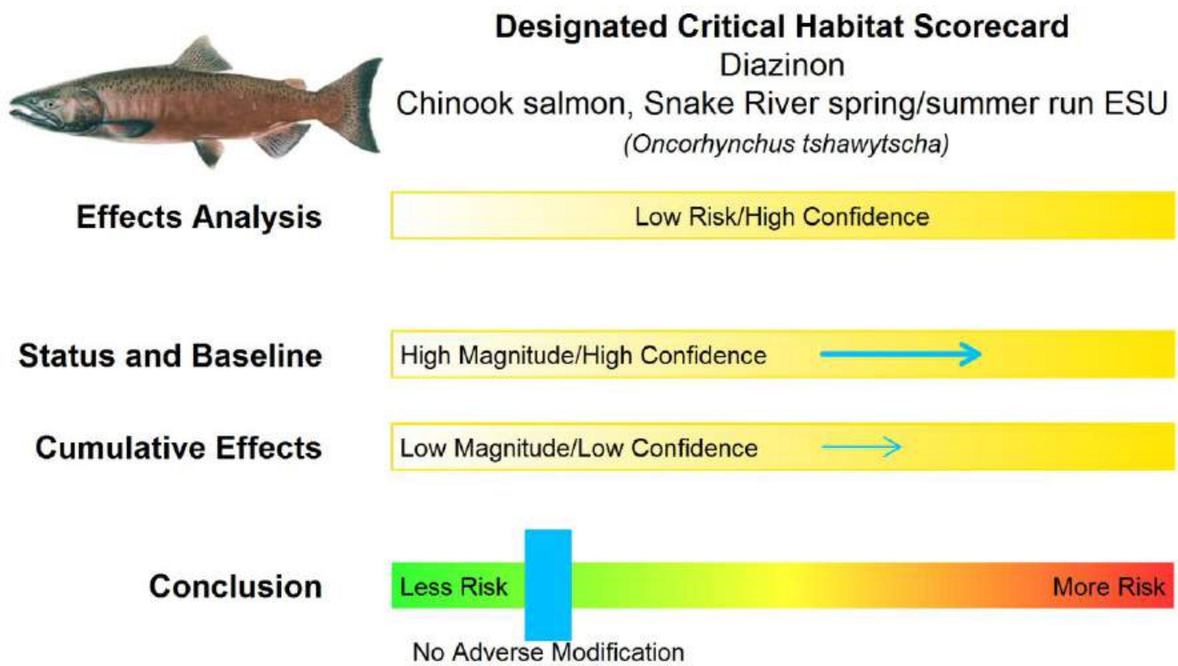

Figure 11. Designated Critical Habitat Scorecard; Chinook salmon, Snake River spring/summer run ESU; Diazinon

Effects Analysis: Low risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of low risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning, rearing and migration PBFs are degraded by loss of habitat, altered stream flows, barriers to fish passage, dams, loss of cover, and poor water quality
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- The entire river corridor is considered of high conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a low risk to this species' designated critical habitat due to minimal overlap with diazinon use sites. Reductions in prey and degradation of water quality are not anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

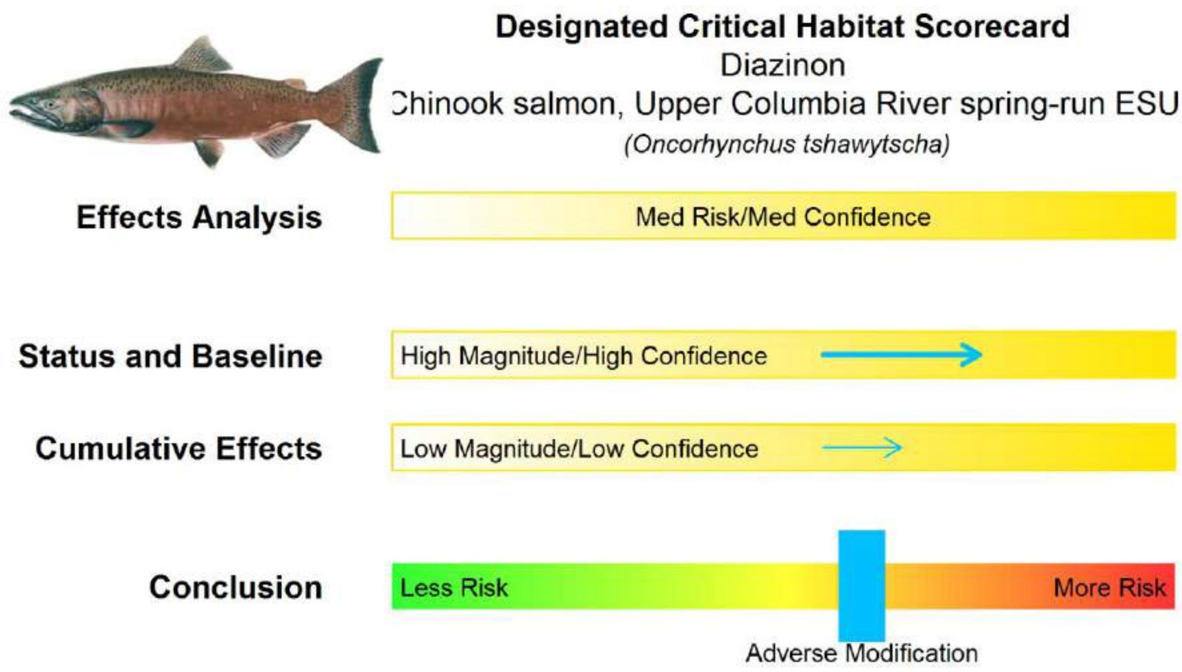

Figure 12. Designated Critical Habitat Scorecard; Chinook salmon, Upper Columbia River spring-run ESU; Diazinon

Effects Analysis: Medium risk/Medium confidence
- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find medium confidence of medium risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence
- Spawning and rearing PBFs are degraded by urbanization and irrigation water diversions
- Migration PBFs degraded by numerous dams
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of occupied watersheds, 26 are of high and 5 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence
- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find medium confidence of a medium risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Three use site categories, totaling more than 135,640 acres (over 4% of critical habitat) currently overlap. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Diazinon is likely to adversely modify designated critical habitat: Adverse Modification

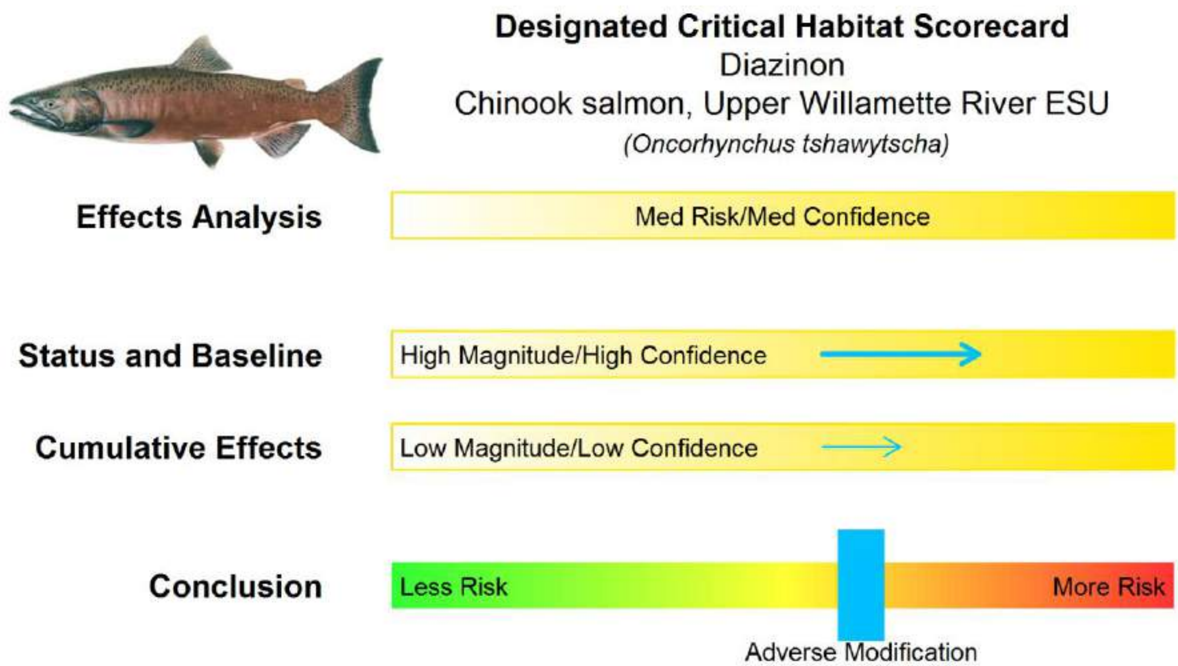

Figure 13. Designated Critical Habitat Scorecard; Chinook salmon, Upper Willamette River ESU; Diazinon

Effects Analysis: Medium risk/Medium confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find medium confidence of medium risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Migration, rearing, and estuary PBFs are degraded by dams, water management, loss of riparian vegetation, and quality of floodplain habitat
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 59 assessed watersheds, 22 are of high and 18 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find medium confidence of a medium risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Three use site categories, totaling more than 56,510 acres (over 1% of critical habitat) currently overlap. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Diazinon is likely to adversely modify designated critical habitat: Adverse Modification

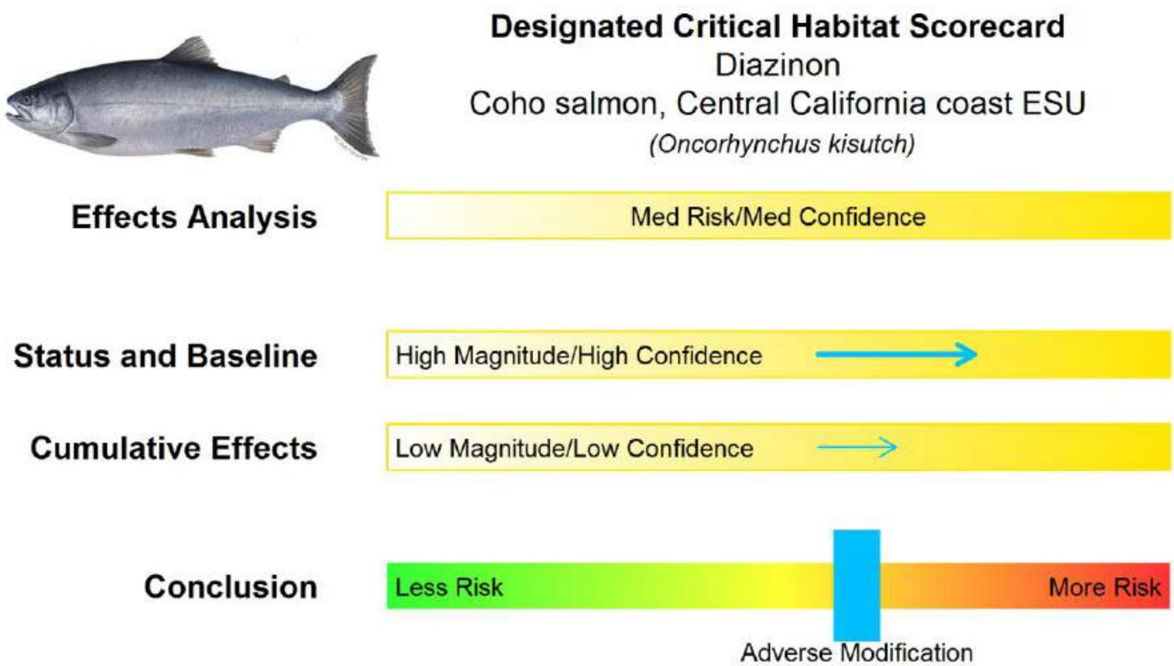

Figure 14. Designated Critical Habitat Scorecard; Coho salmon, Central California coast ESU; Diazinon

<u>Effects Analysis: Medium risk/Medium confidence</u>

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find medium confidence of medium risk due to expected exposures in freshwater habitats

<u>Status and Baseline: Increased risk; High magnitude/High confidence</u>

- Degradation in quality and quantity of PBFs, especially in southern end of range
- Rearing PBFs degraded by loss of suitable incubation substrate and loss of habitat
- Elevated temperatures anticipated in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats may impact PBFs

<u>Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence</u>

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

<u>Conclusion:</u> We find medium confidence of a medium risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Three use site categories, totaling more than 100,726 acres (more than 3% of critical habitat) currently overlap. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Diazinon is likely to adversely modify designated critical habitat: Adverse Modification

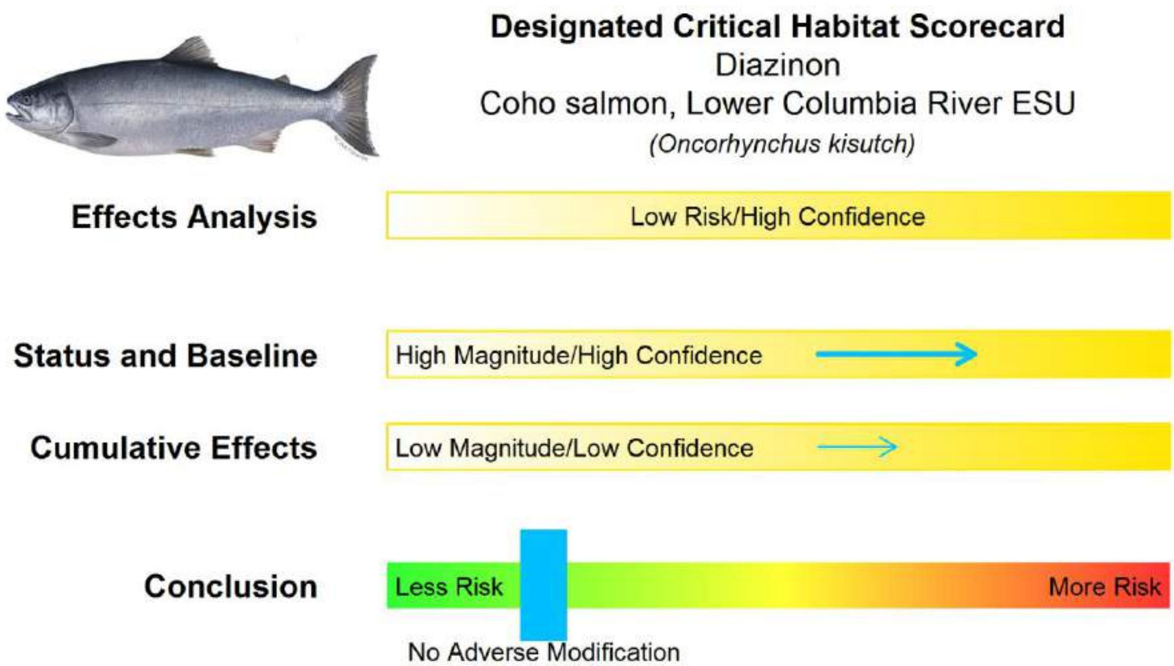

Figure 15. Designated Critical Habitat Scorecard; Coho salmon, Lower Columbia River ESU; Diazinon

Effects Analysis: Low risk/High confidence

- Reductions in prey and degradation of water quality are not likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature may increase adverse effects
- We find high confidence of low risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning and rearing PBFs are degraded by timber harvest, agriculture, urbanization, loss of floodplain habitat, and reduced natural cover
- Migration PBFs impacted by dams
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a low risk to this species' designated critical habitat due to minimal overlap with diazinon use sites. Reductions in prey and degradation of water quality are not anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

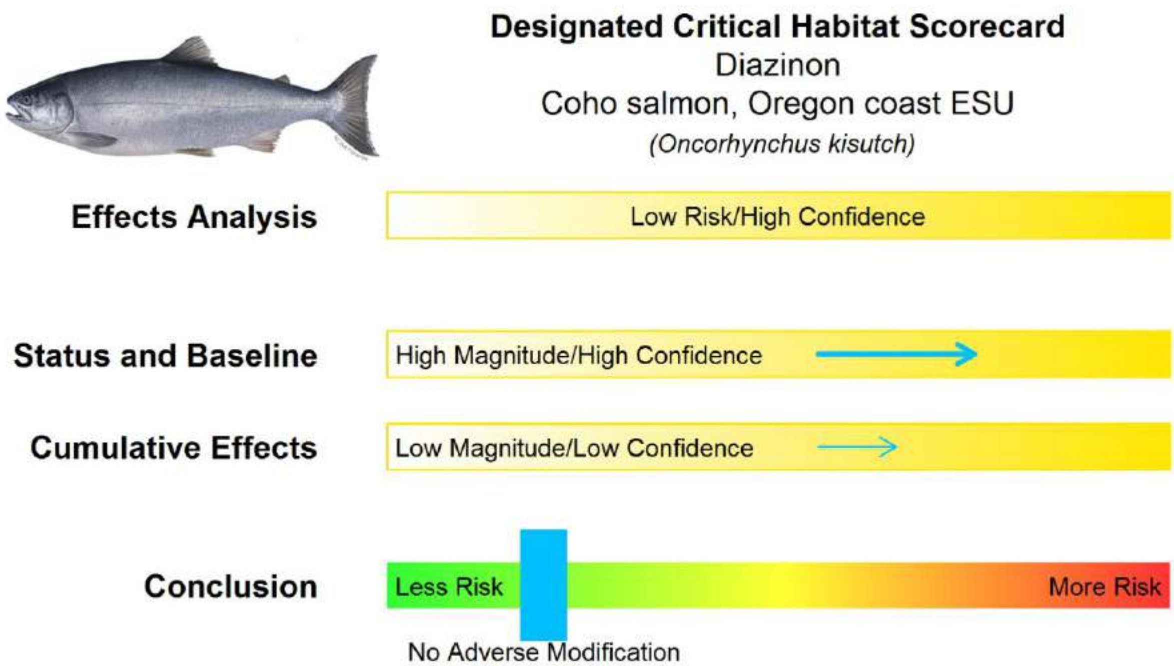

Figure 16. Designated Critical Habitat Scorecard; Coho salmon, Oregon coast ESU; Diazinon

Effects Analysis: Low risk/High confidence

- Reductions in prey and degradation of water quality are not likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature may increase adverse effects
- We find high confidence of low risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Rearing PBFs are degraded by elevated water temperature
- All PBFs degraded by reduced water quality from contaminants and excess nutrients
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 80 assessed watersheds, 45 are of high and 27 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a low risk to this species' designated critical habitat due to minimal overlap with diazinon use sites. Reductions in prey and degradation of water quality are not anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

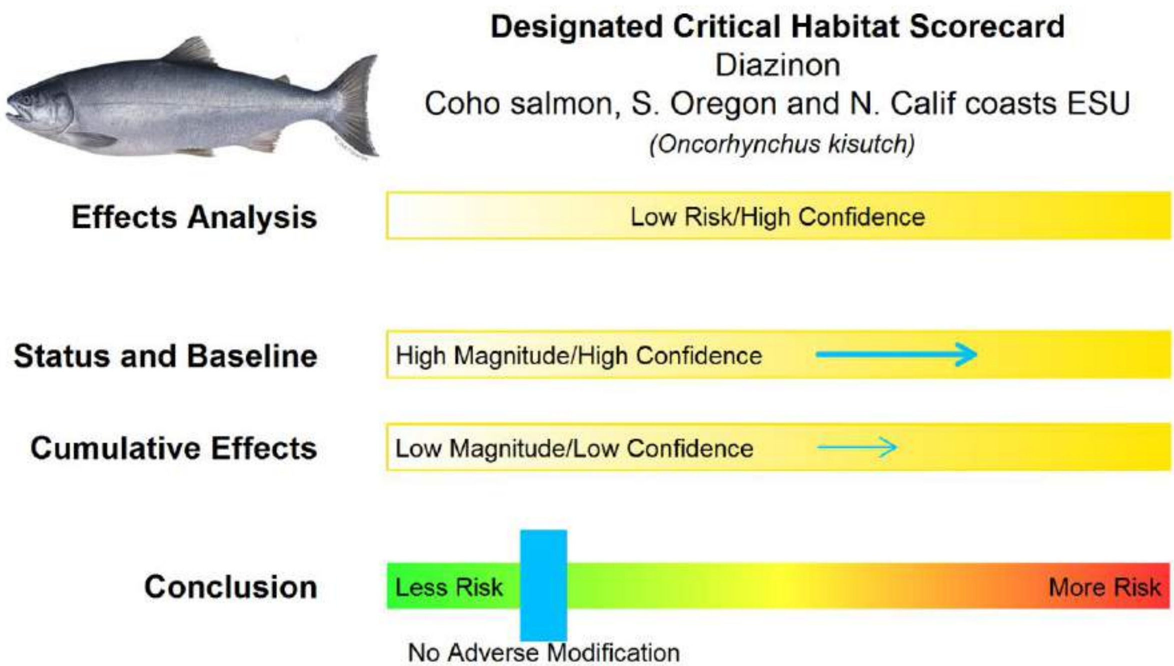

Figure 17. Designated Critical Habitat Scorecard; Coho salmon, S. Oregon and N. Calif coasts ESU; Diazinon

Effects Analysis: Low risk/High confidence

- Reductions in prey and degradation of water quality are not likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature may increase adverse effects
- We find high confidence of low risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning PBFs are degraded by logging
- Rearing and migration PBFs degraded by loss of riparian vegetation and loss of floodplain habitat
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a low risk to this species' designated critical habitat due to minimal overlap with diazinon use sites. Reductions in prey and degradation of water quality are not anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

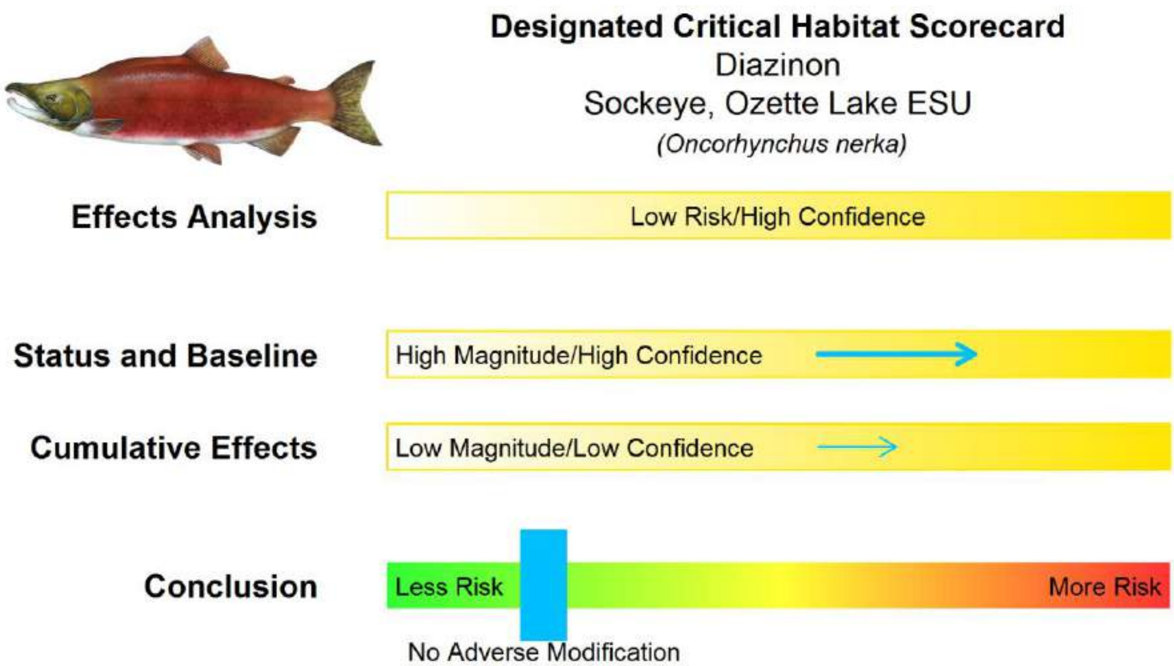

Figure 18. Designated Critical Habitat Scorecard; Sockeye, Ozette Lake ESU; Diazinon

Effects Analysis: Low risk/High confidence

- Reductions in prey and degradation of water quality are not ikely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature may increase adverse effects
- We find high confidence of low risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Rearing PBFs are degraded by excessive predation, invasive species, and loss of habitat
- Spawning and migration PBFs are degraded by low water levels, loss of suitable spawning habitat, and low summer water flows
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- The entire watershed is of high conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a low risk to this species' designated critical habitat due to a lack of overlap with diazinon use sites. Reductions in prey and degradation of water quality are not anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

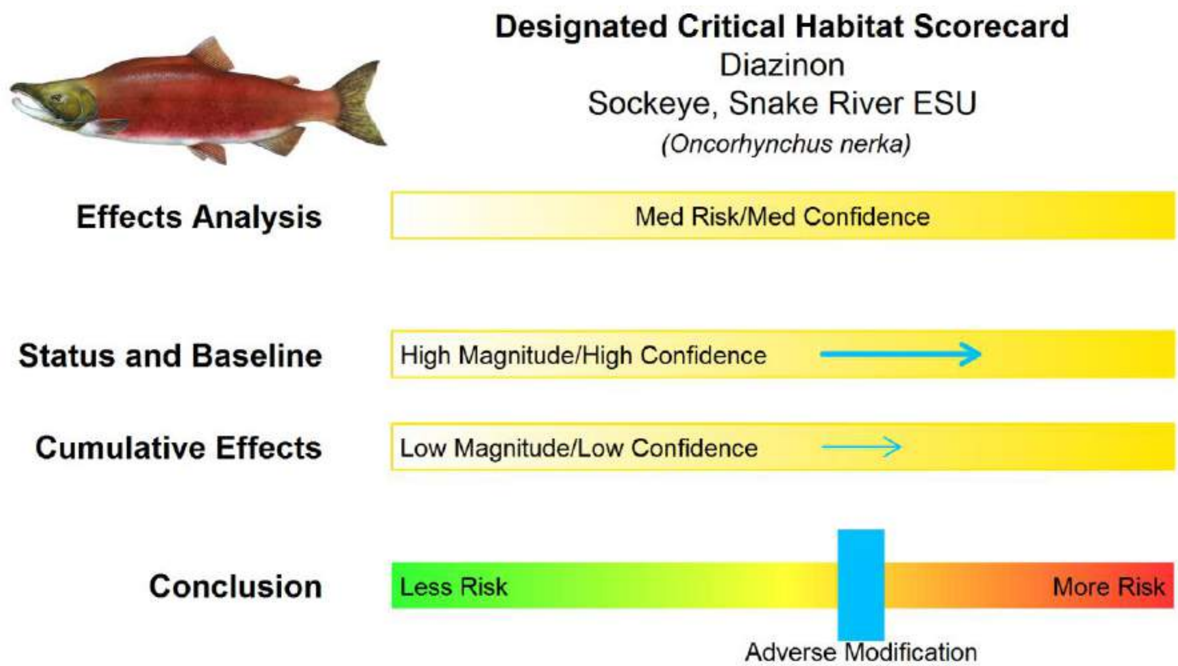

Figure 19. Designated Critical Habitat Scorecard; Sockeye, Snake River ESU; Diazinon

Effects Analysis: Medium risk/Medium confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find medium confidence of medium risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Rearing and migration PBFs are degraded by impaired water quality from adjacent land uses
- Migration PBFs are degraded by multiple dams
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- All occupied and used areas of the watershed are of high conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find medium confidence of a medium risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Three use site categories, totaling more than 58,848 acres (over 1% of critical habitat) currently overlap. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Diazinon is likely to adversely modify designated critical habitat: Adverse Modification

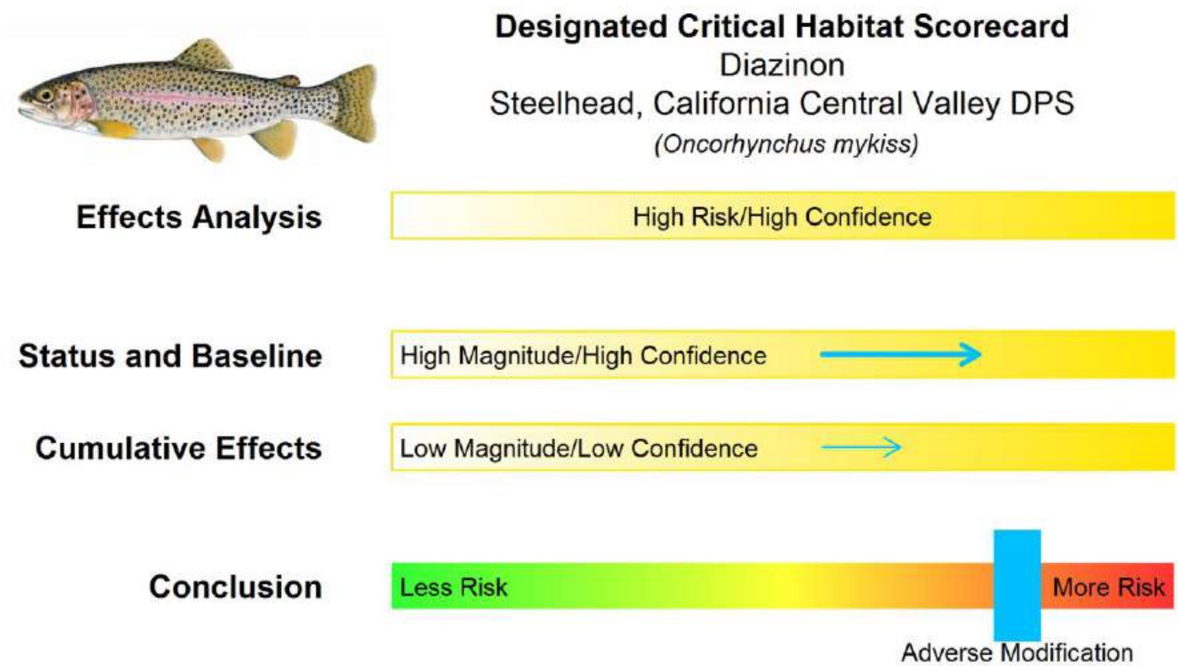

Figure 20. Designated Critical Habitat Scorecard; Steelhead, California Central Valley Distinct Population Segment (DPS); Diazinon

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning Physical and Biological Features (PBFs) are degraded by altered water flows and temperature
- Rearing and migration PBFs are degraded by altered riverine habitat, dense urbanization and agriculture, poor water quality, and water diversions
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 67 occupied watersheds, 37 are of high and 18 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Three use site categories, totaling more than 702,424 acres (over 13% of critical habitat) currently overlap. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Diazinon is likely to adversely modify designated critical habitat: Adverse Modification

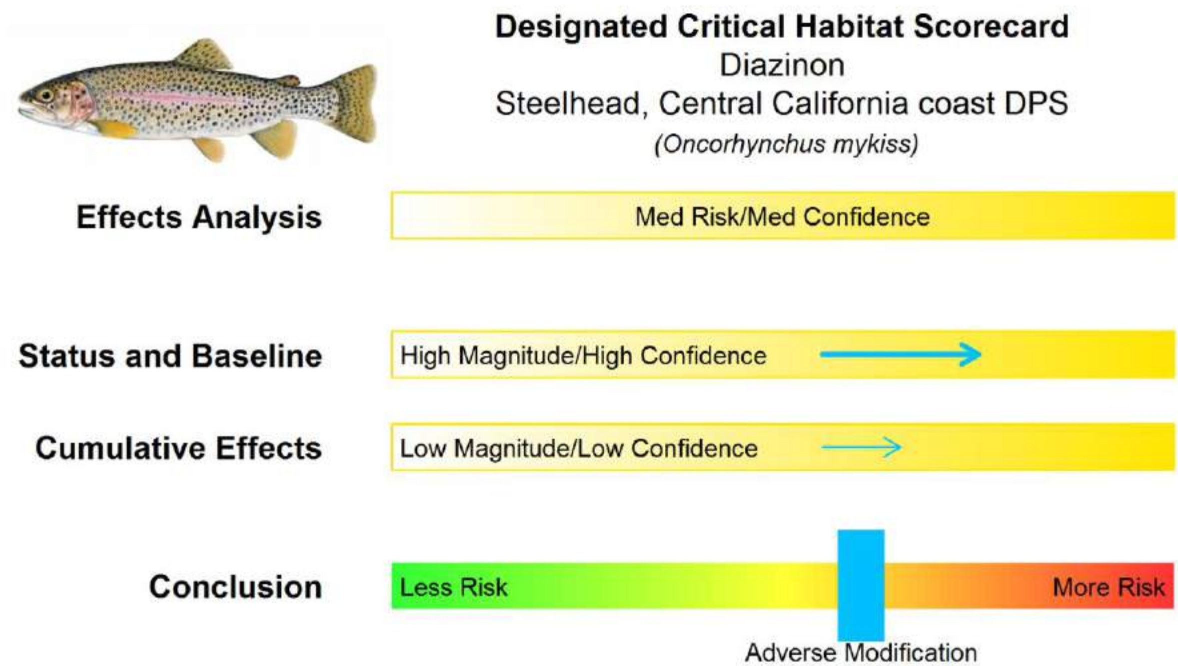

Figure 21. Designated Critical Habitat Scorecard; Steelhead, Central California coast DPS; Diazinon

Effects Analysis: Medium risk/Medium confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find medium confidence of medium risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning and rearing PBFs are degraded by sedimentation and elevated temperature
- All PBFs are degraded by loss of habitat, low summer flows, erosion, and contaminants
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 47 occupied watersheds, 19 are of high and 15 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find medium confidence of a medium risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Three use site categories, totaling more than 95,207 acres (less than 4% of critical habitat) currently overlap. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Diazinon is likely to adversely modify designated critical habitat: Adverse Modification

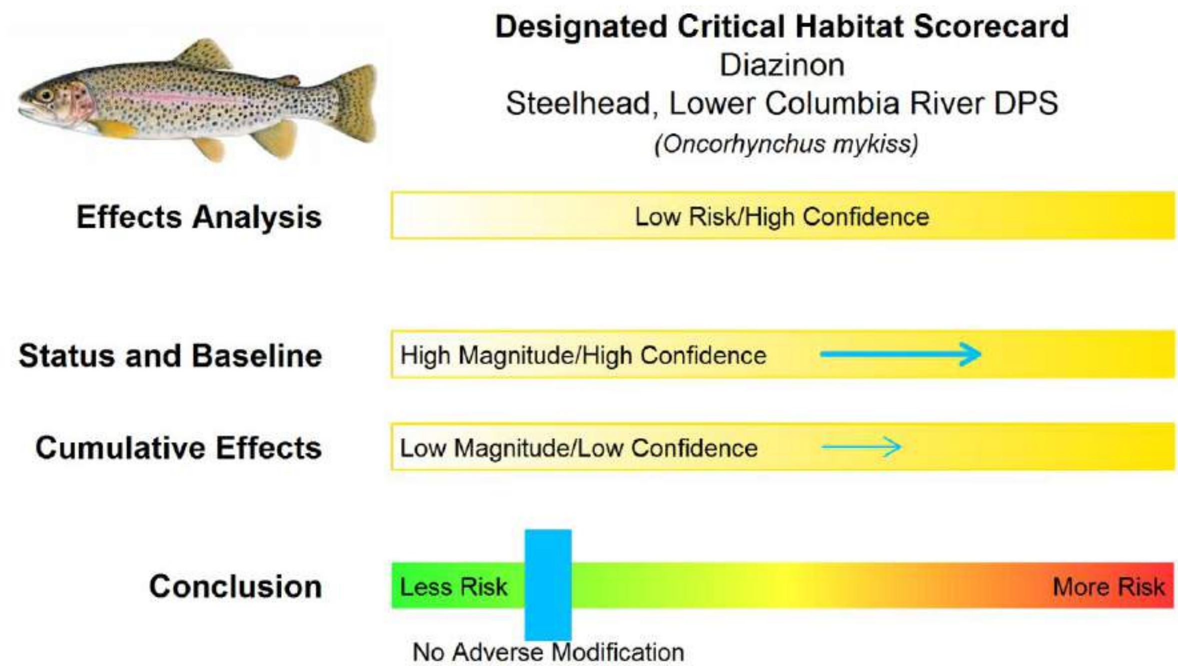

Figure 22. Designated Critical Habitat Scorecard; Steelhead, Lower Columbia River DPS; Diazinon

Effects Analysis: Low risk/High confidence

- Reductions in prey and degradation of water quality are not likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature may increase adverse effects
- We find high confidence of low risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Rearing PBFs are degraded by agricultural runoff and lack of available prey
- Spawning, rearing and migration PBFs are degraded by timber harvests, dams, and loss of floodplain habitat
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 41 occupied watersheds, 28 are of high and 11 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a low risk to this species' designated critical habitat due to minimal overlap with diazinon use sites. Reductions in prey and degradation of water quality are not anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

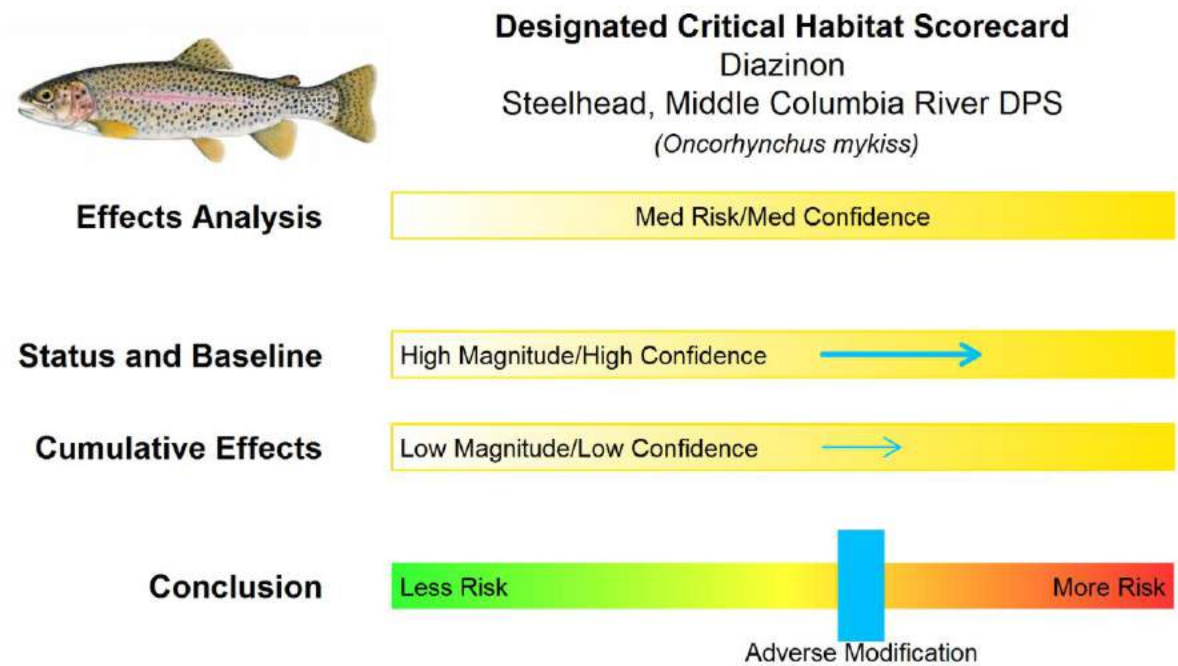

Figure 23. Designated Critical Habitat Scorecard; Steelhead, Middle Columbia River DPS; Diazinon

Effects Analysis: Medium risk/Medium confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find medium confidence of medium risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Rearing PBFs are degraded by water quality, reduced invertebrate prey, and loss of riparian vegetation
- Migration PBFs are degraded by several dams
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 106 assessed watersheds, 73 are of high and 24 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find medium confidence of a medium risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Three use site categories, totaling more than 316,948 acres (more than 3% of critical habitat) currently overlap. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Diazinon is likely to adversely modify designated critical habitat: Adverse Modification

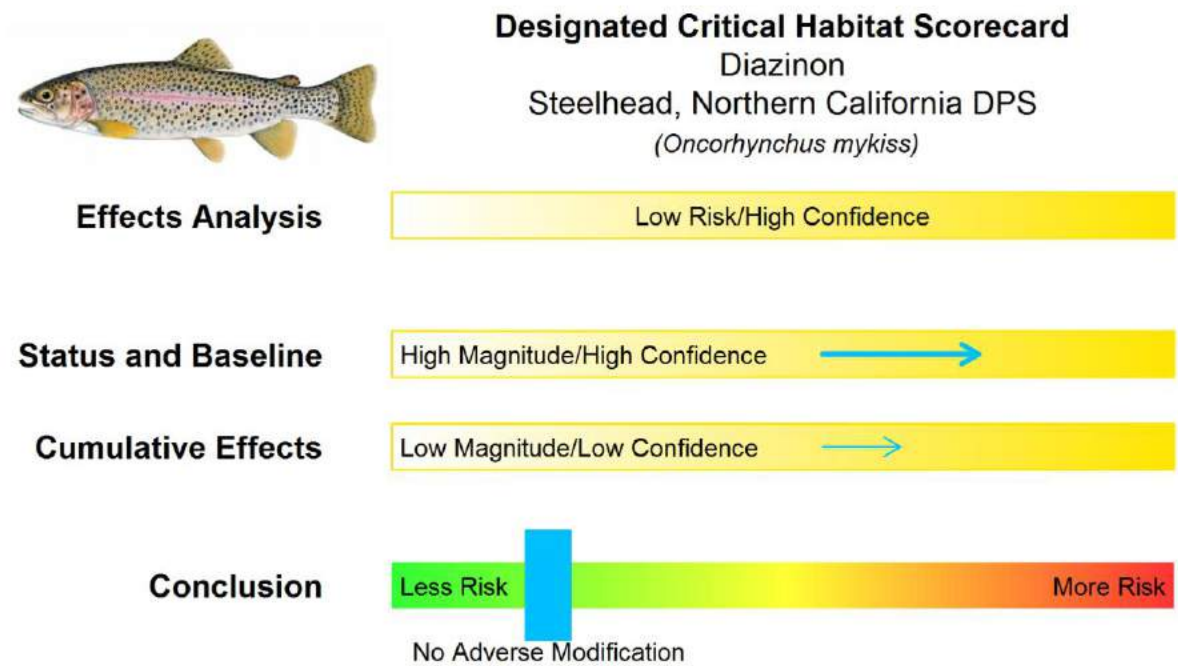

Figure 24. Designated Critical Habitat Scorecard; Steelhead, Northern California DPS; DIazinon

Effects Analysis: Low risk/High confidence

- Reductions in prey and degradation of water quality are not ikely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature may increase adverse effects
- We find high confidence of low risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Rearing PBFs are degraded by loss of riparian vegetation and elevated temperature
- Spawning PBFs are degraded by lack of quality substrate and sedimentation
- Migration PBFs are degraded by bridges, culverts, and forest road construction
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 50 assessed watersheds, 27 are of high and 14 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a low risk to this species' designated critical habitat due to minimal overlap with diazinon use sites. Reductions in prey and degradation of water quality are not anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

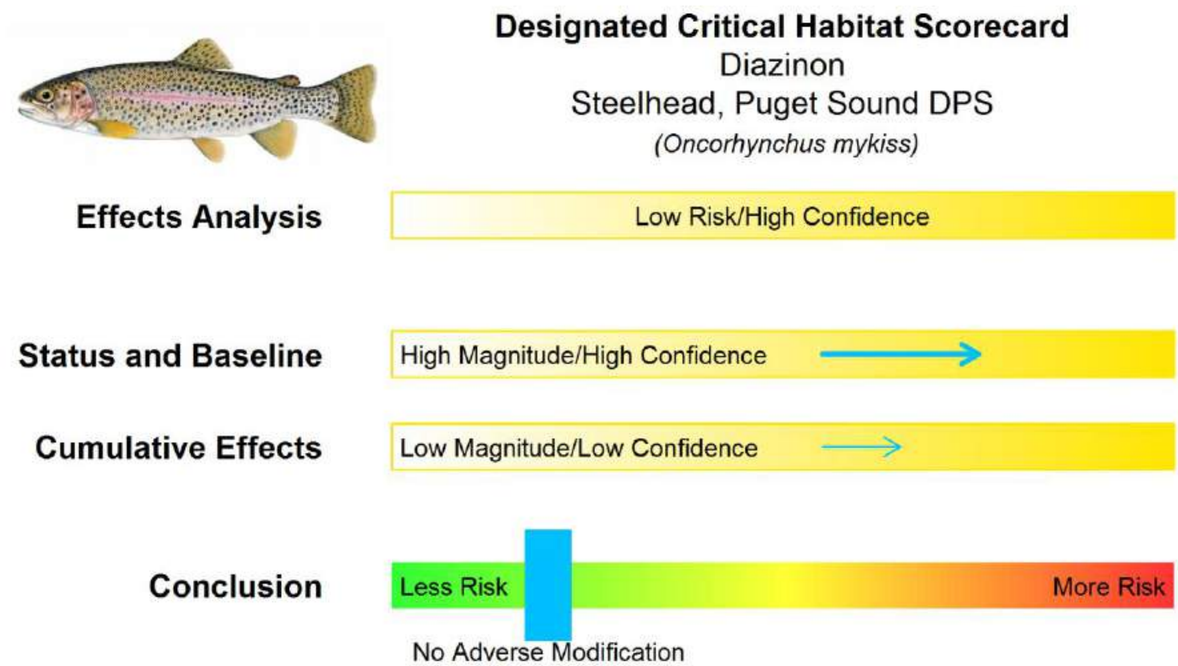

Figure 25. Designated Critical Habitat Scorecard; Steelhead, Puget Sound DPS; Diazinon

Effects Analysis: Low risk/High confidence

- Reductions in prey and degradation of water quality are not likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature may increase adverse effects
- We find high confidence of low risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Rearing, migration and spawning PBFs are degraded by forestry, agriculture, urbanization, loss of floodplain habitat, and poor water quality
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Most watersheds are of high or medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a low risk to this species' designated critical habitat due to minimal overlap with diazinon use sites. Reductions in prey and degradation of water quality are not anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

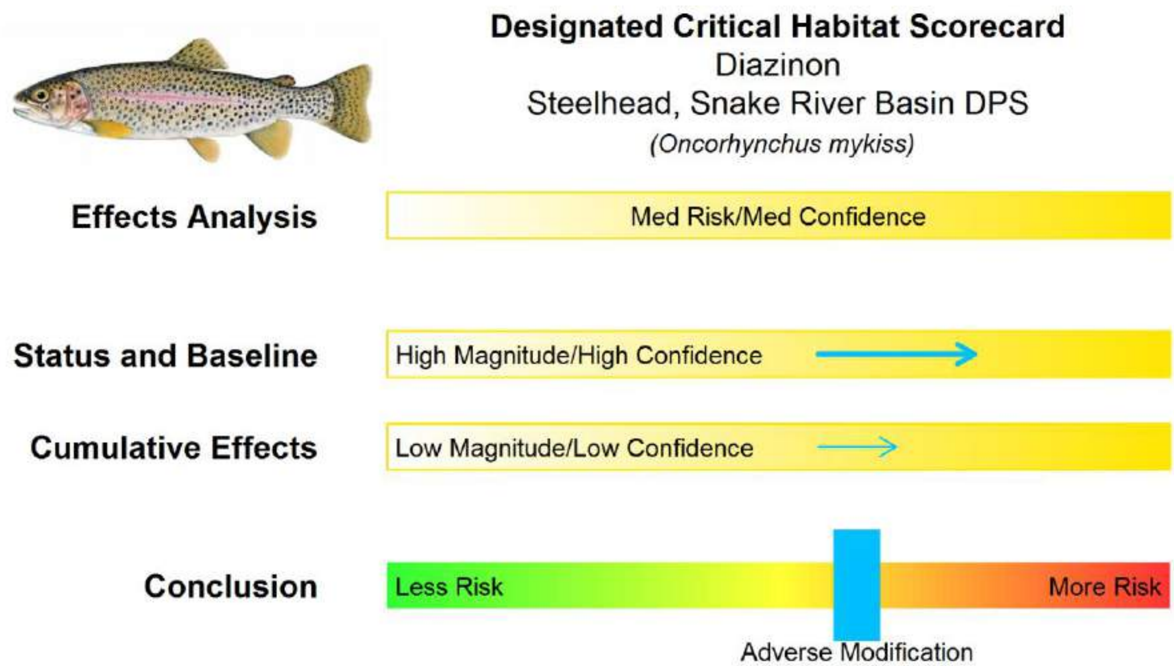

Figure 26. Designated Critical Habitat Scorecard; Steelhead, Snake River Basin DPS; Diazinon

Effects Analysis: Medium risk/Medium confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find medium confidence of medium risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Rearing PBFs are degraded by agricultural runoff, reduced invertebrate prey, loss of riparian vegetation, and elevated temperature
- Migration PBFs are degraded by several dams
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of assessed watersheds, 229 are of high and 41 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find medium confidence of a medium risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Three use site categories, totaling more than 188,229 acres (less than 2% of critical habitat) currently overlap. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Diazinon is likely to adversely modify designated critical habitat: Adverse Modification

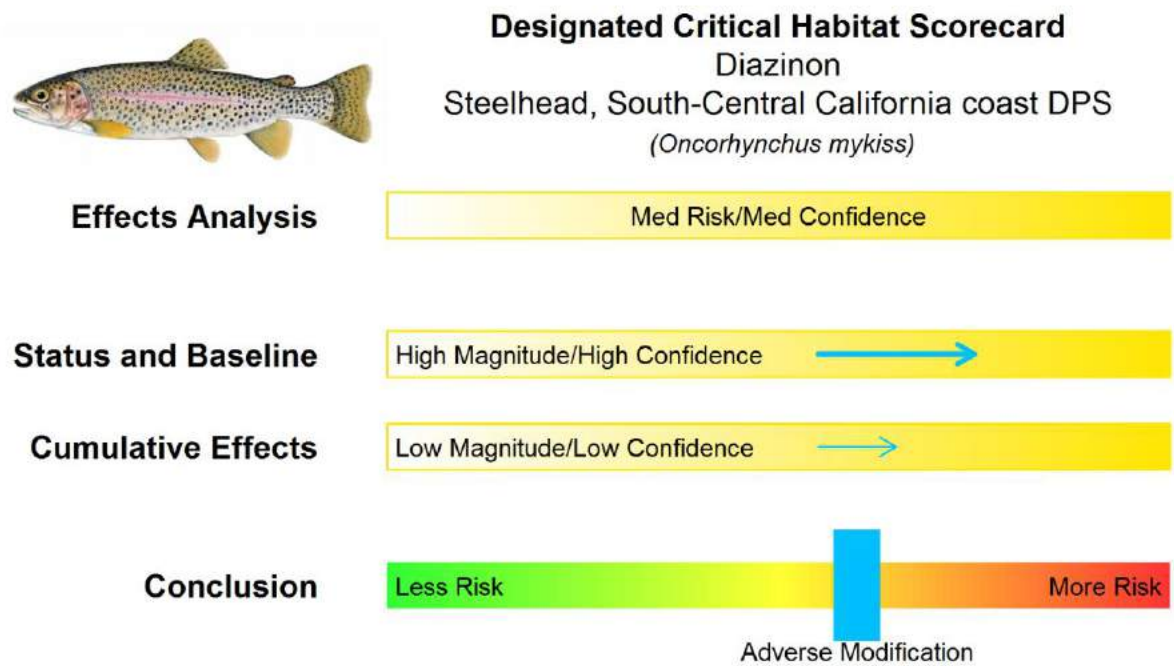

Figure 27. Designated Critical Habitat Scorecard; Steelhead, South-Central California coast DPS; Diazinon

<u>Effects Analysis: Medium risk/Medium confidence</u>

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find medium confidence of medium risk due to expected exposures in freshwater habitats

<u>Status and Baseline: Increased risk; High magnitude/High confidence</u>

- Rearing and migration PBFs are degraded by elevated temperatures and contaminants from urban and agricultural runoff
- Estuarine PBFs are degraded by altered habitat and contaminated runoff
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 29 occupied watersheds, 12 are of high and 11 are of medium conservation value

<u>Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence</u>

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

<u>Conclusion:</u> We find medium confidence of a medium risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Three use site categories, totaling more than 129,200 acres (4% of critical habitat) currently overlap. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Diazinon is likely to adversely modify designated critical habitat: Adverse Modification

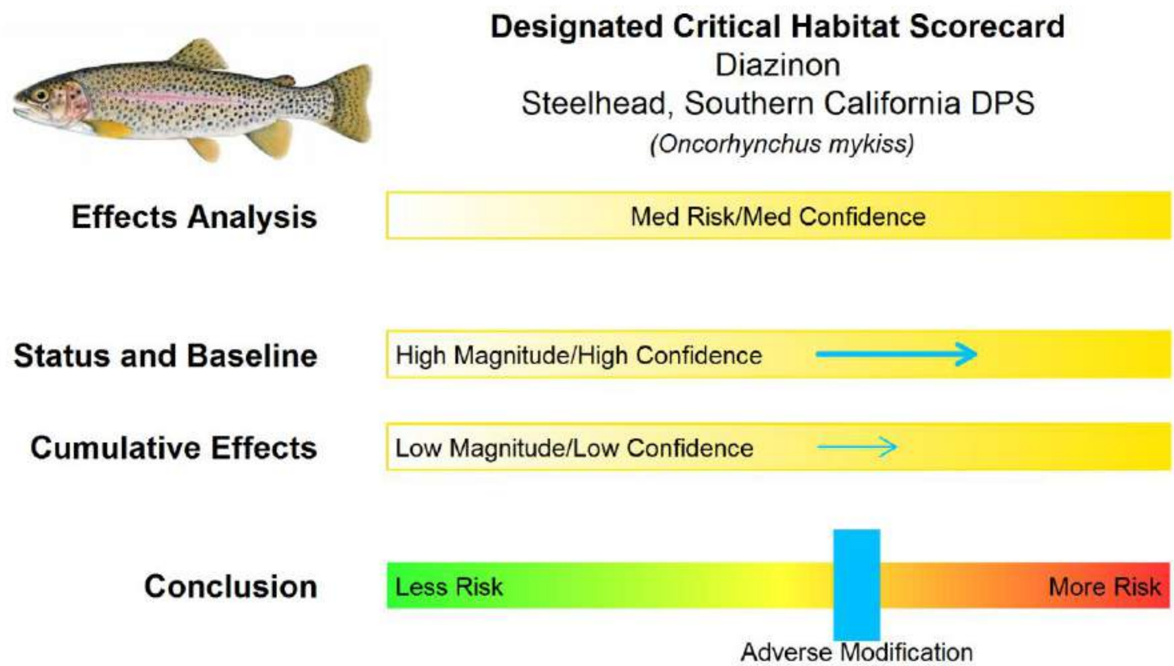

Figure 28. Designated Critical Habitat Scorecard; Steelhead, Southern California DPS; Diazinon

Effects Analysis: Medium risk/Medium confidence
- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find medium confidence of medium risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence
- All PBFs are degraded by pollutants in urban and agricultural runoff, elevated temperatures, erosion, and low water flows
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 29 freshwater and estuarine watersheds, 21 are of high and 5 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence
- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find medium confidence of a medium risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Three use site categories, totaling more than 25,045 acres (less than 2% of critical habitat) currently overlap. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Diazinon is likely to adversely modify designated critical habitat: Adverse Modification

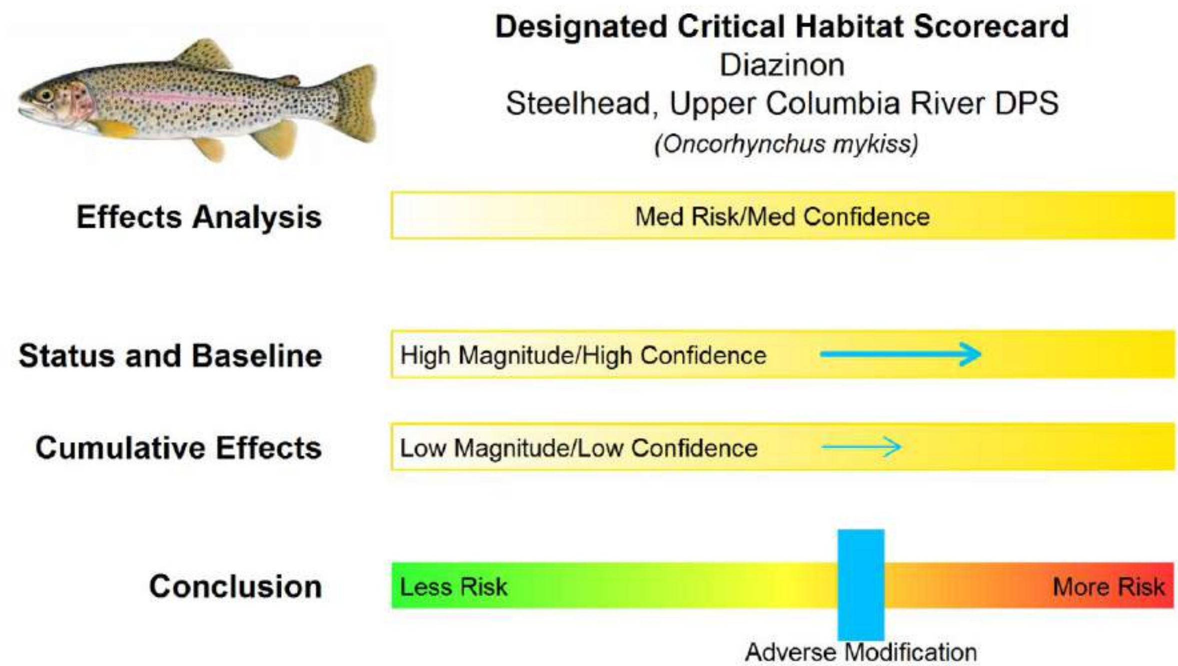

Figure 29. Designated Critical Habitat Scorecard; Steelhead, Upper Columbia River DPS; Diazinon

<u>Effects Analysis: Medium risk/Medium confidence</u>

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find medium confidence of medium risk due to expected exposures in freshwater habitats

<u>Status and Baseline: Increased risk; High magnitude/High confidence</u>

- Rearing PBFs are degraded by agricultural runoff and lack of available prey
- Migration PBFs are degraded by several dams
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 41 occupied watersheds, 31 are of high and 7 are of medium conservation value

<u>Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence</u>

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

<u>Conclusion:</u> We find medium confidence of a medium risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Three use site categories, totaling more than 184,048 acres (4% of critical habitat) currently overlap. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Diazinon is likely to adversely modify designated critical habitat: Adverse Modification

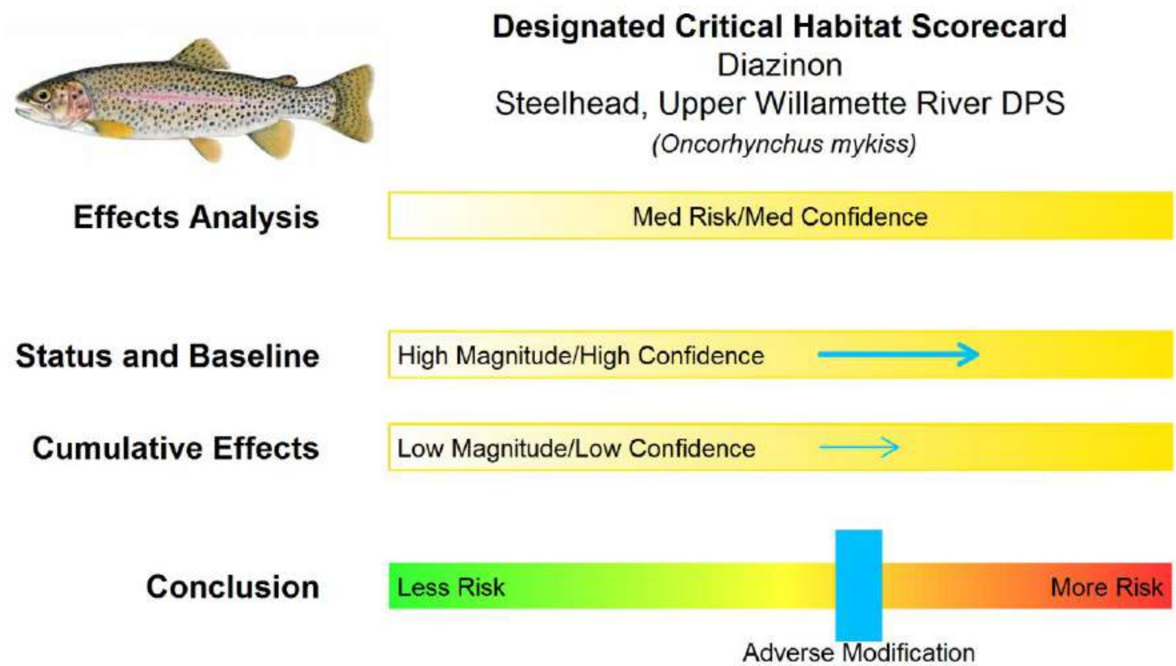

Figure 30. Designated Critical Habitat Scorecard; Steelhead, Upper Willamette River DPS; Diazinon

<u>Effects Analysis: Medium risk/Medium confidence</u>

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find medium confidence of medium risk due to expected exposures in freshwater habitats

<u>Status and Baseline: Increased risk; High magnitude/High confidence</u>

- Rearing PBFs are degraded by agricultural runoff and lack of available prey
- Migration PBFs are degraded by dams and elevated temperatures
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of assessed watersheds, 14 are of high and 6 are of medium conservation value

<u>Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence</u>

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

<u>Conclusion:</u> We find medium confidence of a medium risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Three use site categories, totaling more than 69,784 acres (3% of critical habitat) currently overlap. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Diazinon is likely to adversely modify designated critical habitat: Adverse Modification

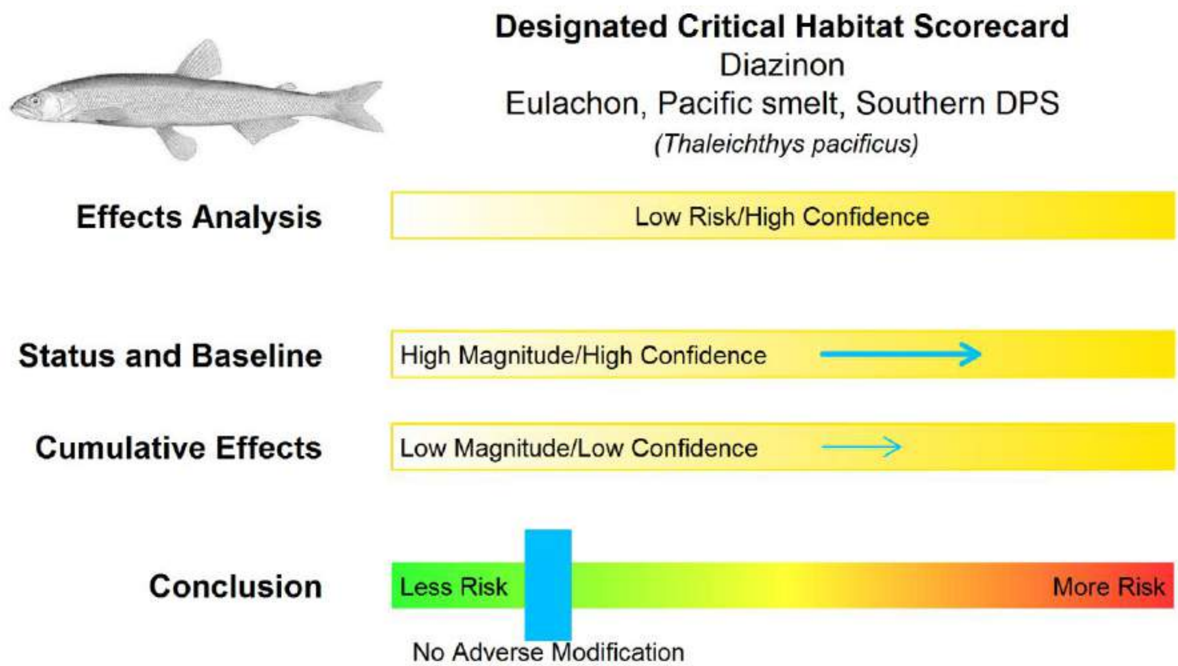

Figure 31. Designated Critical Habitat Scorecard; Eulachon, Pacific smelt, Southern DPS; Diazinon

Effects Analysis: Low risk/High confidence

- Reductions in prey and degradation of water quality are not likely to reduce the overall conservation value of designated critical habitat.
- We find high confidence of low risk due to expected exposures predicted in habitats.

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning, incubation, and rearing PBFs are degraded.
- Dams block flow and access to historical spawning grounds and are cause for degraded spawning substrates below.
- Elevated temperatures prevalent in freshwater habitats.
- Environmental mixtures anticipated in freshwater habitats may affect prey.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely. Global climate change may threaten eulachon, particularly in the southern portion of their range where ocean warming trends may be the most pronounced and may alter prey, spawning, and rearing success.
- Anticipated hydrologic changes in freshwater areas may affect PBFs.

Conclusion: We find a low likelihood of exposure and effects to designated critical habitat. The magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses the overall conservation value of designated critical habitat is not anticipated to decrease. Overall the risk is low and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

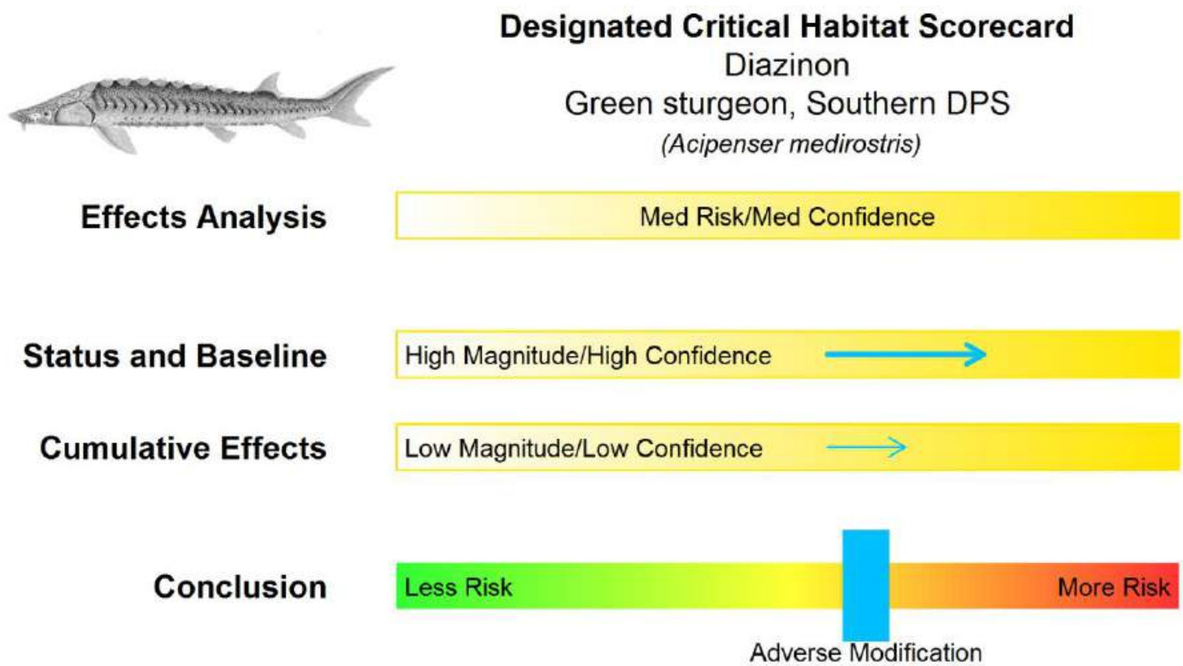

Figure 32. Designated Critical Habitat Scorecard; Green sturgeon, Southern DPS; Diazinon

Effects Analysis: Medium risk/Medium confidence

- Reductions in prey species and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat.
- We find medium confidence of medium risk due to expected exposures predicted in habitats.

Status and Baseline: Increased risk; High magnitude/High confidence

- Insufficient freshwater flow rates in spawning areas.
- Contaminants (e.g., pesticides) prevalent in freshwater habitat.
- Impassable barriers limit spawning to limited sections in Sacramento River.
- Elevated water temperatures persist in freshwater habitat.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Elevated temperatures likely to remain. Global climate change may threaten PBFs.
- Anticipated hydrologic changes in freshwater areas may further affect PBFs.

Conclusion: We find a medium likelihood that stressors of the action will negatively affect physical and biological features. Both reductions in prey and degradation of water quality are likely throughout designated critical habitat of this species. Three use site categories, totaling more than 432,870 acres (less than 4 percent of acres) adjacent to critical habitat are currently present. Anticipated reductions in prey and degradation of water quality will reduce conservation values throughout designated critical habitat over the 15-year duration of the action.

Diazinon is likely to adversely modify designated critical habitat: Adverse Modification

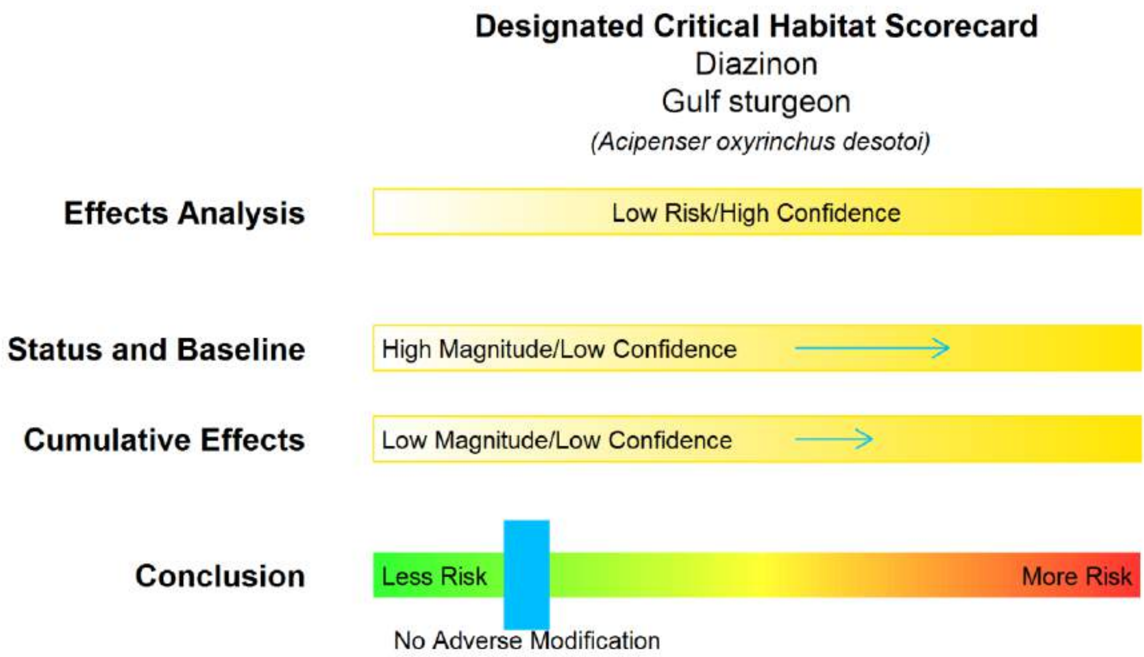

Figure 33. Designated Critical Habitat Scorecard; Gulf sturgeon; Diazinon

Effects Analysis: Low risk/High confidence

- Reductions in prey species and degradation of water quality in marine habitats are not anticipated to reduce the overall conservation value of designated critical habitat.
- We find high confidence of low risk due to exposures predicted in their marine habitats.

Status and Baseline: Increased risk; High magnitude/Low confidence

- Construction of water control structures, such as dams and sills exacerbated habitat loss.
- Dredging.
- Groundwater extraction, irrigation, and altered flows.
- Poor water quality.
- Contaminants, primarily from industrial sources.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Global climate change may threaten PBFs.

Conclusion: We have low confidence in EECs predicted for the marine habitats. We find that the overall risk is medium and the confidence associated with that risk is low. We do not anticipate reductions in prey and degradation of water quality will reduce conservation values throughout the marine portion of this species designated critical habitat over the 15-year duration of the action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

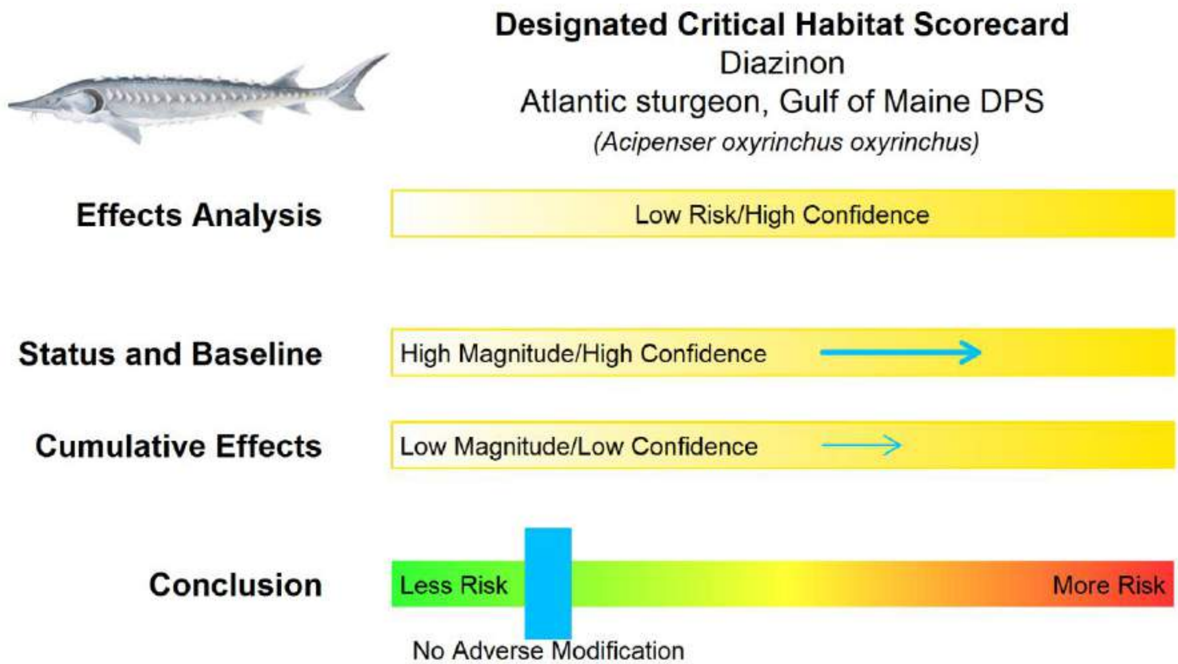

Figure 34. Designated Critical Habitat Scorecard; Atlantic sturgeon, Gulf of Maine DPS; Diazinon

Effects Analysis: Low risk/High confidence

- Reductions in prey species and degradation of water quality in marine habitats are not anticipated to reduce the overall conservation value of designated critical habitat.

Status and Baseline: Increased risk; High magnitude/High confidence

- Contaminants (e.g., pesticides).
- Impassable barriers limit spawning to limited sections
- Elevated water temperatures.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely. Global climate change may threaten PBFs.
- Anticipated hydrologic changes in freshwater areas may further affect PBFs.

Conclusion: We find a low likelihood of exposure and effects to designated critical habitat. The magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses the overall conservation value of designated critical habitat is not anticipated to decrease. Overall the risk is low and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

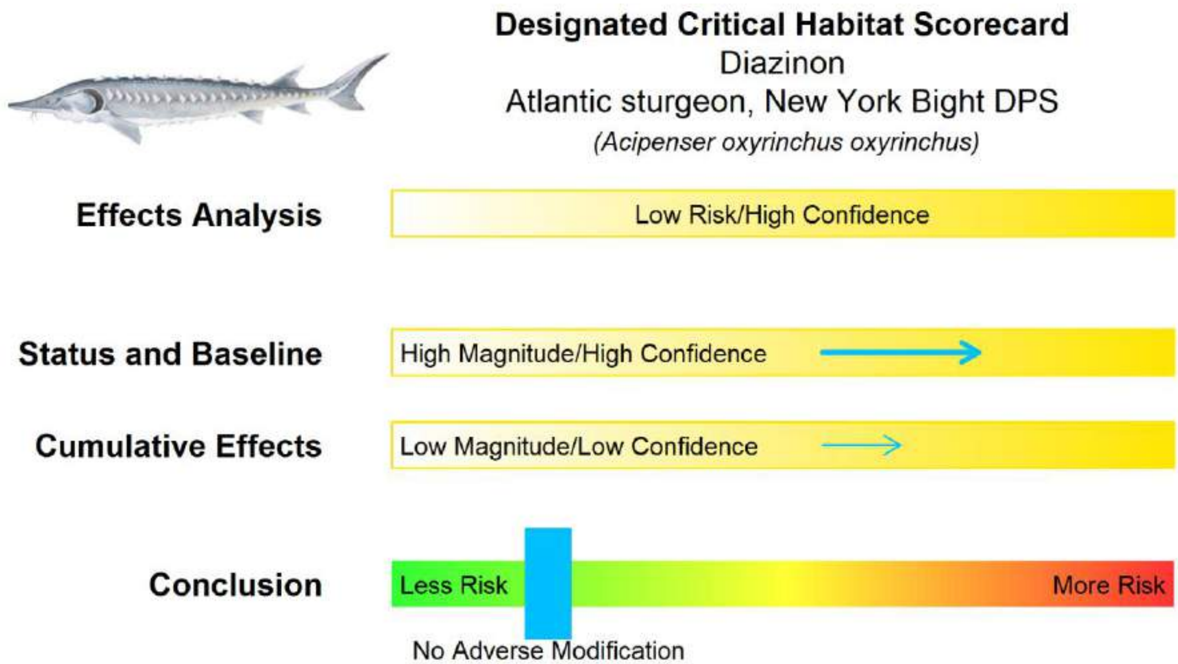

Figure 35. Designated Critical Habitat Scorecard; Atlantic sturgeon, New York Bight DPS; Diazinon

Effects Analysis: Low risk/High confidence

- Reductions in prey species and degradation of water quality in marine habitats are not anticipated to reduce the overall conservation value of designated critical habitat.

Status and Baseline: Increased risk; High magnitude/High confidence

- Contaminants (e.g., pesticides).
- Impassable barriers limit spawning to limited sections
- Elevated water temperatures.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely. Global climate change may threaten PBFs.
- Anticipated hydrologic changes in freshwater areas may further affect PBFs.

Conclusion: We find a low likelihood of exposure and effects to designated critical habitat. The magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses the overall conservation value of designated critical habitat is not anticipated to decrease. Overall the risk is low and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

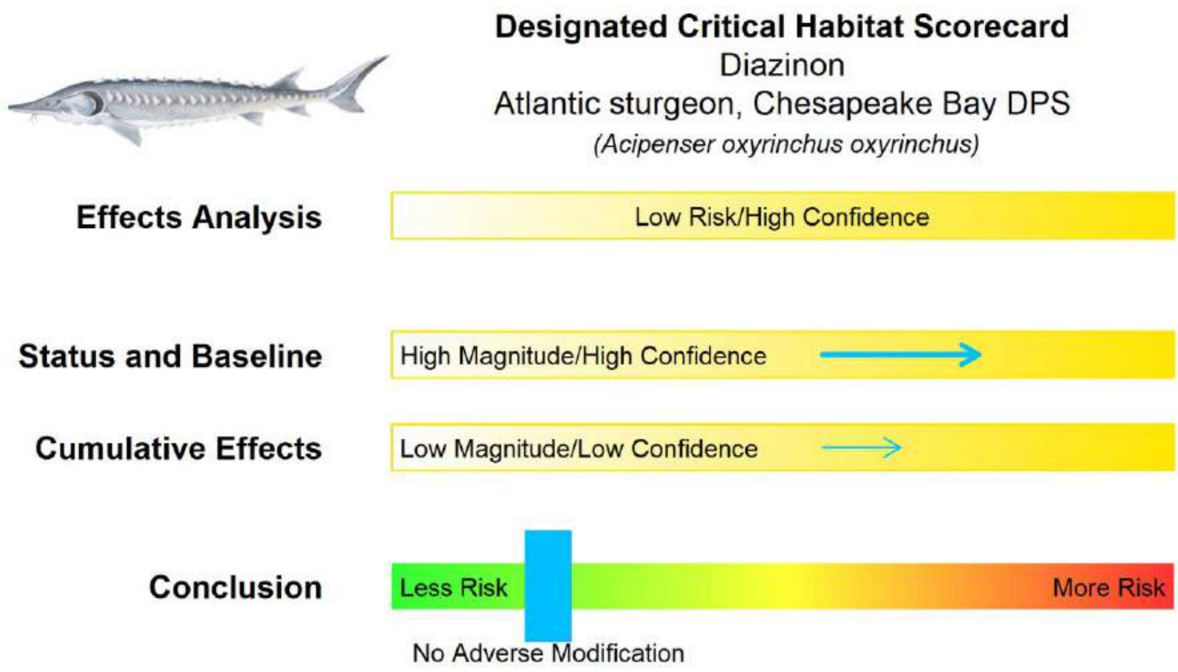

Figure 36. Designated Critical Habitat Scorecard; Atlantic sturgeon, Chesapeake Bay DPS; Diazinon

<u>Effects Analysis: Low risk/High confidence</u>

- Reductions in prey species and degradation of water quality in marine habitats are not anticipated to reduce the overall conservation value of designated critical habitat.

<u>Status and Baseline: Increased risk; High magnitude/High confidence</u>

- Contaminants (e.g., pesticides).
- Impassable barriers limit spawning to limited sections
- Elevated water temperatures.

<u>Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence</u>

- Future elevated temperatures likely. Global climate change may threaten PBFs.
- Anticipated hydrologic changes in freshwater areas may further affect PBFs.

<u>Conclusion:</u> We find a low likelihood of exposure and effects to designated critical habitat. The magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses the overall conservation value of designated critical habitat is not anticipated to decrease. Overall the risk is low and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

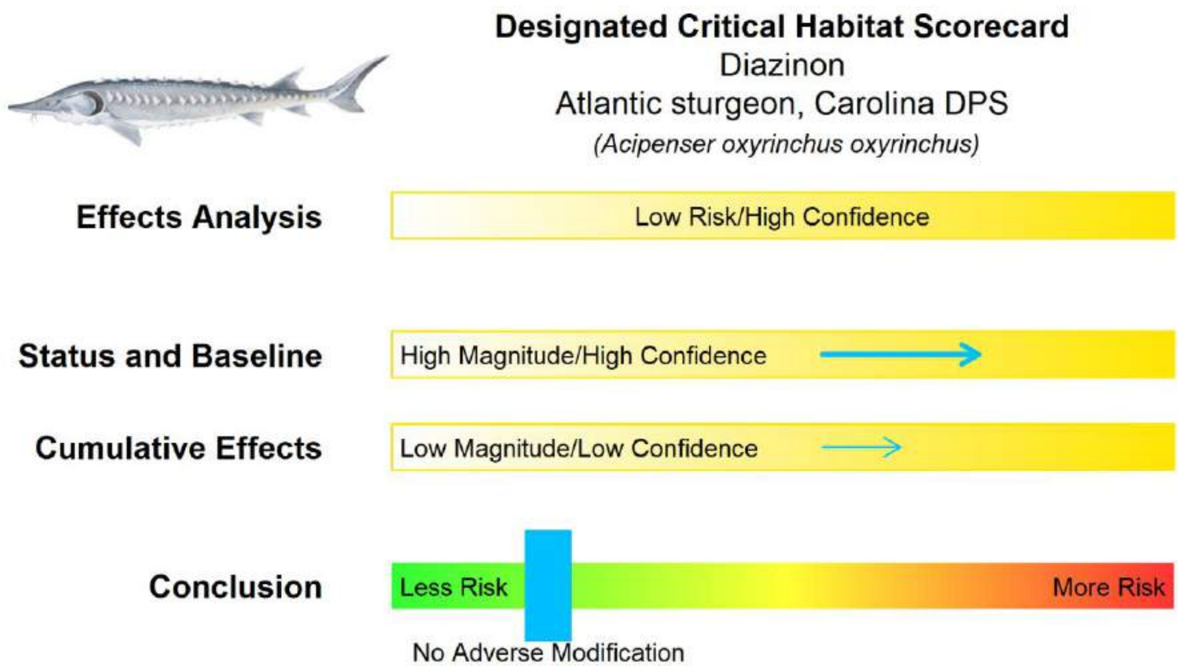

Figure 37. Designated Critical Habitat Scorecard; Atlantic sturgeon, Carolina DPS; Diazinon

<u>Effects Analysis: Low risk/High confidence</u>

- Reductions in prey species and degradation of water quality in marine habitats are not anticipated to reduce the overall conservation value of designated critical habitat.

<u>Status and Baseline: Increased risk; High magnitude/High confidence</u>

- Contaminants (e.g., pesticides).
- Impassable barriers limit spawning to limited sections
- Elevated water temperatures.

<u>Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence</u>

- Future elevated temperatures likely. Global climate change may threaten PBFs.
- Anticipated hydrologic changes in freshwater areas may further affect PBFs.

<u>Conclusion:</u> We find a low likelihood of exposure and effects to designated critical habitat. The magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses the overall conservation value of designated critical habitat is not anticipated to decrease. Overall the risk is low and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

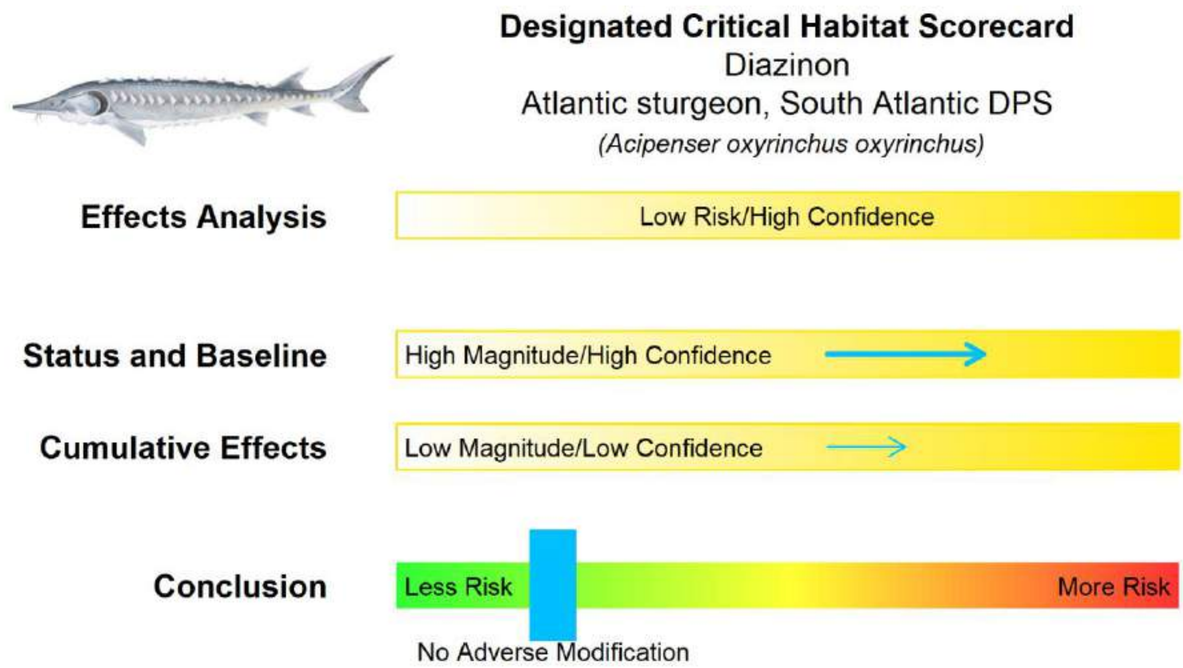

Figure 38. Designated Critical Habitat Scorecard; Atlantic sturgeon, South Atlantic DPS; Diazinon

Effects Analysis: Low risk/High confidence

- Reductions in prey species and degradation of water quality in marine habitats are not anticipated to reduce the overall conservation value of designated critical habitat.

Status and Baseline: Increased risk; High magnitude/High confidence

- Contaminants (e.g., pesticides).
- Impassable barriers limit spawning to limited sections
- Elevated water temperatures.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely. Global climate change may threaten PBFs.
- Anticipated hydrologic changes in freshwater areas may further affect PBFs.

Conclusion: We find a low likelihood of exposure and effects to designated critical habitat. The magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses the overall conservation value of designated critical habitat is not anticipated to decrease. Overall the risk is low and the confidence associated with that risk is high due to the exposures predicted in freshwater habitats over the 15-year duration of the action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

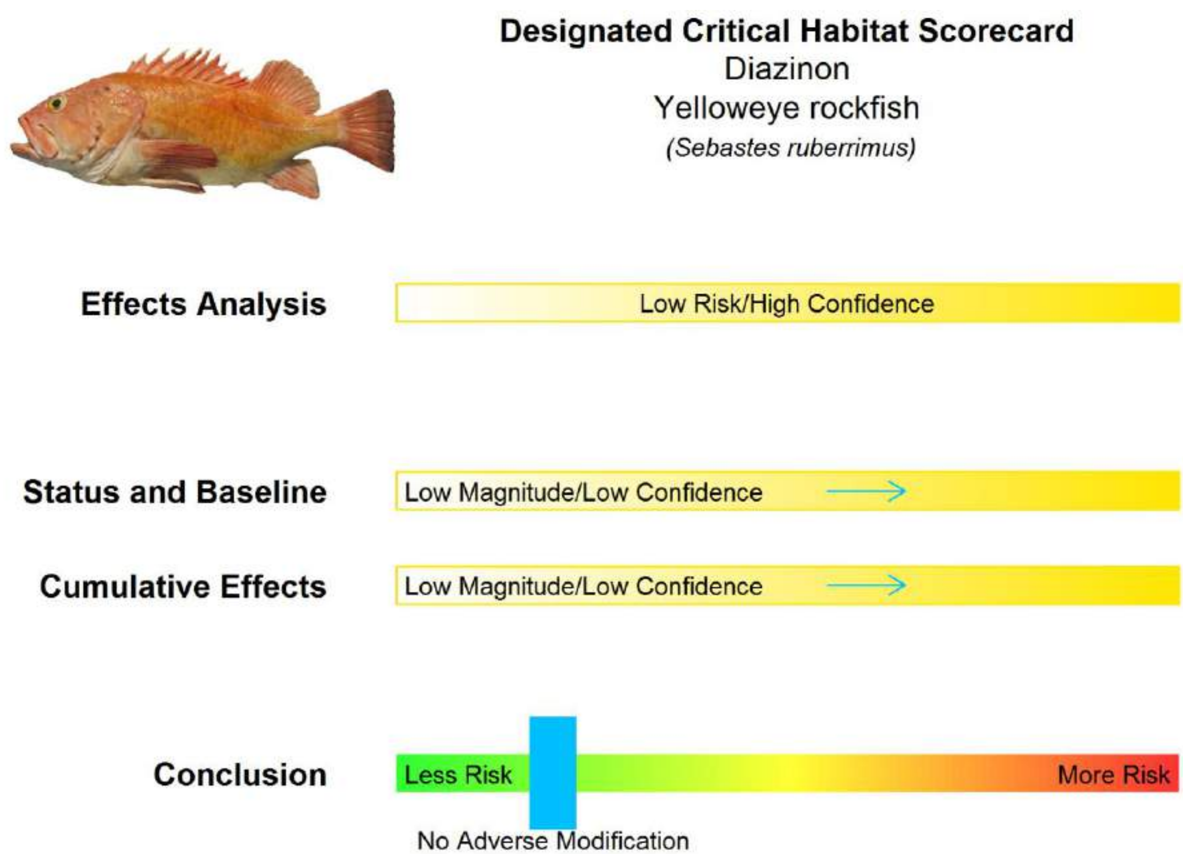

Figure 39. Designated Critical Habitat Scorecard; Yelloweye rockfish; Diazinon

Effects Analysis: Low risk/High confidence

- Reductions in prey species and degradation of water quality in marine habitats are not anticipated to reduce the overall conservation value of designated critical habitat.
- We find high confidence of low risk due to exposures predicted in their marine habitats.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Adverse environmental factors have led to prey reductions and recruitment failures.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions brought about by climate change may threaten PBFs.

Conclusion: We find that the overall risk is low and the confidence associated with that risk is high. We do not anticipate reductions in prey and degradation of water quality will reduce conservation values throughout designated critical habitat over the 15-year duration of the action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

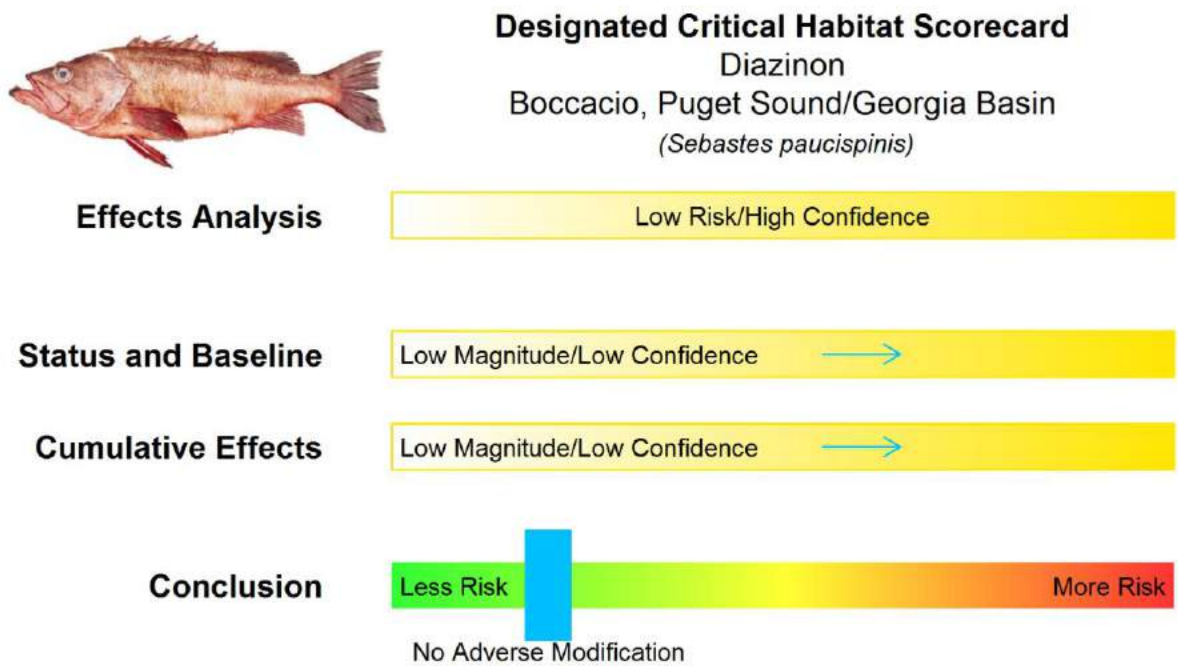

Figure 40. Designated Critical Habitat Scorecard; Boccacio, Puget Sound/Georgia Basin; Diazinon

Effects Analysis: Low risk/High confidence

- Reductions in prey species and degradation of water quality in marine habitats are not anticipated to reduce the overall conservation value of designated critical habitat.
- We find high confidence of low risk due to exposures predicted in their marine habitats.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Adverse environmental factors have led to prey reductions and recruitment failures.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions brought about by climate change may threaten PBFs.

Conclusion: We find that the overall risk is low and the confidence associated with that risk is high. We do not anticipate reductions in prey and degradation of water quality will reduce conservation values throughout designated critical habitat over the 15-year duration of the action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

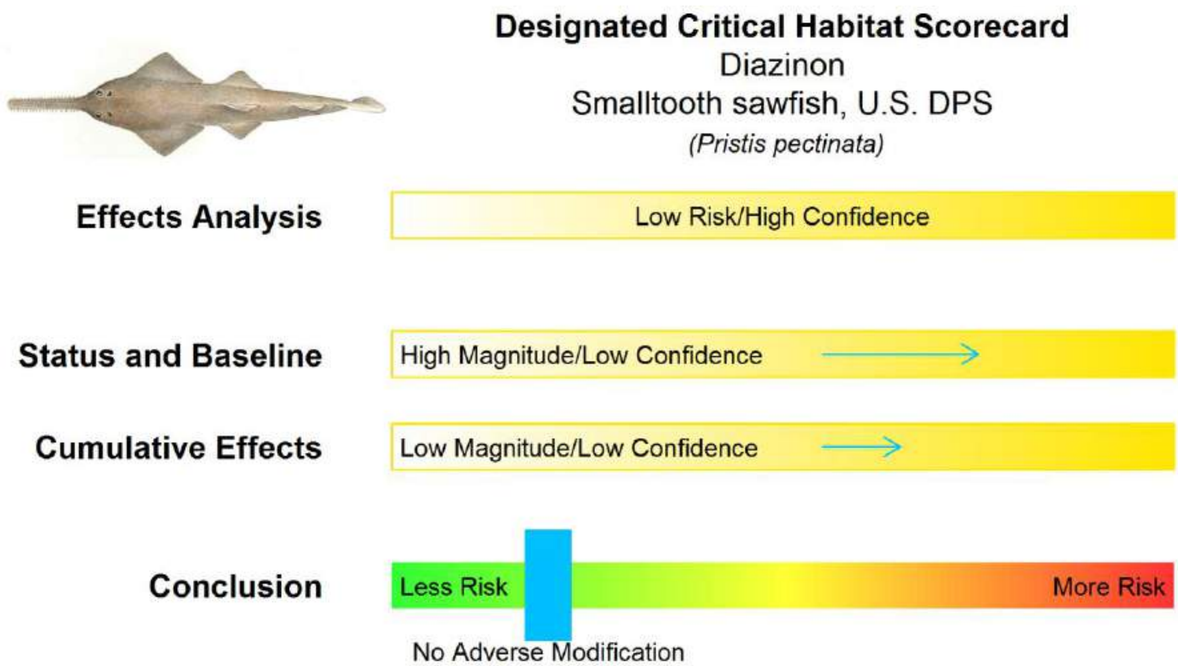

Figure 41. Designated Critical Habitat Scorecard; Smalltooth sawfish, U.S. DPS; Diazinon

<u>Effects Analysis: Low risk/High confidence</u>

- Reductions in prey species and degradation of water quality are not likely to reduce the overall conservation value of designated critical habitat.
- We find high confidence of low risk due to expected exposures predicted in habitats.

<u>Status and Baseline: Increased risk; High magnitude/Low confidence</u>

- Loss and degradation of female pupping sites and juvenile rearing habitats.
- Point and non-point contaminants.
- Marine Debris.

<u>Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence</u>

- Future losses in vegetated shallow water habitats from developmental pressures, changes in ocean conditions, and hydrology may further threaten PBFs.

<u>Conclusion:</u> We do not anticipate that the stressors of the action will negatively affect physical or biological features (PBFs). Neither reductions in prey, nor degradation of water quality are likely throughout designated critical habitat of Smalltooth Sawfish. The low magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses, the overall conservation value of designated critical habitat is not anticipated to decrease over the 15-year duration of the action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

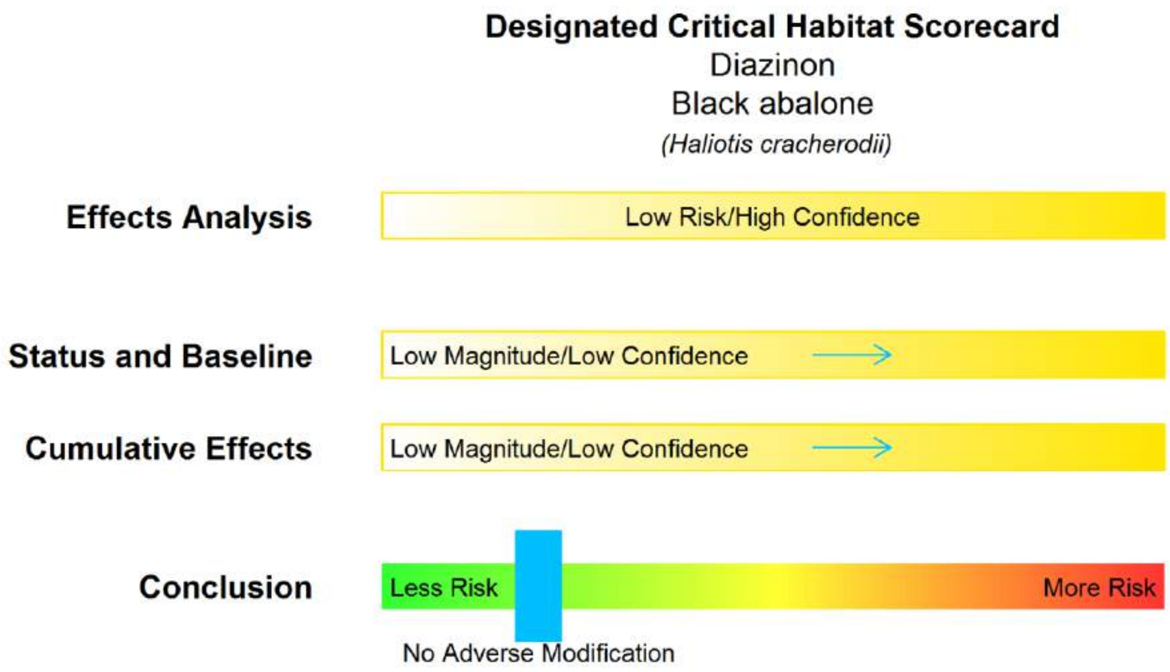

Figure 42. Designated Critical Habitat Scorecard; Black abalone; Diazinon

Effects Analysis: Low risk/High confidence

- We do not anticipate reductions in prey species and degradation of water quality in marine nearshore and inter-tidal habitats to reduce the overall conservation value of designated critical habitat.
- We find high confidence of low risk due to exposures predicted.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Habitat destruction.
- Disease.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Developmental pressures could reduce available habitat and create competition for space with other marine invertebrates.
- Changes in ocean conditions (ocean acidification) may threaten PBFs.

Conclusion: We do not anticipate that the stressors of the action will negatively affect physical or biological features. Neither reductions in prey, nor degradation of water quality are likely throughout designated critical habitat of Black Abalone. The low magnitude of toxic effects may result in some adverse effects, however due to the minimal extent of diazinon-containing uses the overall conservation value of designated critical habitat is not anticipated to decrease during the 15-year duration of the action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

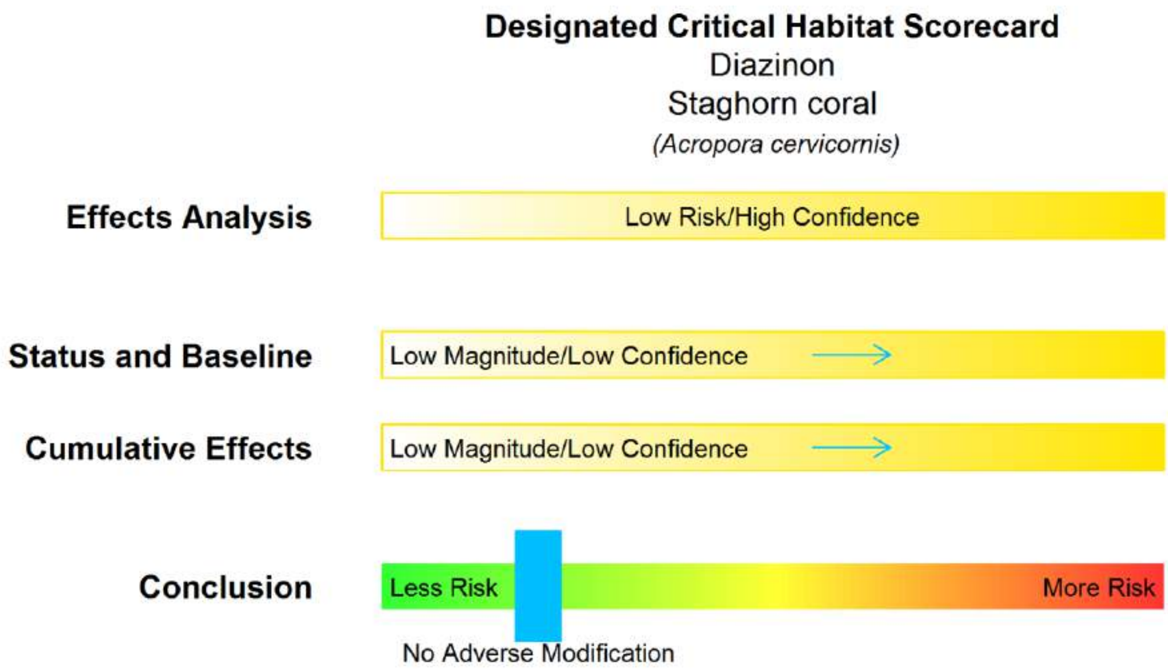

Figure 43. Designated Critical Habitat Scorecard; Staghorn coral; Diazinon

Effects Analysis: Low risk/High confidence

- We do not anticipate reductions in PBFs or reductions in the overall conservation value of designated critical habitat.
- We find high confidence of low risk due to exposures predicted and PBFs identified.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Disease (white band).
- Habitat destruction.
- Bleaching (temperature variations).
- Sedimentation.
- Algal overgrowth (nutrification).

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions (e.g. increased water temperature and acidification) may threaten PBFs.

Conclusion: There are no physical and biological features identified in Staghorn Coral designated critical habitat that could be affected by the proposed action. We find that the overall risk is low and the confidence associated with that risk is high over the 15-year duration of the action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

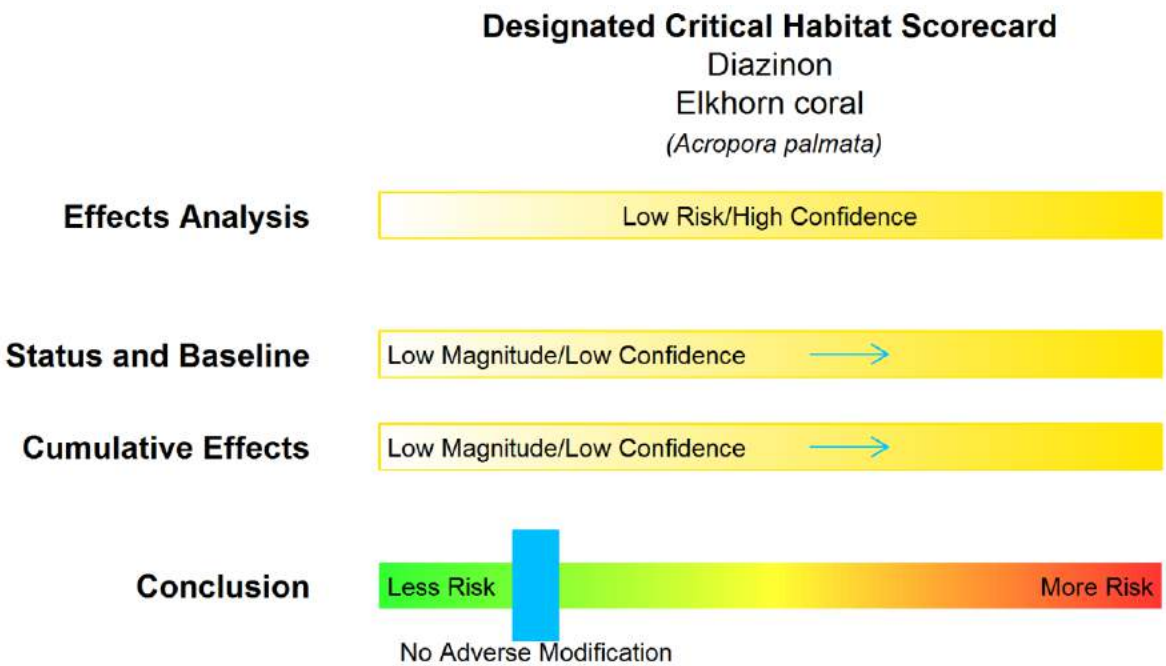

Figure 44. Designated Critical Habitat Scorecard; Elkhorn coral; Diazinon

Effects Analysis: Low risk/High confidence

- We do not anticipate reductions in PBFs or reductions in the overall conservation value of designated critical habitat.
- We find high confidence of low risk due to exposures predicted and PBFs identified.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Disease (white band).
- Habitat destruction.
- Bleaching (temperature variations).
- Sedimentation.
- Algal overgrowth (nutrification).

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions (e.g. increased water temperature and acidification) may threaten PBFs.

Conclusion: There are no physical and biological features identified in Elkhorn Coral designated critical habitat that could be affected by the proposed action. We find that the overall risk is low and the confidence associated with that risk is high over the 15-year duration of the action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

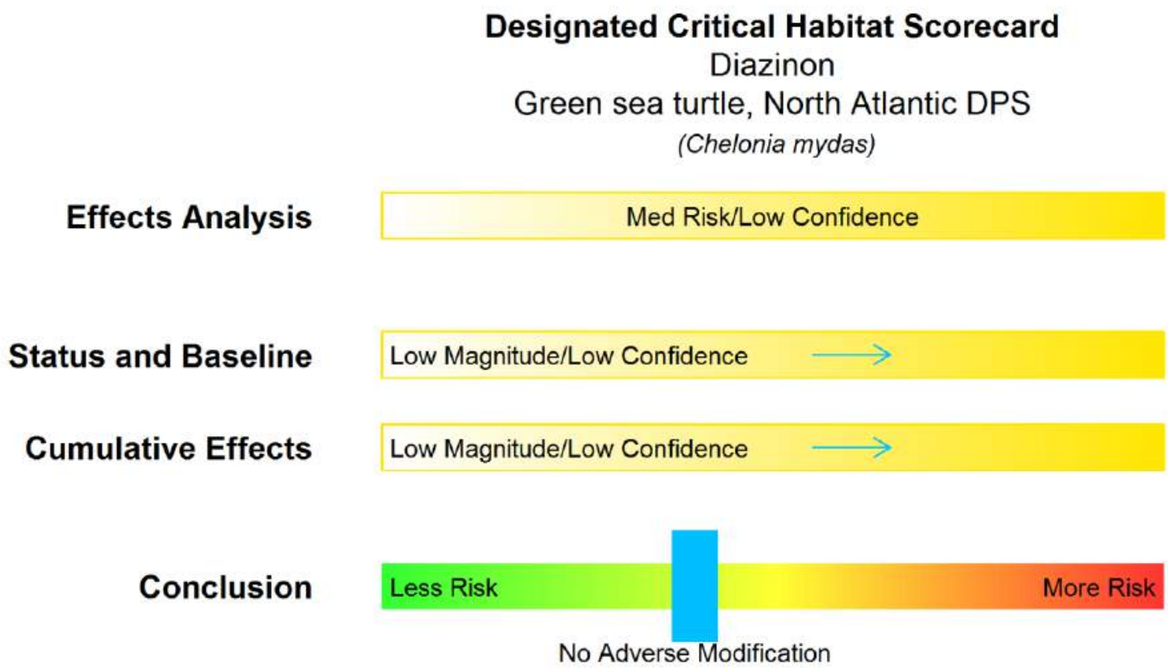

Figure 45. Designated Critical Habitat Scorecard; Green sea turtle, North Atlantic DPS; Diazinon

Effects Analysis: Medium risk/Low confidence

- We do not anticipate reductions in water quality in marine and nearshore habitats to reduce the overall conservation value of designated critical habitat.
- We find low confidence of medium risk due to exposures predicted.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Disease.
- Point and non-point pollution.
- Marine debris continues to build in critical habitat.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions may threaten PBFs.
- Increased coastal construction may threaten PBFs.

Conclusion: The stressors of the action may negatively affect relevant physical or biological features within marine and nearshore habitats. However, we have low confidence in the EECs predicted for the marine nearshore habitats. We do not anticipate that the stressors of the action will reduce the overall conservation value of the designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

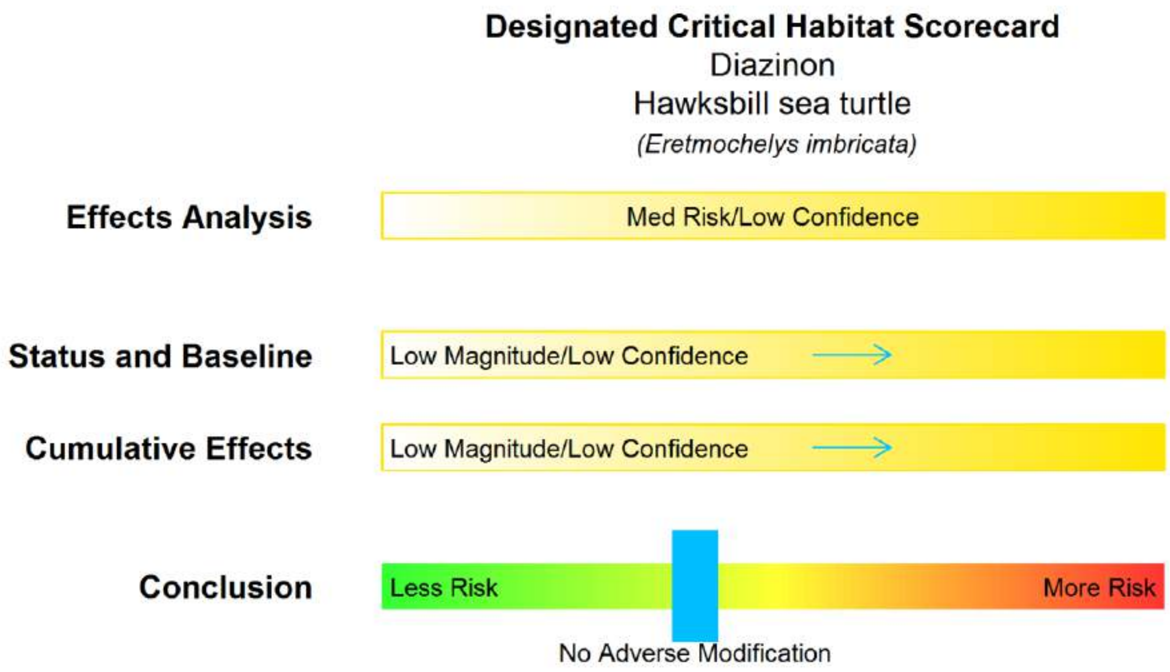

Figure 46. Designated Critical Habitat Scorecard; Hawksbill sea turtle; Diazinon

Effects Analysis: Medium risk/Low confidence

- We do not anticipate reductions in water quality in marine and nearshore habitats to reduce the overall conservation value of designated critical habitat.
- We find low confidence of medium risk due to exposures predicted.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Disease.
- Point and non-point pollution.
- Marine debris.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions brought about by climate change may threaten PBFs.
- Increased coastal construction may threaten PBFs.

Conclusion: The stressors of the action may negatively affect relevant physical and biological features within marine and nearshore habitats. However, we have low confidence in the EECs predicted for the marine nearshore habitats. We do not anticipate that the stressors of the action will reduce the overall conservation value of the designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

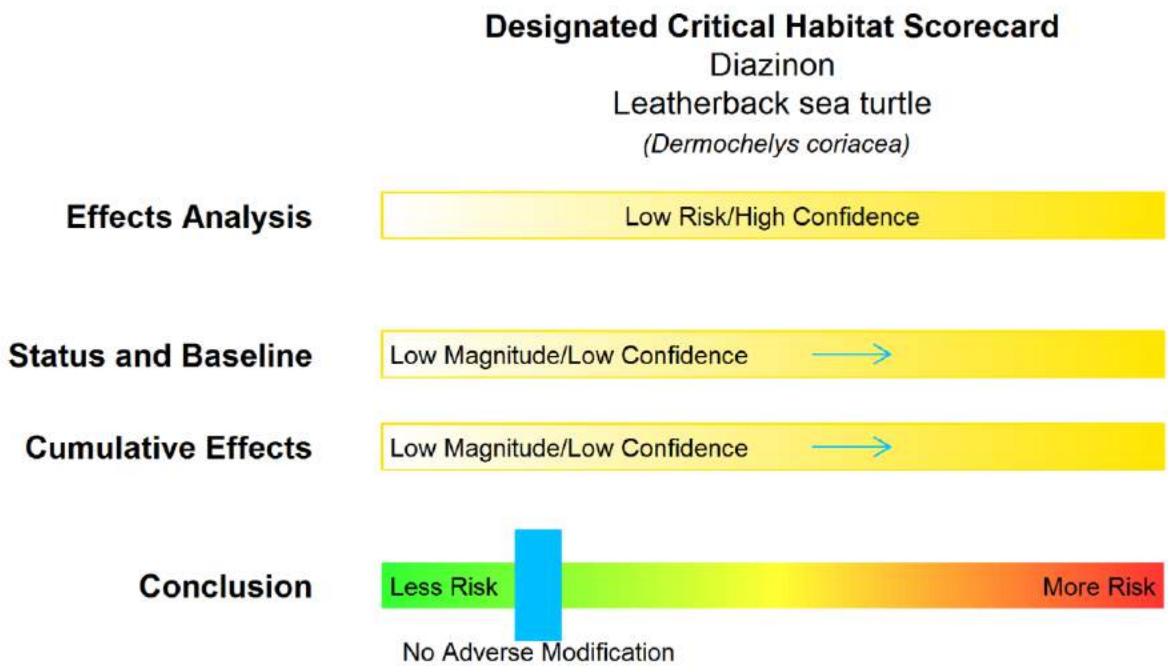

Figure 47. Designated Critical Habitat Scorecard; Leatherback sea turtle; Diazinon

Effects Analysis: Low risk/High confidence

- We do not anticipate reductions in prey in marine and nearshore habitats to reduce the overall conservation value of designated critical habitat.
- We find high confidence of low risk due to exposures predicted.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Disease.
- Point and non-point pollution.
- Marine debris.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions brought about by climate change may threaten PBFs.
- Increased coastal construction may threaten PBFs.

Conclusion: The stressors of the action are not expected to negatively affect physical or biological features within nearshore designated critical habitat of Leatherback Sea Turtle. The likelihood and magnitude of toxic effects are not likely to reduce the overall conservation value of designated critical habitat. We find that the overall risk is low and the confidence associated with that risk is high over the 15-year duration of the action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

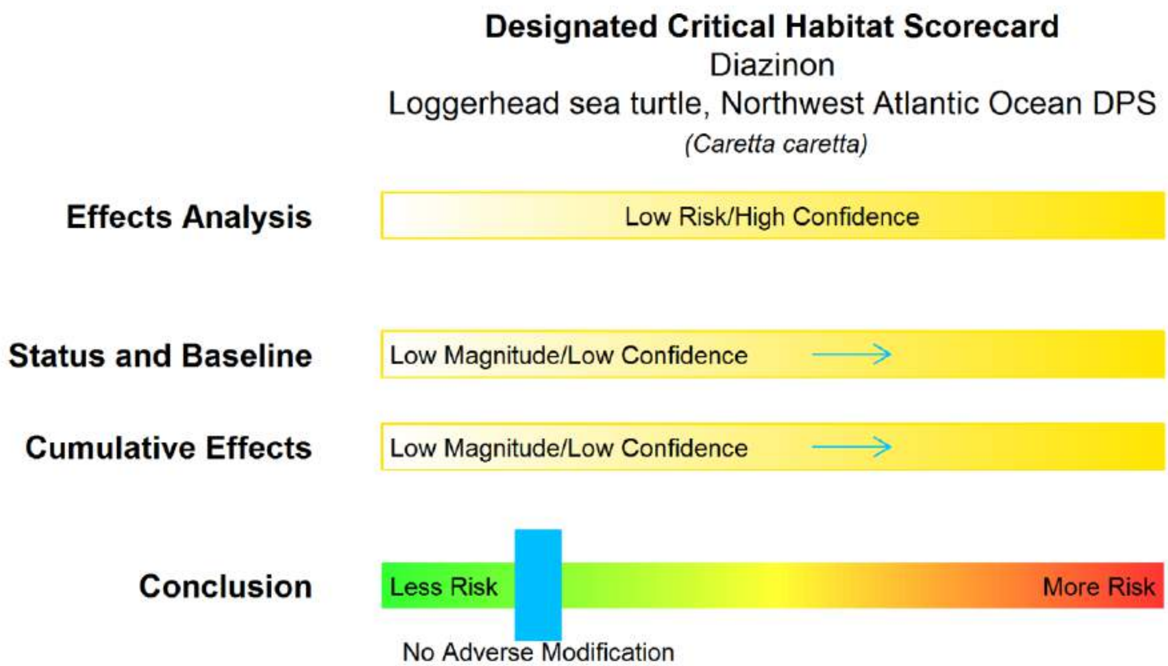

Figure 48. Designated Critical Habitat Scorecard; Loggerhead sea turtle, Northwest Atlantic Ocean DPS; Diazinon

Effects Analysis: Low risk/High confidence

- We do not anticipate reductions in prey in marine and nearshore habitats to reduce the overall conservation value of designated critical habitat.
- We find high confidence of low risk due to exposures predicted.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Point and non-point pollution.
- Marine debris.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions brought about by climate change may threaten PBFs.
- Increased coastal construction may threaten PBFs.

Conclusion: The stressors of the action are not expected to negatively affect physical or biological features within nearshore designated critical habitat of Loggerhead Sea Turtle (NW Atlantic Ocean DPS). The likelihood and magnitude of toxic effects are not likely to reduce the overall conservation value of designated critical habitat. We find that the overall risk is low and the confidence associated with that risk is high over the 15-year duration of the action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

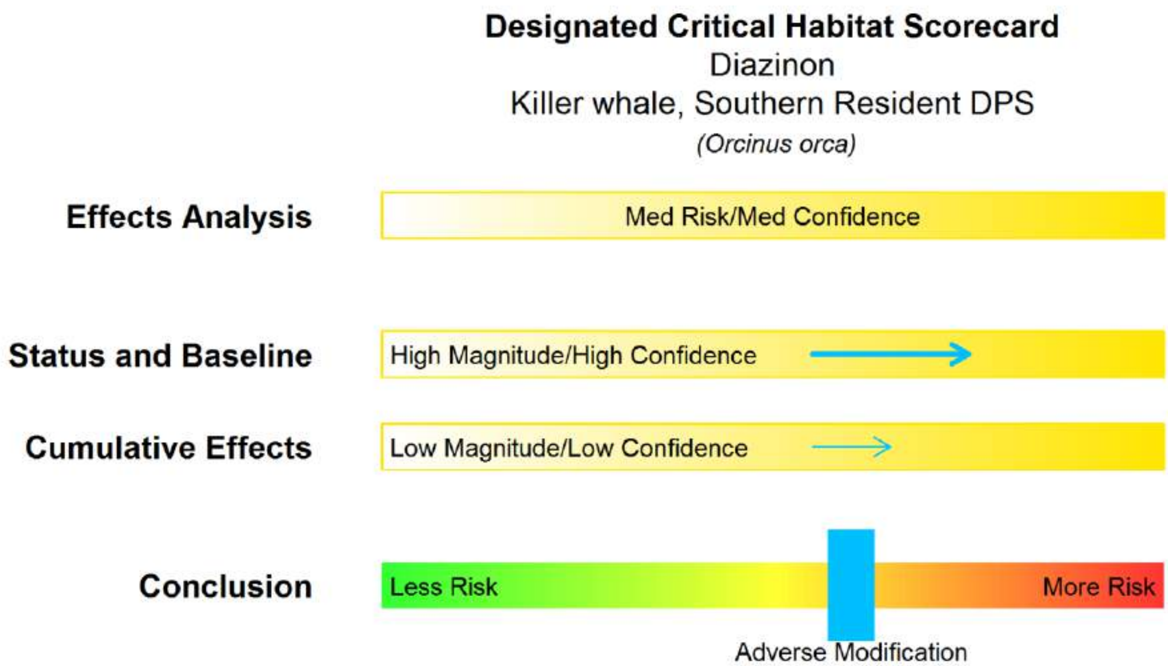

Figure 49. Designated Critical Habitat Scorecard; Killer whale, Southern Resident DPS; Diazinon

Effects Analysis: Medium risk/Medium confidence

- Reductions in prey species availability (i.e. recruiting into designated critical habitat) are likely to reduce the overall conservation value of designated critical habitat.
- We find medium confidence of medium risk due to expected exposures predicted in habitats.

Status and Baseline: Increased risk; High magnitude/High confidence

- Depleted prey throughout designated critical habitat.
- Point and non-point contaminants.
- Noise disturbance.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions brought about by climate change may threaten PBFs.
- Altered hydrology and affects to prey brought about by climate change.
- Increased stresses (e.g., temperature) to freshwater habitats critical to prey.

Conclusion: We do not anticipate stressors of the action will directly affect physical and biological features (PBFs). Reductions in suitable prey and degradation of water quality are unlikely throughout designated critical habitat of Southern Resident Killer Whale from this action. However, indirectly, prey species (Chinook salmon) will be adversely affected by exposures anticipated in their freshwater habitats. The likelihood and magnitude of toxic effects will reduce the overall conservation value of designated critical habitat by reducing the recruitment and availability of this important prey. We find that the overall risk is medium and the confidence associated with that risk is medium over the 15-year duration of the action.

Diazinon is likely to adversely modify designated critical habitat: Adverse Modification

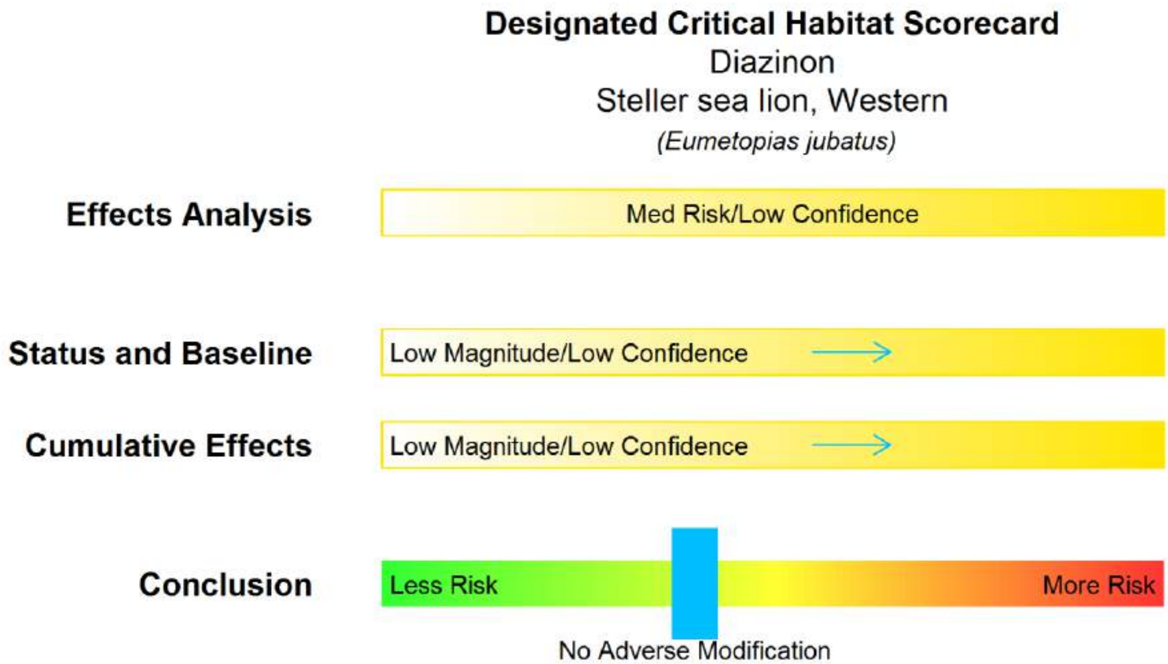

Figure 50. Designated Critical Habitat Scorecard; Steller sea lion, Western; Diazinon

<u>Effects Analysis: Medium risk/Low confidence</u>

- We do not anticipate reductions in prey in marine and nearshore habitats to reduce the overall conservation value of designated critical habitat.
- We find low confidence of medium risk due to exposures predicted.

<u>Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence</u>

- Point and non-point contaminants/pollution.
- Habitat degradation.
- Oil and gas exploration.

<u>Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence</u>

- Changes in ocean conditions brought about by climate change may threaten PBFs.
- Increased coastal construction/activities may threaten PBFs.

<u>Conclusion:</u> The stressors of the action may negatively affect a relevant physical and biological feature within nearshore designated critical habitat of Steller Sea Lion (Western DPS). However, we have low confidence in the EECs predicted for the marine nearshore habitats. The likelihood and magnitude of toxic effects are not likely to reduce the overall conservation value of designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

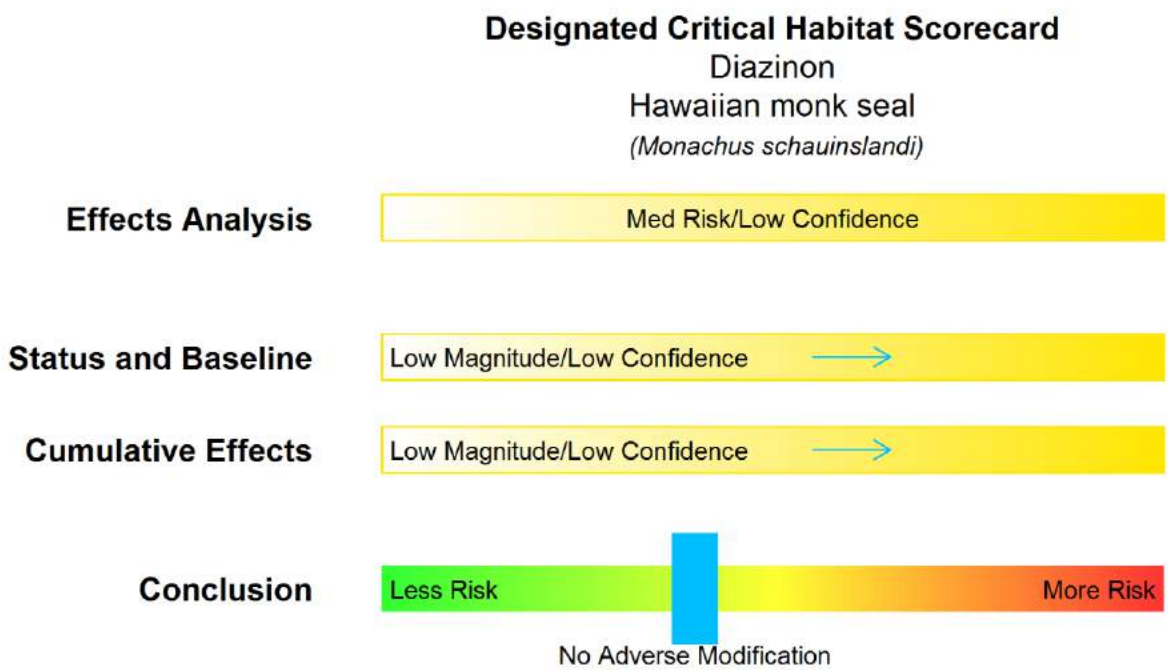

Figure 51. Designated Critical Habitat Scorecard; Hawaiian monk seal; Diazinon

Effects Analysis: Medium risk/Low confidence

- We do not anticipate reductions in prey in marine and nearshore habitats to reduce the overall conservation value of designated critical habitat.
- We find low confidence of medium risk due to exposures predicted.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Limitations in food.
- Marine debris (entanglement).
- Habitat degradation.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions brought about by climate change may threaten PBFs.
- Increased coastal construction/activities may threaten PBFs.

Conclusion: The stressors of the action may negatively affect a relevant physical and biological feature within nearshore designated critical habitat of Hawaiian Monk Seal. However, we have low confidence in the EECs predicted for the marine nearshore habitats. The likelihood and magnitude of toxic effects are not likely to reduce the overall conservation value of the marine portion of their designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

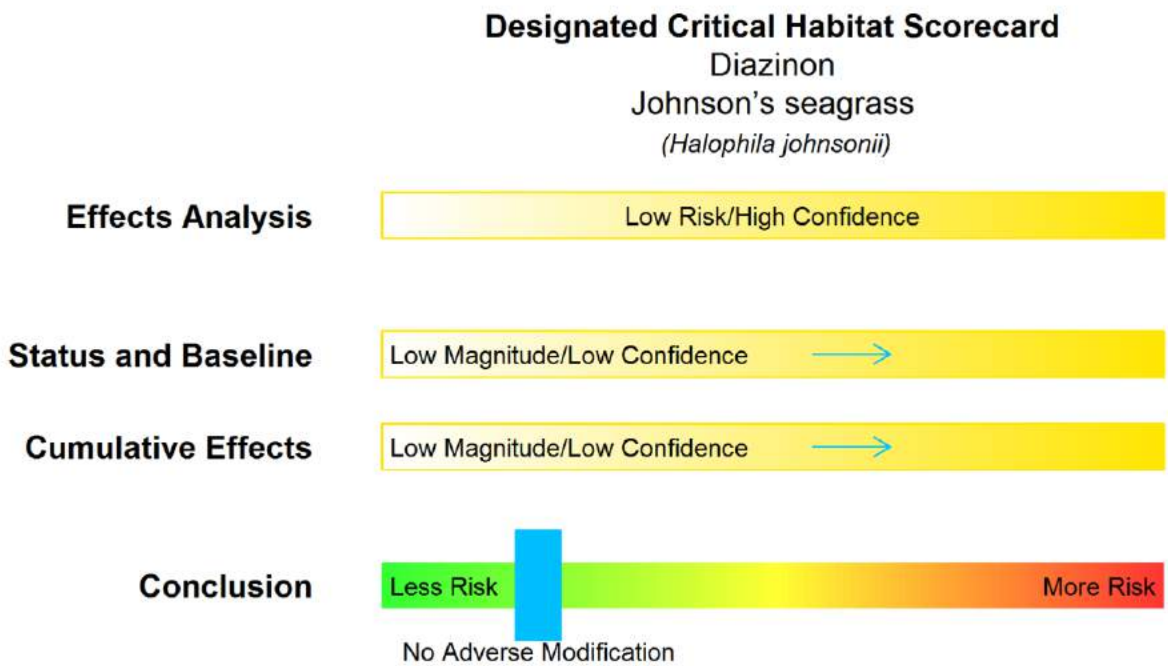

Figure 52. Designated Critical Habitat Scorecard; Johnson's seagrass; Diazinon

Effects Analysis: Low risk/High confidence

- We do not anticipate reductions in PBFs or reductions in the overall conservation value of designated critical habitat.
- We find high confidence of low risk due to exposures predicted and PBFs identified.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Degraded water quality.
- Habitat destruction
- Siltation due to land-use practices.
- Algal overgrowth (nutrification).

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions brought about by climate change may threaten PBFs.

Conclusion: Water quality is a physical and biological features identified in Johnson's seagrass designated critical habitat. However, we do not anticipate exposures from the stressors of the action to be sufficient to reduce conservation values of this PBF. We find that the overall risk is low and the confidence associated with that risk is high over the 15-year duration of the action.

Diazinon is not likely to adversely modify designated critical habitat: No Adverse Modification

CHAPTER 24

INTEGRATION AND SYNTHESIS FOR DESIGNATED CRITICAL HABITAT

MALATHION

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24.1 Introduction

The integration and synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action to the environmental baseline and the cumulative effects to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of an Endangered Species Act (ESA)-listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated critical habitat for the conservation of an ESA-listed species. These assessments are made in full consideration of the status of the species.

We treat the information from the status of the species, environmental baseline, and cumulative effects, as "risk modifiers," in that the effects described in the effects analysis section may be modified by the condition of the species; the condition of environmental baseline, and the anticipated cumulative effects. The key questions addressed include:

- Status of Designated Critical Habitat:
  - Are the PBFs impaired or degraded?
- Environmental Baseline:
  - Are freshwater temperatures elevated?
  - Are pesticide environmental mixtures present, or anticipated based on current land use?
- Cumulative Effects:
  - Will future temperatures impair species aquatic habitats?
  - Will future hydrologic flows impair freshwater species habitats?
  - How might changes in ocean conditions affect the species habitat?

As detailed in the Environmental Baseline and Cumulative Effects chapters, adverse toxic responses to exposures to these OP pesticides are heightened with increases in temperature. In addition, exposures to other pesticides in the environment can cause additive or synergistic responses when simultaneously exposed to any of these OPs. Altered hydraulic flows can cause migratory blockages. Lower hydraulic flows can also result in increases in water temperatures and reductions in dissolved oxygen levels. These conditions can put stress on aquatic species and increases toxic responses when exposed to these pesticides.

Once each of the above sections is evaluated i.e., questions answered, the effects of the action and the risk modifiers are depicted graphically on a "scorecard." First, we assign a magnitude of influence (small or large) indicated graphically with one of two lengths of arrows. The shorter of the two arrows indicates a low magnitude, while the longer of the two arrows indicates a high magnitude as a risk modifier. The direction an arrow is pointed indicates the directionality of the risk modifier. For example, an environmental baseline arrow pointing towards more risk may indicate that environmental mixtures and elevated temperatures occur in the Environmental Baseline, which further stresses the species in question. We also assign a level of confidence in our selection of the small and large magnitude, indicated by a bold arrow (high confidence) or an un-bolded arrow (low confidence). The final arrow representing the influence on risk is graphically depicted on each of the designated critical habitat scorecards.

Figure 1. Example of arrows to represent direction, magnitude, and confidence of risk modifiers

Conclusion Section:

We combine the effects analysis conducted in chapters 15 – 17 with the baseline status of the species habitat, and cumulative effects to determine whether the action could reasonably be expected to appreciably diminish the conservation value of designated critical habitat. We state our conclusion as to whether the action is likely to destroy or adversely modify each of the species designated critical habitats.

A scorecard is generated for each species designated critical habitat. The effects of the proposed action is considered based on magnitude and confidence of the three arrows. Next, an adverse modification or no adverse modification vertical blue bar is placed on the horizontal risk bar i.e., the colored bar beginning with green (less risk) to red (more risk) (***Figure 2***) to depict our conclusion.

Figure 2: Example conclusion graphic

24.2 Designated Critical Habitat Scorecards (Malathion)

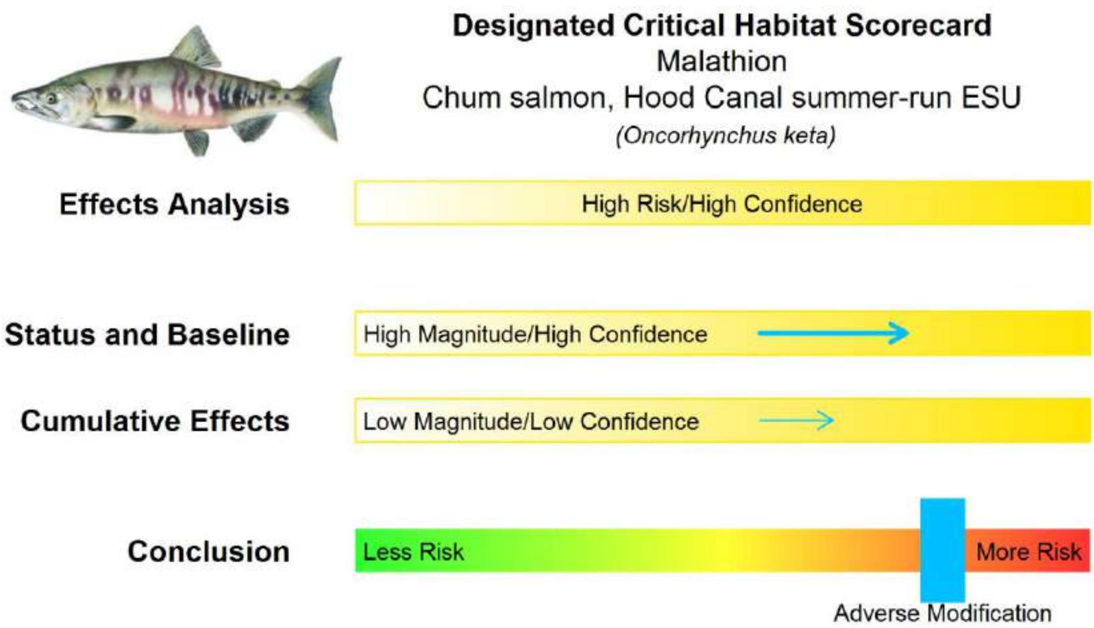

Figure 3. Designated Critical Habitat Scorecard; Chum salmon, Hood Canal summer-run Evolutionarily Significant Unit (ESU); Malathion

<u>Effects Analysis: High risk/High confidence</u>

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

<u>Status and Baseline: Increased risk; High magnitude/High confidence</u>

- Spawning and rearing PBFs are degraded
- Migration and rearing PBFs are impaired by loss of floodplain habitat necessary for juvenile growth and development
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- All 12 watersheds of high or medium conservation value

<u>Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence</u>

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

<u>Conclusion:</u> We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Twelve use site categories, totaling more than 68,260 acres (over 3% of critical habitat) currently overlap. Malathion may be applied anywhere in this critical habitat for mosquito control. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

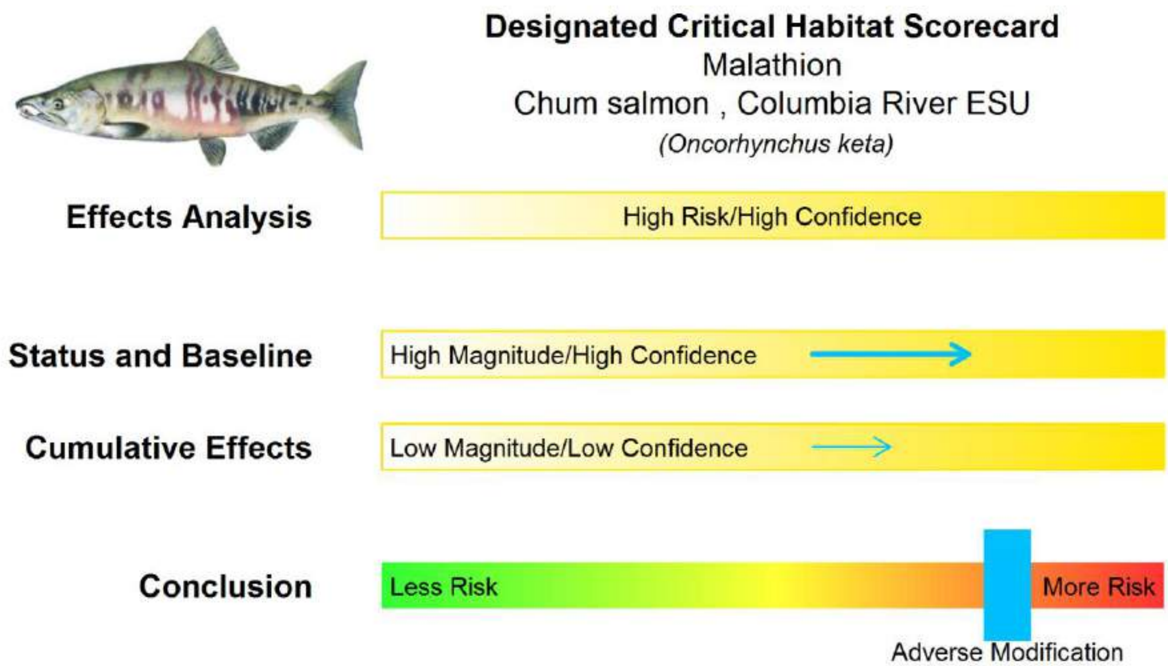

Figure 4. Designated Critical Habitat Scorecard; Chum salmon, Columbia River ESU; Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Rearing PBFs (water quality and cover) are degraded
- Migration PBFs significantly impacted by dams
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- All 19 watersheds of high or medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Twelve use site categories, totaling more than 245,091 acres (over 8% of critical habitat) currently overlap. Malathion may be applied anywhere in this critical habitat for mosquito control. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

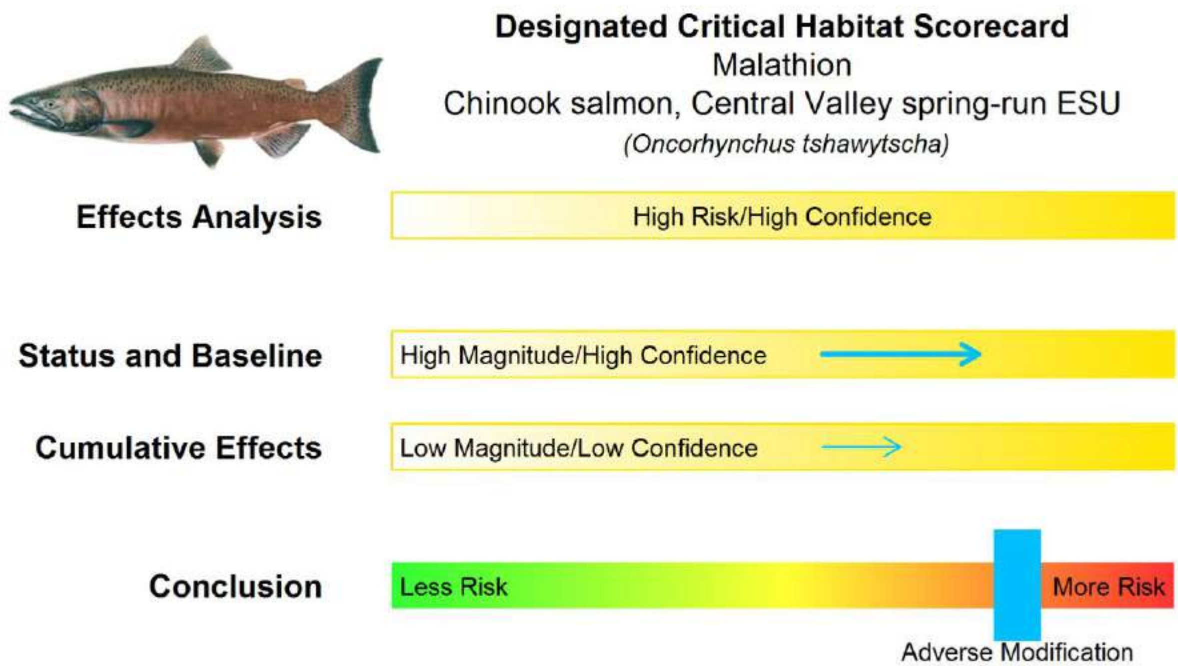

Figure 5. Designated Critical Habitat Scorecard; Chinook salmon, Central Valley spring-run ESU; Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning and rearing PBFs are degraded by elevated temperatures, lost access to historic spawning sites, and loss of floodplain habitat
- Migration PBFs degraded by loss of cover and water diversions
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 38 watersheds, 28 are of high and 3 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Twelve use site categories, totaling more than 1,902,050 acres (over 58% of critical habitat) currently overlap. Malathion may be applied anywhere in this critical habitat for mosquito control. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

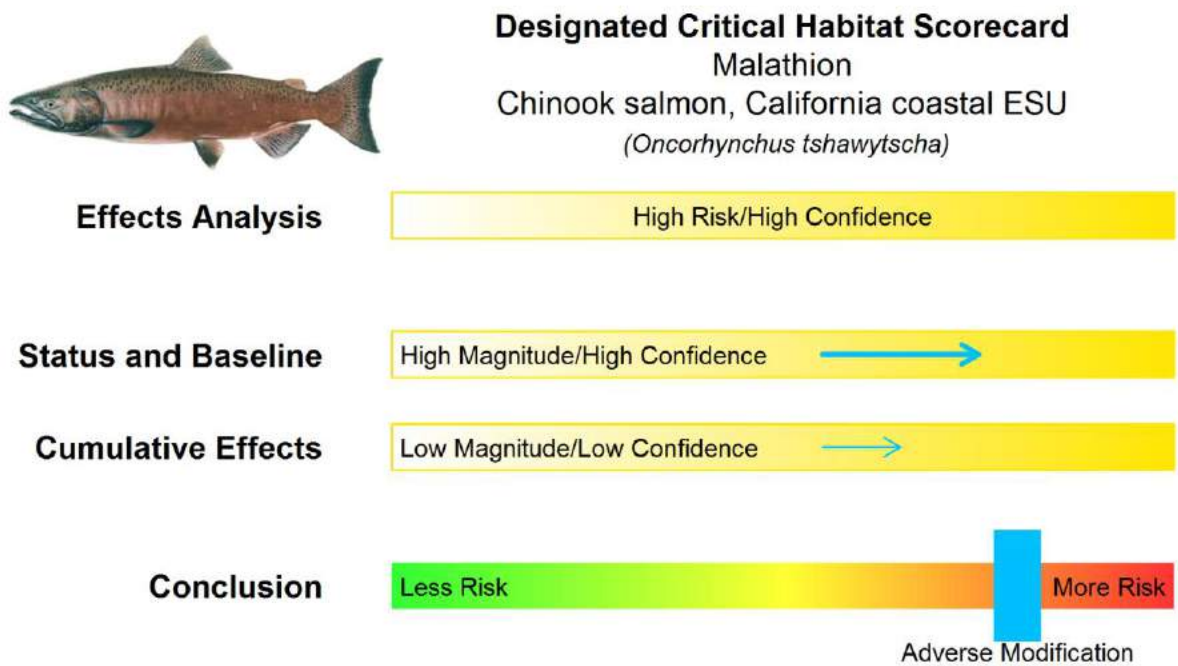

Figure 6. Designated Critical Habitat Scorecard; Chinook salmon, California coastal ESU; Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning PBFs are degraded by timber harvest
- Rearing and migration PBFs impacted by dams and invasive species.
- Estuarine PBFs degraded by water quality and saltwater mixing
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 45 watersheds, 27 are of high and 10 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Eleven use site categories, totaling more than 465,967 acres (over 13% of critical habitat) currently overlap. Malathion may be applied anywhere in this critical habitat for mosquito control. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

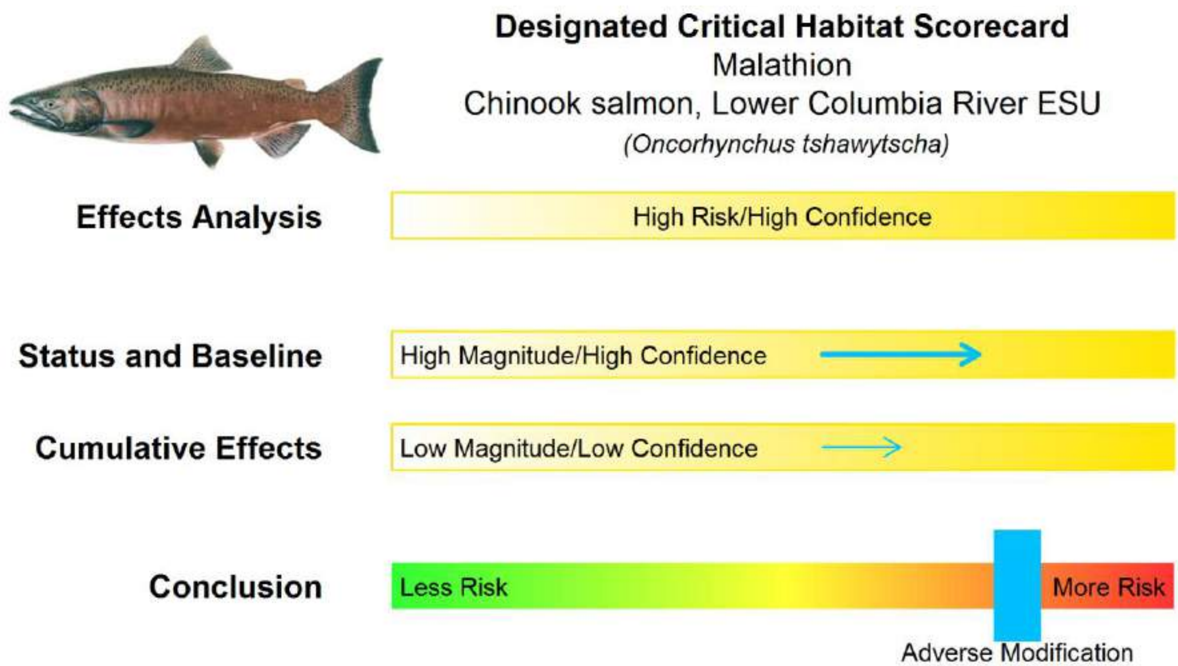

Figure 7. Designated Critical Habitat Scorecard; Chinook salmon, Lower Columbia River ESU; Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning and rearing PBFs are degraded by timber harvest, agriculture, urbanization, loss of floodplain habitat, and reduced natural cover
- Migration PBFs impacted by dams
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of occupied watersheds, 31 are of high and 13 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Twelve use site categories, totaling more than 441,831 acres (over 13% of critical habitat) currently overlap. Malathion may be applied anywhere in this critical habitat for mosquito control. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

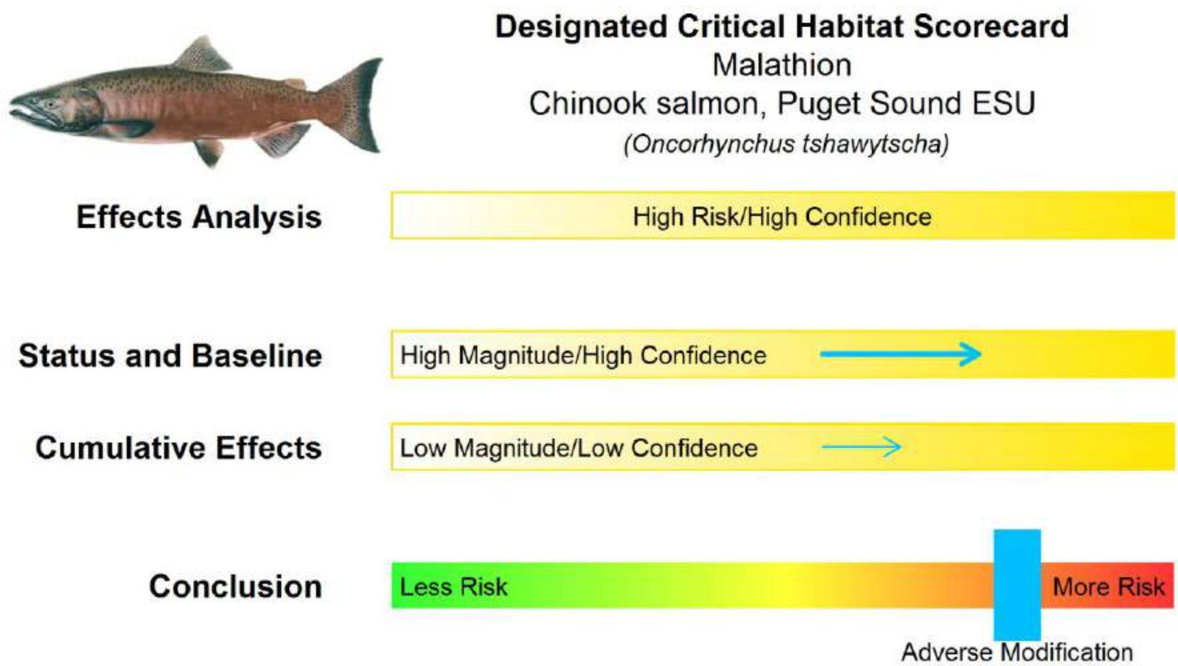

Figure 8. Designated Critical Habitat Scorecard; Chinook salmon, Puget Sound ESU; Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning, rearing and migration PBFs are degraded by forestry, agriculture, urbanization, and loss of habitat
- Estuarine PBFs degraded by water quality, altered salinity, and lack of natural cover
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 61 watersheds, 40 are of high and 9 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Twelve use site categories, totaling more than 1,144,865 acres (over 12% of critical habitat) currently overlap. Malathion may be applied anywhere in this critical habitat for mosquito control. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

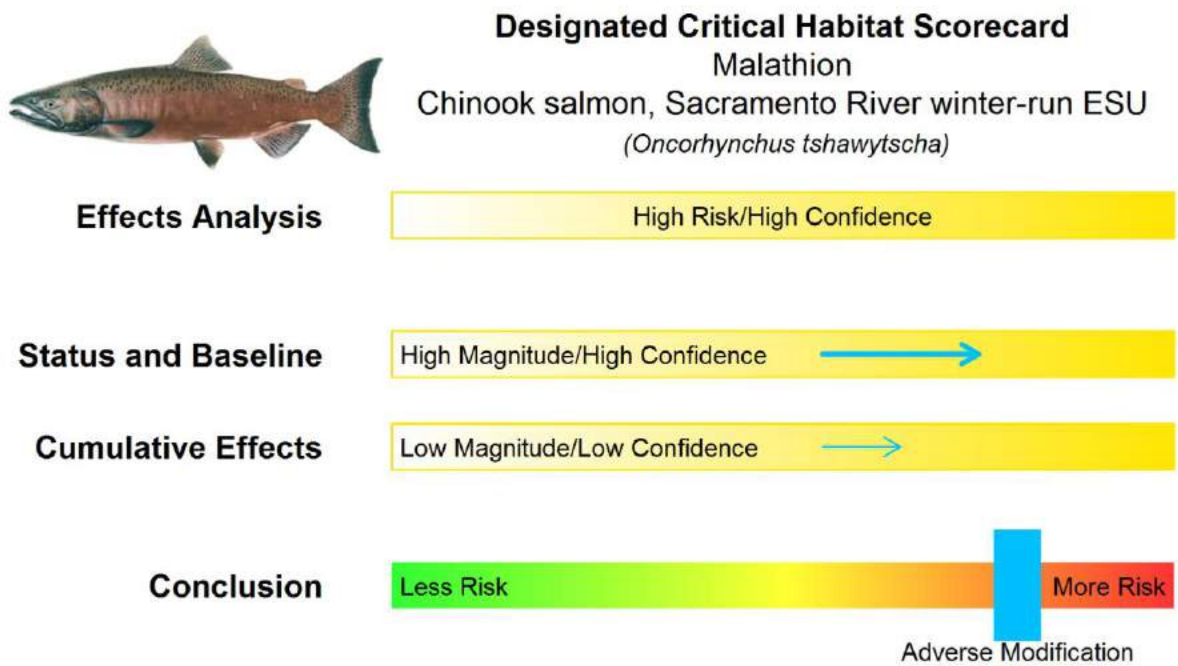

Figure 9. Designated Critical Habitat Scorecard; Chinook salmon, Sacramento River winter-run ESU; Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning and rearing PBFs are degraded by elevated temperatures and loss of habitat
- Migration PBFs degraded by lack of natural cover and water diversions
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- The entire Sacramento river and delta are considered of high conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Twelve use site categories, totaling more than 789,342 acres (over 53% of critical habitat) currently overlap. Malathion may be applied anywhere in this critical habitat for mosquito control. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

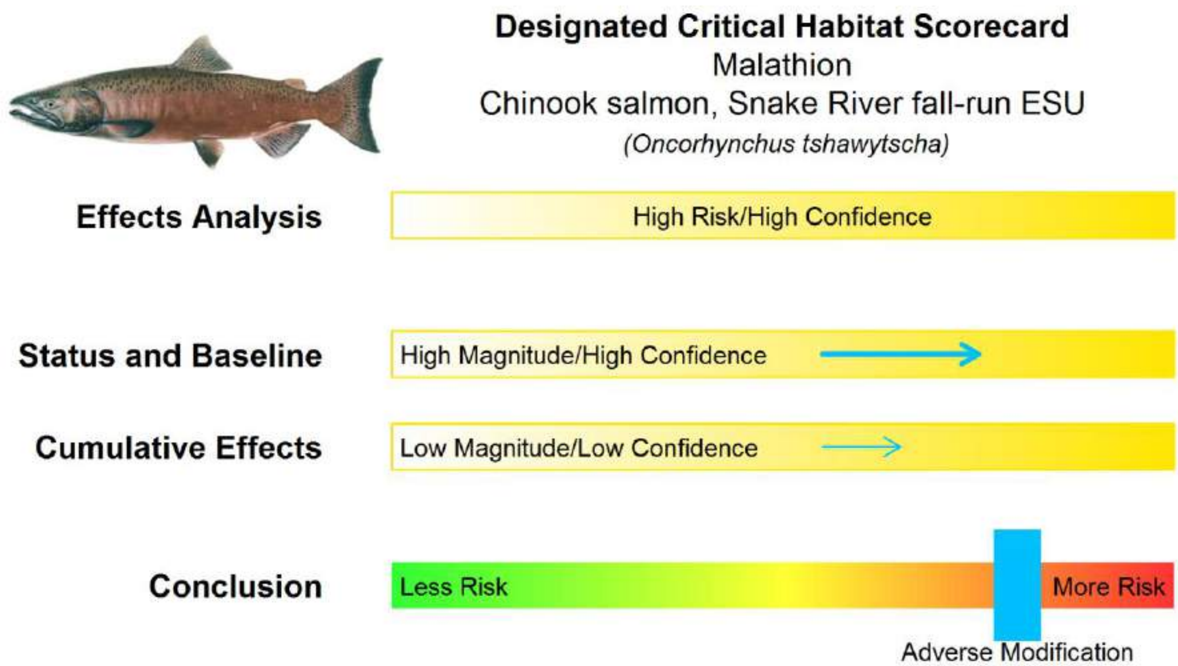

Figure 10. Designated Critical Habitat Scorecard; Chinook salmon, Snake River fall-run ESU; Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning, rearing and migration PBFs are degraded by loss of habitat, impaired stream flows, barriers to fish passage, and poor water quality
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- The entire river corridor is considered of high conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Twelve use site categories, totaling more than 3,440,270 acres (over 42% of critical habitat) currently overlap. Malathion may be applied anywhere in this critical habitat for mosquito control. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

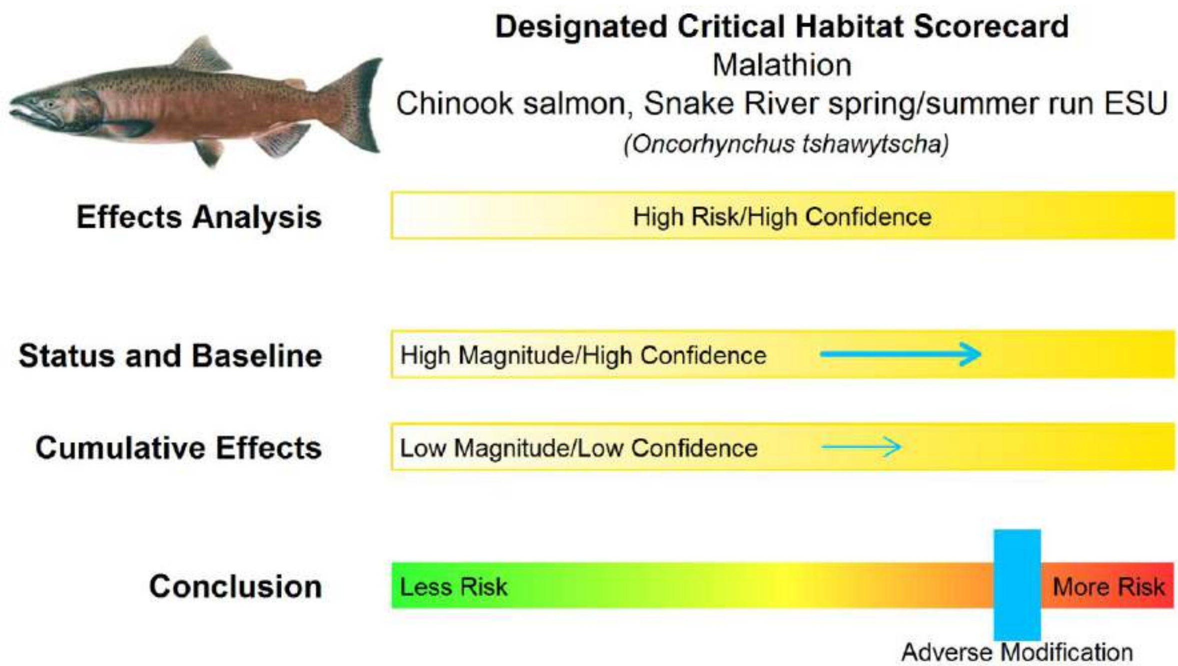

Figure 11. Designated Critical Habitat Scorecard; Chinook salmon, Snake River spring/summer run ESU; Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning, rearing and migration PBFs are degraded by loss of habitat, altered stream flows, barriers to fish passage, dams, loss of cover, and poor water quality
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- The entire river corridor is considered of high conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Twelve use site categories, totaling more than 17,435,837 acres (over 23% of critical habitat) currently overlap. Malathion may be applied anywhere in this critical habitat for mosquito control. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

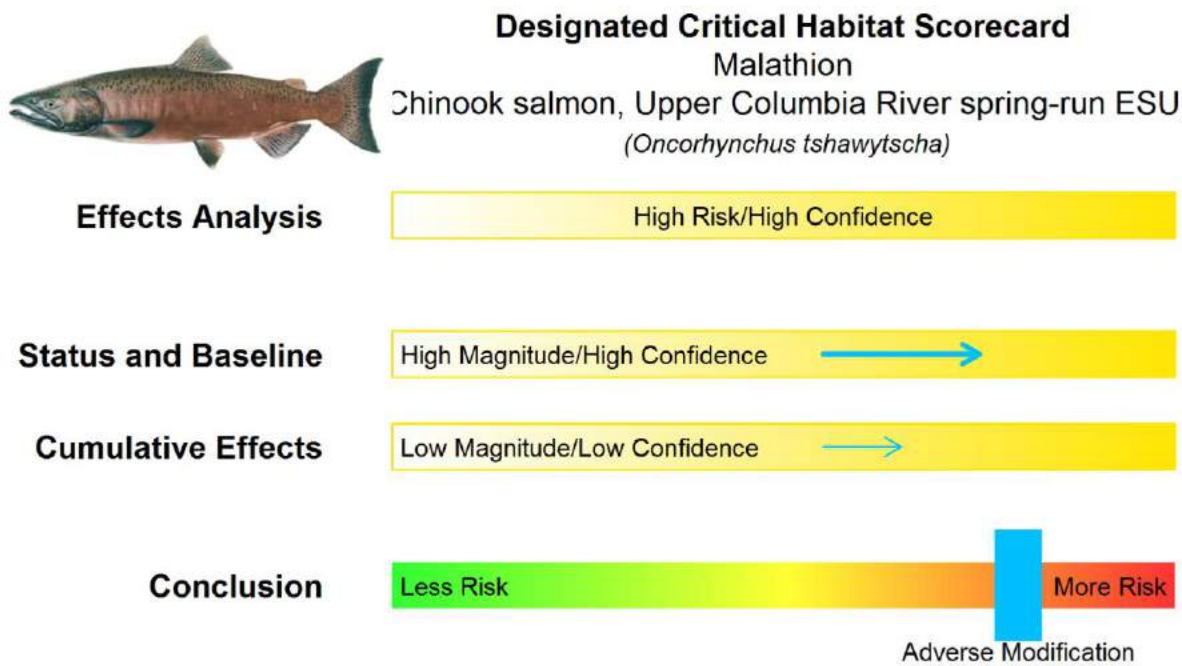

Figure 12. Designated Critical Habitat Scorecard; Chinook salmon, Upper Columbia River spring-run ESU; Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning and rearing PBFs are degraded by urbanization and irrigation water diversions
- Migration PBFs degraded by numerous dams
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of occupied watersheds, 26 are of high and 5 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Twelve use site categories, totaling more than 660,759 acres (over 18% of critical habitat) currently overlap. Malathion may be applied anywhere in this critical habitat for mosquito control. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

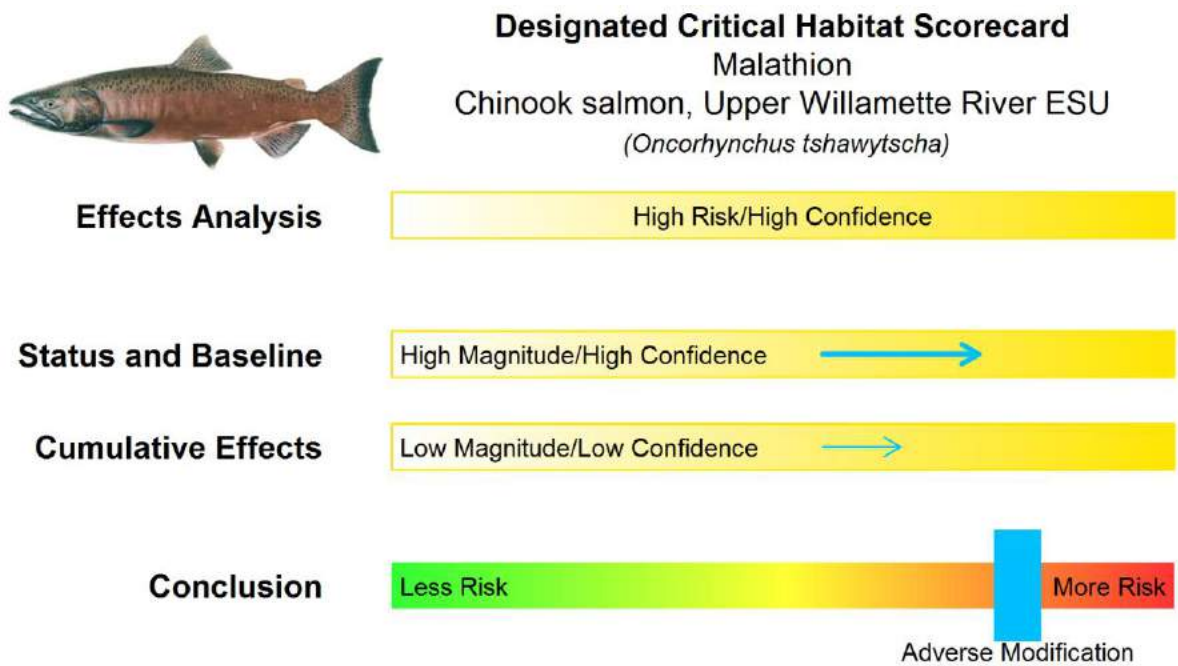

Figure 13. Designated Critical Habitat Scorecard; Chinook salmon, Upper Willamette River ESU; Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Migration, rearing, and estuary PBFs are degraded by dams, water management, loss of riparian vegetation, and quality of floodplain habitat
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 59 assessed watersheds, 22 are of high and 18 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Twelve use site categories, totaling more than 935,427 acres (over 28% of critical habitat) currently overlap. Malathion may be applied anywhere in this critical habitat for mosquito control. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

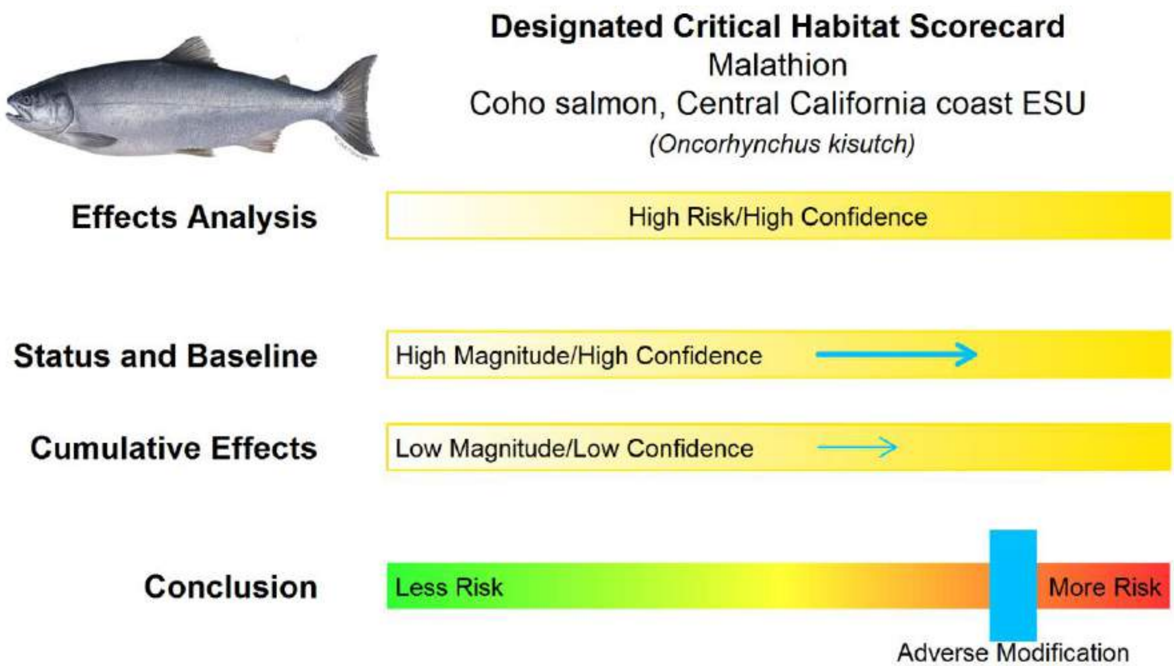

Figure 14. Designated Critical Habitat Scorecard; Coho salmon, Central California coast ESU; Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Degradation in quality and quantity of PBFs, especially in southern end of range
- Rearing PBFs degraded by loss of suitable incubation substrate and loss of habitat
- Elevated temperatures anticipated in freshwater habitats
- Environmental mixtures anticipated in freshwater habitats may impact PBFs

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Twelve use site categories, totaling more than 885,452 acres (over 23% of critical habitat) currently overlap. Malathion may be applied anywhere in this critical habitat for mosquito control. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Malathions is likely to adversely modify designated critical habitat: Adverse Modification

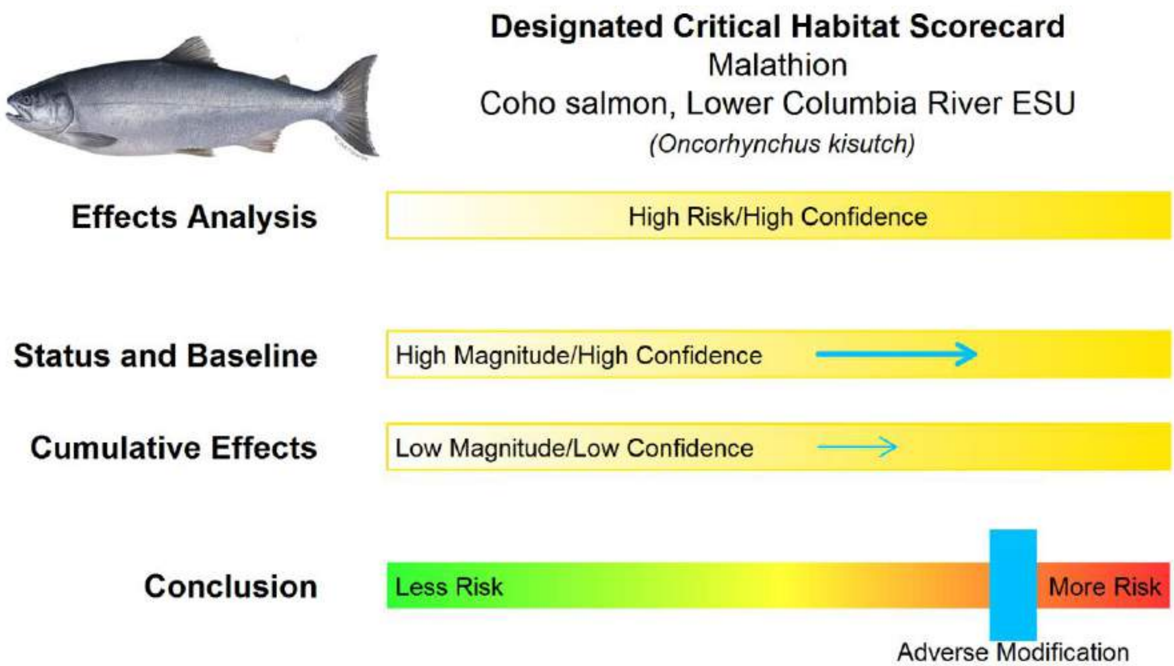

Figure 15. Designated Critical Habitat Scorecard; Coho salmon, Lower Columbia River ESU; Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning and rearing PBFs are degraded by timber harvest, agriculture, urbanization, loss of floodplain habitat, and reduced natural cover
- Migration PBFs impacted by dams
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Twelve use site categories, totaling more than 603,588 acres (over 15% of critical habitat) currently overlap. Malathion may be applied anywhere in this critical habitat for mosquito control. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

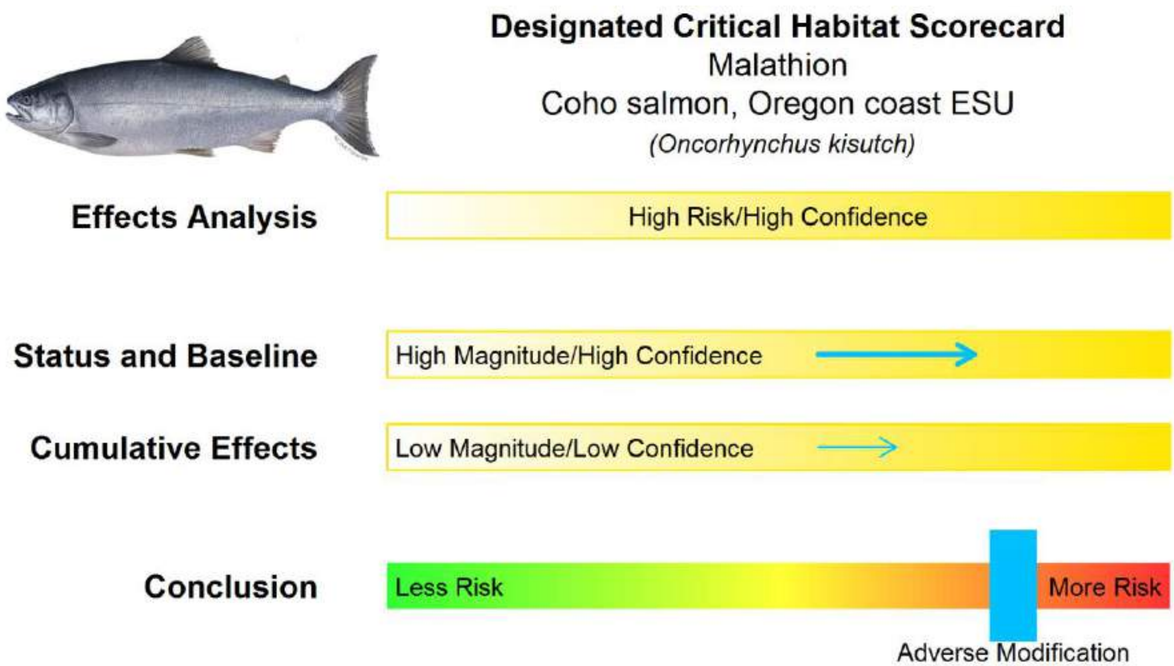

Figure 16. Designated Critical Habitat Scorecard; Coho salmon, Oregon coast ESU; Malathion

<u>Effects Analysis: High risk/High confidence</u>

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

<u>Status and Baseline: Increased risk; High magnitude/High confidence</u>

- Rearing PBFs are degraded by elevated water temperature
- All PBFs degraded by reduced water quality from contaminants and excess nutrients
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 80 assessed watersheds, 45 are of high and 27 are of medium conservation value

<u>Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence</u>

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

<u>Conclusion:</u> We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Twelve use site categories, totaling more than 630,749 acres (over 11% of critical habitat) currently overlap. Malathion may be applied anywhere in this critical habitat for mosquito control. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

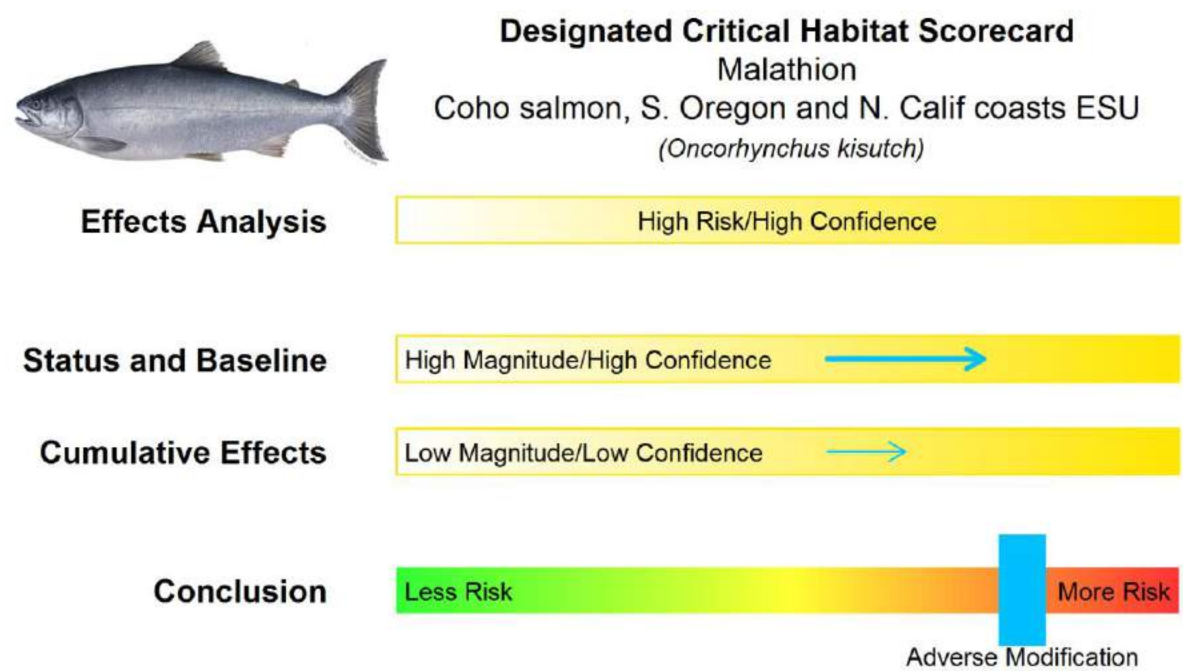

Figure 17. Designated Critical Habitat Scorecard; Coho salmon, S. Oregon and N. Calif coasts ESU; Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning PBFs are degraded by logging
- Rearing and migration PBFs degraded by loss of riparian vegetation and loss of floodplain habitat
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Eleven use site categories, totaling more than 1,037,089 acres (over 8% of critical habitat) currently overlap. Malathion may be applied anywhere in this critical habitat for mosquito control. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

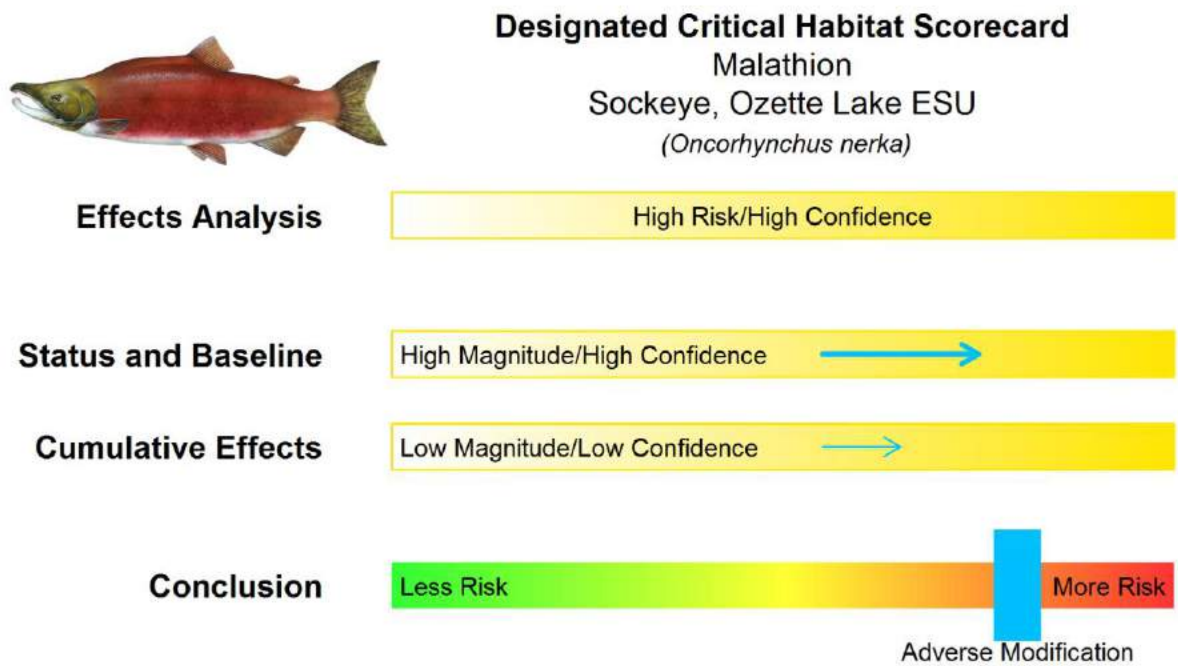

Figure 18. Designated Critical Habitat Scorecard; Sockeye, Ozette Lake ESU; Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Rearing PBFs are degraded by excessive predation, invasive species, and loss of habitat
- Spawning and migration PBFs are degraded by low water levels, loss of suitable spawning habitat, and low summer water flows
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- The entire watershed is of high conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Three use site categories, totaling more than 1,678 acres (over 3% of critical habitat) currently overlap. Malathion may be applied anywhere in this critical habitat for mosquito control. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

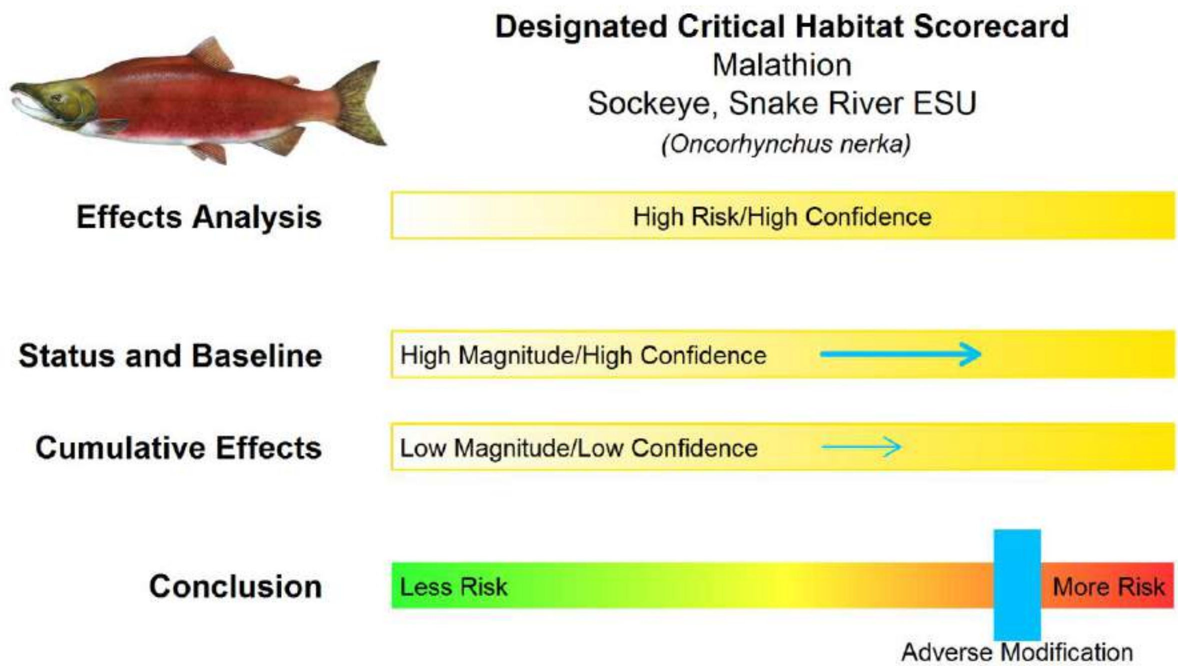

Figure 19. Designated Critical Habitat Scorecard; Sockeye, Snake River ESU; Malathion

<u>Effects Analysis: High risk/High confidence</u>

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

<u>Status and Baseline: Increased risk; High magnitude/High confidence</u>

- Rearing and migration PBFs are degraded by impaired water quality from adjacent land uses
- Migration PBFs are degraded by multiple dams
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- All occupied and used areas of the watershed are of high conservation value

<u>Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence</u>

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

<u>Conclusion:</u> We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Twelve use site categories, totaling more than 7,991,653 acres (over 24% of critical habitat) currently overlap. Malathion may be applied anywhere in this critical habitat for mosquito control. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

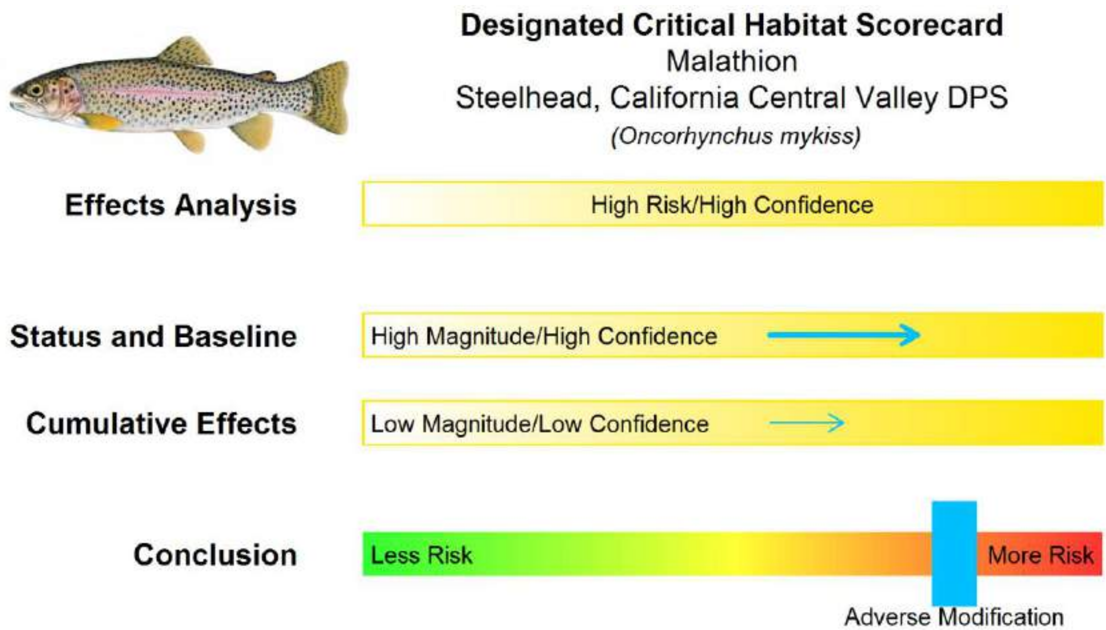

Figure 20. Designated Critical Habitat Scorecard; Steelhead, California Central Valley Distinct Population Segment (DPS); Malathion

<u>Effects Analysis: High risk/High confidence</u>

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

<u>Status and Baseline: Increased risk; High magnitude/High confidence</u>

- Spawning Physical and Biological Features (PBFs) are degraded by altered water flows and temperature
- Rearing and migration PBFs are degraded by altered riverine habitat, dense urbanization and agriculture, poor water quality, and water diversions
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 67 occupied watersheds, 37 are of high and 18 are of medium conservation value

<u>Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence</u>

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

<u>Conclusion:</u> We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Twelve use site categories, totaling more than 3,306,149 acres (over 61% of critical habitat) currently overlap. Malathion may be applied anywhere in this critical habitat for mosquito control. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

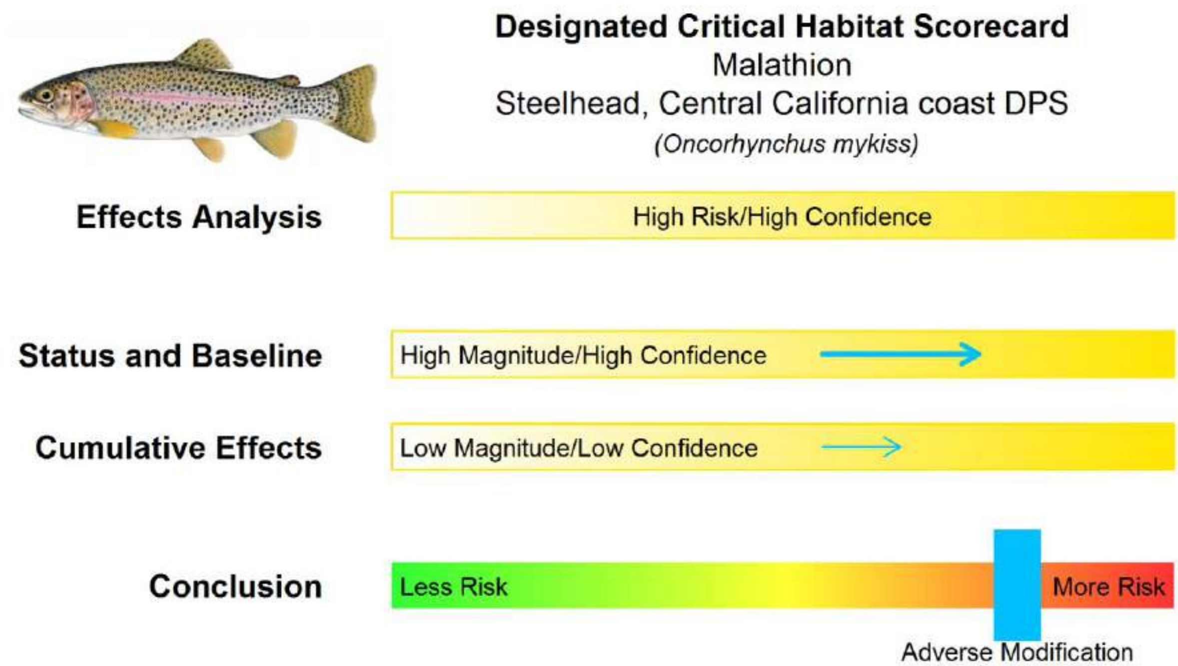

Figure 21. Designated Critical Habitat Scorecard; Steelhead, Central California coast DPS; Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning and rearing PBFs are degraded by sedimentation and elevated temperature
- All PBFs are degraded by loss of habitat, low summer flows, erosion, and contaminants
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 47 occupied watersheds, 19 are of high and 15 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Twelve use site categories, totaling more than 824,556 acres (over 28% of critical habitat) currently overlap. Malathion may be applied anywhere in this critical habitat for mosquito control. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

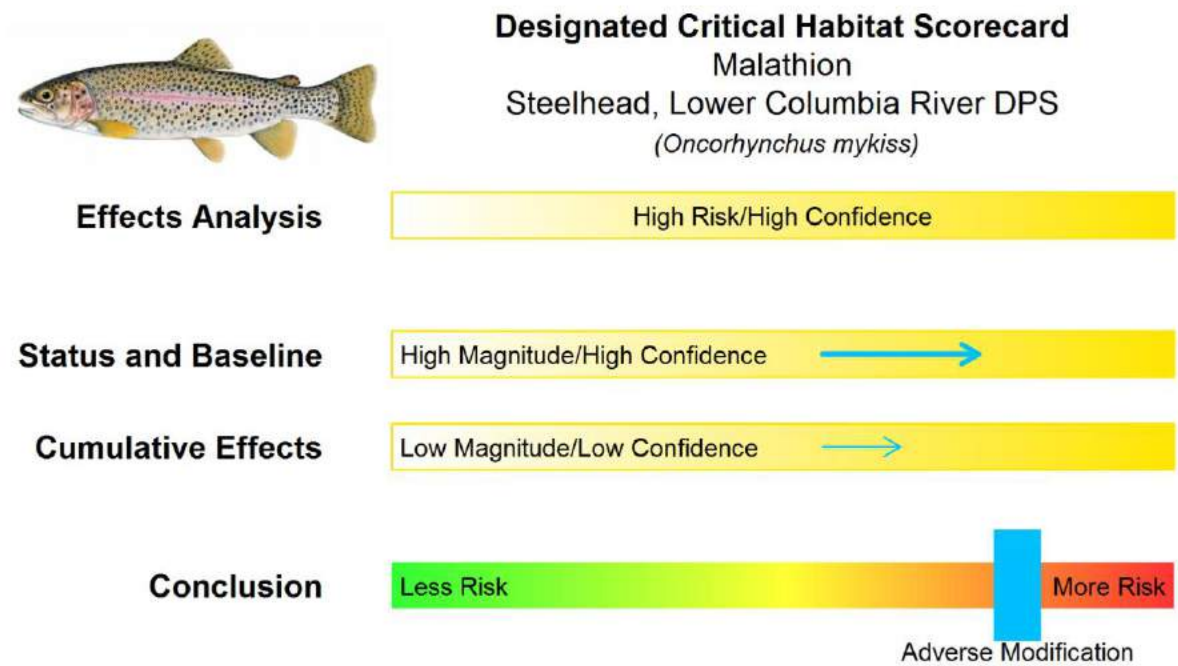

Figure 22. Designated Critical Habitat Scorecard; Steelhead, Lower Columbia River DPS; Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Rearing PBFs are degraded by agricultural runoff and lack of available prey
- Spawning, rearing and migration PBFs are degraded by timber harvests, dams, and loss of floodplain habitat
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 41 occupied watersheds, 28 are of high and 11 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Twelve use site categories, totaling more than 499,957 acres (over 8% of critical habitat) currently overlap. Malathion may be applied anywhere in this critical habitat for mosquito control. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

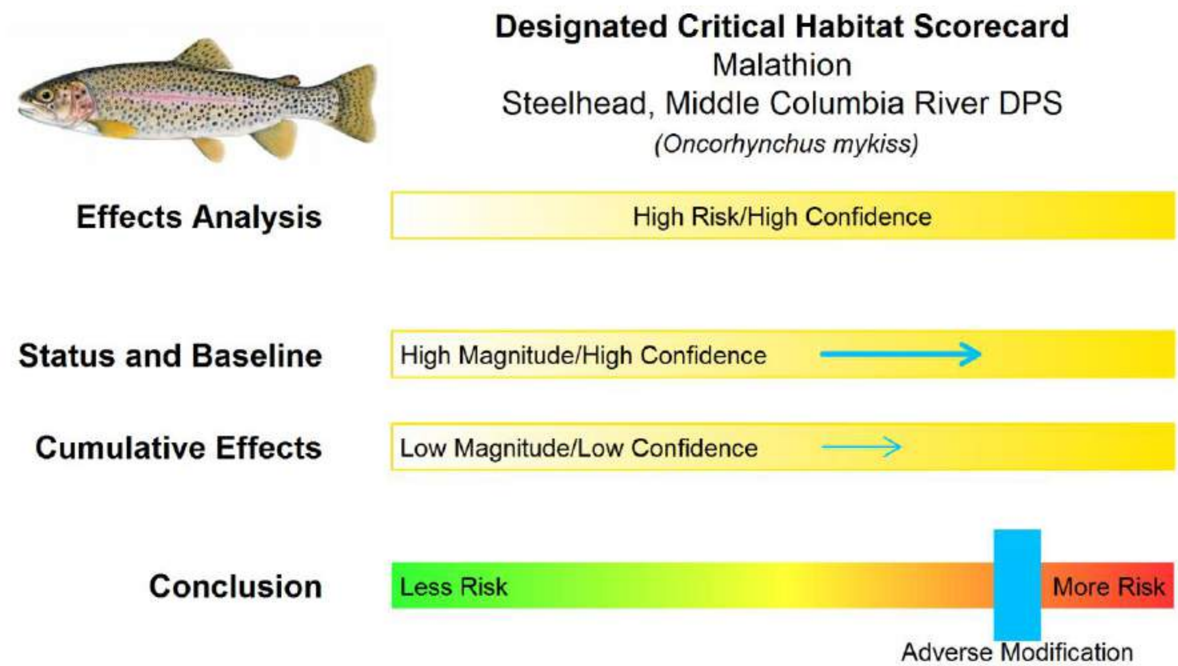

Figure 23. Designated Critical Habitat Scorecard; Steelhead, Middle Columbia River DPS; Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Rearing PBFs are degraded by water quality, reduced invertebrate prey, and loss of riparian vegetation
- Migration PBFs are degraded by several dams
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 106 assessed watersheds, 73 are of high and 24 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Twelve use site categories, totaling more than 2,483,713 acres (over 19% of critical habitat) currently overlap. Malathion may be applied anywhere in this critical habitat for mosquito control. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

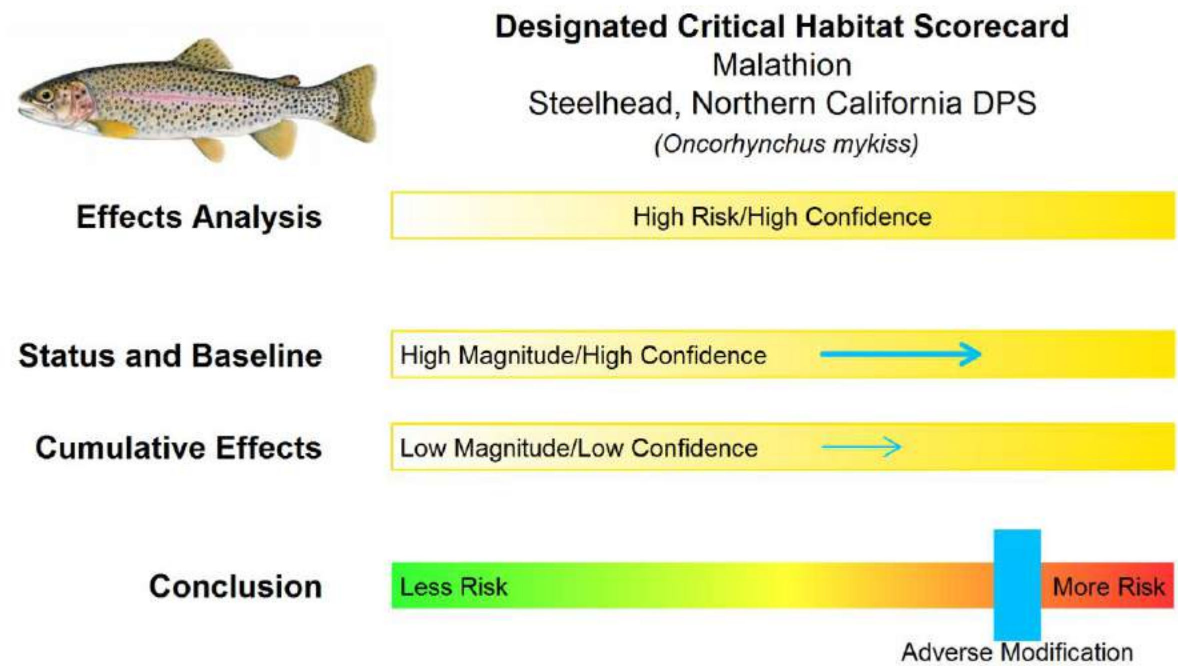

Figure 24. Designated Critical Habitat Scorecard; Steelhead, Northern California DPS; Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Rearing PBFs are degraded by loss of riparian vegetation and elevated temperature
- Spawning PBFs are degraded by lack of quality substrate and sedimentation
- Migration PBFs are degraded by bridges, culverts, and forest road construction
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 50 assessed watersheds, 27 are of high and 14 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Ten use site categories, totaling more than 413,593 acres (over 9% of critical habitat) currently overlap. Malathion may be applied anywhere in this critical habitat for mosquito control. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

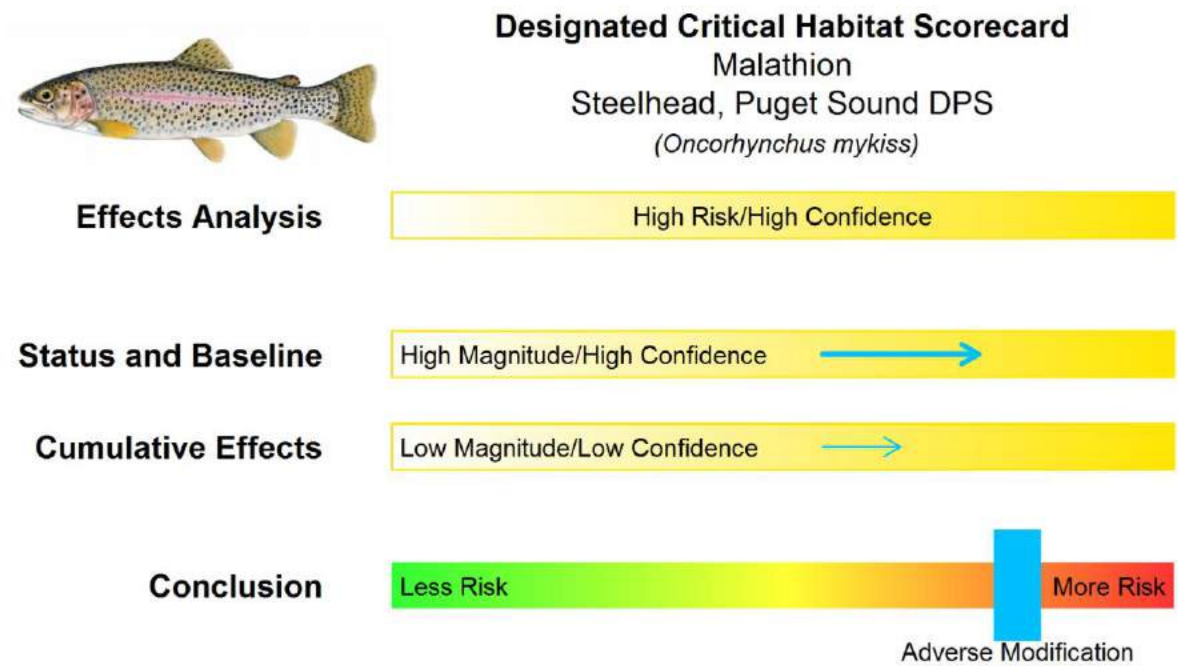

Figure 25. Designated Critical Habitat Scorecard; Steelhead, Puget Sound DPS; Malathion

<u>Effects Analysis: High risk/High confidence</u>

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

<u>Status and Baseline: Increased risk; High magnitude/High confidence</u>

- Rearing, migration and spawning PBFs are degraded by forestry, agriculture, urbanization, loss of floodplain habitat, and poor water quality
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Most watersheds are of high or medium conservation value

<u>Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence</u>

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

<u>Conclusion:</u> We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Twelve use site categories, totaling more than 7,137,589 acres (over 17% of critical habitat) currently overlap. Malathion may be applied anywhere in this critical habitat for mosquito control. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

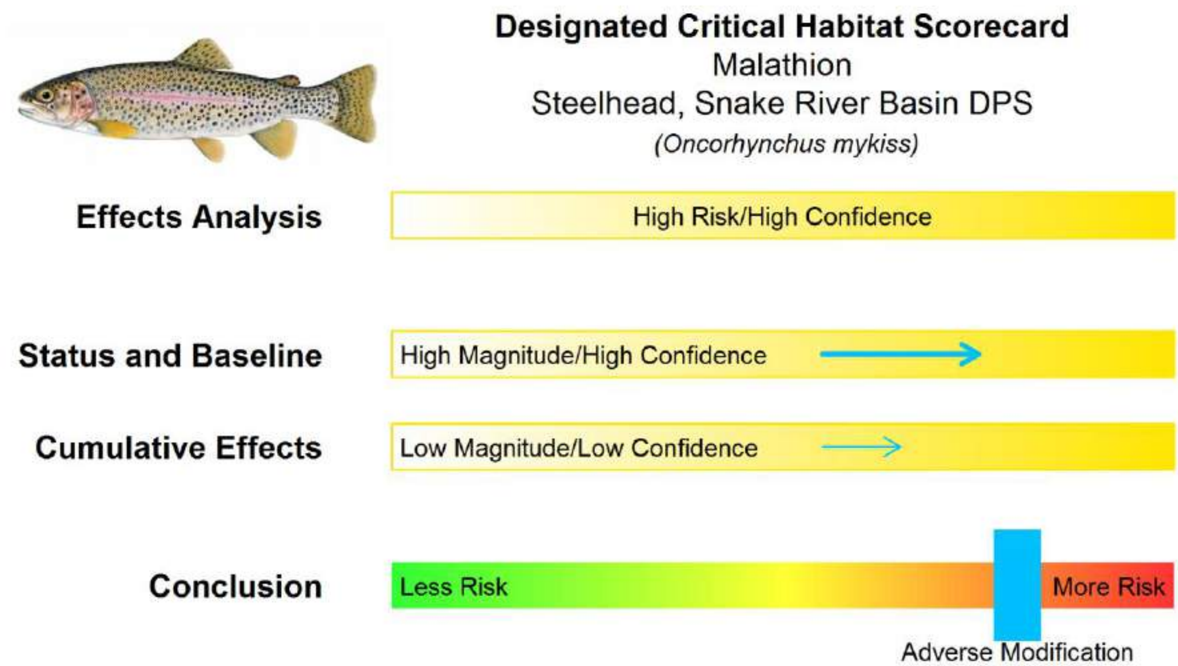

Figure 26. Designated Critical Habitat Scorecard; Steelhead, Snake River Basin DPS; Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Rearing PBFs are degraded by agricultural runoff, reduced invertebrate prey, loss of riparian vegetation, and elevated temperature
- Migration PBFs are degraded by several dams
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of assessed watersheds, 229 are of high and 41 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Twelve use site categories, totaling more than 3,622,139 acres (over 21% of critical habitat) currently overlap. Malathion may be applied anywhere in this critical habitat for mosquito control. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

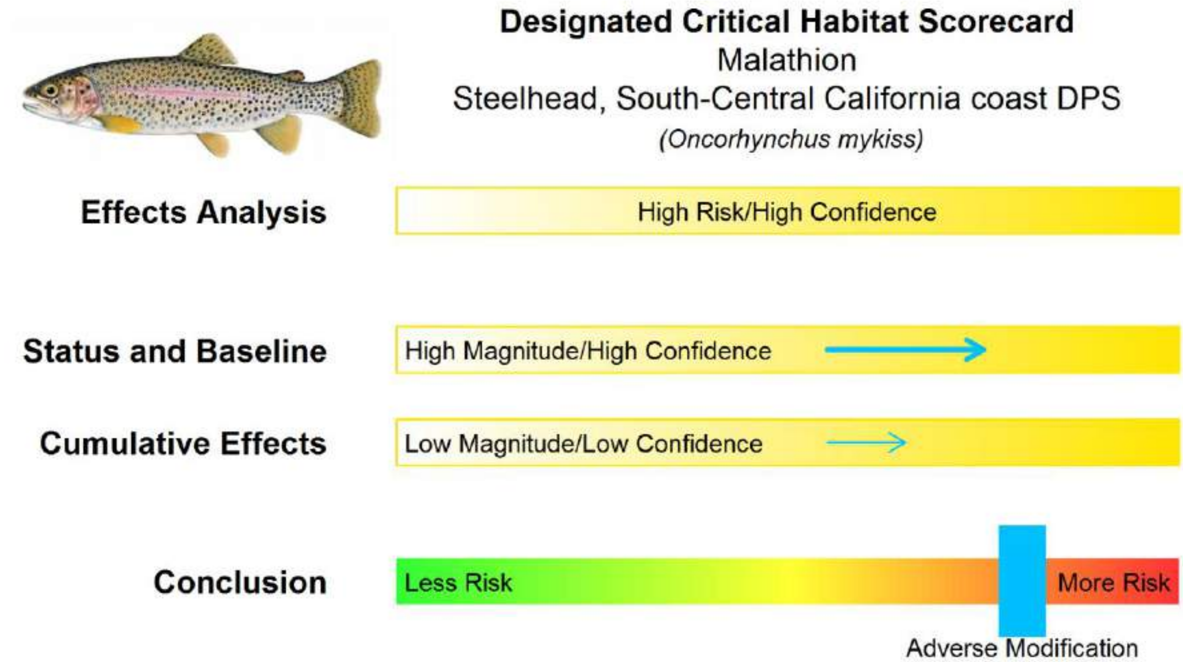

Figure 27. Designated Critical Habitat Scorecard; Steelhead, South-Central California coast DPS; Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Rearing and migration PBFs are degraded by elevated temperatures and contaminants from urban and agricultural runoff
- Estuarine PBFs are degraded by altered habitat and contaminated runoff
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 29 occupied watersheds, 12 are of high and 11 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Twelve use site categories, totaling more than 1,149,507 acres (over 35% of critical habitat) currently overlap. Malathion may be applied anywhere in this critical habitat for mosquito control. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

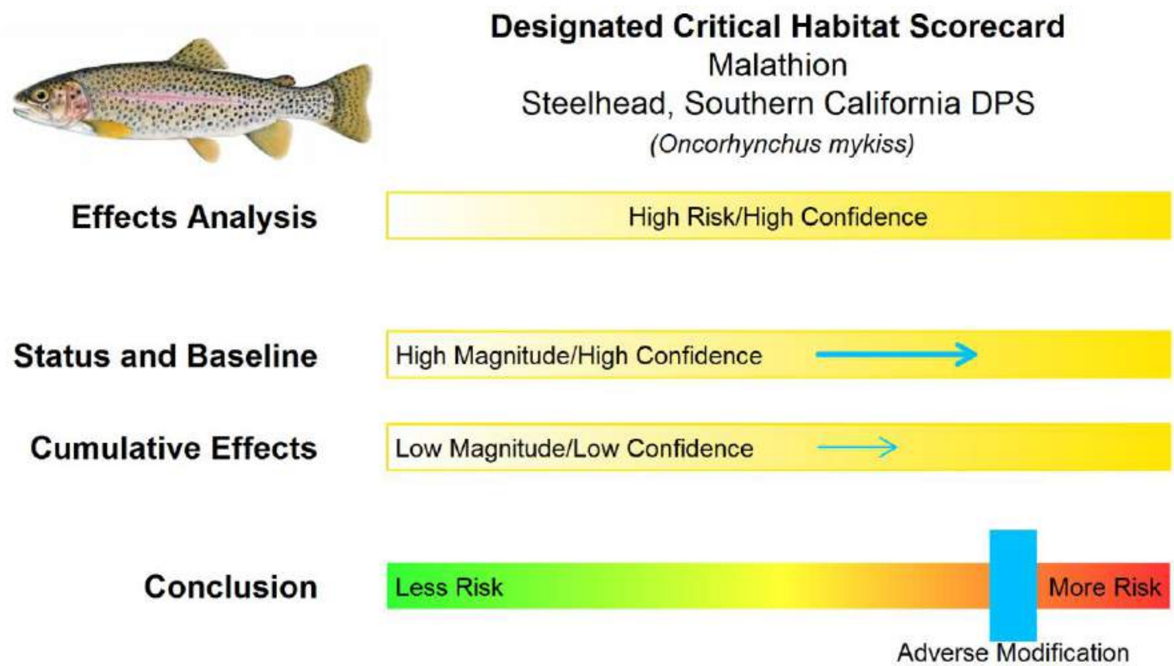

Figure 28. Designated Critical Habitat Scorecard; Steelhead, Southern California DPS; Malathion

<u>Effects Analysis: High risk/High confidence</u>

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

<u>Status and Baseline: Increased risk; High magnitude/High confidence</u>

- All PBFs are degraded by pollutants in urban and agricultural runoff, elevated temperatures, erosion, and low water flows
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 29 freshwater and estuarine watersheds, 21 are of high and 5 are of medium conservation value

<u>Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence</u>

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

<u>Conclusion:</u> We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Eleven use site categories, totaling more than 461,428 acres (over 22% of critical habitat) currently overlap. Malathion may be applied anywhere in this critical habitat for mosquito control. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

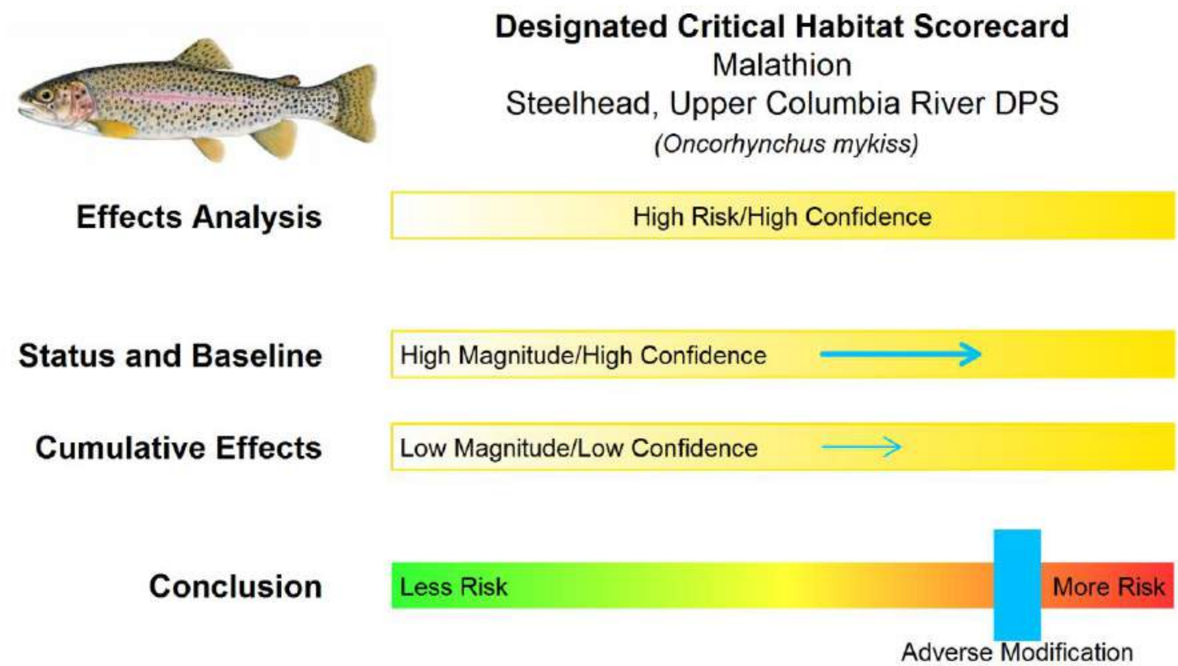

Figure 29. Designated Critical Habitat Scorecard; Steelhead, Upper Columbia River DPS; Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Rearing PBFs are degraded by agricultural runoff and lack of available prey
- Migration PBFs are degraded by several dams
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of 41 occupied watersheds, 31 are of high and 7 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Twelve use site categories, totaling more than 875,660 acres (over 20% of critical habitat) currently overlap. Malathion may be applied anywhere in this critical habitat for mosquito control. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

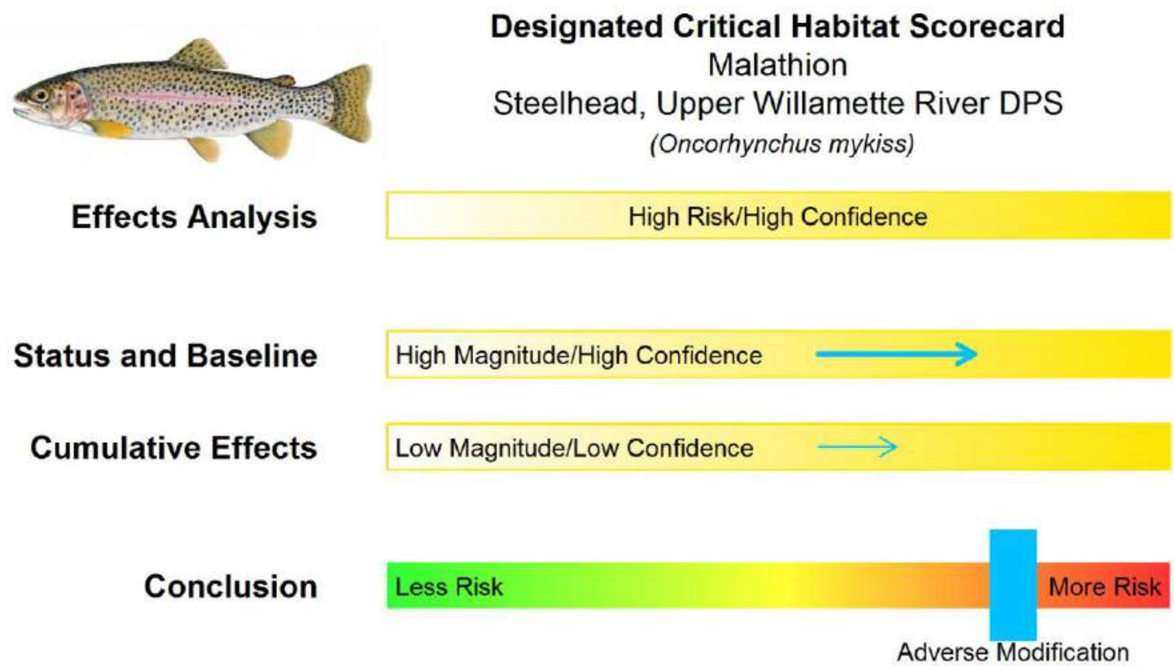

Figure 30. Designated Critical Habitat Scorecard; Steelhead, Upper Willamette River DPS; Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat
- Exposure to mixtures and elevated temperature expected to increase adverse effects
- We find high confidence of high risk due to expected exposures in freshwater habitats

Status and Baseline: Increased risk; High magnitude/High confidence

- Rearing PBFs are degraded by agricultural runoff and lack of available prey
- Migration PBFs are degraded by dams and elevated temperatures
- Elevated temperatures and environmental mixtures anticipated in freshwater habitats
- Of assessed watersheds, 14 are of high and 6 are of medium conservation value

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely; global climate change may threaten PBFs
- Anticipated hydrologic effects in freshwater areas may impact PBFs

Conclusion: We find high confidence of a high risk to this species' designated critical habitat. Critical habitat is most at risk in areas of extensive overlap with use sites. Twelve use site categories, totaling more than 982,770 acres (over 44% of critical habitat) currently overlap. Malathion may be applied anywhere in this critical habitat for mosquito control. Reductions in prey and degradation of water quality are anticipated to reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

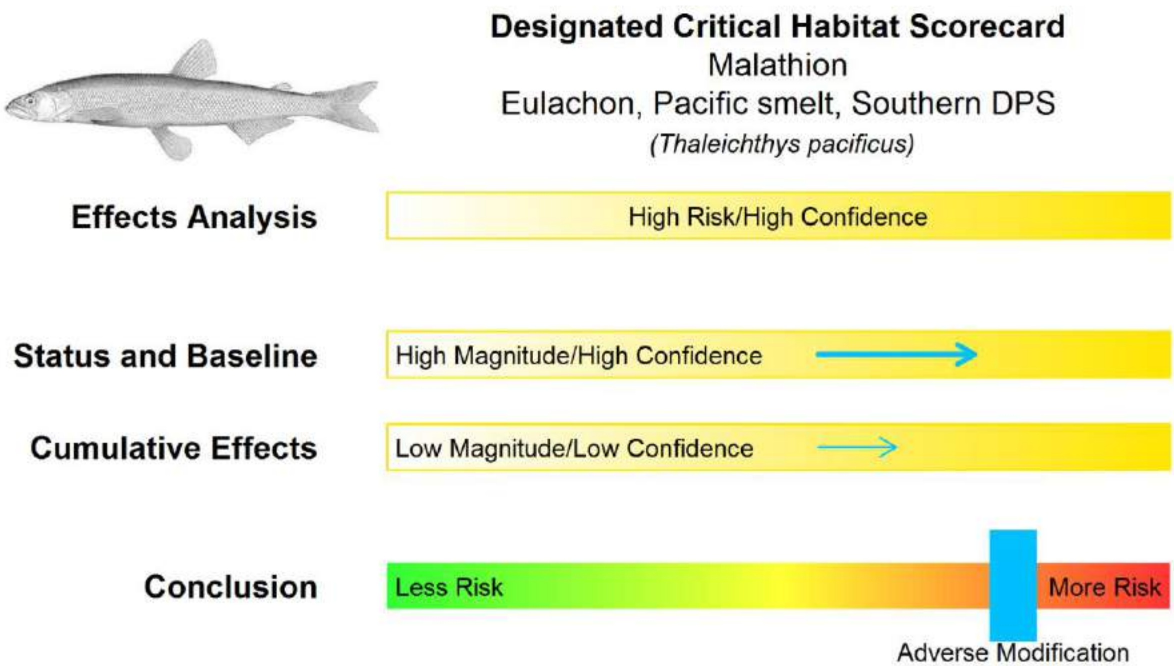

Figure 31. Designated Critical Habitat Scorecard; Eulachon, Pacific smelt, Southern DPS; Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat.
- We find high confidence of high risk due to expected exposures predicted in habitats.

Status and Baseline: Increased risk; High magnitude/High confidence

- Spawning, incubation, and rearing PBFs are degraded.
- Dams block flow and access to historical spawning grounds and are cause for degraded spawning substrates below.
- Elevated temperatures prevalent in freshwater habitats.
- Environmental mixtures anticipated in freshwater habitats may affect prey.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely. Global climate change may threaten eulachon, particularly in the southern portion of their range where ocean warming trends may be the most pronounced and may alter prey, spawning, and rearing success.
- Anticipated hydrologic changes in freshwater areas may affect PBFs.

Conclusion: We find a high likelihood of exposure and effects to designated critical habitat. Critical habitat is most at risk in areas where there is extensive overlap with use sites. Malathion may be applied anywhere in eulachon critical habitat for mosquito control. Twelve use site categories, totaling more than 99,572 acres (over 6 percent of acres) are currently present. Anticipated reductions in prey and degradation of water quality will reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

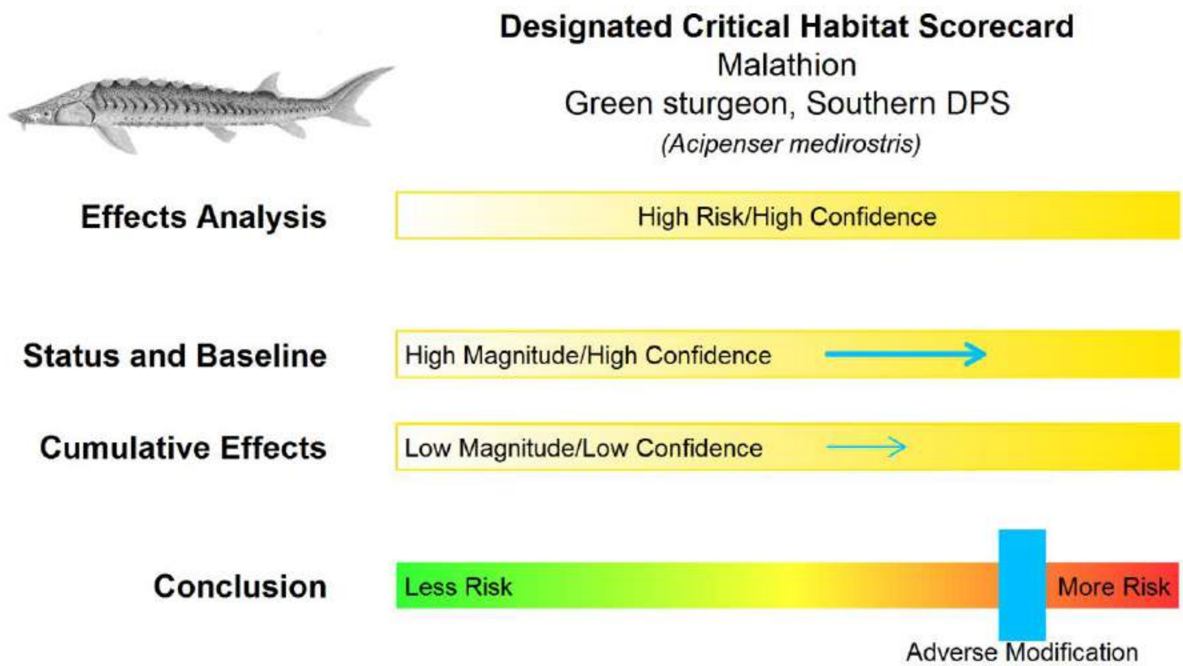

Figure 32. Designated Critical Habitat Scorecard; Green sturgeon, Southern DPS; Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey species and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat.
- We find high confidence of high risk due to expected exposures predicted in habitats.

Status and Baseline: Increased risk; High magnitude/High confidence

- Insufficient freshwater flow rates in spawning areas.
- Contaminants (e.g., pesticides) prevalent in freshwater habitat.
- Impassable barriers limit spawning to limited sections in Sacramento River.
- Elevated water temperatures persist in freshwater.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Elevated temperatures likely to remain. Global climate change may threaten PBFs.
- Anticipated hydrologic changes in freshwater areas may further affect PBFs.

Conclusion: We find a high likelihood of exposure and effects to designated critical habitat. Critical habitat is most at risk in areas where there is extensive overlap with use sites. Malathion may be applied anywhere in eulachon critical habitat for mosquito control. Thirteen use site categories, totaling more than 2,829,232 acres (over 28 percent of acres) are currently present. Anticipated reductions in prey and degradation of water quality will reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

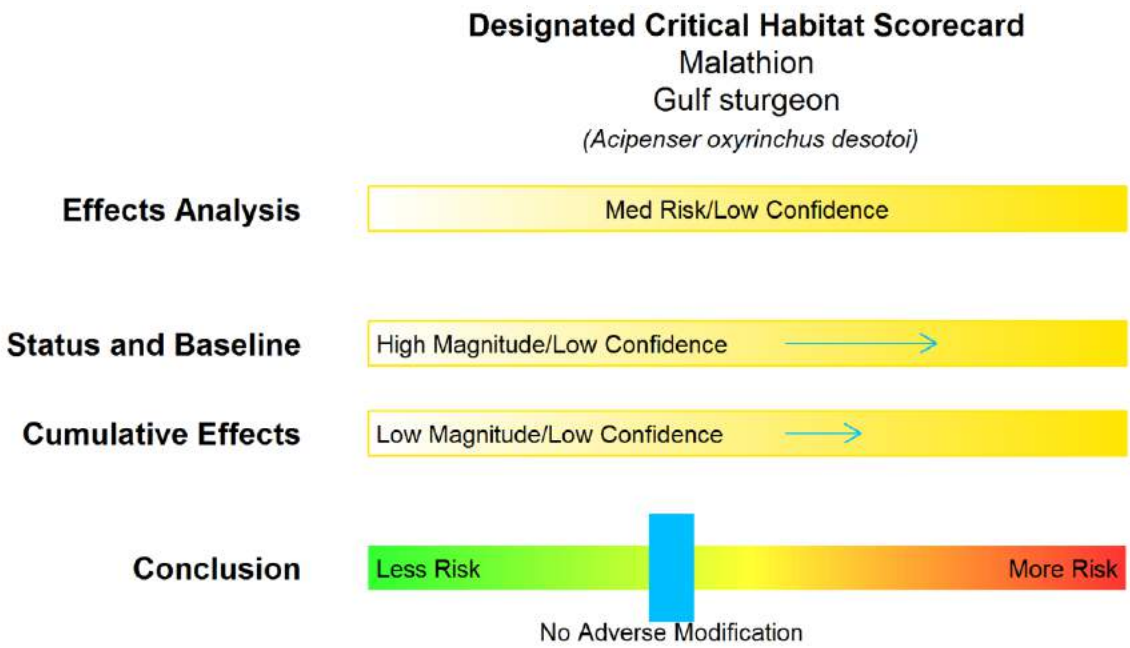

Figure 33. Designated Critical Habitat Scorecard; Gulf sturgeon; Malathion

<u>Effects Analysis: Medium risk/Low confidence</u>

- Reductions in prey species and degradation of water quality in marine habitats are not anticipated to reduce the overall conservation value of designated critical habitat.
- We find low confidence of medium risk due to exposures predicted in their marine habitats.

<u>Status and Baseline: Increased risk; High magnitude/Low confidence</u>

- Construction of water control structures, such as dams and sills exacerbated habitat loss.
- Dredging.
- Groundwater extraction, irrigation, and altered flows.
- Poor water quality.
- Contaminants, primarily from industrial sources.

<u>Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence</u>

- Global climate change may threaten PBFs.

<u>Conclusion:</u> We have low confidence in EECs predicted for the marine habitats. We find that the overall risk is medium and the confidence associated with that risk is low. We do not anticipate reductions in prey and degradation of water quality will reduce conservation values throughout the marine portion of this species designated critical habitat over the 15-year action.

Malathion is not likely to adversely modify designated critical habitat: No Adverse Modification

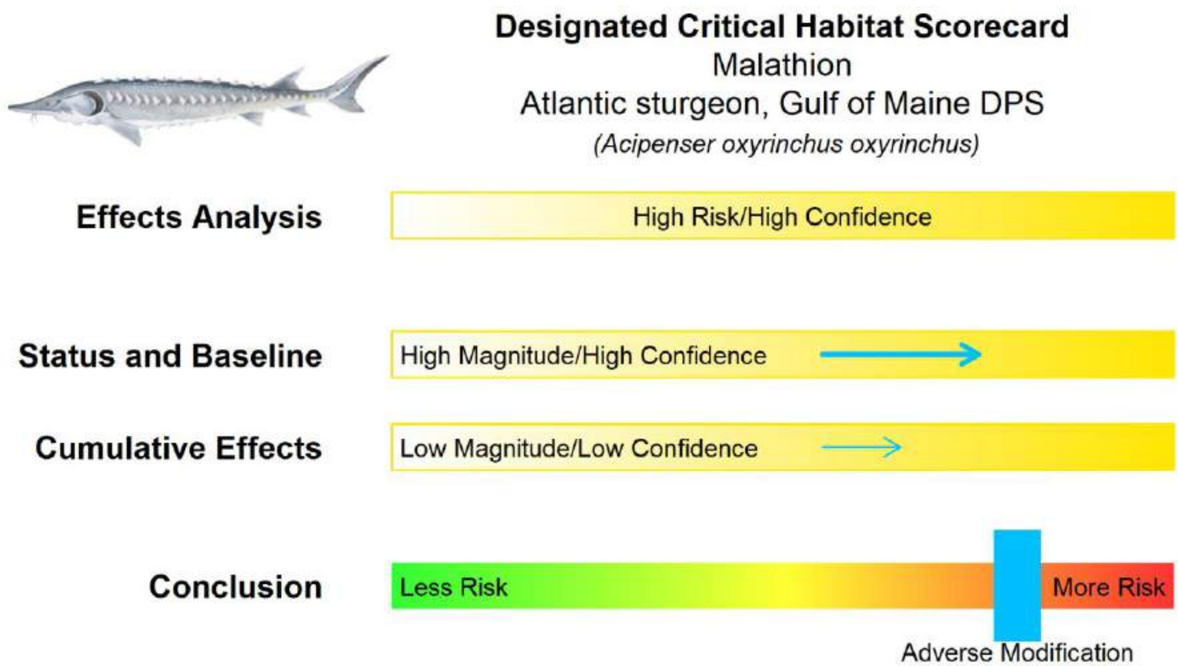

Figure 34. Designated Critical Habitat Scorecard; Atlantic sturgeon, Gulf of Maine DPS; Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey species and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat.
- We find high confidence of high risk due to expected exposures predicted in habitats.

Status and Baseline: Increased risk; High magnitude/High confidence

- Contaminants (e.g., pesticides).
- Impassable barriers limit spawning to limited sections
- Elevated water temperatures.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely. Global climate change may threaten PBFs.
- Anticipated hydrologic changes in freshwater areas may further affect PBFs.

Conclusion: We find a high likelihood of exposure and effects to designated critical habitat. Critical habitat is most at risk in areas where there is extensive overlap with use sites. Malathion may be applied anywhere in this species critical habitat for mosquito control. Anticipated reductions in prey and degradation of water quality will reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

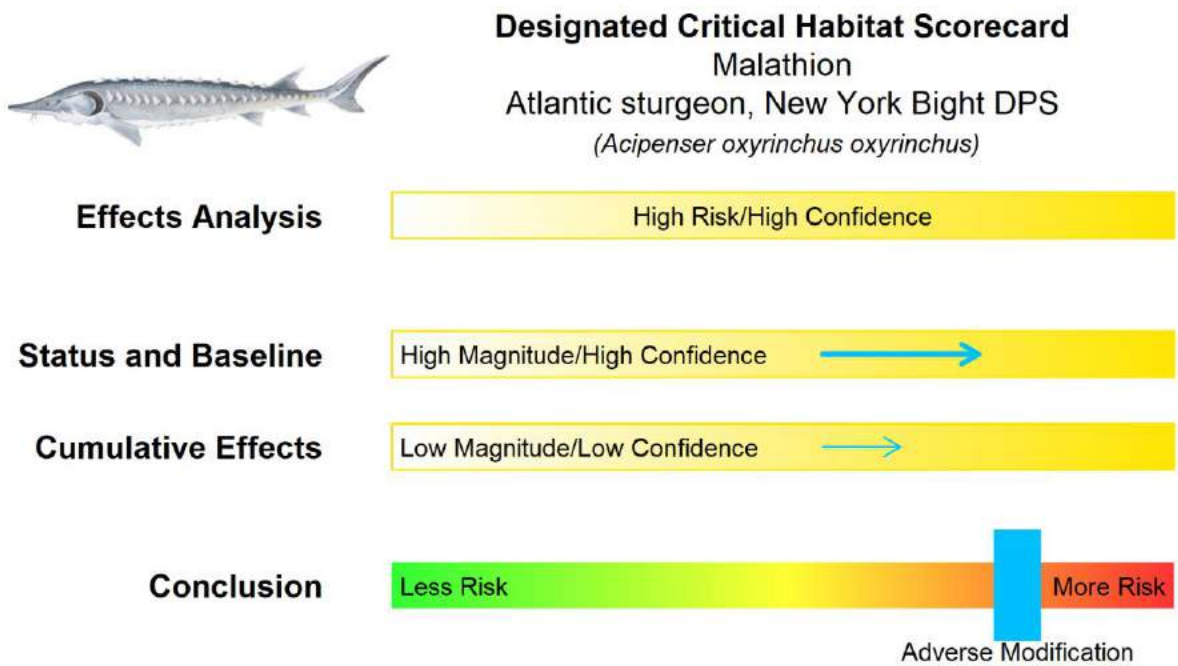

Figure 35. Designated Critical Habitat Scorecard; Atlantic sturgeon, New York Bight DPS; Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey species and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat.
- We find high confidence of high risk due to expected exposures predicted in habitats.

Status and Baseline: Increased risk; High magnitude/High confidence

- Contaminants (e.g., pesticides).
- Impassable barriers limit spawning to limited sections
- Elevated water temperatures.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely. Global climate change may threaten PBFs.
- Anticipated hydrologic changes in freshwater areas may further affect PBFs.

Conclusion: We find a high likelihood of exposure and effects to designated critical habitat. Critical habitat is most at risk in areas where there is extensive overlap with use sites. Malathion may be applied anywhere in this species critical habitat for mosquito control. Anticipated reductions in prey and degradation of water quality will reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

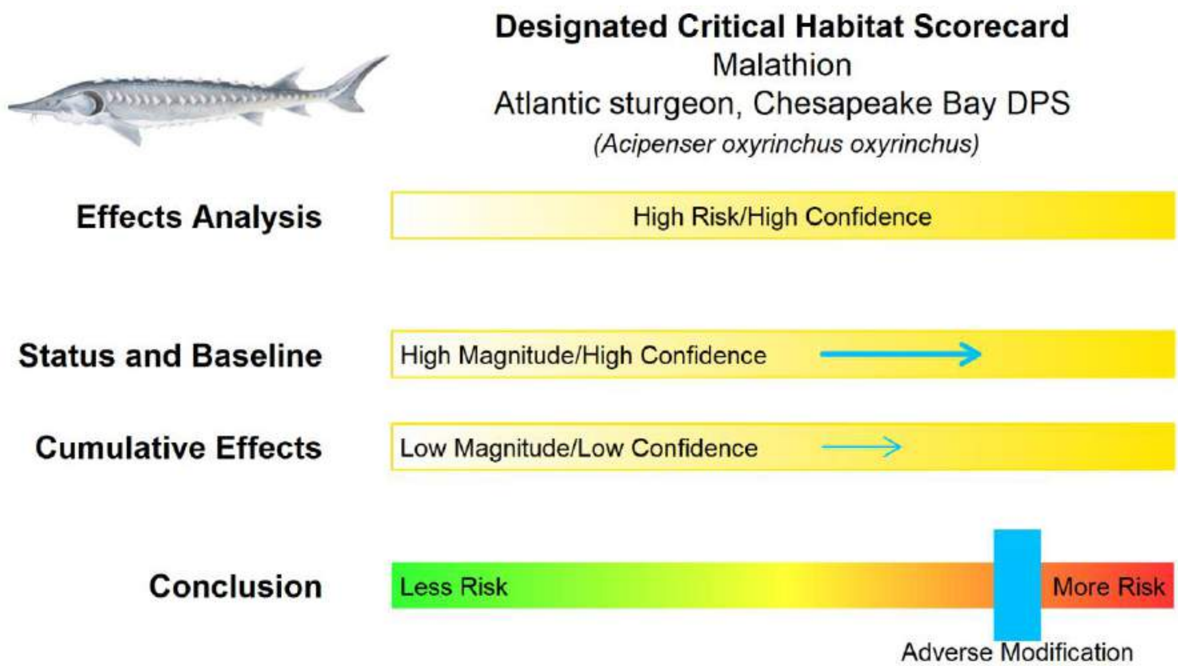

Figure 36. Designated Critical Habitat Scorecard; Atlantic sturgeon, Chesapeake Bay DPS; Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey species and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat.
- We find high confidence of high risk due to expected exposures predicted in habitats.

Status and Baseline: Increased risk; High magnitude/High confidence

- Contaminants (e.g., pesticides).
- Impassable barriers limit spawning to limited sections
- Elevated water temperatures.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely. Global climate change may threaten PBFs.
- Anticipated hydrologic changes in freshwater areas may further affect PBFs.

Conclusion: We find a high likelihood of exposure and effects to designated critical habitat. Critical habitat is most at risk in areas where there is extensive overlap with use sites. Malathion may be applied anywhere in this species critical habitat for mosquito control. Anticipated reductions in prey and degradation of water quality will reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

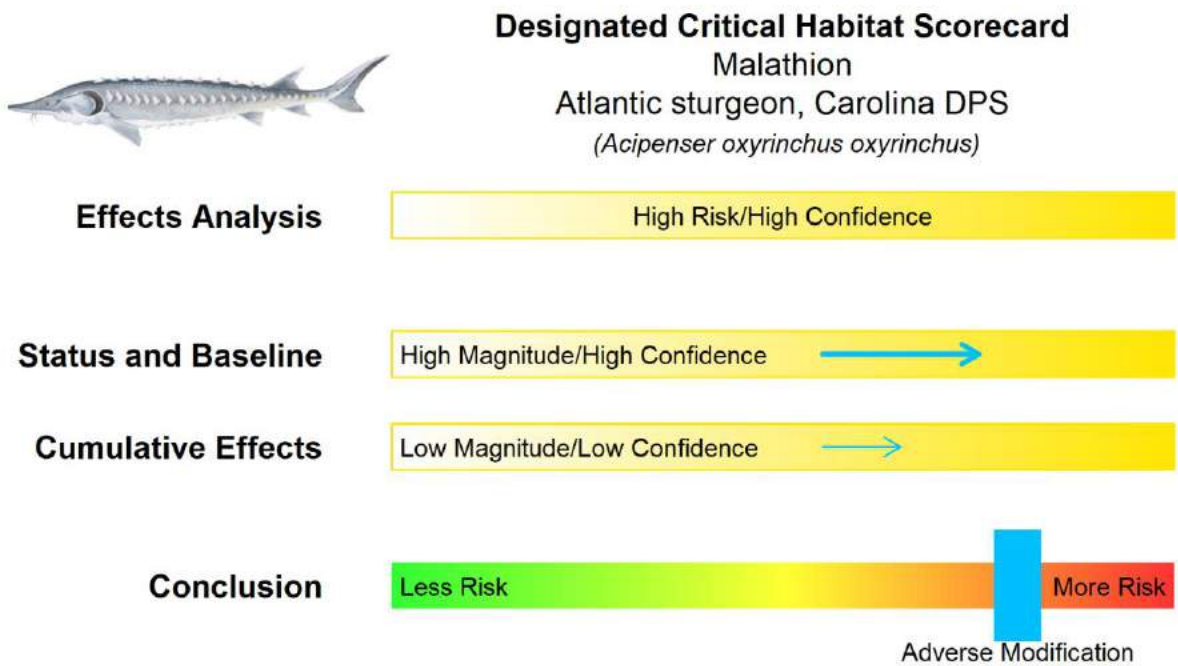

Figure 37. Designated Critical Habitat Scorecard; Atlantic sturgeon, Carolina DPS, Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey species and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat.
- We find high confidence of high risk due to expected exposures predicted in habitats.

Status and Baseline: Increased risk; High magnitude/High confidence

- Contaminants (e.g., pesticides).
- Impassable barriers limit spawning to limited sections
- Elevated water temperatures.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely. Global climate change may threaten PBFs.
- Anticipated hydrologic changes in freshwater areas may further affect PBFs.

Conclusion: We find a high likelihood of exposure and effects to designated critical habitat. Critical habitat is most at risk in areas where there is extensive overlap with use sites. Malathion may be applied anywhere in this species critical habitat for mosquito control. Anticipated reductions in prey and degradation of water quality will reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

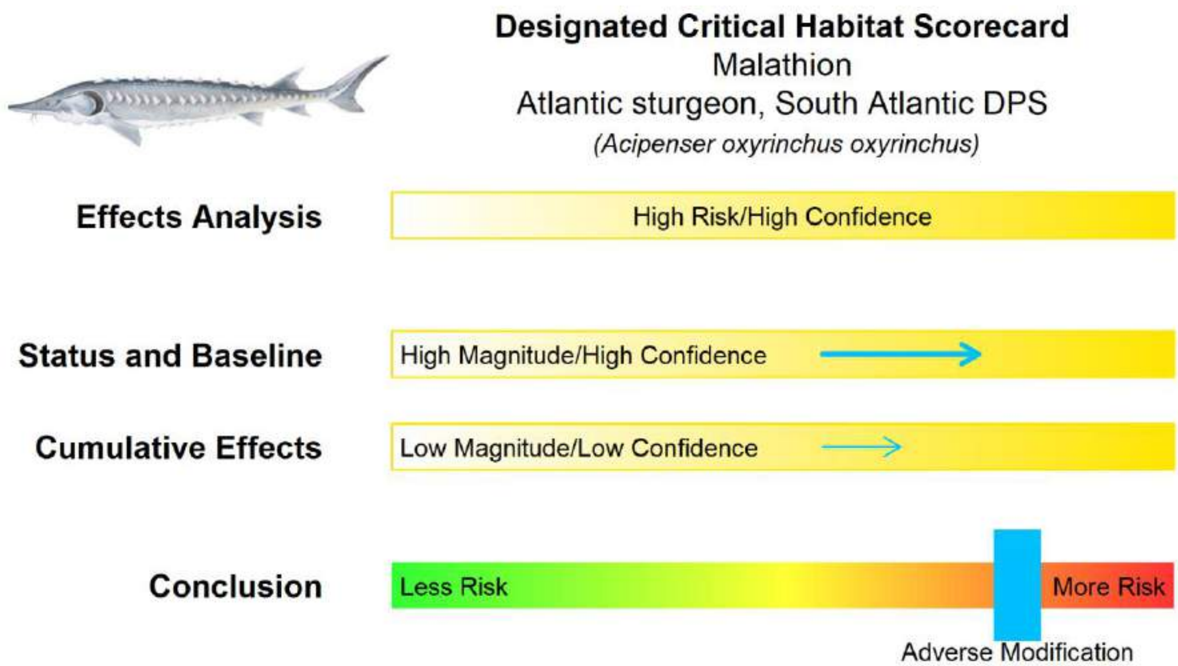

Figure 38. Designated Critical Habitat Scorecard; Atlantic sturgeon, South Atlantic DPS; Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey species and degradation of water quality are likely to reduce the overall conservation value of designated critical habitat.
- We find high confidence of high risk due to expected exposures predicted in habitats.

Status and Baseline: Increased risk; High magnitude/High confidence

- Contaminants (e.g., pesticides).
- Impassable barriers limit spawning to limited sections
- Elevated water temperatures.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future elevated temperatures likely. Global climate change may threaten PBFs.
- Anticipated hydrologic changes in freshwater areas may further affect PBFs.

Conclusion: We find a high likelihood of exposure and effects to designated critical habitat. Critical habitat is most at risk in areas where there is extensive overlap with use sites. Malathion may be applied anywhere in this species critical habitat for mosquito control. Anticipated reductions in prey and degradation of water quality will reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

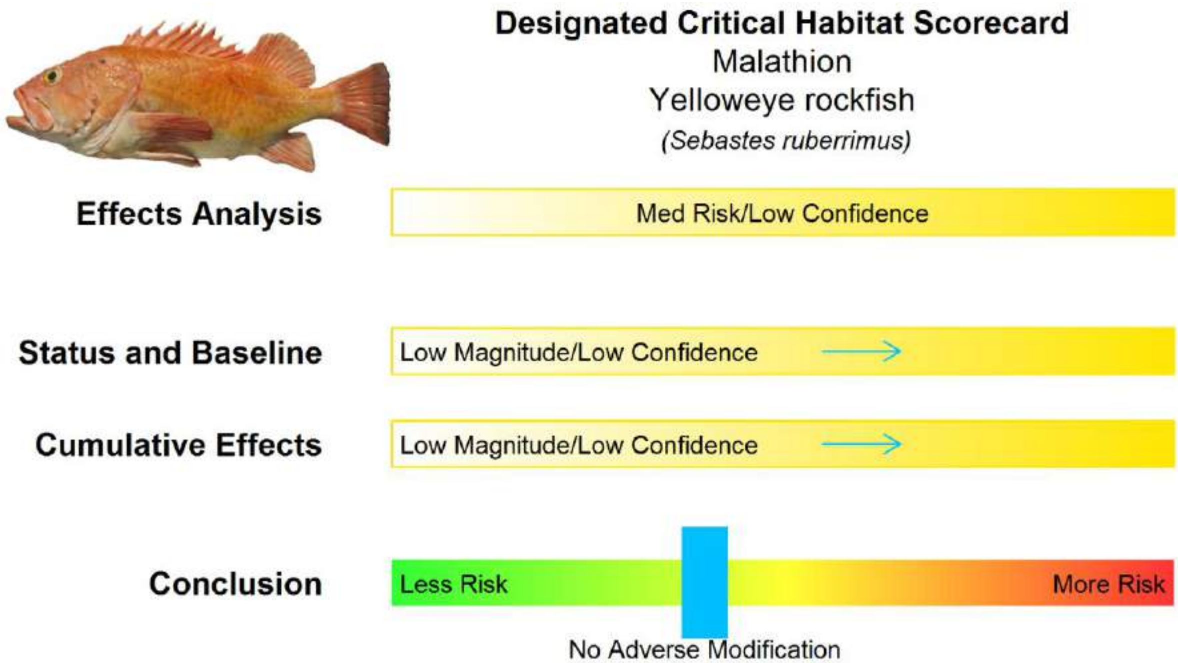

Figure 39. Designated Critical Habitat Scorecard; Yelloweye rockfish; Malathion

Effects Analysis: Medium risk/Low confidence

- Reductions in prey species and degradation of water quality in marine habitats are not anticipated to reduce the overall conservation value of designated critical habitat.
- We find low confidence of medium risk due to exposures predicted in their marine habitats.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Adverse environmental factors have led to prey reductions and recruitment failures.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions brought about by climate change may threaten PBFs.

Conclusion: We have low confidence in EECs predicted for the marine habitats. We find that the overall risk is medium and the confidence associated with that risk is low. We do not anticipate reductions in prey and degradation of water quality will reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is not likely to adversely modify designated critical habitat: No Adverse Modification

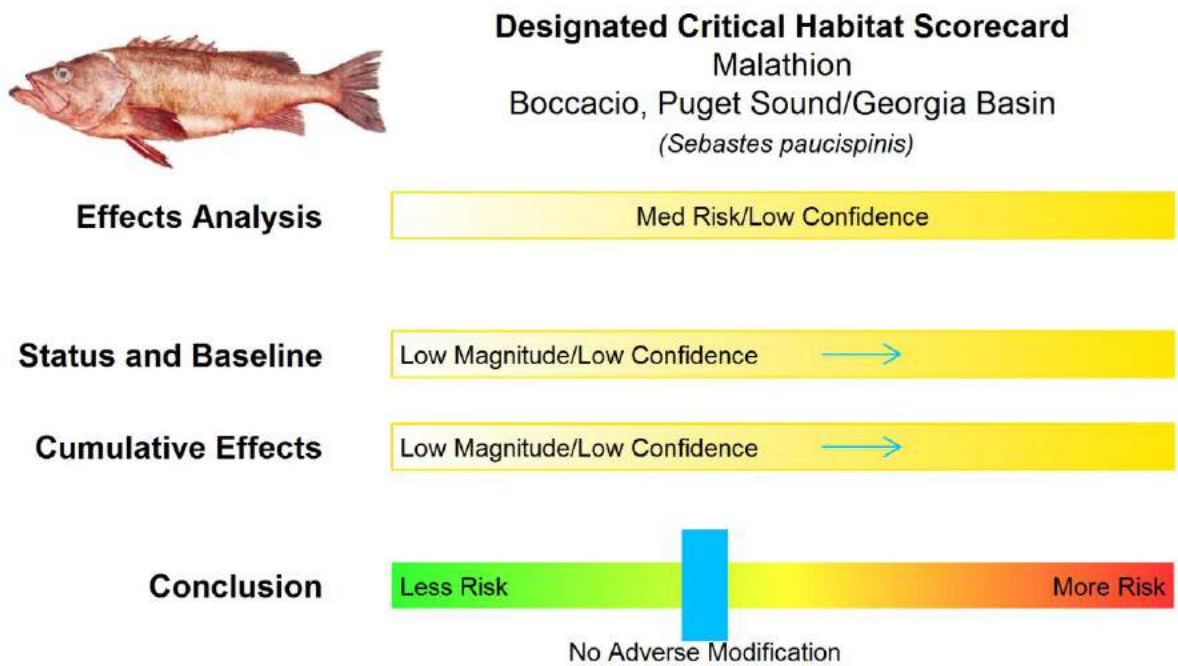

Figure 40. Designated Critical Habitat Scorecard; Boccacio, Puget Sound/Georgia Basin; Malathion

Effects Analysis: Medium risk/Low confidence

- Reductions in prey species and degradation of water quality in marine habitats are not anticipated to reduce the overall conservation value of designated critical habitat.
- We find low confidence of medium risk due to exposures predicted in their marine habitats.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Adverse environmental factors have led to prey reductions and recruitment failures.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions brought about by climate change may threaten PBFs.

Conclusion: We have low confidence in EECs predicted for the marine habitats. We find that the overall risk is medium and the confidence associated with that risk is low. We do not anticipate reductions in prey and degradation of water quality will reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is not likely to adversely modify designated critical habitat: No Adverse Modification

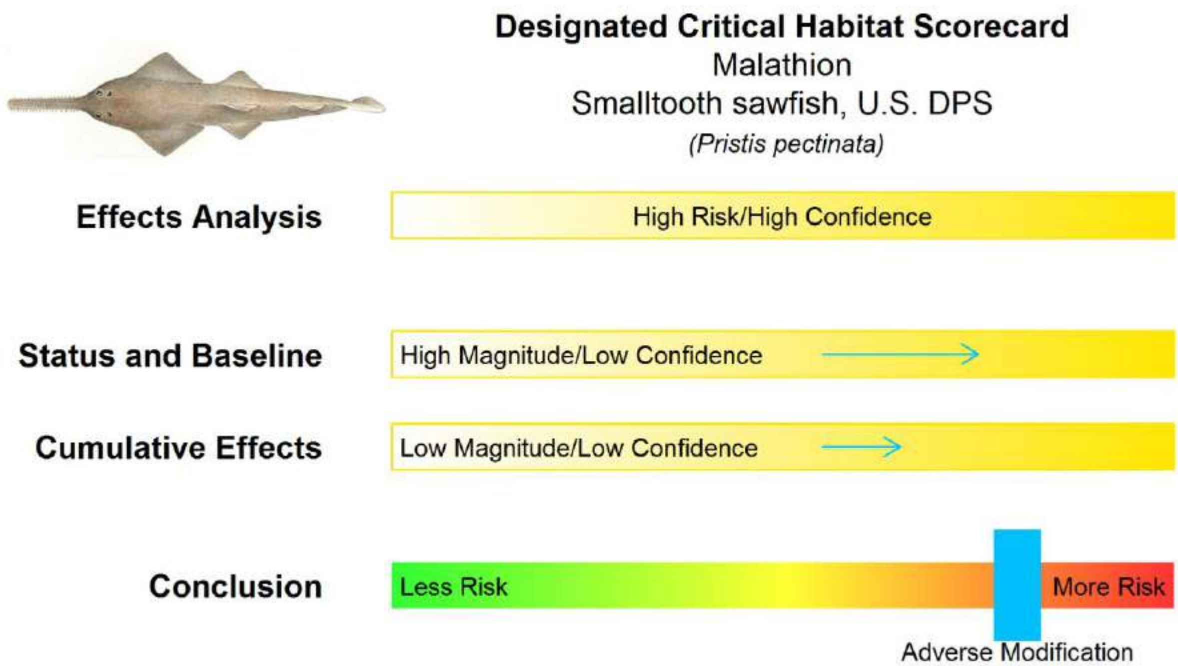

Figure 41. Designated Critical Habitat Scorecard; Smalltooth sawfish, U.S. DPS; Malathion

Effects Analysis: High risk/High confidence

- Reductions in prey species are likely to reduce the overall conservation value of designated critical habitat.
- We find high confidence of high risk due to expected exposures predicted in habitats.

Status and Baseline: Increased risk; High magnitude/Low confidence

- Loss and degradation of female pupping sites and juvenile rearing habitats.
- Point and non-point contaminants.
- Marine Debris.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Future losses in vegetated shallow water habitats from developmental pressures, changes in ocean conditions, and hydrology may further threaten PBFs.

Conclusion: We find a high likelihood of exposure and effects to designated critical habitat. Critical habitat is most at risk in areas where there is extensive overlap with use sites. Malathion may be applied anywhere in this species critical habitat for mosquito control. Eight use site categories, totaling more than 249,000 acres (over 8 percent of acres) are currently present in land adjacent to designated critical habitat. Anticipated reductions in prey will reduce conservation values throughout designated critical habitat over the 15-year action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

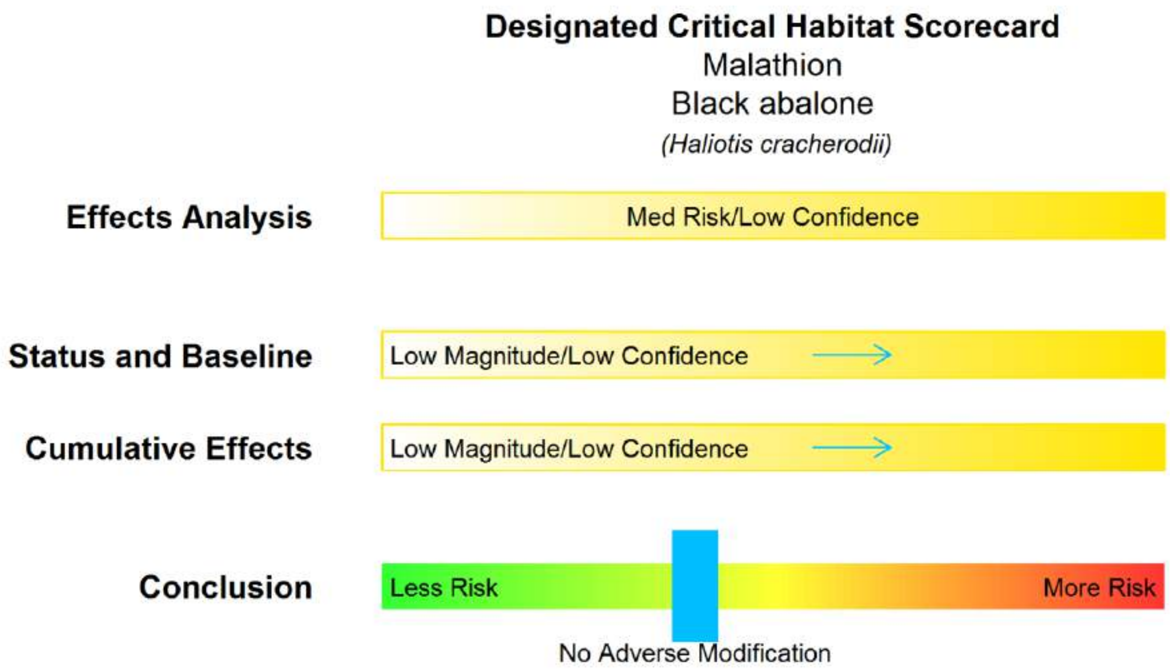

Figure 42. Designated Critical Habitat Scorecard; Black abalone; Malathion

Effects Analysis: Medium risk/Low confidence

- We do not anticipate reductions in prey species and degradation of water quality in marine nearshore and inter-tidal habitats to reduce the overall conservation value of designated critical habitat.
- We find low confidence of medium risk due to exposures predicted.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Habitat destruction.
- Disease.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Developmental pressures could reduce available habitat and create competition for space with other marine invertebrates.
- Changes in ocean conditions (ocean acidification) may threaten PBFs.

Conclusion: The stressors of the action may negatively affect relevant physical and biological features within nearshore habitats. However, we have low confidence in the EECs predicted for the marine nearshore habitats. We do not anticipate that the stressors of the action will reduce the overall conservation value of the designated critical habitat of Black Abalone. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.

Malathion is not likely to adversely modify designated critical habitat: No Adverse Modification

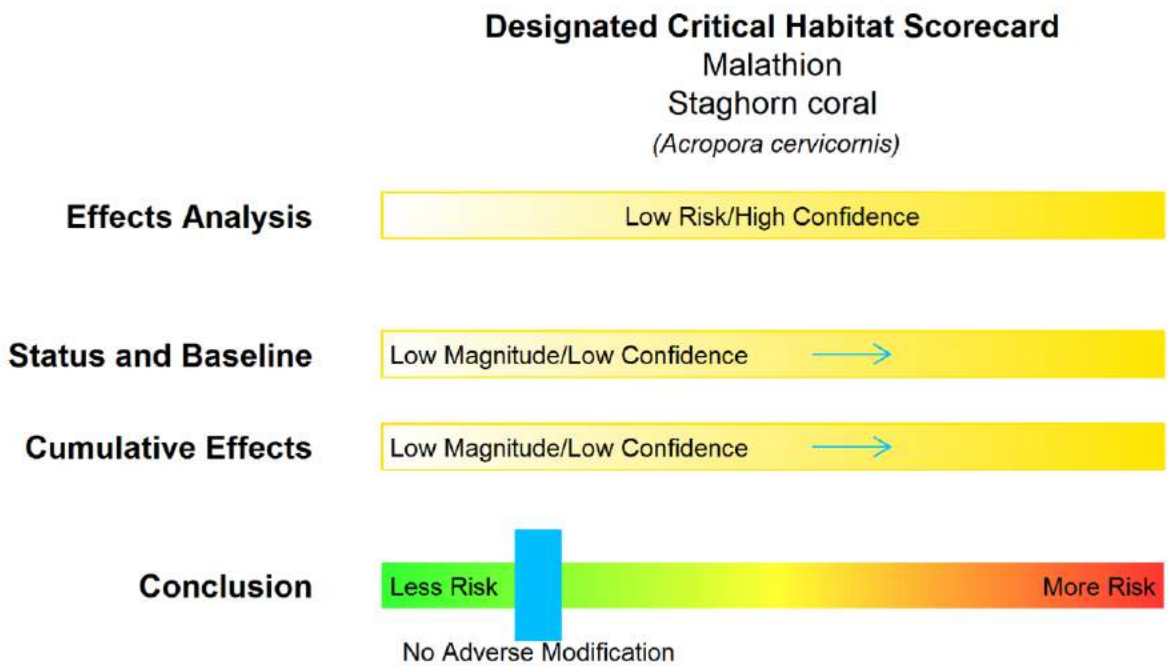

Figure 43. Designated Critical Habitat Scorecard; Staghorn coral; Malathion

Effects Analysis: Low risk/High confidence

- We do not anticipate reductions in PBFs or reductions in the overall conservation value of designated critical habitat.
- We find high confidence of low risk due to exposures predicted and PBFs identified.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Disease (white band).
- Habitat destruction.
- Bleaching (temperature variations).
- Sedimentation.
- Algal overgrowth (nutrification).

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions (e.g. increased water temperture and acidification) may threaten PBFs.

Conclusion: There are no physical and biological features identified in Staghorn Coral designated critical habitat that could be affected by the proposed action. We find that the overall risk is low and the confidence associated with that risk is high over the 15-year duration of the action.

Malathion is not likely to adversely modify designated critical habitat: No Adverse Modification

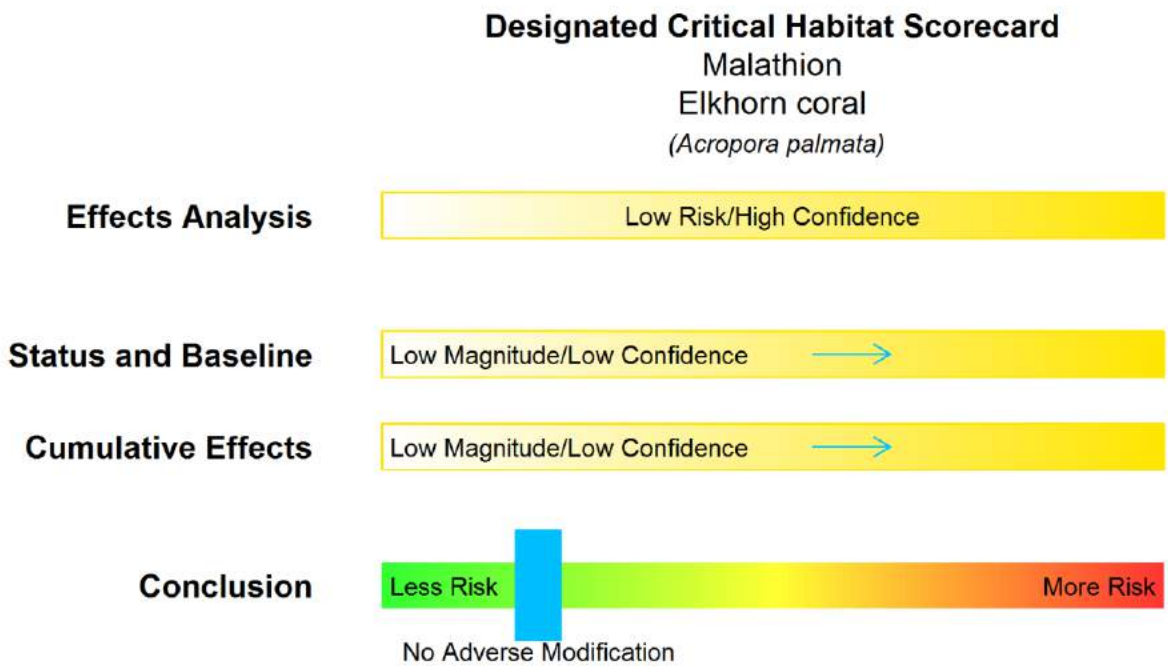

Figure 44. Designated Critical Habitat Scorecard; Elkhorn coral; Malathion

Effects Analysis: Low risk/High confidence

- We do not anticipate reductions in PBFs or reductions in the overall conservation value of designated critical habitat.
- We find high confidence of low risk due to exposures predicted and PBFs identified.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Disease (white band).
- Habitat destruction.
- Bleaching (temperature variations).
- Sedimentation.
- Algal overgrowth (nutrification).

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions (e.g. increased water temperature and acidification) may threaten PBFs.

Conclusion: There are no physical and biological features identified in Elkhorn Coral designated critical habitat that could be affected by the proposed action. We find that the overall risk is low and the confidence associated with that risk is high over the 15-year duration of the action.

Malathion is not likely to adversely modify designated critical habitat: No Adverse Modification

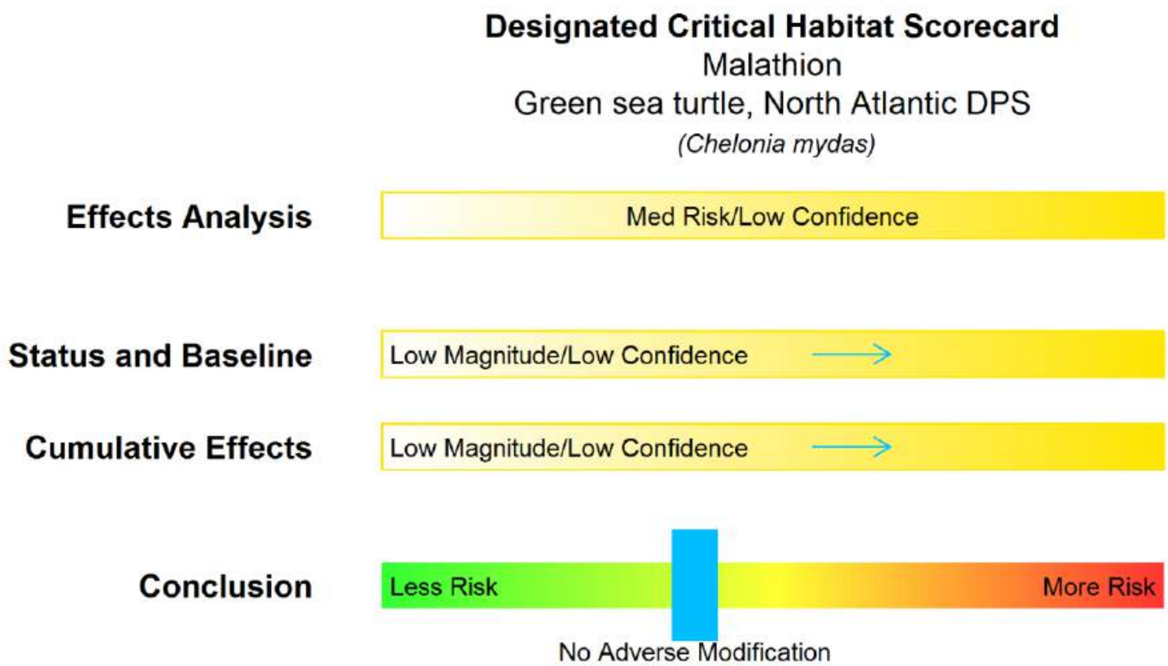

Figure 45. Designated Critical Habitat Scorecard; Green sea turtle, North Atlantic DPS; Malathion

Effects Analysis: Medium risk/Low confidence

- We do not anticipate reductions in water quality in marine and nearshore habitats to reduce the overall conservation value of designated critical habitat.
- We find low confidence of medium risk due to exposures predicted.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Disease.
- Point and non-point pollution.
- Marine debris continues to build in critical habitat.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions may threaten PBFs.
- Increased coastal construction may threaten PBFs.

Conclusion: The stressors of the action may negatively affect relevant physical or biological features within marine and nearshore habitats. However, we have low confidence in the EECs predicted for the marine nearshore habitats. We do not anticipate that the stressors of the action will reduce the overall conservation value of the designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.

Malathion is not likely to adversely modify designated critical habitat: No Adverse Modification

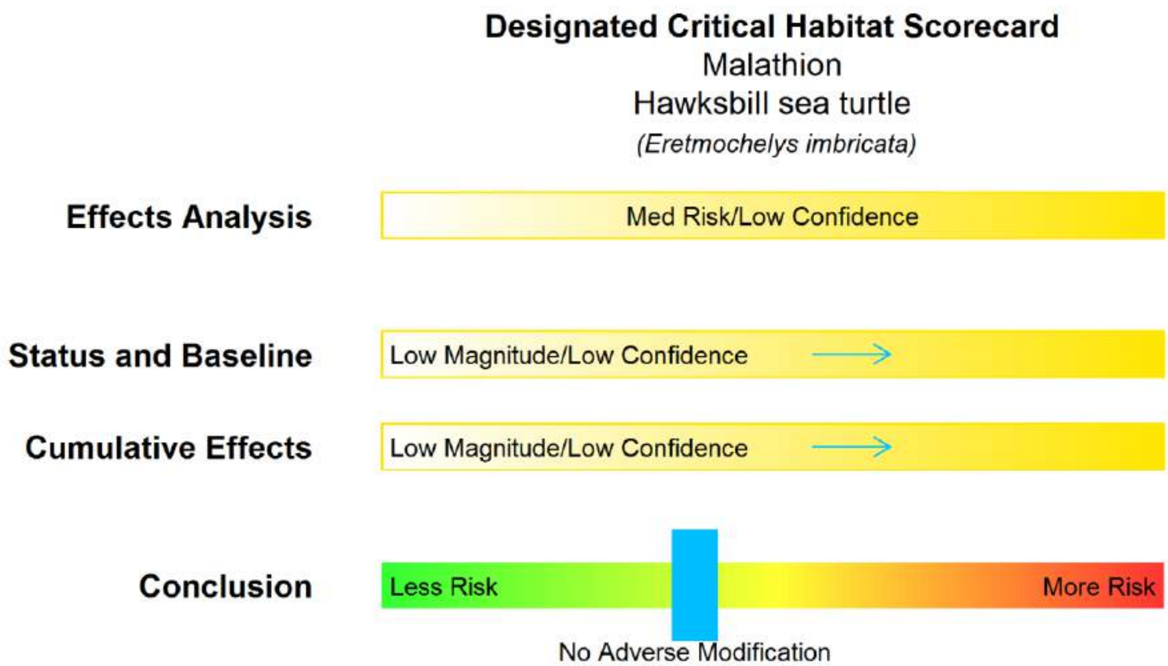

Figure 46. Designated Critical Habitat Scorecard; Hawksbill sea turtle; Malathion

Effects Analysis: Medium risk/Low confidence

- We do not anticipate reductions in water quality in marine and nearshore habitats to reduce the overall conservation value of designated critical habitat.
- We find low confidence of medium risk due to exposures predicted.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Disease.
- Point and non-point pollution.
- Marine debris.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions brought about by climate change may threaten PBFs.
- Increased coastal construction may threaten PBFs.

Conclusion: The stressors of the action may negatively affect relevant physical and biological features within marine and nearshore habitats. However, we have low confidence in the EECs predicted for the marine nearshore habitats. We do not anticipate that the stressors of the action will reduce the overall conservation value of the designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.

Malathion is not likely to adversely modify designated critical habitat: No Adverse Modification

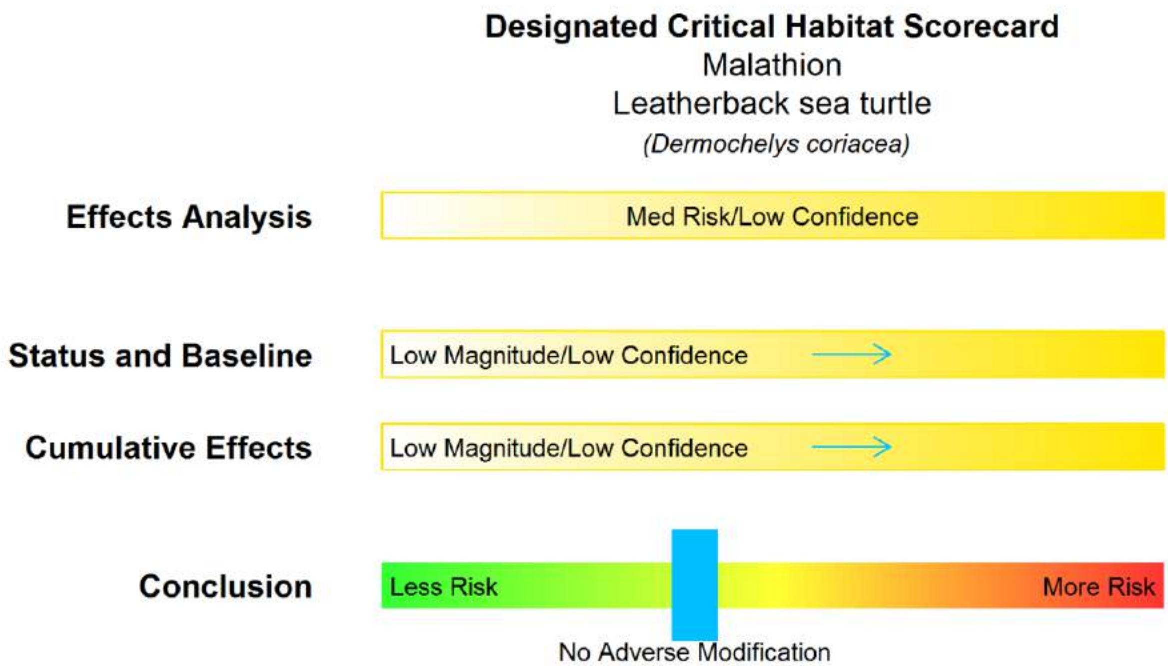

Figure 47. Designated Critical Habitat Scorecard; Leatherback sea turtle; Malathion

Effects Analysis: Medium risk/Low confidence

- We do not anticipate reductions in prey in marine and nearshore habitats to reduce the overall conservation value of designated critical habitat.
- We find low confidence of medium risk due to exposures predicted.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Disease.
- Point and non-point pollution.
- Marine debris.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions brought about by climate change may threaten PBFs.
- Increased coastal construction may threaten PBFs.

Conclusion: The stressors of the action may negatively affect relevant physical and biological features within marine and nearshore habitats. However, we have low confidence in the EECs predicted for the marine nearshore habitats. We do not anticipate that the stressors of the action will reduce the overall conservation value of the designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.

Malathion is not likely to adversely modify designated critical habitat: No Adverse Modification

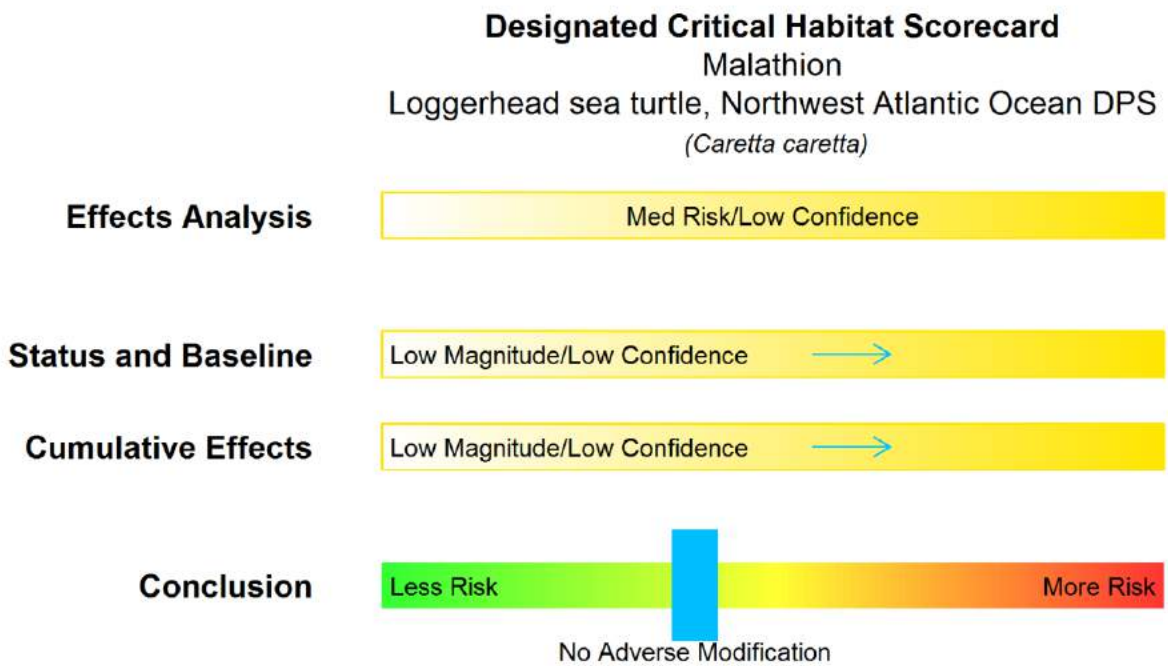

Figure 48. Designated Critical Habitat Scorecard; Loggerhead sea turtle, Northwest Atlantic Ocean DPS; Malathion

Effects Analysis: Medium risk/Low confidence

- We do not anticipate reductions in prey in marine and nearshore habitats to reduce the overall conservation value of designated critical habitat.
- We find low confidence of medium risk due to exposures predicted.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Point and non-point pollution.
- Marine debris.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions brought about by climate change may threaten PBFs.
- Increased coastal construction may threaten PBFs.

Conclusion: The stressors of the action may negatively affect relevant physical and biological features within marine and nearshore habitats. However, we have low confidence in the EECs predicted for the marine nearshore habitats. We do not anticipate that the stressors of the action will reduce the overall conservation value of the designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.

Malathion is not likely to adversely modify designated critical habitat: No Adverse Modification

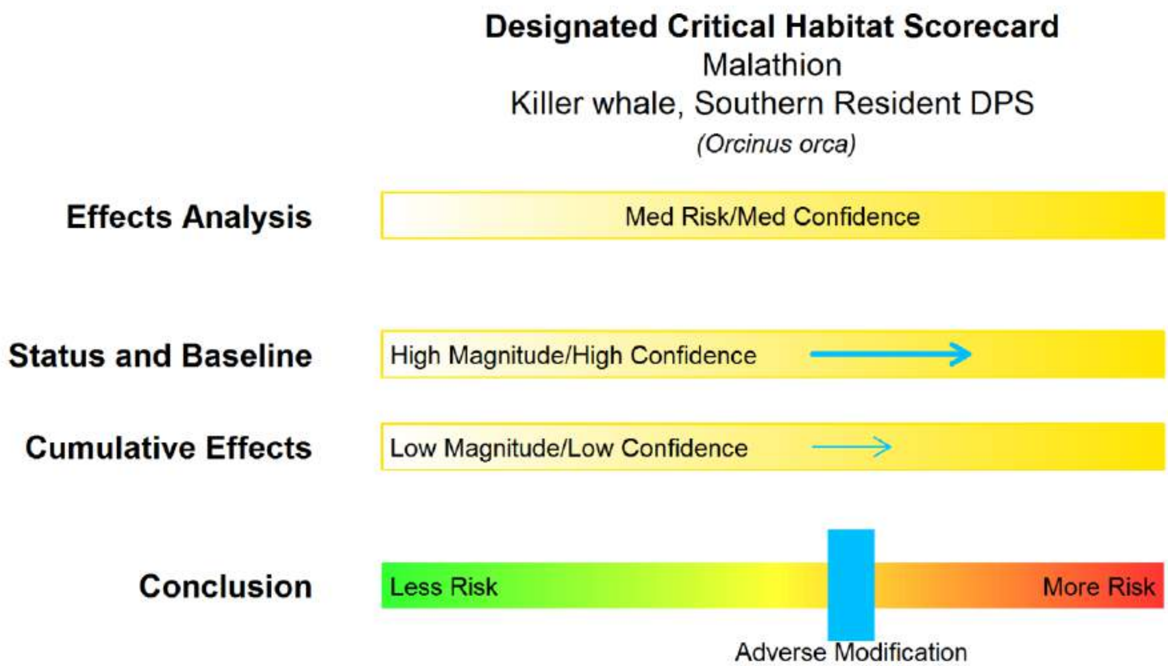

Figure 49. Designated Critical Habitat Scorecard; Killer whale, Southern Resident DPS; Malathion

Effects Analysis: Medium risk/Medium confidence
- Reductions in prey species availability (i.e. recruiting into designated critical habitat) are likely to reduce the overall conservation value of designated critical habitat.
- We find medium confidence of medium risk due to expected exposures predicted in habitats.

Status and Baseline: Increased risk; High magnitude/High confidence
- Depleted prey throughout designated critical habitat.
- Point and non-point contaminants.
- Noise disturbance.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence
- Changes in ocean conditions brought about by climate change may threaten PBFs.
- Altered hydrology and affects to prey brought about by climate change.
- Increased stresses (e.g., temperature) to freshwater habitats critical to prey.

Conclusion: We do not anticipate stressors of the action will directly affect physical and biological features (PBFs). Reductions in suitable prey and degradation of water quality are unlikely throughout designated critical habitat of Southern Resident Killer Whale from this action. However, indirectly, prey species (Chinook salmon) will be adversely affected by exposures anticipated in their freshwater habitats. The likelihood and magnitude of toxic effects will reduce the overall conservation value of designated critical habitat by reducing the recruitment and availability of this important prey. We find that the overall risk is medium and the confidence associated with that risk is medium over the 15-year duration of the action.

Malathion is likely to adversely modify designated critical habitat: Adverse Modification

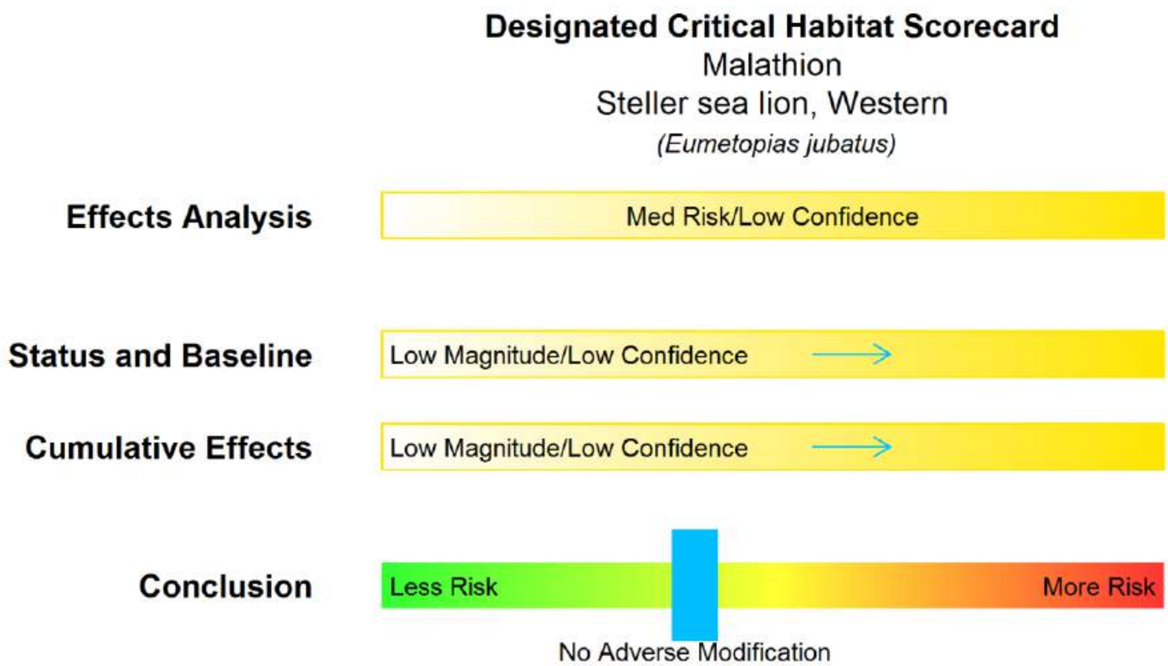

Figure 50. Designated Critical Habitat Scorecard; Steller sea lion, Western; Malathion

Effects Analysis: Medium risk/Low confidence

- We do not anticipate reductions in prey in marine and nearshore habitats to reduce the overall conservation value of designated critical habitat.
- We find low confidence of medium risk due to exposures predicted.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Point and non-point contaminants/pollution.
- Habitat degradation.
- Oil and gas exploration.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions brought about by climate change may threaten PBFs.
- Increased coastal construction/activities may threaten PBFs.

Conclusion: The stressors of the action may negatively affect a relevant physical and biological feature within nearshore designated critical habitat of Steller Sea Lion (Western DPS). However, we have low confidence in the EECs predicted for the marine nearshore habitats. The likelihood and magnitude of toxic effects are not likely to reduce the overall conservation value of designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.

Malathion is not likely to adversely modify designated critical habitat: No Adverse Modification

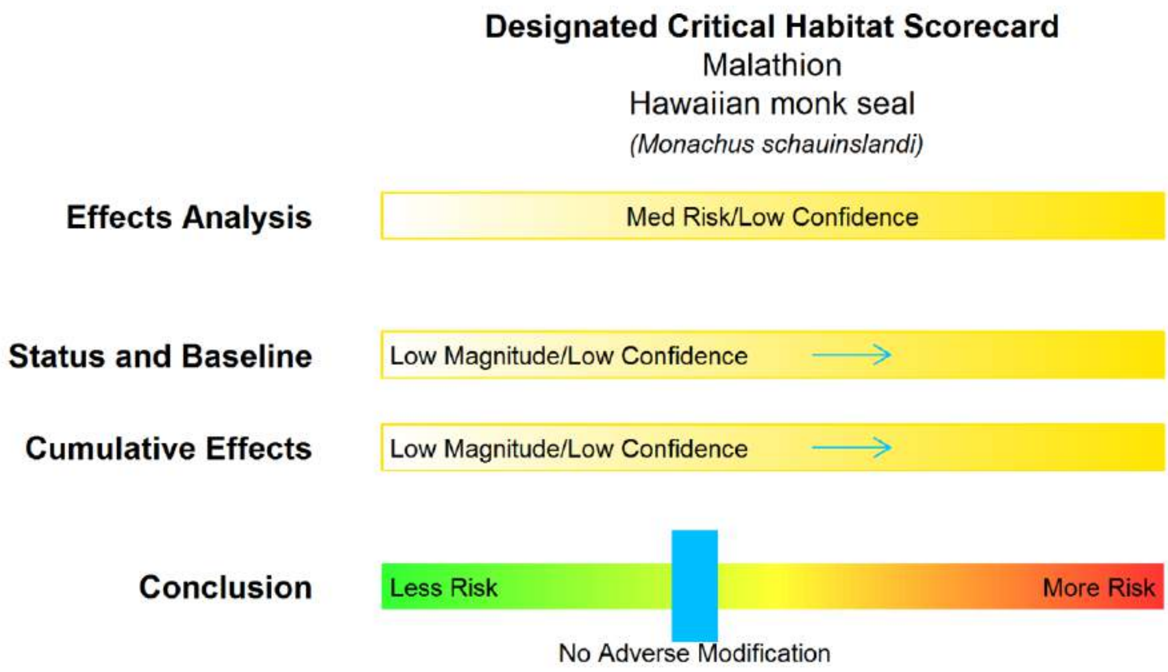

Figure 51. Designated Critical Habitat Scorecard; Hawaiian monk seal; Malathion

Effects Analysis: Medium risk/Low confidence

- We do not anticipate reductions in prey in marine and nearshore habitats to reduce the overall conservation value of designated critical habitat.
- We find low confidence of medium risk due to exposures predicted.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Limitations in food.
- Marine debris (entanglement).
- Habitat degradation.

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions brought about by climate change may threaten PBFs.
- Increased coastal construction/activities may threaten PBFs.

Conclusion: The stressors of the action may negatively affect a relevant physical and biological feature within nearshore designated critical habitat of Hawaiian Monk Seal. However, we have low confidence in the EECs predicted for the marine nearshore habitats. The likelihood and magnitude of toxic effects are not likely to reduce the overall conservation value of the marine portion of their designated critical habitat. We find that the overall risk is medium and the confidence associated with that risk is low over the 15-year duration of the action.

Malathion is not likely to adversely modify designated critical habitat: No Adverse Modification

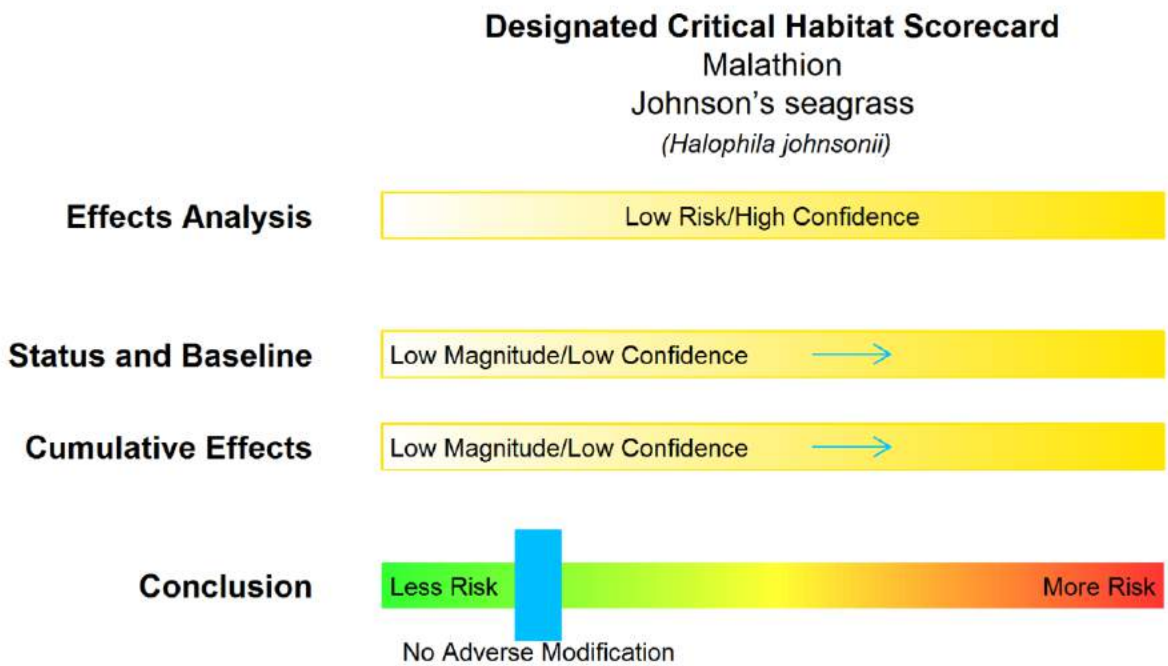

Figure 52. Designated Critical Habitat Scorecard; Johnson's seagrass; Malathion

Effects Analysis: Low risk/High confidence

- We do not anticipate reductions in PBFs or reductions in the overall conservation value of designated critical habitat.
- We find high confidence of low risk due to exposures predicted and PBFs identified.

Status and Baseline: Minimal increase in risk; Low magnitude/Low confidence

- Degraded water quality.
- Habitat destruction
- Siltation due to land-use practices.
- Algal overgrowth (nutrification).

Cumulative Effects: Minimal increase in risk; Low magnitude/Low confidence

- Changes in ocean conditions brought about by climate change may threaten PBFs.

Conclusion: Water quality is a physical and biological features identified in Johnson's seagrass designated critical habitat. However, we do not anticipate exposures from the stressors of the action to be sufficient to reduce conservation values of this PBF. We find that the overall risk is low and the confidence associated with that risk is high over the 15-year duration of the action.

Malathion is not likely to adversely modify designated critical habitat: No Adverse Modification

CHAPTER 25

CONCLUSION

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25.1 Chlorpyrifos

After reviewing the current status of the Endangered Species Act (ESA)-listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent actions, and cumulative effects, it is the National Marine Fisheries Services'(NMFS') biological opinion that the Environmental Protection Agency's (EPA's) registration of the uses, as described by product labels, of all pesticide products containing chlorpyrifos (the Action) is likely to jeopardize the continued existence of thirty-eight species and to destroy or adversely modify the designated critical habitat of thirty-seven listed species (***Table 1,Table 2***).

25.2 Diazinon

After reviewing the current status of the ESA-listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent actions, and cumulative effects, it is NMFS' biological opinion that the EPA's registration of the uses, as described by product labels, of all pesticide products containing diazinon (the Action) is likely to jeopardize the continued existence of twenty-five listed species and to destroy or adversely modify the designated critical habitat of eighteen listed species (***Table 1, Table 2***).

25.3 Malathion

After reviewing the current status of the ESA-listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent actions, and cumulative effects, it is NMFS' biological opinion that the EPA's registration of the uses, as described by product labels, of all pesticide products containing malathion (the Action) is likely to jeopardize the continued existence of thirty-eight listed species and to destroy or adversely modify the designated critical habitat of thirty-seven species (***Table 1, Table 2***).

Table 1. Jeopardy conclusions for ESA-listed species; chlorpyrifos, diazinon, and malathion.

Species Jeopardy Analysis Conclusions			
Species Name	**Chlorpyrifos**	**Diazinon**	**Malathion**
Atlantic salmon, Gulf of Maine ESU	No	No	No
Chum salmon , Columbia River ESU	Jeopardy	No	Jeopardy
Chum salmon, Hood Canal summer-run ESU	Jeopardy	No	Jeopardy
Chinook salmon, California coastal ESU	Jeopardy	Jeopardy	Jeopardy
Chinook salmon, Central Valley spring-run ESU	Jeopardy	Jeopardy	Jeopardy
Chinook salmon, Lower Columbia River ESU	Jeopardy	Jeopardy	Jeopardy
Chinook salmon, Puget Sound ESU	Jeopardy	Jeopardy	Jeopardy
Chinook salmon, Sacramento River winter-run ESU	Jeopardy	Jeopardy	Jeopardy

Chinook salmon, Snake River fall-run ESU	Jeopardy	Jeopardy	Jeopardy
Chinook salmon, Snake River spring/summer run ESU	Jeopardy	Jeopardy	Jeopardy
Chinook salmon, Upper Columbia River spring-run ESU	Jeopardy	Jeopardy	Jeopardy
Chinook salmon, Upper Willamette River ESU	Jeopardy	Jeopardy	Jeopardy
Coho salmon, Central California coast ESU	Jeopardy	Jeopardy	Jeopardy
Coho salmon, Lower Columbia River ESU	Jeopardy	No	Jeopardy
Coho salmon, Oregon coast ESU	Jeopardy	No	Jeopardy
Coho salmon, S. Oregon and N. Calif coasts ESU	Jeopardy	No	Jeopardy
Sockeye, Ozette Lake ESU	Jeopardy	No	Jeopardy
Sockeye, Snake River ESU	Jeopardy	Jeopardy	Jeopardy
Steelhead, California Central Valley ESU	Jeopardy	Jeopardy	Jeopardy
Steelhead, Central California coast ESU	Jeopardy	Jeopardy	Jeopardy
Steelhead, Lower Columbia River ESU	Jeopardy	Jeopardy	Jeopardy
Steelhead, Middle Columbia River ESU	Jeopardy	Jeopardy	Jeopardy
Steelhead, Northern California ESU	Jeopardy	Jeopardy	Jeopardy
Steelhead, Puget Sound ESU	Jeopardy	No	Jeopardy
Steelhead, Snake River Basin ESU	Jeopardy	Jeopardy	Jeopardy
Steelhead, South-Central California coast ESU	Jeopardy	Jeopardy	Jeopardy
Steelhead, Southern California ESU	Jeopardy	Jeopardy	Jeopardy
Steelhead, Upper Columbia River ESU	Jeopardy	Jeopardy	Jeopardy
Steelhead, Upper Willamette River ESU	Jeopardy	Jeopardy	Jeopardy
Eulachon, Pacific smelt, Southern DPS	Jeopardy	No	Jeopardy
Green sturgeon, Southern DPS	Jeopardy	Jeopardy	Jeopardy
Shortnose sturgeon	Jeopardy	No	Jeopardy
Atlantic sturgeon, Carolina DPS	Jeopardy	No	Jeopardy
Atlantic sturgeon, Chesapeake Bay DPS	Jeopardy	No	Jeopardy
Atlantic sturgeon, Gulf of Maine DPS	Jeopardy	No	Jeopardy
Atlantic sturgeon, New York Bight DPS	Jeopardy	Jeopardy	Jeopardy
Atlantic sturgeon, South Atlantic DPS	Jeopardy	Jeopardy	Jeopardy
Gulf sturgeon	No	No	No
Yelloweye rockfish	No	No	No
Boccacio, Puget Sound/Georgia Basin	No	No	No
Gulf grouper	No	No	No
Nassau grouper	No	No	No
Smalltooth sawfish, U.S. DPS	Jeopardy	No	Jeopardy
Black abalone	No	No	No
White abalone	No	No	No
Staghorn coral	No	No	No
Elkhorn coral	No	No	No
Coral, Acropora globiceps	No	No	No
Coral, Acropora jacquelineae	No	No	No

Coral, Acropora retusa	No	No	No
Coral, Acropora speciosa	No	No	No
Coral, Euphyllia pardivisa	No	No	No
Coral, Isopora crateriformis	No	No	No
Coral, Seriatopora aculeata	No	No	No
Boulder star coral	No	No	No
Lobed star coral	No	No	No
Mountainous star coral	No	No	No
Pillar coral	No	No	No
Rough cactus coral	No	No	No
Green sea turtle, Central North Pacific DPS	No	No	No
Green sea turtle, Central South Pacific DPS	No	No	No
Green sea turtle, Central West Pacific DPS	No	No	No
Green sea turtle, East Pacific DPS	No	No	No
Green sea turtle, North Atlantic DPS	No	No	No
Green sea turtle, South Atlantic DPS	No	No	No
Hawksbill sea turtle	No	No	No
Kemp's ridley sea turtle	No	No	No
Leatherback sea turtle	No	No	No
Loggerhead sea turtle, North Pacific Ocean DPS	No	No	No
Loggerhead sea turtle, Northwest Atlantic Ocean DPS	No	No	No
Olive ridley sea turtle, Mexico's Pacific Coast breeding colonies	No	No	No
Olive ridley sea turtle, all other areas	No	No	No
Killer whale, Southern Resident DPS	Jeopardy	Jeopardy	Jeopardy
Steller sea lion, Western	No	No	No
Guadalupe fur seal	No	No	No
Hawaiian monk seal	No	No	No
Johnson's seagrass	No	No	No
Totals (Jeopardy determinations / total LAA species)	**38 / 77**	**25 / 77**	**38 / 77**

Table 2. Adverse Modification conclusions for designated critical habitat; chlorpyrifos, diazinon, and malathion.

Designated Critical Habitat Adverse Modification Analysis Conclusions			
Species Name	**Chlorpyrifos**	**Diazinon**	**Malathion**
Chum salmon , Columbia River ESU	Adverse Modification	No	Adverse Modification
Chum salmon, Hood Canal summer-run ESU	Adverse Modification	No	Adverse Modification
Chinook salmon, California coastal ESU	Adverse Modification	Adverse Modification	Adverse Modification
Chinook salmon, Central Valley spring-run ESU	Adverse Modification	Adverse Modification	Adverse Modification
Chinook salmon, Lower Columbia River ESU	Adverse Modification	No	Adverse Modification
Chinook salmon, Puget Sound ESU	Adverse Modification	No	Adverse Modification
Chinook salmon, Sacramento River winter-run ESU	Adverse Modification	Adverse Modification	Adverse Modification
Chinook salmon, Snake River fall-run ESU	Adverse Modification	Adverse Modification	Adverse Modification
Chinook salmon, Snake River spring/summer run ESU	Adverse Modification	No	Adverse Modification
Chinook salmon, Upper Columbia River spring-run ESU	Adverse Modification	Adverse Modification	Adverse Modification
Chinook salmon, Upper Willamette River ESU	Adverse Modification	Adverse Modification	Adverse Modification
Coho salmon, Central California coast ESU	Adverse Modification	Adverse Modification	Adverse Modification
Coho salmon, Lower Columbia River ESU	Adverse Modification	No	Adverse Modification
Coho salmon, Oregon coast ESU	Adverse Modification	No	Adverse Modification
Coho salmon, S. Oregon and N. Calif coasts ESU	Adverse Modification	No	Adverse Modification
Sockeye, Ozette Lake ESU	Adverse Modification	No	Adverse Modification
Sockeye, Snake River ESU	Adverse Modification	Adverse Modification	Adverse Modification
Steelhead, California Central Valley ESU	Adverse Modification	Adverse Modification	Adverse Modification
Steelhead, Central California coast ESU	Adverse Modification	Adverse Modification	Adverse Modification
Steelhead, Lower Columbia River ESU	Adverse Modification	No	Adverse Modification
Steelhead, Middle Columbia River ESU	Adverse Modification	Adverse Modification	Adverse Modification
Steelhead, Northern California ESU	Adverse Modification	No	Adverse Modification

Steelhead, Puget Sound ESU	Adverse Modification	No	Adverse Modification
Steelhead, Snake River Basin ESU	Adverse Modification	Adverse Modification	Adverse Modification
Steelhead, South-Central California coast ESU	Adverse Modification	Adverse Modification	Adverse Modification
Steelhead, Southern California ESU	Adverse Modification	Adverse Modification	Adverse Modification
Steelhead, Upper Columbia River ESU	Adverse Modification	Adverse Modification	Adverse Modification
Steelhead, Upper Willamette River ESU	Adverse Modification	Adverse Modification	Adverse Modification
Eulachon, Pacific smelt, Southern DPS	Adverse Modification	No	Adverse Modification
Green sturgeon, Southern DPS	Adverse Modification	Adverse Modification	Adverse Modification
Gulf sturgeon	No	No	No
Atlantic sturgeon, Carolina DPS	Adverse Modification	No	Adverse Modification
Atlantic sturgeon, Chesapeake Bay DPS	Adverse Modification	No	Adverse Modification
Atlantic sturgeon, Gulf of Maine DPS	Adverse Modification	No	Adverse Modification
Atlantic sturgeon, New York Bight DPS	Adverse Modification	No	Adverse Modification
Atlantic sturgeon, South Atlantic DPS	Adverse Modification	No	Adverse Modification
Yelloweye rockfish	No	No	No
Boccacio, Puget Sound/Georgia Basin	No	No	No
Smalltooth sawfish, U.S. DPS	Adverse Modification	No	Adverse Modification
Black abalone	No	No	No
Staghorn coral	No	No	No
Elkhorn coral	No	No	No
Green sea turtle, North Atlantic DPS	No	No	No
Hawksbill sea turtle	No	No	No
Leatherback sea turtle	No	No	No
Loggerhead sea turtle, Northwest Atlantic Ocean DPS	No	No	No
Killer whale, Southern Resident DPS	Adverse Modification	Adverse Modification	Adverse Modification
Steller sea lion, Western	No	No	No
Hawaiian monk seal	No	No	No
Johnson's seagrass	No	No	No
Totals (Adverse Modification determinations / total LAA designated critical habits)	**37 / 50**	**18 / 50**	**37 / 50**

CHAPTER 26

REASONABLE AND PRUDENT ALTERNATIVES; REASONABLE AND PRUDENT MEASURES; TERMS AND CONDITIONS; INCIDENTAL TAKE STATEMENT; CONSERVATION RECOMMENDATIONS; REINITIATION NOTICE

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26.1 RPA Introduction

When the National Marine Fisheries Service (NMFS) concludes that an action is likely to jeopardize an Endangered Species Act (ESA)-listed species or destroy or adversely modify critical habitat, NMFS suggests a reasonable and prudent alternative (RPA) that would allow the action to proceed in compliance with section 7(a)(2) and that can be taken by the action agency and the applicant (ESA Section 7(a)(3)(A)). Joint NMFS and U.S. Fish and Wildlife Service regulations (50 CFR §402.02) implementing section 7 define "jeopardize the continued existence of" means "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a ESA-listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR §402.02). As noted above, NMFS relies on statutory language to determine adverse modification.

The NMFS' implementing regulations define reasonable and prudent alternatives as alternative actions, identified during formal consultation, that: (1) can be implemented in a manner consistent with the intended purpose of the action; (2) can be implemented consistent with the scope of the action agency's legal authority and jurisdiction; (3) are economically and technologically feasible; and (4) NMFS believes would avoid the likelihood of jeopardizing the continued existence of ESA-listed species or resulting in the destruction or adverse modification of critical habitat (50 CFR §402.02). The overarching requirement is that an RPA must be capable of avoiding jeopardizing ESA-listed species and adversely modifying critical habitat – all other elements of the definition must be evaluated within this context (*Greenpeace v. NMFS*, 55 F. Supp. 2d 1248, 1268 (W.D. Wa. 1999)). NMFS in the preamble to the final section 7 regulations make clear that the overriding consideration is whether a RPA avoids the likelihood of jeopardy. NMFS notes that the action agency's responsibility "permeates the full range of discretionary authority held by the action agency." Thus, NMFS can specify an RPA that involves the maximum exercise of the action agency's authority when the Services deem necessary to avoid the likelihood of jeopardy (51 FR 19926, 19937 (June 3, 1986)).

The other three factors are intended to implement the statutory phrase "can be taken." The third factor, technological and economic feasibility, refers to the ability of the federal agency to implement the RPA: "[t]he requirement that a RPA be 'economically and technologically feasible' only requires that the Corps have the resources and technology necessary to implement the RPA." *In Re: Operation of the Missouri River System Litigation.* 363 F. Supp. 2d 1145, 1161 (D. Minn. 2004), citing *Kandra v. U.S.*, 145 F.Supp. 2d 1192, 1207 (D. Ore.) ("the RPAs must be economically and technically feasible for *the government* to implement."); see also San Luis & Delta-Mendota Water Authority v. Jewell, 2014 WL 975130 at 38-40 (C.A.9 (Cal.)). This regulatory factor was included in the final section 7 implementing regulations in response to a comment, without further explanation or discussion. The ESA contains no requirement for analysis of economic impacts resulting from implementation of a RPA, and the insertion of the phrase "economically feasible" in regulation cannot create this requirement. Any obligation that NMFS "balance the benefit to the species against the economic and technical burden on the industry before approving an RPA would be fundamentally inconsistent with the purposes of the

ESA and with case law interpreting the Act." *Greenpeace v. NMFS,* 55 F. Supp. 2d 1248, 1267 (W.D. Wash. 1999). While the Services will defer in most cases to the action agency's expertise as to whether a RPA is reasonable, including whether the RPA is technologically and economically feasible, the Services cannot abdicate their duty to formulate and recommend RPAs (51 FR at 19952). However, the action agency may choose or may be obligated to conduct an economic analysis and to evaluate impacts to interests other than the applicants when it implements a RPA pursuant to its authorities.

In this Opinion, NMFS concluded that the Environmental Protection Agency's (EPA's) proposed registration of chlorpyrifos, diazinon and malathion is likely to jeopardize 38 listed species and likely to adversely modify or destroy the designated critical habitat of 37 species. NMFS reached these conclusions because predicted concentrations of these three a.i.s are likely to have direct and indirect adverse effects to these species and to the primary biological features of their designated critical habitat. As a result, affected species are likely to suffer reductions in viability from one or more of the a.i.s given the severity of expected changes in abundance and productivity associated with the proposed action. These adverse effects are expected to appreciably reduce the likelihood of both the survival and recovery of these listed species and reduce the conservation value of some of the species' designated critical habitat.

The RPA accounts for the following issues: (1) the action will result in exposure to other chemical stressors in addition to the a.i. that may increase the risk of the action to ESA-listed species, including unspecified inert ingredients, adjuvants, and tank mixes; (2) exposure to chemical mixtures containing the a.i.s and other chemical compounds may result in greater toxicity; and (3) exposure to other chemicals and physical stressors (*e.g.,* temperature) in the baseline habitat will likely intensify response to the a.i.s.

The action as implemented under the RPA will remove the likelihood of jeopardy and of destruction or adverse modification of critical habitat by reducing exposure of the stressors of the action. In the proposed RPA, NMFS does not attempt to ensure there is no take of ESA-listed species. NMFS concludes that take will likely occur, and has provided an incidental take statement exempting that take from the take prohibitions as long as the action is conducted in compliance with the terms and conditions of the incidental take statement. Avoiding take altogether would most likely entail canceling registration, or prohibiting all use in watersheds inhabited by listed species. The goal of the RPA is to reduce exposure to ensure that the action is not likely to jeopardize ESA-listed species or destroy or adversely modify critical habitat.

For each active ingredient, the elements of the RPA apply only to the range of the ESUs/DPSs where NMFS has determined that EPA cannot ensure that its registration of that a.i. avoids jeopardy or the destruction or adverse modification of critical habitat (Chapter 25). These elements rely upon recognized practices for reducing loading of pesticide products into aquatic habitats.

Overall, the RPA listed here focus on reducing exposure potential to listed species and their habitats by targeting risk reduction measures that effectively reduce drift and runoff. The RPA include pesticide use restrictions that shall be specified on Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) labels of all pesticide products containing the three active ingredients; this shall be accomplished by incorporating the required elements of the RPA into the "Directions for Use" section of the FIFRA labels or on EPA Endangered Species Protection

Program Bulletins that serve as enforceable extensions to these labels (https://www.epa.gov/endangered-species/endangered-species-protection-bulletins).

The RPA listed here also incorporates risk reduction measures for pesticide users that participate in conservation activities. These include: 1) installing/maintaining riparian systems alongside aquatic habitats, and 2) participation in a recognized pesticide stewardship plan. Pesticide users that take advantage of these activities receive full points for required risk reduction measures for drift and runoff/drainage.

Riparian areas occur alongside watercourses or water bodies and are typically distinct from surrounding lands due to their unique soil and vegetation characteristics that are influenced by the hydrologic conditions of the soil. Pesticides can move from treated agricultural and forested areas via spray drift and surface water runoff into the broader environment. Riparian areas filter runoff and intercept drift thereby reducing loading into off target water bodies. Generally, the use of riparian areas, coupled with low-drift application methods, substantially reduce drift deposition and runoff into sensitive aquatic habitats adjacent to pesticide use sites. Therefore, a functional riparian zone substantially reduces pesticide loading, potentially negating the need for no-spray buffers. The effectiveness in reducing pesticide loading depends on site-specific factors such as dimensions, type, and complexity of the riparian vegetation.

Pesticide stewardship plans[1], such as Salmon-Safe, work with landowners to create a management plan that reduces or eliminates use of pesticides thereby removing potential exposure to listed species and their habitats. Therefore, landowners that participate in such plans would receive full credit for required risk reduction measures.

26.1.1 Reasonable and Prudent Alternatives

Five distinct elements are required to ensure jeopardy is avoided and to ensure designated critical habitat is not destroyed or modified. These elements are:

1. Reduce pesticide loading for high risk use sites;
2. Limit the frequency of application to once per year for persistent pesticides i.e., chlorpyrifos;
3. Limit area of application for mosquito control;
4. Limit area of application for wide area use;
5. Employ an effectiveness monitoring plan.

Element 1 involves three options which EPA can implement through label revisions that would reduce pesticide loading in listed species aquatic habitats (Table 1). The first of these options changes the action by prohibiting the use of high risk uses within a species range and/or modifying labels based on actual usage. In the second option, EPA could require specific no application buffers and mandate a 6 meter vegetative filter strip for all high risk uses within the species range. The third option provides flexibility for pesticide users to select risk reduction measures using the point system approach described below. This option includes a variety of risk reduction measures including no-spray buffers, vegetative filter strips, spray drift reduction technologies, and participation in pesticide stewardship programs such as "Salmon-Safe".

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[1] NMFS approval of stewardship plan required to receive risk reduction credit

Table 1. RPA Elements

RPA Element	Description
Element 1	Reduce pesticide loading for all high risk use sites. Choose 1(a) or 1(b) or 1(c). 1(a) Remove label authorization for all high risk uses. If current usage on use sites effectively reduces exposure[2], modify labels to reflect current usage. 1(b) Modify labels to include standard buffers and vegetative filter strips: 300 meter no-spray buffer for all aerial applications; 150 meter buffer for all ground applications; 6 meter vegetative filter strip for all applications. 1(c) Point System. Implement a combination of risk reduction measures to reduce pesticide drift, runoff, and drainage.
Element 2	Limit the frequency of application to once per year for persistent pesticides e.g. chlorpyrifos.
Element 3	Restrict mosquito applications to residential and developed areas within species' range.
Element 4	Restrict wide area use to residential and developed areas with spot treatment only.
Element 5	EPA shall, in close coordination with NMFS Office of Protected Resources, develop and implement an effectiveness monitoring plan to ensure the RPA(s) selected is/are feasible, effective, and implemented.

26.1.2 Points System Overview: Element 1(c)

Pesticide end-users could also follow a simple point system to arrive at sufficient risk reduction measures. The points system is based on the European Union's Mitigating the Risks of Plant Protection Products in the Environment, referred to as MAgPIE (Alix et al. 2017). While the goal of MAgPIE was to develop a harmonized approach for risk management among EU countries, the approach achieves quantifiable reductions in pesticide loading while allowing maximum flexibility for the grower/applicator. It also rewards landowners who are already implementing reduction measures such as Best Management Practices (BMPs) that reduce loading and improve habitat for listed species.

Important aspects of the points approach:

- The pesticide applicator can choose from a list of risk reduction measures (e.g. Table 2) listed on EPA's Bulletins Live website.
- Each risk reduction measure on the list has a point value based on its effectiveness at reducing loading from drift and runoff/drainage.

[2]Requires NMFS concurrence that EPA-proposed alternative based on usage information effectively reduces exposure

- The applicator can choose which risk reduction measures to implement as long as the required number of points are achieved for each exposure pathway (drift and runoff/drainage).
- The point system is only required for high risk uses. High risk uses are those which received a high rating for effect of exposure and a high or medium rating for likelihood of exposure as presented in the Effects of the Proposed Action.

Risk reduction measures and associated points are presented below in Table 2, Table 3, and Table 4. The RPA and RPM for each of the three pesticides apply to applications on high risk use sites within 300 meters adjacent to, or that drain to listed species aquatic habitats for which jeopardy or adverse modification of designated critical habitat was determined.

Table 2. Chlorpyrifos Risk Reduction Measures and Associated Points

Drift Measures	Estimated % reduction in loading	Points	Runoff/drainage Measures	Estimated % reduction in loading	Points
No Spray Drift Buffers :			No Spray Buffer ≥300 meters to listed species habitat or water that drains to habitat	99	80
Ground boom[1] /chemigation buffer:					
10 meters	25	5			
20 meters	60	40			
100 meters	90	70			
200 meters	95	75			
300 meters	99	80			
Air blast buffer[2]:					
20 meters	40	20			
100 meters	99	80			
Aerial buffer[3]:					
100 meters	60	40			
300 meters	99	80			
Spray Drift Reduction Technology[4] (nozzles, etc.):			Vegetated filter strip[5]:		
Category one	25-50	20	5 meters	40	20
Category two	50-75	45	10 meters	65	45
Category three	75-90	65	20 meters	80	60
Category four	>90	75	Inter row	50	30
Granular treatment	99	80	Bunds[5]:		
			Edge of field	40	20
			In-field	50	30
Spot Applications <0.1 A[6]	99	80	Spot Applications <0.1A[6]	99	80
			Vegetated ditches[5]	50	30
Riparian plantings[7]	27-36	10	No-till or reduced tillage[5]	50	30
			Retention pond[5]	75	55
Participation in recognized stewardship program	99	80	Participation in recognized stewardship program	99	80
Functional riparian system alongside water ways, > 10 meters wide	99	80	Functional riparian system alongside water ways, > 10 meters wide	99	80

[1] *AgDrift Tier 1 Ground Boom – point deposition estimates compared to 25 foot ground application buffer: low boom, very fine to fine distribution, 50th percentile distribution.*
[2] *AgDrift Tier 1 Orchard Airblast - point deposition estimates for sparse orchard compared to 50 foot airblast application buffer.*
[3] *AgDrift Tier 1 Aerial – point deposition estimates compared to 150 foot aerial application buffer.*
[4] *EPA may have not verified any products yet (https://www.epa.gov/reducing-pesticide-drift/epa-verified-and-rated-drift-reduction-technologies).*
[5] *MAgPIE. 2017*
[6] *Assumes median field size of 0.278 km^2 (Yan and Roy 2016)*
[7] *Washington State Department of Agriculture riparian vegetation pilot study (2015)*

Table 3. Diazinon Risk Reduction Measures and Associated Points

Drift Measures	Estimated % reduction in loading	Points	Runoff/drainage Measures	Estimated % reduction in loading	Points
No Spray Drift Buffers : Ground boom[1] /chemigation buffer: 10 meters	90	70	No Spray Buffer ≥300 meters to listed species habitat or water that drains to habitat	99	80
Air blast buffer[2]: 10 meters	80	60			
20 meters	95	75			
Aerial buffer[3]: 10 meters	55	35			
20 meters	70	50			
100 meters	95	75			
Spray Drift Reduction Technology[4] (nozzles, etc.): Category one	25-50	20	Vegetated filter strip[5]: 5 meters	40	20
Category two	50-75	45	10 meters	65	45
Category three	75-90	65	20 meters	80	60
Category four	>90	75	Inter row	50	30
Granular treatment	99	80	Bunds[5]: Edge of field	40	20
			In-field	50	30
Spot Applications <0.1 A[6]	99	80	Spot Applications <0.1A[6]	99	80
			Vegetated ditches[5]	50	30
Riparian plantings[7]	27-36	10	No-till or reduced tillage[5]	50	30
			Retention pond[5]	75	55
Participation in recognized stewardship program	99	80	Participation in recognized stewardship program	99	80
Functional riparian system alongside water ways, > 10 meters wide	99	80	Functional riparian system alongside water ways, > 10 meters wide	99	80

[1] *AgDrift Tier 1 Ground Boom – point deposition estimates compared to field edge (1 m buffer): low boom, very fine to fine distribution, 50th percentile distribution.*
[2] *AgDrift Tier 1 Orchard Airblast - point deposition estimates for sparse orchard compared to field edge (1m buffer).*
[3] *AgDrift Tier 1 Aerial – point deposition estimates compared to field edge (1 meter buffer)*
[4] *EPA may have not verified any products yet (https://www.epa.gov/reducing-pesticide-drift/epa-verified-and-rated-drift-reduction-technologies).*
[5] *MAgPIE 2017*
[6] *Assumes median field size of 0.278 km^2 (Yan and Roy 2016)*
[7] *Washington State Department of Agriculture riparian vegetation pilot study (2015)*

Table 4. Malathion Risk Reduction Measures and Associated Points

Drift Measures	Estimated % reduction in loading	Points	Runoff/drainage Measures	Estimated % reduction in loading	Points
No Spray Drift Buffers : Ground boom[1] /chemigation buffer: 10 meters Air blast buffer[2]: 10 meters 20 meters Aerial buffer[3]: 20 meters 100 meters 150 meters	 90 80 95 35 85 90	 70 60 75 15 65 70	No Spray Buffer ≥300 meters to listed species habitat or water that drains to habitat	99	80
Spray Drift Reduction Technology[4](nozzles, etc.): Category one Category two Category three Category four	 25-50 50-75 75-90 >90	 20 45 65 75	Vegetated filter strip[5]: 5 meters 10 meters 20 meters Inter row	 40 65 80 50	 20 45 60 30
Granular treatment	99	80	Bunds[5]: Edge of field In-field	 40 50	 20 30
Spot Applications <0.1 A[6]	99	80	Spot Applications <0.1A[6]	99	80
			Vegetated ditches[5]	50	30
Riparian plantings[7]	27-36	10	No-till or reduced tillage[5]	50	30
			Retention pond[5]	75	55
Participation in recognized stewardship program	99	80	Participation in recognized stewardship program	99	80
Functional riparian system alongside water ways, > 10 meters wide	99	80	Functional riparian system alongside water ways, > 10 meters wide	99	80

[1] *AgDrift Tier 1 Ground Boom – point deposition estimates compared to field edge (1 m buffer): low boom, very fine to fine distribution, 50th percentile distribution.*
[2] *AgDrift Tier 1 Orchard Airblast - point deposition estimates for sparse orchard compared to field edge (1m buffer).*
[3] *AgDrift Tier 1 Aerial – Fine to medium distribution, point deposition estimates compared to 25 foot non-ULV aerial buffer.*
[4] *Range corresponds with EPA star program (https://www.epa.gov/reducing-pesticide-drift/epa-verified-and-rated-drift-reduction-technologies).*
[5] *MAgPIE 2017*
[6] *Assumes median field size of 0.278 km^2 (Yan and Roy 2016)*
[7] *Washington State Department of Agriculture riparian vegetation pilot study (2015)*

26.2 Reasonable and Prudent Alternatives for Each Species and Pesticide

This section describes chemical-specific RPA elements for each of the ESA-listed species for which jeopardy or adverse modification of designated critical habitats was determined.

26.2.1 Chlorpyrifos RPA

- Reduce pesticide loading for all high risk use sites.
    - 1(a) Remove label authorization for all high risk uses. If current usage on use sites effectively reduces exposure, modify labels to reflect current usage.
    - 1(b) Modify labels to include 300 meter no-spray buffer for all aerial applications; 150 meter buffer for all ground applications; 6 meter vegetative filter strip for all applications.
    - 1(c) Point System. Implement a combination of risk reduction measures to reduce pesticide drift and runoff (Table 5).
- Limit the frequency of application to once per year.
- Restrict mosquito applications to residential and developed areas within species' range.
- Restrict wide area use to residential and developed areas with spot treatment only.
- EPA shall, in close coordination with NMFS Office of Protected Resources, develop and implement an effectiveness monitoring plan to ensure the elements selected are feasible, effective, and implemented.

Table 5. High risk uses for chlorpyrifos and risk reduction points required for drift and runoff/drainage

Chlorpyrifos	**Risk Reduction Options for High Risk Uses**		
Species	**Remove label authorization for all high risk uses**	**No-spray Buffer: 300m aerial application, 150m ground application; and 6m vegetative filter strip**	**Required Points: Drift Runoff/drainage**
Chum salmon , Columbia River Evolutionarily Significant Unit (ESU) (T)	Right of Way Pasture Developed	Right of Way Pasture Developed	80 drift 80 runoff
Chum salmon, Hood Canal summer-run ESU (T)	Managed Forest Right of Way Pasture Developed	Managed Forest Right of Way Pasture Developed	80 drift 80 runoff
Chinook salmon, California coastal ESU (T)	Pasture Managed Forest Right of Way Developed Orchards and Vineyards	Pasture Managed Forest Right of Way Developed Orchards and Vineyards	80 drift 80 runoff
Chinook salmon, Central Valley spring-run ESU (T)	Pasture Orchards and Vineyards Right of Way Developed	Pasture Orchards and Vineyards Right of Way Developed	80 drift 80 runoff

Chlorpyrifos	Risk Reduction Options for High Risk Uses		
Species	**Remove label authorization for all high risk uses**	**No-spray Buffer: 300m aerial application, 150m ground application; and 6m vegetative filter strip**	**Required Points: Drift Runoff/drainage**
	Other Crops Corn Managed Forest Vegetables and Ground Fruit Wheat Other Grains Cotton Other Row Crops	Other Crops Corn Managed Forest Vegetables and Ground Fruit Wheat Other Grains Cotton Other Row Crops	
Chinook salmon, Lower Columbia River ESU (T)	Managed Forest Right of Way Pasture Developed Christmas Trees Orchards and Vineyards Other Crops Vegetables and Ground Fruit Corn Wheat Other Grains	Managed Forest Right of Way Pasture Developed Christmas Trees Orchards and Vineyards Other Crops Vegetables and Ground Fruit Corn Wheat Other Grains	80 drift 80 runoff
Chinook salmon, Puget Sound ESU (T)	Managed Forest Right of Was Developed Pasture Vegetables and Ground Fruit Corn Other Grains Wheat	Managed Forest Right of Was Developed Pasture Vegetables and Ground Fruit Corn Other Grains Wheat	80 drift 80 runoff
Chinook salmon, Sacramento River winter-run ESU (E)	Pasture Right of Way Developed Orchards and Vineyards Other Crops Corn Managed Forest Vegetables and Ground Fruit Wheat Other Grains Other Row Crops	Pasture Right of Way Developed Orchards and Vineyards Other Crops Corn Managed Forest Vegetables and Ground Fruit Wheat Other Grains Other Row Crops	80 drift 80 runoff
Chinook salmon, Snake River fall-run ESU (T)	Pasture Managed Forest Right of Way Wheat Developed Other Crops	Pasture Managed Forest Right of Way Wheat Developed Other Crops	80 drift 80 runoff

Chlorpyrifos	Risk Reduction Options for High Risk Uses		
Species	**Remove label authorization for all high risk uses**	**No-spray Buffer:** **300m aerial application,** **150m ground application; and** **6m vegetative filter strip**	**Required Points:** **Drift** **Runoff/drainage**
	Vegetables and Ground Fruit orchards and Vineyards Corn Other Grains	Vegetables and Ground Fruit orchards and Vineyards Corn Other Grains	
Chinook salmon, Snake River spring/summer run ESU (T)	Managed Forest Pastures Wheat Right of Way Other Crops Developed Vegetables and Ground Orchards and Vineyards Corn	Managed Forest Pastures Wheat Right of Way Other Crops Developed Vegetables and Ground Orchards and Vineyards Corn	80 drift 80 runoff
Chinook salmon, Upper Columbia River spring-run ESU (E)	Managed Forest Pasture Right of Way Developed Orchards and Vineyards Wheat Other Crops Vegetables and Ground Fruit Corn	Managed Forest Pasture Right of Way Developed Orchards and Vineyards Wheat Other Crops Vegetables and Ground Fruit Corn	80 drift 80 runoff
Chinook salmon, Upper Willamette River ESU (T)	Managed Forest Pasture Right of Way Developed Other Crops Vegetables and Ground fruit Wheat Christmas Trees Orchards and Vineyards Corn Other grains Other Row Crops	Managed Forest Pasture Right of Way Developed Other Crops Vegetables and Ground fruit Wheat Christmas Trees Orchards and Vineyards Corn Other grains Other Row Crops	80 drift 80 runoff
Coho salmon, Central California coast ESU (E)	Right of Way Pasture Developed Managed Forest Orchards and Vineyards	Right of Way Pasture Developed Managed Forest Orchards and Vineyards	80 drift 80 runoff
Coho salmon, Lower Columbia River ESU (E)	Managed Forest Right of Way Pasture Developed	Managed Forest Right of Way Pasture Developed	80 drift 80 runoff

Chlorpyrifos	Risk Reduction Options for High Risk Uses		
Species	**Remove label authorization for all high risk uses**	**No-spray Buffer: 300m aerial application, 150m ground application; and 6m vegetative filter strip**	**Required Points: Drift Runoff/drainage**
Coho salmon, Oregon coast ESU (T)	Managed Forest Pasture Right of Way Developed	Managed Forest Pasture Right of Way Developed	80 drift 80 runoff
Coho salmon, S. Oregon and N. Calif coasts ESU (T)	Managed Forest Pasture Right of Way Developed Other Crops	Managed Forest Pasture Right of Way Developed Other Crops	80 drift 80 runoff
Sockeye, Ozette Lake ESU (T)	Managed Forest Right of Way Pasture	Managed Forest Right of Way Pasture	80 drift 80 runoff
Sockeye, Snake River ESU (E)	Managed Forest Pasture Right of Way	Managed Forest Pasture Right of Way	80 drift 80 runoff
Steelhead, California Central Valley ESU (T)	Pasture Orchards and Vineyards Right of Way Developed Other Crops Managed Forest Corn Vegetables and Ground Fruit What Other Grains Cotton Other Row Crops	Pasture Orchards and Vineyards Right of Way Developed Other Crops Managed Forest Corn Vegetables and Ground Fruit What Other Grains Cotton Other Row Crops	80 drift 80 runoff
Steelhead, Central California coast ESU (T)	Right of Way Pasture Developed Managed Forest Orchards and Vineyards Other grains Other Crops Wheat	Right of Way Pasture Developed Managed Forest Orchards and Vineyards Other grains Other Crops Wheat	80 drift 80 runoff
Steelhead, Lower Columbia River ESU (T)	Managed Forest Right of Way Pasture Developed Orchards and Vineyards Other Crops Vegetables and Ground Fruit Corn Wheat	Managed Forest Right of Way Pasture Developed Orchards and Vineyards Other Crops Vegetables and Ground Fruit Corn Wheat	80 drift 80 runoff

Chlorpyrifos	Risk Reduction Options for High Risk Uses		
Species	**Remove label authorization for all high risk uses**	**No-spray Buffer: 300m aerial application, 150m ground application; and 6m vegetative filter strip**	**Required Points: Drift Runoff/drainage**
	Other Grains	Other Grains	
Steelhead, Middle Columbia River ESU (T)	Managed Forest Pasture Right of Way Wheat Other Crops Developed Orchards and Vineyards Vegetables and Ground Fruit Corn Other Row Crops	Managed Forest Pasture Right of Way Wheat Other Crops Developed Orchards and Vineyards Vegetables and Ground Fruit Corn Other Row Crops	80 drift 80 runoff
Steelhead, Northern California ESU (T)	Managed Forest Pasture Right of Way Developed Golf Courses Orchards and Vineyards	Managed Forest Pasture Right of Way Developed Golf Courses Orchards and Vineyards	80 drift 80 runoff
Steelhead, Puget Sound ESU (T)	Managed Forests Right of Way Developed Pasture	Managed Forests Right of Way Developed Pasture	80 drift 80 runoff
Steelhead, Snake River Basin ESU (T)	Managed Forest Pasture Wheat Right of Way Other Crops Developed Vegetables and Ground Fruit Other Grains Orchards and Vineyards Corn	Managed Forest Pasture Wheat Right of Way Other Crops Developed Vegetables and Ground Fruit Other Grains Orchards and Vineyards Corn	80 drift 80 runoff
Steelhead, South-Central California coast ESU (T)	Pasture Right of Way Orchards and Vineyards Developed Managed Forest Other Crops Vegetables and Ground Fruit Other Grains Wheat Corn Cotton	Pasture Right of Way Orchards and Vineyards Developed Managed Forest Other Crops Vegetables and Ground Fruit Other Grains Wheat Corn Cotton	80 drift 80 runoff
Steelhead, Southern California ESU (E)	Right of Way Developed	Right of Way Developed	80 drift 80 runoff

Chlorpyrifos	Risk Reduction Options for High Risk Uses		
Species	**Remove label authorization for all high risk uses**	**No-spray Buffer: 300m aerial application, 150m ground application; and 6m vegetative filter strip**	**Required Points: Drift Runoff/drainage**
	Pasture Managed Forest Golf Courses Orchards and Vineyards Vegetables and Ground Fruit Other Crops Other Grains Cotton Corn	Pasture Managed Forest Golf Courses Orchards and Vineyards Vegetables and Ground Fruit Other Crops Other Grains Cotton Corn	
Steelhead, Upper Columbia River ESU (T)	Managed Forest Pasture Right of Way Developed Orchards and Vineyards Wheat Other Crops Vegetables and Ground Fruit Corn	Managed Forest Pasture Right of Way Developed Orchards and Vineyards Wheat Other Crops Vegetables and Ground Fruit Corn	80 drift 80 runoff
Steelhead, Upper Willamette River ESU (T)	Managed Forest Pasture Right of Way Developed Other Crops Christmas Trees Wheat Vegetables and Ground Fruit Orchards and Vineyards Corn Other Grains Golf Courses Other Row Crops	Managed Forest Pasture Right of Way Developed Other Crops Christmas Trees Wheat Vegetables and Ground Fruit Orchards and Vineyards Corn Other Grains Golf Courses Other Row Crops	80 drift 80 runoff
Eulachon, Pacific smelt, Southern Distinct Population Segment (DPS) (T)	Managed Forest Right of Way Pasture Developed	Managed Forest Right of Way Pasture Developed	80 drift 80 runoff
Green sturgeon, Southern DPS (T)	Right of Way Pasture Managed Forest Developed Orchards and Vineyards Other Crops Corn Vegetables and Ground Fruit Wheat	Right of Way Pasture Managed Forest Developed Orchards and Vineyards Other Crops Corn Vegetables and Ground Fruit Wheat	80 drift 80 runoff

Chlorpyrifos	**Risk Reduction Options for High Risk Uses**		
Species	**Remove label authorization for all high risk uses**	**No-spray Buffer:** **300m aerial application,** **150m ground application; and** **6m vegetative filter strip**	**Required Points:** **Drift** **Runoff/drainage**
	Other Grains Golf Courses Other Row Crops	Other Grains Golf Courses Other Row Crops	
Shortnose sturgeon (E)	Managed Forest Right of Way Developed Pasture Soybean Corn	Managed Forest Right of Way Developed Pasture Soybean Corn	80 drift 80 runoff
Atlantic sturgeon, Carolina DPS (E)	Managed Forest Right of Way Soybeans Pasture Corn Developed Cotton Other Crops Wheat	Managed Forest Right of Way Soybeans Pasture Corn Developed Cotton Other Crops Wheat	80 drift 80 runoff
Atlantic sturgeon, Chesapeake Bay DPS (E)	Right of Way Managed Forest Soybean Developed Corn Pasture Golf Courses Cotton Wheat	Right of Way Managed Forest Soybean Developed Corn Pasture Golf Courses Cotton Wheat	80 drift 80 runoff
Atlantic sturgeon, Gulf of Maine DPS (T)	Right of Way Developed Pasture Managed forest	Right of Way Developed Pasture Managed forest	80 drift 80 runoff
Atlantic sturgeon, New York Bight DPS (E)	Right of Way Developed Managed Forest Pasture Corn Soybeans Other Crops Golf Courses Vegetables and Ground Fruit Wheat Orchards and Vineyards	Right of Way Developed Managed Forest Pasture Corn Soybeans Other Crops Golf Courses Vegetables and Ground Fruit Wheat Orchards and Vineyards	80 drift 80 runoff

Chlorpyrifos	**Risk Reduction Options for High Risk Uses**		
Species	**Remove label authorization for all high risk uses**	**No-spray Buffer: 300m aerial application, 150m ground application; and 6m vegetative filter strip**	**Required Points: Drift Runoff/drainage**
Atlantic sturgeon, South Atlantic DPS (E)	Managed Forest Pasture Right of Way Developed Cotton Other Crops Corn Other Row Crops Soybeans Orchards and Vineyards Wheat	Managed Forest Pasture Right of Way Developed Cotton Other Crops Corn Other Row Crops Soybeans Orchards and Vineyards Wheat	80 drift 80 runoff
Smalltooth sawfish, U.S. DPS.*	Managed Forest Right of Way Pasture Developed Golf Course Orchards	Managed Forest Right of Way Pasture Developed Golf Course Orchards	80 drift 80 runoff
Killer whale, Southern Resident DPS	Implementation of RPAs for all west coast Chinook ESUs		

For smalltooth sawfish, risk reduction measures are only required at use sites within the species nursery areas, as opposed to within the entire species range.

26.2.2 Diazinon RPA

- Reduce pesticide loading for all high risk use sites.
  - 1(a) Remove label authorization for all high risk uses. If current usage on use sites effectively reduces exposure, modify labels to reflect current usage.
  - 1(b) Modify labels to include 300 meter no-spray buffer for all aerial applications; 150 meter buffer for all ground applications; 6 meter vegetative filter strip for all applications.
  - 1(c) Point System. Implement a combination of risk reduction measures to reduce pesticide drift and runoff (Table 6)
- EPA shall, in close coordination with NMFS Office of Protected Resources, develop and implement an effectiveness monitoring plan to ensure the RPA(s) selected is/are feasible, effective, and implemented.

Table 6. High risk uses for diazinon and risk reduction points required for drift and runoff

Diazinon	**Risk Reduction Options for High Risk Uses**		
Species	**Remove label authorization for all high risk uses**	**No-spray Buffer: 300m aerial application, 150m ground application; and 6m vegetative filter strip**	**Required Points: Drift Runoff/drainage**
Chinook salmon, Central Valley spring-run ESU (T)	Orchards and Vineyards Vegetables and Ground Fruit	Orchards and Vineyards Vegetables and Ground Fruit	80 drift 80 runoff
Chinook salmon, Lower Columbia River ESU (T)	Orchards and Vineyards Vegetables and Ground Fruit	Orchards and Vineyards Vegetables and Ground Fruit	80 drift 80 runoff
Chinook salmon, Puget Sound ESU (T)	Vegetables and Ground Fruit	Vegetables and Ground Fruit	80 drift 80 runoff
Chinook salmon, Sacramento River winter-run ESU (E)	Orchards and Vineyards Vegetables and Ground Fruit	Orchards and Vineyards Vegetables and Ground Fruit	80 drift 80 runoff
Chinook salmon, Snake River fall-run ESU (T)	Vegetables and Ground Fruit Orchards and Vineyards	Vegetables and Ground Fruit Orchards and Vineyards	80 drift 80 runoff
Chinook salmon, Snake River spring/summer run ESU (T)	Vegetables and Ground Fruit Orchards and Vineyards	Vegetables and Ground Fruit Orchards and Vineyards	80 drift 80 runoff
Chinook salmon, Upper Columbia River spring-run ESU (E)	Orchards and Vineyards Vegetables and Ground Fruit	Orchards and Vineyards Vegetables and Ground Fruit	80 drift 80 runoff
Chinook salmon, Upper Willamette River ESU (T)	Vegetables and Ground Fruit Orchards and Vineyards	Vegetables and Ground Fruit Orchards and Vineyards	80 drift 80 runoff
Coho salmon, Central California coast ESU (E)	Orchards and Vineyards	Orchards and Vineyards	80 drift 80 runoff

Diazinon	Risk Reduction Options for High Risk Uses		
Species	**Remove label authorization for all high risk uses**	**No-spray Buffer: 300m aerial application, 150m ground application; and 6m vegetative filter strip**	**Required Points: Drift Runoff/drainage**
Sockeye, Snake River ESU (E)	Vegetables & Ground Fruit Orchards and Vineyards	Vegetables & Ground Fruit Orchards and Vineyards	80 drift 80 runoff
Steelhead, California Central Valley ESU (T)	Orchards and Vineyards Vegetables and Ground Fruit	Orchards and Vineyards Vegetables and Ground Fruit	80 drift 80 runoff
Steelhead, Central California coast ESU (T)	Orchards and Vineyards	Orchards and Vineyards	80 drift 80 runoff
Steelhead, Lower Columbia River ESU (T)	Orchards and Vineyards Vegetables and Ground Fruit	Orchards and Vineyards Vegetables and Ground Fruit	80 drift 80 runoff
Steelhead, Middle Columbia River ESU (T)	Orchards and Vineyards Vegetables and Ground Fruit	Orchards and Vineyards Vegetables and Ground Fruit	80 drift 80 runoff
Steelhead, Northern California ESU (T)	Orchards and Vineyards	Orchards and Vineyards	80 drift 80 runoff
Steelhead, Snake River Basin ESU (T)	Vegetables and Ground Fruit Orchards and Vineyards	Vegetables and Ground Fruit Orchards and Vineyards	80 drift 80 runoff
Steelhead, South-Central California coast ESU (T)	Orchards and Vineyards Vegetables and Ground Fruit	Orchards and Vineyards Vegetables and Ground Fruit	80 drift 80 runoff
Steelhead, Southern California ESU (E)	Orchards and Vineyards Vegetables and Ground Fruit	Orchards and Vineyards Vegetables and Ground Fruit	80 drift 80 runoff
Steelhead, Upper Columbia River ESU (T)	Orchards and Vineyards Vegetables and Ground Fruit	Orchards and Vineyards Vegetables and Ground Fruit	80 drift 80 runoff
Steelhead, Upper Willamette River ESU (T)	Vegetables and Ground Fruit Orchards and Vineyards	Vegetables and Ground Fruit Orchards and Vineyards	80 drift 80 runoff
Green sturgeon, Southern DPS (T)	Orchards and Vineyards Vegetables and Ground Fruit	Orchards and Vineyards Vegetables and Ground Fruit	80 drift 80 runoff
Atlantic sturgeon, New York Bight DPS (E)	Vegetables and Ground Fruit Orchards and Vineyards	Vegetables and Ground Fruit Orchards and Vineyards	70 drift 70 runoff
Atlantic sturgeon, South Atlantic DPS (E)	Orchards and Vineyards	Orchards and Vineyards	70 drift 70 runoff
Killer whale, Southern Resident DPS	Implementation of RPAs for all west coast Chinook ESUs		

26.2.3 Malathion RPA

- Reduce pesticide loading for all high risk use sites.
    - 1(a) Remove label authorization for all high risk uses. If current usage on use sites effectively reduces exposure, modify labels to reflect current usage.
    - 1(b) Modify labels to include 300 meter no-spray buffer for all aerial applications; 150 meter buffer for all ground applications; 6 meter vegetative filter strip for all applications.
    - 1(c) Point System. Implement a combination of risk reduction measures to reduce pesticide drift and runoff (Table 7).
- Restrict mosquito applications to residential and developed areas within species' range.
- EPA shall, in close coordination with NMFS Office of Protected Resources, develop and implement an effectiveness monitoring plan to ensure the RPA(s) selected is/are feasible, effective, and implemented.

Table 7. High risk uses for malathion and risk reduction points required for drift and runoff

Malathion	**Risk Reduction Options for High Risk Uses**		
Species	**Remove label authorization for all high risk uses**	**No-Spray Buffer: 300m aerial application, 150m ground application; and 6m vegetative filter strip**	**Required Points: Drift Runoff/drainage**
Chum salmon , Columbia River ESU (T)	Pasture Developed	Pasture Developed	80 drift 80 runoff
Chum salmon, Hood Canal summer-run ESU (T)	Pasture Developed	Pasture Developed	80 drift 80 runoff
Chinook salmon, California coastal ESU (T)	Pasture Developed Orchards and Vineyards	Pasture Developed Orchards and Vineyards	80 drift 80 runoff
Chinook salmon, Central Valley spring-run ESU (T)	Pasture Orchards and Vineyards Developed Other Crops Corn Vegetables and Ground fruits Wheat Other Grains Cotton Other Row Crops	Pasture Orchards and Vineyards Developed Other Crops Corn Vegetables and Ground fruits Wheat Other Grains Cotton Other Row Crops	80 drift 80 runoff
Chinook salmon, Lower Columbia River ESU (T)	Pasture Developed Christmas Trees Orchards and Vineyards Other Crops Vegetables and Ground fruit	Pasture Developed Christmas Trees Orchards and Vineyards Other Crops Vegetables and Ground fruit	80 drift 80 runoff

Malathion	**Risk Reduction Options for High Risk Uses**		
Species	**Remove label authorization for all high risk uses**	**No-Spray Buffer: 300m aerial application, 150m ground application; and 6m vegetative filter strip**	**Required Points: Drift Runoff/drainage**
	Corn Nurseries Other Grains	Corn Nurseries Other Grains	
Chinook salmon, Puget Sound ESU (T)	Developed Pasture Vegetables and Ground Fruit Corn Other Grains Wheat	Developed Pasture Vegetables and Ground Fruit Corn Other Grains Wheat	80 drift 80 runoff
Chinook salmon, Sacramento River winter-run ESU (E)	Pasture Developed Orchards and Vineyards Other Crops Corn Vegetables and Ground Fruit Wheat Other Grains Other Row Crops	Pasture Developed Orchards and Vineyards Other Crops Corn Vegetables and Ground Fruit Wheat Other Grains Other Row Crops	80 drift 80 runoff
Chinook salmon, Snake River fall-run ESU (T)	Pasture Wheat Developed Other Crops Vegetables and Ground fruit Orchards and Vineyards Corn Other Grains	Pasture Wheat Developed Other Crops Vegetables and Ground fruit Orchards and Vineyards Corn Other Grains	80 drift 80 runoff
Chinook salmon, Snake River spring/summer run ESU (T)	Pasture Wheat Other Crops Developed Vegetables and Ground fruit Orchards and Vineyards Corn	Pasture Wheat Other Crops Developed Vegetables and Ground fruit Orchards and Vineyards Corn	80 drift 80 runoff
Chinook salmon, Upper Columbia River spring-run ESU (E)	Pasture Developed Orchards and Vineyards Wheat Other Crops Vegetables and Ground Fruit Corn	Pasture Developed Orchards and Vineyards Wheat Other Crops Vegetables and Ground Fruit Corn	80 drift 80 runoff
Chinook salmon, Upper Willamette River ESU (T)	Pasture Developed Other Crops Vegetables and Ground Fruit	Pasture Developed Other Crops Vegetables and Ground Fruit	80 drift 80 runoff

Malathion	Risk Reduction Options for High Risk Uses		
Species	**Remove label authorization for all high risk uses**	**No-Spray Buffer: 300m aerial application, 150m ground application; and 6m vegetative filter strip**	**Required Points: Drift Runoff/drainage**
	Wheat Christmas Trees Orchards and Vineyards Corn Other Grains Other Row Crops	Wheat Christmas Trees Orchards and Vineyards Corn Other Grains Other Row Crops	
Coho salmon, Central California coast ESU (E)	Pasture Developed Orchards and Vineyards	Pasture Developed Orchards and Vineyards	80 drift 80 runoff
Coho salmon, Lower Columbia River ESU (E)	Pasture Developed	Pasture Developed	80 drift 80 runoff
Coho salmon, Oregon coast ESU (T)	Pasture Developed	Pasture Developed	80 drift 80 runoff
Coho salmon, S. Oregon and N. Calif coasts ESU (T)	Pasture Developed Other Crops	Pasture Developed Other Crops	80 drift 80 runoff
Sockeye, Ozette Lake ESU (T)	Pasture	Pasture	80 drift 80 runoff
Sockeye, Snake River ESU (E)	Pasture	Pasture	80 drift 80 runoff
Steelhead, California Central Valley ESU (T)	Pasture Orchards and Vineyards Developed Other Crops Corn Vegetables and Ground Fruit Wheat Other Grains Cotton Other Row Crops	Pasture Orchards and Vineyards Developed Other Crops Corn Vegetables and Ground Fruit Wheat Other Grains Cotton Other Row Crops	80 drift 80 runoff
Steelhead, Central California coast ESU (T)	Pasture Developed Orchards and Vineyards Other Grains Other Crops Wheat	Pasture Developed Orchards and Vineyards Other Grains Other Crops Wheat	80 drift 80 runoff
Steelhead, Lower Columbia River ESU (T)	Pasture Developed Christmas Trees Orchards and Vineyards Other Crops Vegetables and Ground Fruit Corn	Pasture Developed Christmas Trees Orchards and Vineyards Other Crops Vegetables and Ground Fruit Corn	80 drift 80 runoff

Malathion	Risk Reduction Options for High Risk Uses		
Species	**Remove label authorization for all high risk uses**	**No-Spray Buffer: 300m aerial application, 150m ground application; and 6m vegetative filter strip**	**Required Points: Drift Runoff/drainage**
	Wheat Other Grains	Wheat Other Grains	
Steelhead, Middle Columbia River ESU (T)	Pasture Wheat Other Crops Developed Orchards and Vineyards Vegetables and Ground Fruit Corn Other Row Crops	Pasture Wheat Other Crops Developed Orchards and Vineyards Vegetables and Ground Fruit Corn Other Row Crops	80 drift 80 runoff
Steelhead, Northern California ESU (T)	Pasture Developed Orchards and Vineyards	Pasture Developed Orchards and Vineyards	80 drift 80 runoff
Steelhead, Puget Sound ESU (T)	Developed Pasture	Developed Pasture	80 drift 80 runoff
Steelhead, Snake River Basin ESU (T)	Pasture Wheat Other Crops Developed Vegetables and Ground Fruit Other Grains Orchards and Vineyards Corn	Pasture Wheat Other Crops Developed Vegetables and Ground Fruit Other Grains Orchards and Vineyards Corn	80 drift 80 runoff
Steelhead, South-Central California coast ESU (T)	Pasture Orchards and Vineyards Developed Other Crops Vegetables and Ground Fruit Other Grains Wheat Corn Cotton	Pasture Orchards and Vineyards Developed Other Crops Vegetables and Ground Fruit Other Grains Wheat Corn Cotton	80 drift 80 runoff
Steelhead, Southern California ESU (E)	Developed Pasture Orchards and Vineyards Vegetables and Ground Fruit Cotton Corn	Developed Pasture Orchards and Vineyards Vegetables and Ground Fruit Cotton Corn	80 drift 80 runoff
Steelhead, Upper Columbia River ESU (T)	Pasture Developed Orchards and Vineyards Wheat Other Crops Vegetables and Ground fruit	Pasture Developed Orchards and Vineyards Wheat Other Crops Vegetables and Ground fruit	80 drift 80 runoff

Malathion	Risk Reduction Options for High Risk Uses		
Species	**Remove label authorization for all high risk uses**	**No-Spray Buffer: 300m aerial application, 150m ground application; and 6m vegetative filter strip**	**Required Points: Drift Runoff/drainage**
	Corn	Corn	
Steelhead, Upper Willamette River ESU (T)	Pasture Developed Other Crops Christmas Trees Wheat Vegetables and Ground Fruit Orchards and Vineyards Corn Other Grains Other Row Crops	Pasture Developed Other Crops Christmas Trees Wheat Vegetables and Ground Fruit Orchards and Vineyards Corn Other Grains Other Row Crops	80 drift 80 runoff
Eulachon, Pacific smelt, Southern DPS (T)	Pasture Developed	Pasture Developed	80 drift 80 runoff
Green sturgeon, Southern DPS (T)	Pasture Developed Orchards and Vineyards Other Crops Corn Vegetables and Ground Fruit Wheat Other Grains Other Row Crops	Pasture Developed Orchards and Vineyards Other Crops Corn Vegetables and Ground Fruit Wheat Other Grains Other Row Crops	70 drift 70 runoff
Shortnose sturgeon (E)	Developed Pasture Corn	Developed Pasture Corn	70 drift 70 runoff
Atlantic sturgeon, Carolina DPS (E)	Pasture Corn Developed Cotton Other Crops Wheat	Pasture Corn Developed Cotton Other Crops Wheat	70 drift 70 runoff
Atlantic sturgeon, Chesapeake Bay DPS (E)	Developed Corn Pasture Cotton Wheat	Developed Corn Pasture Cotton Wheat	70 drift 70 runoff
Atlantic sturgeon, Gulf of Maine DPS (T)	Developed Pasture	Developed Pasture	70 drift 70 runoff
Atlantic sturgeon, New York Bight DPS (E)	Developed Pasture Corn Other Crops Vegetables and Ground fruit	Developed Pasture Corn Other Crops Vegetables and Ground fruit	70 drift 70 runoff

Malathion	Risk Reduction Options for High Risk Uses		
Species	**Remove label authorization for all high risk uses**	**No-Spray Buffer: 300m aerial application, 150m ground application; and 6m vegetative filter strip**	**Required Points: Drift Runoff/drainage**
	Wheat Orchards and Vineyards	Wheat Orchards and Vineyards	
Atlantic sturgeon, South Atlantic DPS (E)	Pasture Developed Cotton Other Crops Corn Other Row Crops Orchards and Vineyards Wheat	Pasture Developed Cotton Other Crops Corn Other Row Crops Orchards and Vineyards Wheat	70 drift 70 runoff
Smalltooth sawfish, U.S. DPS*	Developed Pasture Orchards and Vineyards	Developed Pasture Orchards and Vineyards	80 drift 80 runoff
Killer whale, Southern Resident DPS	Implementation of RPAs for all west coast Chinook ESUs		
For smalltooth sawfish, risk reduction measures are only required at use sites within the species nursery areas, as opposed to within the entire species range.			

26.3 RPM Introduction

Section 7(b)(4) of the ESA requires that when a proposed agency action is found to be consistent with section 7(a)(2) of the ESA, either as proposed by the action agency or modified by a RPA, and the proposed action may incidentally take individuals of ESA-listed species, NMFS will issue a statement that specifies the impact of any incidental taking of endangered or threatened species ("incidental take statement" or "ITS"). To minimize such impacts, NMFS provides reasonable and prudent measures "RPM", and terms and conditions to implement the RPM. Action agency compliance with the terms and conditions provides an exemption from the prohibitions against "take" of listed species. NMFS believes the RPM and the implementing terms and conditions described below are necessary and appropriate to minimize the impacts of incidental take on threatened and endangered species. The measures described below are nondiscretionary, and must be undertaken by the U.S. Environmental Protection Agency so that they become binding conditions for the exemption in section 7(o)(2) to apply. Section 7(b)(4) of the ESA requires that when a proposed agency action is found to be consistent with section 7(a)(2) of the ESA and the proposed action may incidentally take individuals of ESA-listed species, NMFS will issue a statement that specifies the impact of any incidental taking of endangered or threatened species. To minimize such impacts, reasonable and prudent measures, and term and conditions to implement the measures, must be provided. Only incidental take resulting from the agency actions and any specified reasonable and prudent measures and terms and conditions identified in the incidental take statement are exempt from the taking prohibition of section 9(a), pursuant to section 7(o) of the ESA.

Reasonable and prudent measures (RPM)

“Reasonable and prudent measures” are nondiscretionary measures to minimize the amount or extent of incidental take (50 C.F.R. §402.02). The reasonable and prudent measures described below are necessary and appropriate to minimize the impacts of incidental take on threatened and endangered species:

- RPM 1. Revise all chlorpyrifos, diazinon, and malathion product labels and develop relevant EPA Endangered Species Protection Plan Bulletins to conserve listed species.
- RPM 2. Develop user education program, and incident tracking and reporting system.

26.4 Incidental Take Statement

Section 9(a)(1) of the ESA prohibits the taking of endangered species without a specific permit or exemption. Protective regulations adopted pursuant to section 4(d) of the ESA extend the prohibition to threatened species. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct (50 CFR 222.102). Harm is further defined by NMFS an act which actually kills or injures fish or wildlife, and may to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). Incidental take is defined as takings that result from, but are is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action, whether implemented as proposed or as modified by reasonable and prudent alternatives, is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement. NMFS cannot issue an Incidental Take Statement to cover any take of marine mammals that would also be prohibited under the Marine Mammal Protection Act, unless such take has been authorized pursuant to section 101(a)(5) of that Act. Consequently, any exemption of incidental take of marine mammals under this Incidental Take Statement is conditional upon the issuance of an authorization for such take under the MMPA.

26.4.1 Amount or Extent & Effects of Take

Section 7 regulations require NMFS to specify the impact of any incidental take of endangered or threatened species; that is, the amount or extent, of such incidental taking on the species (50 C.F.R. §402.14(i)(1)(i)). The amount of take represents the number of individuals that are expected to be taken by actions. As described earlier in this Opinion, the proposed action for this consultation is EPA’s registrations of all pesticides containing chlorpyrifos, diazinon and malathion for use as described on product labels. The proposed action includes (1) approved product labels containing chlorpyrifos, diazinon and malathion, (2) degradates and metabolites of chlorpyrifos, diazinon and malathion, (3) formulations, including other ingredients within formulations, (4) adjuvants, and (5) tank mixtures. EPA is required to reassess currently registered pesticide active ingredients every 15 years. The EPA authorizes use of these pesticide products for pest control purposes across multiple landscapes. The goal of this Opinion is to evaluate the impacts to NMFS’ listed resources from the EPA’s broad authorization of applied pesticide products.

For this Opinion, NMFS anticipates the general direct and indirect effects that would occur from EPA's registration of pesticide products to 77 listed species under NMFS' jurisdiction during the 15-year duration of the proposed action. The RPA are designed to reduce exposure but not eliminate it. Pesticide runoff and drift of chlorpyrifos, diazinon, and malathion are most likely to reach streams and other aquatic sites when they are applied to crops and other land use settings located adjacent to wetlands, riparian areas, ditches, flood plain habitats, intermittent streams, nearshore estuarine and marine habitats. These inputs into aquatic habitats are especially high when rainfall immediately follows applications, or if wind conditions exacerbate inputs from drift. The effects of pesticides and other contaminants found in urban runoff, especially from areas with a high degree of impervious surfaces, may also exacerbate degraded water quality conditions of receiving waters. Urban runoff is also generally warmer in temperature, and elevated water temperature poses negative effects to many listed species. The range of effects of the 3 a.i.s on listed species includes killing species directly and reductions in prey leading to starvation and impaired growth. For example, impaired growth lends juveniles prone to becoming prey to predators, and starvation may make species more susceptible to disease. In addition, exposed individuals may change normal behaviors (e.g. feeding, sheltering, breeding, etc.). These results are not the purpose of the proposed action. Therefore, incidental take of listed species is reasonably certain to occur over the 15-year duration of the proposed action.

Given the variability of real-life conditions, the broad nature and scope of the proposed action, and the wide-ranging distributions of individuals of listed species, the best scientific and commercial data available are not sufficient to enable NMFS to estimate a specific amount of incidental take associated with the proposed action. As explained in the Description of the Proposed Action and the Effects of the Proposed Action sections, NMFS identified multiple uncertainties associated with the proposed action. Areas of uncertainty include:

1. Limited use and exposure data on stressors of the action for non-agricultural uses of these pesticides;
2. Minimal information on exposure and toxicity for pesticide formulations, adjuvants, and other/inert ingredients within registered formulations;
3. Minimal information on tank mixtures and associated exposure estimates;
4. Limited data on toxicity of environmental mixtures;
5. Variability in annual land use, crop cover, and pest pressure;
6. Temporal and spatial variability of individuals;
7. Pesticide concentrations in nearshore estuarine and marine habitats
8. Pesticide concentrations resulting from non-agricultural uses

Additionally, NMFS recognizes there are multiple impediments that reduce the likelihood of detecting take to listed species from the use of pesticides. It's important to place the significance of mortality incidents in the proper context. Vyas (1999) concluded that most wildlife mortality is unaccounted for as only a small fraction are likely observed, reported, and confirmed. The likelihood of detecting impacts becomes even more difficult in species with limited abundance. Sublethal impacts such as reduced reproduction are nearly impossible to detect without rigorous environmental monitoring. For these reasons, NMFS uses surrogates for the allowable extent of take of listed species, as described below within each of the species groupings.

Anadromous and Marine Fish

NMFS therefore identifies, as a surrogate for the allowable extent of take of anadromous and marine fish, the ability of this action to proceed without any fish kills within the action area attributed to the legal use of chlorpyrifos, diazinon or malathion, or any compounds, degradates, or mixtures affecting aquatic habitats containing listed species. Because of the difficulty of detecting mortality of listed species, individuals killed do not have to be listed species in order for their death to be considered a relevant surrogate for take. For example, salmonids are relatively sensitive to pesticides compared to other species of fish, so that if there are kills of other freshwater fishes attributed to use of these pesticides, it is likely that salmonids have also died, even if no dead salmonids can be located. In addition, if stream conditions due to pesticide use kill less sensitive fishes in certain areas, the potential for lethal and non-lethal takes in downstream areas increases. A fish kill is considered attributable to one of these three ingredients, its metabolites, or degradates, if any of the a.i.s is known to have been applied in the vicinity and may reasonably be supposed to have run off or drifted into the affected area, or if surface water samples or pathology indicate lethal levels of the a.i.(s).

NMFS notes that increased monitoring and study of the impact of these pesticides on water quality, particularly water quality in flood plain habitats, nearshore estuarine, and marine habitats will inform subsequent pesticide consultations and future incidental take statements. Such monitoring and studies will potentially allow other measures of the extent of take.

Marine Invertebrates

NMFS therefore identifies, as a surrogate for the allowable extent of take of marine invertebrates, the ability of this action to proceed without any mortality or adverse reproductive effects to corals or molluscs within the action area attributed to the legal use of chlorpyrifos, diazinon or malathion, or any compounds, degradates, or mixtures affecting aquatic habitats containing listed species. Because of the difficulty of detecting mortality of listed species, individuals killed or adversely affected do not have to be listed species in order for their death or adverse effects to be considered relevant surrogate for take. An adverse effect is considered attributable to one of these three ingredients, its metabolites, or degradates, if any of the a.i.s is known to have been applied in the vicinity and may reasonably be supposed to have run off or drifted into the affected area, or if surface water samples or pathology indicate lethal levels of the a.i.(s).

Sea Turtles

NMFS therefore identifies, as a surrogate for the allowable extent of take sea turtles, the ability of this action to proceed without any mortality or sublethal effects to sea turtles including adverse impacts to swimming or reproduction within the action area attributed to the legal use of chlorpyrifos, diazinon or malathion, or any compounds, degradates, or mixtures affecting aquatic habitats containing listed species. Because of the difficulty of detecting mortality of listed species, individuals killed or adversely affected do not have to be listed species in order for their death or adverse effects to be considered relevant surrogate for take. An adverse effect is considered attributable to one of these three ingredients, its metabolites, or degradates, if any of the a.i.s is known to have been applied in the vicinity and may reasonably be supposed to have run off or drifted into the affected area, or if surface water samples or pathology indicate lethal levels of the a.i.(s).

Pinnipeds
NMFS therefore identifies, as a surrogate for the allowable extent of take of pinnipeds, the ability of this action to proceed without any mortality or adverse impacts to to pinniped swimming or reproduction attributed to the legal use of chlorpyrifos, diazinon or malathion, or any compounds, degradates, or mixtures affecting aquatic habitats containing listed species. Because of the difficulty of detecting mortality or other adverse effects to of listed species, individuals killed or adversely affected do not have to be listed species in order for their death or adverse effects to be considered relevant surrogate for take. An adverse effect is considered attributable to one of these three ingredients, its metabolites, or degradates, if any of the a.i.s is known to have been applied in the vicinity and may reasonably be supposed to have run off or drifted into the affected area, or if surface water samples or pathology indicate lethal levels of the a.i.(s).

Cetaceans - Southern Resident Killer Whale (SRKW)
NMFS therefore identifies, as a surrogate for the allowable take of SRKW, the ability of this action to proceed without any mortality to Pacific Salmonids attributed to the legal use of chlorpyrifos, diazinon, or malathion. Salmon, in particular Chinook salmon, are the prey for SRKW. Currently, the numbers of Chinook and other salmon are insufficient to support increases in the SRKW population size. The reduction in production of Pacific salmon throughout their range that would occur under the Proposed Action would therefore result in harm to SRKW by further reducing prey availability, which may cause animals to forage for longer periods, travel to alternate locations, or abandon foraging efforts. The extent of take from the Proposed Action is not anticipated to cause direct take by serious injury or mortality to SRKWs. However, the Proposed Action is expected to result in take in the form of a reduction in available prey.

26.5 Terms and Conditions

To be exempt from the prohibitions of section 9 of the ESA, the Environmental Protection Agency must comply with the following terms and conditions, which implement the Reasonable and Prudent Measures described above. These include the take minimization, monitoring and reporting measures required by the section 7 regulations (50 C.F.R. §402.14(i)). These terms and conditions are non-discretionary. If the Environmental Protection Agency fails to ensure compliance with these terms and conditions and their implementing reasonable and prudent measures, the protective coverage of section 7(o)(2) may lapse.

To address RPM number 1, EPA shall implement the following revisions on all chlorpyrifos, diazinon, and malathion labels:

a. Prohibit application of pesticide products when wind speeds are greater than or equal to 10 mph.
b. Prohibit application of pesticide products when soil moisture is at field capacity, or when a storm event likely to produce runoff from the treated area is forecasted (by NOAA/National Weather Service, or other similar forecasting service) to occur within 48 hours following application.

c. Prohibit co-application (tank mixing) with other neurotoxic pesticides (i.e., organophosphate, carbamate, pyrethroid, and neonicotinoid pesticides).

To implement RPM number 2, EPA shall:

a) Provide home owner and commercial applicator training on relevant endangered species and designated critical habitats including information on risk reduction measures, best management practices, etc.
b) Report all incidents of mortality and adverse effects to non-target species that occur within the vicinity of the treatment area, including areas downstream and downwind, in the four days following application of and of these a.i.s to EPA's Office of Pesticide Programs (phone: 703-305-7090). Within one year of receipt of this Opinion, EPA shall submit an annual report to NMFS Office of Protected Resources that identifies the total number of non-target species affected and incident locations.
c) EPA shall, in close coordination with NMFS Office of Protected Resources, develop and implement an effectiveness monitoring plan for aquatic habitats. A report summarizing annual monitoring data and including all raw data shall be submitted to NMFS Office of Protected Resources and will summarize annual monitoring data and provide all raw data.
d) EPA shall include the following instructions requiring reporting of mortality events either on the labels for all products containing chlorpyrifos, diazinon, and malathion in ESPP Bulletins:

   NOTICE: Incidents where listed species appear injured or killed as a result of pesticide applications shall be reported to NMFS Office of Protected Resources at 301-713-1401 and EPA's Office of Pesticide Programs. The finder should leave the individuals alone, make note of any circumstances likely causing the death or injury, location and number of individuals involved, and take photographs, if possible. Individuals should generally not be disturbed unless circumstances arise where the individual is obviously injured or killed by pesticide exposure, or some unnatural cause. NMFS Office of Protected Resources or Office of Law Enforcement may request the finder to collect specimens or take other measures to ensure that evidence intrinsic to the specimen is preserved.
e) EPA shall report to NMFS Office of Protected Resources any incidences regarding chlorpyrifos, diazinon, and malathion effects on aquatic ecosystems added to its incident database that it has classified as probable or highly probable.
f) EPA shall provide OPR a commencement date for annual reporting of monitoring results.

26.6 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on ESA-listed species or critical habitat, to help implement recovery plans or develop information (50 C.F.R. §402.02).

The following conservation recommendations would provide information for future consultations involving future authorizations of pesticide active ingredients that may affect ESA-listed species:

1. Develop models that more accurately quantify pesticide exposure in estuarine and near-shore ocean environments.
2. Work with other appropriate federal, state, and local partners to determine efficacy of riparian area management methods in reducing pesticide loading from authorized uses especially the types of vegetation and width of riparian areas needed.
3. Identify and implement other methods that eliminate or significantly reduce pesticide loading into species' habitats.
4. Carryout educational outreach on pesticide risks to threatened and endangered species to pesticide users in high use agriculture and residential environments.
5. Develop improved methods for characterizing exposure from non-agricultural uses.
6. Develop criteria that addresses when pesticide-contaminated sediment is an important route of exposure to aquatic organisms.

In order for NMFS' Office of Protected Resources Endangered Species Act Interagency Cooperation Division to be kept informed of actions minimizing or avoiding adverse effects on, or benefiting, ESA-listed species or their critical habitat, the Environmental Protection Agency should notify the Endangered Species Act Interagency Cooperation Division of any conservation recommendations they implement in their final action.

26.7 Reinitiation Notice

This concludes formal consultation for the Environmental Protection Agency's proposed registration of pesticide products containing chlorpyrifos, diazinon, and malathion to ESA-listed species under the jurisdiction of the NMFS. As 50 C.F.R. §402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if:

1. The amount or extent of taking specified in the incidental take statement is exceeded.
2. New information reveals effects of the agency action that may affect ESA-listed species or critical habitat in a manner or to an extent not previously considered.
3. The identified action is subsequently modified in a manner that causes an effect to ESA-listed species or designated critical habitat that was not considered in this opinion.
4. A new species is listed or critical habitat designated under the ESA that may be affected by the action.

NMFS' analysis and conclusions are based on EPA's action. If changes to product labeling result in modifications to the action that were not considered in this Opinion, including but not limited to label modifications authorizing pesticide application to new locations, additional application methods, or increased application rates or numbers of applications, EPA must contact NMFS to discuss reinitiation. If reinitiation of consultation appears warranted due to one or more of the above circumstances, EPA must contact NMFS Office of Protected Resources, ESA Interagency Cooperation Division. In the event reinitiation conditions (1), (2), or (3) is met, reinitiation will be only for the a.i.(s) which meet that condition, not for all 3 a.i.s considered in the Opinion. If none of these reinitiation triggers are met within the next 15 years, then reinitiation will be required because the Opinion only covers the action for 15 years. It is recommended that EPA request reinitiation with sufficient time prior to reaching 15 years to allow sufficient time to consult and to prevent lapse of coverage for the active ingredients in this Opinion.

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A. APPENDIX: MAGTOOL RESULTS FOR LISTED SPECIES

The MagTool (developed by EPA) was used to generate mortality estimates for 30 of the 77 species being consulted on, all of which are anadromous. MagTool estimates were not generated for nine anadromous species due to inaccuracies in the underlying species range data. See Appendix D for additional information regarding the conceptual design of the MagTool, as well as for inputs used by NMFS to generate the estimates provided below.

Table 1. Chum salmon, Columbia River Evolutionarily Significant Unit (ESU); Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	60	61	63
3	1-day	98	99	99
4	1-day	98	99	99
5	1-day	60	61	63
6	1-day	60	61	63
7	1-day	60	61	63
2	4-day	60	61	63
3	4-day	96	96	97
4	4-day	96	96	97
5	4-day	59	61	63
6	4-day	60	61	63
7	4-day	60	61	63

Table 2. Chum salmon, Columbia River ESU; Prey; Chlorpyrifos

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %

2	1-day	60	61	63	60	61	63
3	1-day	96	97	97	100	100	100
4	1-day	96	97	97	100	100	100
5	1-day	60	61	63	60	61	63
6	1-day	60	61	63	60	61	63
7	1-day	60	61	63	60	61	63
2	4-day	60	61	63	60	61	63
3	4-day	94	95	96	100	100	100
4	4-day	94	95	96	100	100	100
5	4-day	54	58	62	60	61	63
6	4-day	60	61	63	60	61	63
7	4-day	59	61	63	60	61	63

Table 3. Chum salmon, Hood Canal summer-run ESU; Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	57	59	61
3	1-day	89	90	94
4	1-day	89	89	91
5	1-day	57	59	61
6	1-day	57	59	61
7	1-day	57	59	61
2	4-day	57	59	61
3	4-day	88	90	93
4	4-day	88	89	91
5	4-day	57	58	61
6	4-day	57	59	61

7	4-day	57	59	61

Table 4. Chum salmon, Hood Canal summer-run ESU; Prey; Chlorpyrifos

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	57	59	61	57	59	61
3	1-day	88	89	90	89	100	100
4	1-day	88	89	89	89	100	100
5	1-day	57	59	61	57	59	61
6	1-day	57	59	61	57	59	61
7	1-day	57	59	61	57	59	61
2	4-day	57	59	61	57	59	61
3	4-day	86	88	90	89	100	100
4	4-day	86	88	89	89	100	100
5	4-day	54	57	59	57	59	61
6	4-day	57	59	61	57	59	61
7	4-day	57	58	61	57	59	61

Table 5. Chinook salmon, California Coastal ESU; Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	22	25	45
3	1-day	97	98	99
4	1-day	98	98	99
5	1-day	22	25	45
6	1-day	22	24	45
7	1-day	22	24	45
2	4-day	22	25	45
3	4-day	88	95	98
4	4-day	88	96	98
5	4-day	22	24	45
6	4-day	22	24	45
7	4-day	22	24	45

Table 6. Chinook salmon, California Coastal ESU; Prey; Chlorpyrifos

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	22	25	45	22	25	45
3	1-day	92	95	98	100	100	100
4	1-day	92	95	98	100	100	100
5	1-day	22	24	45	22	25	45
6	1-day	22	24	45	22	25	45
7	1-day	22	24	45	22	25	45
2	4-day	22	24	45	22	25	45
3	4-day	68	85	95	100	100	100
4	4-day	70	86	96	100	100	100
5	4-day	22	24	45	22	25	45
6	4-day	22	24	45	22	25	45
7	4-day	22	24	45	22	25	45

Table 7. Chinook salmon, Central Valley spring-run ESU; Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	81	82	86
3	1-day	100	100	100
4	1-day	100	100	100
5	1-day	81	82	86
6	1-day	81	82	86
7	1-day	81	82	86
2	4-day	81	82	86
3	4-day	99	100	100
4	4-day	99	100	100
5	4-day	81	82	86
6	4-day	81	82	86
7	4-day	81	82	86

Table 8. Chinook salmon, Central Valley spring-run ESU; Prey; Chlorpyrifos

Prey	All fish HC10 % mortality	All invert HC10 % mortality

Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	81	82	86	81	82	86
3	1-day	99	100	100	100	100	100
4	1-day	99	100	100	100	100	100
5	1-day	81	82	86	81	82	86
6	1-day	81	82	86	81	82	86
7	1-day	79	82	86	81	82	86
2	4-day	81	82	86	81	82	86
3	4-day	97	99	100	100	100	100
4	4-day	98	99	100	100	100	100
5	4-day	80	82	86	81	82	86
6	4-day	81	82	86	81	82	86
7	4-day	78	81	86	81	82	86

Table 9. Chinook salmon, Lower Columbia River ESU; Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	63	63	65
3	1-day	99	99	99
4	1-day	99	99	99
5	1-day	63	63	65
6	1-day	63	63	65
7	1-day	63	63	65
2	4-day	63	63	65
3	4-day	99	99	99
4	4-day	99	99	99
5	4-day	63	63	65
6	4-day	63	63	65
7	4-day	63	63	65

Table 10. Chinook salmon, Lower Columbia River ESU; Prey; Chlorpyrifos

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	63	63	65	63	63	65
3	1-day	97	98	98	100	100	100

4	1-day	97	98	98	100	100	100
5	1-day	63	63	65	63	63	65
6	1-day	63	63	65	63	63	65
7	1-day	63	63	65	63	63	65
2	4-day	63	63	65	63	63	65
3	4-day	97	98	98	100	100	100
4	4-day	97	98	98	100	100	100
5	4-day	63	63	65	63	63	65
6	4-day	63	63	65	63	63	65
7	4-day	63	63	65	63	63	65

Table 11. Chinook salmon, Puget Sound ESU; Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	61	62	63
3	1-day	93	95	97
4	1-day	93	95	96
5	1-day	61	62	63
6	1-day	61	62	63
7	1-day	61	62	63
2	4-day	61	62	63
3	4-day	91	94	96
4	4-day	91	93	95
5	4-day	60	61	63
6	4-day	61	62	63
7	4-day	61	62	63

Table 12. Chinook salmon, Puget Sound ESU; Prey; Chlorpyrifos

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	61	62	63	61	62	63
3	1-day	91	93	94	96	100	100
4	1-day	91	93	93	96	100	100
5	1-day	60	61	63	61	62	63
6	1-day	61	62	63	61	62	63
7	1-day	60	61	63	61	62	63

2	4-day	61	62	63	61	62	63
3	4-day	88	91	93	95	100	100
4	4-day	87	90	92	95	100	100
5	4-day	55	59	62	61	62	63
6	4-day	61	62	63	61	62	63
7	4-day	60	61	63	61	62	63

Table 13. Chinook salmon, Sacramento River winter-run ESU; Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	75	76	79
3	1-day	99	100	100
4	1-day	99	100	100
5	1-day	75	76	79
6	1-day	75	76	78
7	1-day	75	76	78
2	4-day	75	76	78
3	4-day	98	99	99
4	4-day	98	99	99
5	4-day	75	76	78
6	4-day	75	76	78
7	4-day	75	76	78

Table 14. Chinook salmon, Sacramento River winter-run ESU; Prey; Chlorpyrifos

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	75	76	79	75	76	79
3	1-day	98	99	100	100	100	100
4	1-day	98	99	100	100	100	100
5	1-day	75	76	79	75	76	79
6	1-day	75	76	78	75	76	79
7	1-day	74	75	78	75	76	79
2	4-day	75	76	78	75	76	79
3	4-day	95	97	98	100	100	100
4	4-day	96	97	98	100	100	100
5	4-day	74	75	78	75	76	79

6	4-day	75	76	78	75	76	79
7	4-day	74	75	78	75	76	79

Table 15. Chinook salmon, Snake River fall-run ESU; Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	55	60	65
3	1-day	95	97	98
4	1-day	93	97	97
5	1-day	55	60	65
6	1-day	55	60	65
7	1-day	54	59	65
2	4-day	55	60	65
3	4-day	87	92	95
4	4-day	81	91	95
5	4-day	54	59	65
6	4-day	55	60	65
7	4-day	54	59	65

Table 16. Chinook salmon, Snake River fall-run ESU; Prey; Chlorpyrifos

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	55	60	65	55	60	65
3	1-day	89	95	96	98	98	98
4	1-day	86	94	96	98	98	98
5	1-day	55	59	65	55	60	65
6	1-day	55	59	65	55	60	65
7	1-day	51	56	62	55	60	65
2	4-day	55	59	65	55	60	65
3	4-day	74	84	90	98	98	98
4	4-day	67	81	89	98	98	98
5	4-day	52	57	63	55	60	65
6	4-day	54	59	65	55	60	65
7	4-day	49	54	61	55	60	65

Table 17. Chinook salmon, Snake River spring/summer-run ESU; Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	51	54	59
3	1-day	83	92	96
4	1-day	80	91	95
5	1-day	51	54	59
6	1-day	51	54	59
7	1-day	50	53	59
2	4-day	51	54	59
3	4-day	74	84	91
4	4-day	66	81	90
5	4-day	50	53	59
6	4-day	51	53	59
7	4-day	50	53	59

Table 18. Chinook salmon, Snake River spring/summer-run ESU; Prey; Chlorpyrifos

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	51	54	59	51	54	59
3	1-day	78	86	92	91	99	99
4	1-day	72	83	90	91	99	99
5	1-day	51	53	59	51	54	59
6	1-day	51	53	59	51	54	59
7	1-day	47	51	56	51	54	59
2	4-day	51	53	59	51	54	59
3	4-day	60	73	84	89	99	99
4	4-day	52	69	82	89	99	99
5	4-day	49	52	58	51	54	59
6	4-day	50	53	59	51	54	59
7	4-day	45	50	56	51	54	59

Table 19. Chinook salmon, upper Columbia spring-run ESU; Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %

2	1-day	48	50	53
3	1-day	95	97	97
4	1-day	95	97	97
5	1-day	48	50	53
6	1-day	48	50	53
7	1-day	48	50	53
2	4-day	48	50	53
3	4-day	91	94	95
4	4-day	90	93	95
5	4-day	47	50	53
6	4-day	48	50	53
7	4-day	47	50	53

Table 20. Chinook salmon, upper Columbia spring-run ESU; Prey; Chlorpyrifos

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	48	50	53	48	50	53
3	1-day	93	95	96	98	98	98
4	1-day	92	94	95	98	98	98
5	1-day	48	50	53	48	50	53
6	1-day	48	50	53	48	50	53
7	1-day	46	49	52	48	50	53
2	4-day	48	50	53	48	50	53
3	4-day	85	90	92	98	98	98
4	4-day	84	89	92	98	98	98
5	4-day	44	47	50	48	50	53
6	4-day	48	50	53	48	50	53
7	4-day	45	48	52	48	50	53

Table 21. Chinook salmon, upper Willamette River ESU; Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	73	74	76
3	1-day	98	99	99
4	1-day	98	99	99
5	1-day	73	74	76

6	1-day	73	74	76
7	1-day	73	74	76
2	4-day	73	74	76
3	4-day	98	99	99
4	4-day	98	99	99
5	4-day	73	74	76
6	4-day	73	74	76
7	4-day	73	74	76

Table 22. Chinook salmon, upper Willamette River ESU; Prey; Chlorpyrifos

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	73	74	76	73	74	76
3	1-day	98	98	98	99	99	100
4	1-day	98	98	98	99	99	100
5	1-day	73	74	76	73	74	76
6	1-day	73	74	76	73	74	76
7	1-day	73	74	76	73	74	76
2	4-day	73	74	76	73	74	76
3	4-day	98	98	98	99	99	100
4	4-day	98	98	98	99	99	100
5	4-day	73	74	76	73	74	76
6	4-day	73	74	76	73	74	76
7	4-day	73	74	76	73	74	76

Table 23. Coho salmon, Central California Coast ESU; Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	41	44	49
3	1-day	98	99	100
4	1-day	98	99	100
5	1-day	41	44	49
6	1-day	41	44	49
7	1-day	41	44	49
2	4-day	41	44	49
3	4-day	92	96	98

4	4-day	92	96	99
5	4-day	41	44	49
6	4-day	41	44	49
7	4-day	41	44	49

Table 24. Coho salmon, Central California Coast ESU; Prey; Chlorpyrifos

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	41	44	49	41	44	49
3	1-day	94	96	98	100	100	100
4	1-day	95	96	99	100	100	100
5	1-day	41	44	49	41	44	49
6	1-day	41	44	49	41	44	49
7	1-day	41	44	49	41	44	49
2	4-day	41	44	49	41	44	49
3	4-day	80	88	95	100	100	100
4	4-day	82	89	95	100	100	100
5	4-day	41	44	49	41	44	49
6	4-day	41	44	49	41	44	49
7	4-day	41	44	49	41	44	49

Table 25. Coho salmon, lower Columbia River ESU; Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	63	63	65
3	1-day	98	99	99
4	1-day	98	99	99
5	1-day	63	63	65
6	1-day	63	63	65
7	1-day	63	63	65
2	4-day	63	63	65
3	4-day	97	97	98
4	4-day	97	97	98
5	4-day	62	63	65
6	4-day	63	63	65
7	4-day	63	63	65

Table 26. Coho salmon, lower Columbia River ESU; Prey; Chlorpyrifos

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	63	63	65	63	63	65
3	1-day	97	98	98	100	100	100
4	1-day	97	98	98	100	100	100
5	1-day	62	63	65	63	63	65
6	1-day	63	63	65	63	63	65
7	1-day	62	63	65	63	63	65
2	4-day	63	63	65	63	63	65
3	4-day	95	96	97	100	100	100
4	4-day	94	96	97	100	100	100
5	4-day	58	61	64	63	63	65
6	4-day	63	63	65	63	63	65
7	4-day	62	63	65	63	63	65

Table 27. Coho salmon, Oregon coast ESU; Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	64	67	67
3	1-day	100	100	100
4	1-day	100	100	100
5	1-day	64	67	67
6	1-day	64	67	67
7	1-day	64	67	67
2	4-day	64	67	67
3	4-day	100	100	100
4	4-day	100	100	100
5	4-day	64	67	67
6	4-day	64	67	67
7	4-day	64	67	67

Table 28. Coho salmon, Oregon coast ESU; Prey; Chlorpyrifos

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	64	67	67	64	67	67
3	1-day	100	100	100	100	100	100
4	1-day	100	100	100	100	100	100
5	1-day	64	67	67	64	67	67
6	1-day	64	67	67	64	67	67
7	1-day	64	67	67	64	67	67
2	4-day	64	67	67	64	67	67
3	4-day	100	100	100	100	100	100
4	4-day	99	100	100	100	100	100
5	4-day	62	66	67	64	67	67
6	4-day	64	67	67	64	67	67
7	4-day	64	67	67	64	67	67

Table 29. Coho salmon, southern Oregon/northern California coast ESU; Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	46	48	59
3	1-day	97	98	99
4	1-day	98	98	99
5	1-day	46	48	59
6	1-day	46	48	59
7	1-day	46	48	59
2	4-day	46	48	59
3	4-day	94	96	98
4	4-day	94	96	98
5	4-day	46	48	59
6	4-day	46	48	59
7	4-day	46	48	59

Table 30. Coho salmon, southern Oregon/northern California coast ESU; Prey; Chlorpyrifos

Prey		All fish HC10 % mortality	All invert HC10 % mortality

Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	46	48	59	46	48	59
3	1-day	95	96	97	100	100	100
4	1-day	95	96	97	100	100	100
5	1-day	46	48	59	46	48	59
6	1-day	46	48	59	46	48	59
7	1-day	46	47	59	46	48	59
2	4-day	46	48	59	46	48	59
3	4-day	85	92	95	100	100	100
4	4-day	86	92	95	100	100	100
5	4-day	45	47	59	46	48	59
6	4-day	46	48	59	46	48	59
7	4-day	45	47	59	46	48	59

Table 31. Sockeye salmon, Ozette Lake ESU; Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	43	45	47
3	1-day	100	100	100
4	1-day	100	100	100
5	1-day	43	45	47
6	1-day	43	45	47
7	1-day	43	45	47
2	4-day	43	45	47
3	4-day	100	100	100
4	4-day	100	100	100
5	4-day	43	45	47
6	4-day	43	45	47
7	4-day	43	45	47

Table 32. Sockeye salmon, Ozette Lake ESU; Prey; Chlorpyrifos

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	43	45	47	43	45	47
3	1-day	100	100	100	100	100	100

4	1-day	100	100	100	100	100	100
5	1-day	43	45	47	43	45	47
6	1-day	43	45	47	43	45	47
7	1-day	43	45	47	43	45	47
2	4-day	43	45	47	43	45	47
3	4-day	96	100	100	100	100	100
4	4-day	95	100	100	100	100	100
5	4-day	42	44	47	43	45	47
6	4-day	43	45	47	43	45	47
7	4-day	43	45	47	43	45	47

Table 33. Sockeye salmon, Snake River ESU; Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	50	53	59
3	1-day	89	94	96
4	1-day	86	93	96
5	1-day	50	53	59
6	1-day	50	53	59
7	1-day	50	53	59
2	4-day	50	53	59
3	4-day	81	88	92
4	4-day	73	86	92
5	4-day	50	53	59
6	4-day	50	53	59
7	4-day	50	53	59

Table 34. Sockeye salmon, Snake River ESU; Prey; Chlorpyrifos

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	50	53	59	50	53	59
3	1-day	84	90	94	94	98	98
4	1-day	78	89	93	94	98	98
5	1-day	50	53	59	50	53	59
6	1-day	50	53	59	50	53	59
7	1-day	47	51	57	50	53	59

2	4-day	50	53	59	50	53	59
3	4-day	68	78	86	93	98	98
4	4-day	60	75	85	93	98	98
5	4-day	48	51	57	50	53	59
6	4-day	50	53	59	50	53	59
7	4-day	45	50	56	50	53	59

Table 35. Steelhead, California Central Valley ESU; Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	78	79	84
3	1-day	100	100	100
4	1-day	100	100	100
5	1-day	78	79	84
6	1-day	78	79	84
7	1-day	78	79	84
2	4-day	78	79	84
3	4-day	98	99	100
4	4-day	99	99	100
5	4-day	78	79	84
6	4-day	78	79	84
7	4-day	78	79	84

Table 36. Steelhead, California Central Valley ESU; Prey; Chlorpyrifos

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	78	79	84	78	79	84
3	1-day	99	99	100	100	100	100
4	1-day	99	99	100	100	100	100
5	1-day	78	79	84	78	79	84
6	1-day	78	79	84	78	79	84
7	1-day	76	79	84	78	79	84
2	4-day	78	79	84	78	79	84
3	4-day	96	98	99	100	100	100
4	4-day	96	98	99	100	100	100
5	4-day	78	79	84	78	79	84

6	4-day	78	79	84	78	79	84
7	4-day	76	79	84	78	79	84

Table 37. Steelhead, Central California Coast ESU; Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	54	57	61
3	1-day	99	100	100
4	1-day	99	100	100
5	1-day	54	57	61
6	1-day	54	57	61
7	1-day	54	57	61
2	4-day	54	57	61
3	4-day	96	98	99
4	4-day	97	98	99
5	4-day	54	57	61
6	4-day	54	57	61
7	4-day	54	57	61

Table 38. Steelhead, Central California Coast ESU; Prey; Chlorpyrifos

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	54	57	61	54	57	61
3	1-day	98	99	99	100	100	100
4	1-day	98	99	99	100	100	100
5	1-day	54	57	61	54	57	61
6	1-day	54	57	61	54	57	61
7	1-day	54	57	61	54	57	61
2	4-day	54	57	61	54	57	61
3	4-day	90	94	97	100	100	100
4	4-day	91	94	97	100	100	100
5	4-day	54	57	61	54	57	61
6	4-day	54	57	61	54	57	61
7	4-day	54	57	61	54	57	61

Table 39. Steelhead, Lower Columbia River ESU; Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	61	62	64
3	1-day	96	97	97
4	1-day	96	97	97
5	1-day	61	62	64
6	1-day	61	62	64
7	1-day	61	62	64
2	4-day	61	62	64
3	4-day	94	95	95
4	4-day	94	95	95
5	4-day	61	61	64
6	4-day	61	62	64
7	4-day	61	62	64

Table 40. Steelhead, Lower Columbia River ESU; Prey; Chlorpyrifos

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	61	62	64	61	62	64
3	1-day	95	95	95	97	97	98
4	1-day	94	95	95	97	97	97
5	1-day	61	62	64	61	62	64
6	1-day	61	62	64	61	62	64
7	1-day	61	62	64	61	62	64
2	4-day	61	62	64	61	62	64
3	4-day	92	93	94	97	97	97
4	4-day	92	93	94	97	97	97
5	4-day	57	60	63	61	62	64
6	4-day	61	62	64	61	62	64
7	4-day	61	62	64	61	62	64

Table 41. Steelhead, Middle Columbia River ESU; Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %

2	1-day	43	45	61
3	1-day	88	94	98
4	1-day	85	93	98
5	1-day	43	45	61
6	1-day	43	45	61
7	1-day	43	45	61
2	4-day	43	45	61
3	4-day	70	80	92
4	4-day	63	77	90
5	4-day	42	44	61
6	4-day	43	45	61
7	4-day	42	45	61

Table 42. Steelhead, Middle Columbia River ESU; Prey; Chlorpyrifos

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	43	45	61	43	45	61
3	1-day	77	85	95	99	99	99
4	1-day	73	83	94	99	99	99
5	1-day	43	45	61	43	45	61
6	1-day	43	45	61	43	45	61
7	1-day	39	42	58	43	45	61
2	4-day	43	45	61	43	45	61
3	4-day	55	66	79	99	99	99
4	4-day	49	63	78	99	99	99
5	4-day	40	42	59	43	45	61
6	4-day	43	45	61	43	45	61
7	4-day	38	42	57	43	45	61

Table 43. Steelhead, Northern California ESU; Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	19	21	44
3	1-day	97	98	99
4	1-day	97	98	99
5	1-day	19	21	44

6	1-day	19	21	44
7	1-day	19	21	44
2	4-day	19	21	44
3	4-day	86	94	98
4	4-day	86	95	98
5	4-day	19	21	44
6	4-day	19	21	44
7	4-day	19	21	44

Table 44. Steelhead, Northern California ESU; Prey; Chlorpyrifos

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	19	21	44	19	21	44
3	1-day	91	94	98	100	100	100
4	1-day	91	94	98	100	100	100
5	1-day	19	21	44	19	21	44
6	1-day	19	21	44	19	21	44
7	1-day	19	21	44	19	21	44
2	4-day	19	21	44	19	21	44
3	4-day	64	82	95	100	100	100
4	4-day	66	84	95	100	100	100
5	4-day	19	21	44	19	21	44
6	4-day	19	21	44	19	21	44
7	4-day	19	21	44	19	21	44

Table 45. Steelhead, Puget Sound ESU; Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	64	65	66
3	1-day	95	97	99
4	1-day	95	97	98
5	1-day	64	65	66
6	1-day	64	65	66
7	1-day	64	65	66
2	4-day	64	65	66
3	4-day	94	96	98

4	4-day	93	96	97
5	4-day	63	64	66
6	4-day	64	65	66
7	4-day	64	65	66

Table 46. Steelhead, Puget Sound ESU; Prey; Chlorpyrifos

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	64	65	66	64	65	66
3	1-day	94	95	97	97	100	100
4	1-day	94	95	96	97	100	100
5	1-day	63	64	66	64	65	66
6	1-day	64	65	66	64	65	66
7	1-day	64	65	66	64	65	66
2	4-day	64	65	66	64	65	66
3	4-day	91	94	96	97	100	100
4	4-day	90	93	95	97	100	100
5	4-day	58	62	65	64	65	66
6	4-day	64	65	66	64	65	66
7	4-day	63	65	66	64	65	66

Table 47. Steelhead, Snake River Basin ESU; Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	51	54	59
3	1-day	83	92	96
4	1-day	80	91	95
5	1-day	51	54	59
6	1-day	51	54	59
7	1-day	50	53	59
2	4-day	51	54	59
3	4-day	74	84	91
4	4-day	66	81	90
5	4-day	50	53	59
6	4-day	51	53	59
7	4-day	50	53	59

Table 48. Steelhead, Snake River Basin ESU; Prey; Chlorpyrifos

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	51	54	59	51	54	59
3	1-day	78	86	92	91	99	99
4	1-day	72	83	90	91	99	99
5	1-day	51	53	59	51	54	59
6	1-day	51	53	59	51	54	59
7	1-day	47	51	56	51	54	59
2	4-day	51	53	59	51	54	59
3	4-day	60	73	84	89	99	99
4	4-day	52	69	82	89	99	99
5	4-day	49	52	58	51	54	59
6	4-day	50	53	59	51	54	59
7	4-day	45	50	56	51	54	59

Table 49. Steelhead, South-Central California Coast ESU; Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	45	49	59
3	1-day	99	99	99
4	1-day	99	99	100
5	1-day	45	49	59
6	1-day	45	49	59
7	1-day	45	49	59
2	4-day	45	49	59
3	4-day	95	98	99
4	4-day	95	98	99
5	4-day	45	49	59
6	4-day	45	49	59
7	4-day	45	49	59

Table 50. Steelhead, South-Central California Coast ESU; Prey; Chlorpyrifos

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	45	49	59	45	49	59
3	1-day	97	98	98	100	100	100
4	1-day	97	98	98	100	100	100
5	1-day	45	49	59	45	49	59
6	1-day	45	49	59	45	49	59
7	1-day	45	49	59	45	49	59
2	4-day	45	49	59	45	49	59
3	4-day	86	94	97	100	100	100
4	4-day	88	94	98	100	100	100
5	4-day	45	49	59	45	49	59
6	4-day	45	49	59	45	49	59
7	4-day	44	49	59	45	49	59

Table 51. Steelhead, Southern California ESU; Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	59	63	67
3	1-day	98	100	100
4	1-day	98	100	100
5	1-day	59	63	67
6	1-day	59	63	67
7	1-day	58	63	66
2	4-day	59	63	67
3	4-day	95	99	100
4	4-day	96	99	100
5	4-day	59	63	67
6	4-day	58	63	67
7	4-day	58	63	66

Table 52. Steelhead, Southern California ESU; Prey; Chlorpyrifos

Prey	All fish HC10 % mortality	All invert HC10 % mortality

Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	59	63	67	59	63	67
3	1-day	96	99	99	100	100	100
4	1-day	96	99	99	100	100	100
5	1-day	59	63	67	59	63	67
6	1-day	58	63	66	59	63	67
7	1-day	58	63	66	59	63	67
2	4-day	58	63	67	59	63	67
3	4-day	91	96	98	100	100	100
4	4-day	92	96	99	100	100	100
5	4-day	57	63	66	59	63	67
6	4-day	58	63	66	59	63	67
7	4-day	58	62	66	59	63	67

Table 53. Steelhead, Upper Columbia River ESU; Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	48	50	54
3	1-day	95	97	97
4	1-day	95	97	97
5	1-day	48	50	54
6	1-day	48	50	54
7	1-day	48	50	53
2	4-day	48	50	54
3	4-day	91	94	95
4	4-day	90	93	95
5	4-day	47	50	53
6	4-day	48	50	54
7	4-day	48	50	53

Table 54. Steelhead, Upper Columbia River ESU; Prey; Chlorpyrifos

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	48	50	54	48	50	54
3	1-day	92	95	96	98	98	98

4	1-day	92	94	95	98	98	98
5	1-day	48	50	53	48	50	54
6	1-day	48	50	54	48	50	54
7	1-day	46	49	53	48	50	54
2	4-day	48	50	54	48	50	54
3	4-day	85	90	92	98	98	98
4	4-day	83	89	91	98	98	98
5	4-day	44	47	51	48	50	54
6	4-day	48	50	53	48	50	54
7	4-day	45	48	52	48	50	54

Table 55. Steelhead, Upper Willamette River ESU; Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	73	75	76
3	1-day	99	99	100
4	1-day	99	99	100
5	1-day	73	75	76
6	1-day	73	75	76
7	1-day	73	75	76
2	4-day	73	75	76
3	4-day	98	98	98
4	4-day	98	98	98
5	4-day	72	75	76
6	4-day	73	75	76
7	4-day	73	75	76

Table 56. Steelhead, Upper Willamette River ESU; Prey; Chlorpyrifos

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	73	75	76	73	75	76
3	1-day	98	98	99	100	100	100
4	1-day	98	98	99	100	100	100
5	1-day	73	75	76	73	75	76
6	1-day	73	75	76	73	75	76
7	1-day	73	75	76	73	75	76

2	4-day	73	75	76	73	75	76
3	4-day	98	98	98	100	100	100
4	4-day	97	98	98	100	100	100
5	4-day	68	72	75	73	75	76
6	4-day	73	75	76	73	75	76
7	4-day	73	75	76	73	75	76

Table 57. Shortnose Sturgeon; Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	38	39	43
3	1-day	84	85	86
4	1-day	84	85	86
5	1-day	0	0	0
6	1-day	35	37	41
7	1-day	26	31	35
2	4-day	38	39	43
3	4-day	80	81	82
4	4-day	80	81	81
5	4-day	0	0	0
6	4-day	32	35	40
7	4-day	24	29	34

Table 58. Shortnose Sturgeon; Prey; Chlorpyrifos

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	38	39	43	38	39	43
3	1-day	81	82	83	94	94	94
4	1-day	81	82	83	94	94	94
5	1-day	0	0	0	0	0	0
6	1-day	28	31	35	38	39	43
7	1-day	15	18	25	38	39	43
2	4-day	38	39	43	38	39	43
3	4-day	77	78	79	91	92	92
4	4-day	77	78	79	91	92	92
5	4-day	0	0	0	0	0	0

6	4-day	24	27	32	38	39	43
7	4-day	14	17	23	38	39	43

Table 59. Gulf Sturgeon; Mortality; Chlorpyrifos

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	30	31	32
3	1-day	71	73	75
4	1-day	71	73	75
5	1-day	0	0	0
6	1-day	28	30	31
7	1-day	18	22	28
2	4-day	30	31	32
3	4-day	67	69	70
4	4-day	67	69	70
5	4-day	0	0	0
6	4-day	26	28	30
7	4-day	16	20	27

Table 60. Gulf Sturgeon; Prey; Chlorpyrifos

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	30	31	32	30	31	32
3	1-day	69	70	71	79	79	79
4	1-day	69	70	71	79	79	79
5	1-day	0	0	0	0	0	0
6	1-day	21	24	27	30	31	32
7	1-day	9	11	19	30	31	32
2	4-day	30	31	32	30	31	32
3	4-day	63	64	65	79	79	79
4	4-day	63	64	65	79	79	79
5	4-day	0	0	0	0	0	0
6	4-day	17	19	25	30	31	32
7	4-day	8	10	17	30	31	32

Table 61. Smalltooth sawfish; Mortality; Chlorpyrifos; Full Range

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	44	44	46
3	1-day	88	89	90
4	1-day	0	0	0
5	1-day	44	44	46
6	1-day	39	43	45
7	1-day	28	35	43
2	4-day	44	44	46
3	4-day	83	84	85
4	4-day	0	0	0
5	4-day	41	42	44
6	4-day	36	41	44
7	4-day	26	33	42

Table 62. Smalltooth sawfish; Prey; Chlorpyrifos; Full Range

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	44	44	46	44	44	46
3	1-day	85	85	86	97	97	98
4	1-day	0	0	0	0	0	0
5	1-day	43	44	46	44	44	46
6	1-day	28	34	42	44	44	46
7	1-day	19	23	34	44	44	46
2	4-day	44	44	46	44	44	46
3	4-day	77	79	81	96	97	97
4	4-day	0	0	0	0	0	0
5	4-day	30	34	37	44	44	46
6	4-day	25	29	40	44	44	46
7	4-day	18	21	32	44	44	46

Table 63. Smalltooth sawfish; Mortality; Chlorpyrifos; Nursery Areas

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %

2	1-day	16	16	17
3	1-day	69	71	74
4	1-day	0	0	0
5	1-day	16	16	17
6	1-day	14	16	16
7	1-day	11	13	16
2	4-day	16	16	17
3	4-day	58	60	62
4	4-day	0	0	0
5	4-day	15	16	16
6	4-day	13	15	16
7	4-day	10	12	16

Table 64. Smalltooth sawfish; Prey; Chlorpyrifos; Nursery Areas

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	16	16	17	16	16	17
3	1-day	61	62	64	94	94	95
4	1-day	0	0	0	0	0	0
5	1-day	16	16	16	16	16	17
6	1-day	11	13	16	16	16	17
7	1-day	7	9	13	16	16	17
2	4-day	16	16	17	16	16	17
3	4-day	48	51	54	91	93	93
4	4-day	0	0	0	0	0	0
5	4-day	11	13	13	16	16	17
6	4-day	10	11	15	16	16	17
7	4-day	7	8	12	16	16	17

Table 65. Chum salmon, Columbia River ESU; Mortality; Diazinon

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	11	12	14
3	1-day	0	1	1

4	1-day	0	0	1
5	1-day	11	12	14
6	1-day	10	15	21
7	1-day	1	6	15
2	4-day	1	1	1
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	1	1	1
6	4-day	0	0	0
7	4-day	0	0	0

Table 66. Chum salmon, Columbia River ESU; Prey; Diazinon

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	11	12	14	19	20	22
3	1-day	0	0	0	32	45	57
4	1-day	0	0	0	16	39	52
5	1-day	11	12	14	11	16	21
6	1-day	8	11	18	17	20	22
7	1-day	0	3	12	14	20	22
2	4-day	1	1	1	1	1	1
3	4-day	0	0	0	6	7	9
4	4-day	0	0	0	5	6	8
5	4-day	1	1	1	1	1	1
6	4-day	0	0	0	1	1	1
7	4-day	0	0	0	1	1	1

Table 67. Chum salmon, Hood Canal summer-run ESU; Mortality; Diazinon

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	0	0	0
3	1-day	0	0	0
4	1-day	0	0	0
5	1-day	0	0	0
6	1-day	0	0	0
7	1-day	0	0	0

2	4-day	0	0	0
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	0	0	0
6	4-day	0	0	0
7	4-day	0	0	0

Table 68. Chum salmon, Hood Canal summer-run ESU; Prey; Diazinon

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	0	0	0	0	0	0
3	1-day	0	0	0	0	0	4
4	1-day	0	0	0	0	0	4
5	1-day	0	0	0	0	0	0
6	1-day	0	0	0	0	0	0
7	1-day	0	0	0	0	0	0
2	4-day	0	0	0	0	0	0
3	4-day	0	0	0	0	0	2
4	4-day	0	0	0	0	0	2
5	4-day	0	0	0	0	0	0
6	4-day	0	0	0	0	0	0
7	4-day	0	0	0	0	0	0

Table 69. Chinook salmon, California Coastal ESU; Mortality; Diazinon

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	0	1	1
3	1-day	0	0	0
4	1-day	0	0	0
5	1-day	0	1	1
6	1-day	0	0	1
7	1-day	0	0	0
2	4-day	0	1	1
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	0	1	1

6	4-day	0	0	1
7	4-day	0	0	0

Table 70. Chinook salmon, California Coastal ESU; Prey; Diazinon

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	0	1	1	0	1	1
3	1-day	0	0	0	0	9	15
4	1-day	0	0	0	0	9	15
5	1-day	0	1	1	0	1	1
6	1-day	0	0	0	0	1	1
7	1-day	0	0	0	0	1	1
2	4-day	0	1	1	0	1	1
3	4-day	0	0	0	0	8	12
4	4-day	0	0	0	0	7	12
5	4-day	0	1	1	0	1	1
6	4-day	0	0	0	0	1	1
7	4-day	0	0	0	0	1	1

Table 71. Chinook salmon, Central Valley spring-run ESU; Mortality; Diazinon

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	14	17	19
3	1-day	0	0	2
4	1-day	0	0	2
5	1-day	14	17	19
6	1-day	1	1	4
7	1-day	0	0	0
2	4-day	14	17	19
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	14	17	19
6	4-day	0	1	4
7	4-day	0	0	0

Table 72. Chinook salmon, Central Valley spring-run ESU; Prey; Diazinon

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	14	17	19	14	17	19
3	1-day	0	0	0	66	70	73
4	1-day	0	0	0	65	70	73
5	1-day	14	17	19	14	17	19
6	1-day	0	0	1	14	17	19
7	1-day	0	0	0	14	17	19
2	4-day	13	16	18	14	17	19
3	4-day	0	0	0	62	65	69
4	4-day	0	0	0	61	65	69
5	4-day	13	17	18	14	17	19
6	4-day	0	0	1	14	17	19
7	4-day	0	0	0	14	17	19

Table 73. Chinook salmon, Lower Columbia River ESU; Mortality; Diazinon

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	0	0	1
3	1-day	0	0	0
4	1-day	0	0	0
5	1-day	0	0	1
6	1-day	0	0	0
7	1-day	0	0	0
2	4-day	0	0	0
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	0	0	1
6	4-day	0	0	0
7	4-day	0	0	0

Table 74. Chinook salmon, Lower Columbia River ESU; Prey; Diazinon

Prey		All fish HC10 % mortality			All invert HC10 % mortality		

Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	0	0	0	0	0	1
3	1-day	0	0	0	5	7	9
4	1-day	0	0	0	5	7	8
5	1-day	0	0	0	0	0	1
6	1-day	0	0	0	0	0	1
7	1-day	0	0	0	0	0	1
2	4-day	0	0	0	0	0	1
3	4-day	0	0	0	4	5	6
4	4-day	0	0	0	3	4	6
5	4-day	0	0	0	0	0	1
6	4-day	0	0	0	0	0	1
7	4-day	0	0	0	0	0	1

Table 75. Chinook salmon, Puget Sound ESU; Mortality; Diazinon

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	0	1	1
3	1-day	0	0	0
4	1-day	0	0	0
5	1-day	0	1	1
6	1-day	0	0	1
7	1-day	0	0	0
2	4-day	0	1	1
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	0	1	1
6	4-day	0	0	1
7	4-day	0	0	0

Table 76. Chinook salmon, Puget Sound ESU; Prey; Diazinon

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	0	1	1	0	1	1
3	1-day	0	0	0	6	9	11

4	1-day	0	0	0	6	9	11
5	1-day	0	1	1	0	1	1
6	1-day	0	0	1	0	1	1
7	1-day	0	0	0	0	1	1
2	4-day	0	1	1	0	1	1
3	4-day	0	0	0	4	6	9
4	4-day	0	0	0	4	6	9
5	4-day	0	1	1	0	1	1
6	4-day	0	0	1	0	1	1
7	4-day	0	0	0	0	1	1

Table 77. Chinook salmon, Sacramento River winter-run ESU; Mortality; Diazinon

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	9	10	12
3	1-day	0	0	1
4	1-day	0	0	1
5	1-day	9	10	12
6	1-day	0	1	6
7	1-day	0	0	1
2	4-day	9	10	11
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	9	10	12
6	4-day	0	1	5
7	4-day	0	0	1

Table 78. Chinook salmon, Sacramento River winter-run ESU; Prey; Diazinon

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	9	10	11	9	10	12
3	1-day	0	0	0	59	67	74
4	1-day	0	0	0	60	67	74
5	1-day	9	10	11	9	10	12
6	1-day	0	0	2	9	10	12
7	1-day	0	0	0	9	10	12

2	4-day	8	9	11	9	10	12
3	4-day	0	0	0	56	60	65
4	4-day	0	0	0	55	60	65
5	4-day	9	10	11	9	10	12
6	4-day	0	0	1	9	10	12
7	4-day	0	0	0	9	10	12

Table 79. Chinook salmon, Snake River fall-run ESU; Mortality; Diazinon

Table 80. Chinook salmon, Snake River fall-run ESU; Prey; Diazinon

Table 81. Chinook salmon, Snake River spring/summer-run ESU; Mortality; Diazinon

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	1	1	1
3	1-day	0	0	0
4	1-day	0	0	0
5	1-day	1	1	1
6	1-day	0	0	1
7	1-day	0	0	0
2	4-day	1	1	1
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	1	1	1
6	4-day	0	0	1
7	4-day	0	0	0

Table 82. Chinook salmon, Snake River spring/summer-run ESU; Prey; Diazinon

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	1	1	1	1	1	1
3	1-day	0	0	0	11	13	14
4	1-day	0	0	0	11	13	14
5	1-day	1	1	1	1	1	1

6	1-day	0	0	0	1	1	1
7	1-day	0	0	0	1	1	1
2	4-day	1	1	1	1	1	1
3	4-day	0	0	0	9	11	12
4	4-day	0	0	0	9	11	12
5	4-day	1	1	1	1	1	1
6	4-day	0	0	0	1	1	1
7	4-day	0	0	0	1	1	1

Table 83. Chinook salmon, upper Columbia spring-run ESU; Mortality; Diazinon

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	3	4	5
3	1-day	0	0	0
4	1-day	0	0	0
5	1-day	3	4	5
6	1-day	0	1	1
7	1-day	0	0	0
2	4-day	3	4	5
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	3	4	5
6	4-day	0	0	1
7	4-day	0	0	0

Table 84. Chinook salmon, upper Columbia spring-run ESU; Prey; Diazinon

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	3	4	5	3	4	5
3	1-day	0	0	0	27	36	37
4	1-day	0	0	0	25	32	37
5	1-day	3	4	5	3	4	5
6	1-day	0	0	0	3	4	5
7	1-day	0	0	0	3	4	5
2	4-day	3	4	4	3	4	5
3	4-day	0	0	0	24	29	31

4	4-day	0	0	0	21	24	28
5	4-day	3	4	4	3	4	5
6	4-day	0	0	0	3	4	5
7	4-day	0	0	0	3	4	5

Table 85. Chinook salmon, upper Willamette River ESU; Mortality; Diazinon

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	1	2	2
3	1-day	0	0	0
4	1-day	0	0	0
5	1-day	1	2	2
6	1-day	1	1	1
7	1-day	0	0	1
2	4-day	1	2	2
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	1	2	2
6	4-day	0	1	1
7	4-day	0	0	1

Table 86. Chinook salmon, upper Willamette River ESU; Prey; Diazinon

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	1	2	2	1	2	2
3	1-day	0	0	0	26	27	30
4	1-day	0	0	0	25	27	30
5	1-day	1	2	2	1	2	2
6	1-day	0	0	1	1	2	2
7	1-day	0	0	0	1	2	2
2	4-day	1	2	2	1	2	2
3	4-day	0	0	0	20	23	26
4	4-day	0	0	0	18	23	26
5	4-day	1	2	2	1	2	2
6	4-day	0	0	1	1	2	2
7	4-day	0	0	0	1	2	2

Table 87. Coho salmon, Central California Coast ESU; Mortality; Diazinon

Mortality Bin	Avg period	HC05 LC50 % mortality 5th %	50th %	95th %
2	1-day	0	2	2
3	1-day	0	0	0
4	1-day	0	0	0
5	1-day	0	2	2
6	1-day	0	0	1
7	1-day	0	0	0
2	4-day	0	2	2
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	0	2	2
6	4-day	0	0	1
7	4-day	0	0	0

Table 88. Coho salmon, Central California Coast ESU; Prey; Diazinon

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	0	2	2	0	2	2
3	1-day	0	0	0	6	25	37
4	1-day	0	0	0	6	25	37
5	1-day	0	2	2	0	2	2
6	1-day	0	0	0	0	2	2
7	1-day	0	0	0	0	2	2
2	4-day	0	2	2	0	2	2
3	4-day	0	0	0	2	17	25
4	4-day	0	0	0	2	16	25
5	4-day	0	2	2	0	2	2
6	4-day	0	0	0	0	2	2
7	4-day	0	0	0	0	2	2

Table 89. Coho salmon, lower Columbia River ESU; Mortality; Diazinon

Mortality	HC05 LC50 % mortality

Bin	Avg period	5th %	50th %	95th %
2	4-day	0	0	0
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	0	0	1
6	4-day	0	0	0
7	4-day	0	0	0
2	4-day	0	0	0
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	0	0	1
6	4-day	0	0	0
7	4-day	0	0	0

Table 90. Coho salmon, lower Columbia River ESU; Prey; Diazinon

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	4-day	0	0	0	0	0	1
3	4-day	0	0	0	4	5	6
4	4-day	0	0	0	3	4	6
5	4-day	0	0	0	0	0	1
6	4-day	0	0	0	0	0	1
7	4-day	0	0	0	0	0	1
2	4-day	0	0	0	0	0	1
3	4-day	0	0	0	4	5	6
4	4-day	0	0	0	3	4	6
5	4-day	0	0	0	0	0	1
6	4-day	0	0	0	0	0	1
7	4-day	0	0	0	0	0	1

Table 91. Coho salmon, Oregon coast ESU; Mortality; Diazinon

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	0	0	0
3	1-day	0	0	0

4	1-day	0	0	0
5	1-day	0	0	0
6	1-day	0	0	0
7	1-day	0	0	0
2	4-day	0	0	0
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	0	0	0
6	4-day	0	0	0
7	4-day	0	0	0

Table 92. Coho salmon, Oregon coast ESU; Prey; Diazinon

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	0	0	0	0	0	0
3	1-day	0	0	0	0	0	0
4	1-day	0	0	0	0	0	0
5	1-day	0	0	0	0	0	0
6	1-day	0	0	0	0	0	0
7	1-day	0	0	0	0	0	0
2	4-day	0	0	0	0	0	0
3	4-day	0	0	0	0	0	0
4	4-day	0	0	0	0	0	0
5	4-day	0	0	0	0	0	0
6	4-day	0	0	0	0	0	0
7	4-day	0	0	0	0	0	0

Table 93. Coho salmon, southern Oregon/northern California coast ESU; Mortality; Diazinon

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	0	0	0
3	1-day	0	0	0
4	1-day	0	0	0
5	1-day	0	0	0
6	1-day	0	0	0
7	1-day	0	0	0

2	4-day	0	0	0
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	0	0	0
6	4-day	0	0	0
7	4-day	0	0	0

Table 94. Coho salmon, southern Oregon/northern California coast ESU; Prey; Diazinon

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	0	0	0	0	0	0
3	1-day	0	0	0	0	0	1
4	1-day	0	0	0	0	0	1
5	1-day	0	0	0	0	0	0
6	1-day	0	0	0	0	0	0
7	1-day	0	0	0	0	0	0
2	4-day	0	0	0	0	0	0
3	4-day	0	0	0	0	0	0
4	4-day	0	0	0	0	0	0
5	4-day	0	0	0	0	0	0
6	4-day	0	0	0	0	0	0
7	4-day	0	0	0	0	0	0

Table 95. Sockeye salmon, Ozette Lake ESU; Mortality; Diazinon

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	0	0	0
3	1-day	0	0	0
4	1-day	0	0	0
5	1-day	0	0	0
6	1-day	0	0	0
7	1-day	0	0	0
2	4-day	0	0	0
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	0	0	0

6	4-day	0	0	0
7	4-day	0	0	0

Table 96. Sockeye salmon, Ozette Lake ESU; Prey; Diazinon

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	0	0	0	0	0	0
3	1-day	0	0	0	0	0	1
4	1-day	0	0	0	0	0	1
5	1-day	0	0	0	0	0	0
6	1-day	0	0	0	0	0	0
7	1-day	0	0	0	0	0	0
2	4-day	0	0	0	0	0	0
3	4-day	0	0	0	0	0	0
4	4-day	0	0	0	0	0	0
5	4-day	0	0	0	0	0	0
6	4-day	0	0	0	0	0	0
7	4-day	0	0	0	0	0	0

Table 97. Sockeye salmon, Snake River ESU; Mortality; Diazinon

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	2	3	3
3	1-day	0	0	0
4	1-day	0	0	0
5	1-day	2	3	3
6	1-day	0	1	1
7	1-day	0	0	0
2	4-day	2	3	3
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	2	3	3
6	4-day	0	0	1
7	4-day	0	0	0

Table 98. Sockeye salmon, Snake River ESU; Prey; Diazinon

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	2	3	3	2	3	3
3	1-day	0	0	0	18	21	22
4	1-day	0	0	0	18	20	21
5	1-day	2	3	3	2	3	3
6	1-day	0	0	0	2	3	3
7	1-day	0	0	0	2	3	3
2	4-day	2	3	3	2	3	3
3	4-day	0	0	0	16	18	19
4	4-day	0	0	0	16	17	18
5	4-day	2	3	3	2	3	3
6	4-day	0	0	0	2	3	3
7	4-day	0	0	0	2	3	3

Table 99. Steelhead, California Central Valley ESU; Mortality; Diazinon

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	11	15	16
3	1-day	0	0	2
4	1-day	0	0	2
5	1-day	11	15	16
6	1-day	0	1	4
7	1-day	0	0	0
2	4-day	11	15	16
3	4-day	0	0	2
4	4-day	0	0	2
5	4-day	11	15	16
6	4-day	0	1	4
7	4-day	0	0	0

Table 100. Steelhead, California Central Valley ESU; Prey; Diazinon

Prey	All fish HC10 % mortality	All invert HC10 % mortality

Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	11	14	16	11	15	16
3	1-day	0	0	0	59	63	66
4	1-day	0	0	0	58	64	67
5	1-day	11	15	16	11	15	16
6	1-day	0	0	1	11	15	16
7	1-day	0	0	0	11	15	16
2	4-day	11	14	16	11	15	16
3	4-day	0	0	0	59	63	66
4	4-day	0	0	0	58	64	67
5	4-day	11	15	16	11	15	16
6	4-day	0	0	1	11	15	16
7	4-day	0	0	0	11	15	16

Table 101. Steelhead, Central California Coast ESU; Mortality; Diazinon

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	0	3	3
3	1-day	0	0	0
4	1-day	0	0	0
5	1-day	0	3	3
6	1-day	0	0	1
7	1-day	0	0	0
2	4-day	0	2	3
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	0	3	3
6	4-day	0	0	1
7	4-day	0	0	0

Table 102. Steelhead, Central California Coast ESU; Prey; Diazinon

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	0	2	3	0	3	3
3	1-day	0	0	0	9	33	49

4	1-day	0	0	0	9	33	50
5	1-day	0	3	3	0	3	3
6	1-day	0	0	0	0	3	3
7	1-day	0	0	0	0	3	3
2	4-day	0	2	3	0	3	3
3	4-day	0	0	0	3	23	33
4	4-day	0	0	0	3	22	33
5	4-day	0	2	3	0	3	3
6	4-day	0	0	0	0	3	3
7	4-day	0	0	0	0	3	3

Table 103. Steelhead, Lower Columbia River ESU; Mortality; Diazinon

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	0	0	1
3	1-day	0	0	0
4	1-day	0	0	0
5	1-day	0	0	1
6	1-day	0	0	0
7	1-day	0	0	0
2	4-day	0	0	1
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	0	0	1
6	4-day	0	0	0
7	4-day	0	0	0

Table 104. Steelhead, Lower Columbia River ESU; Prey; Diazinon

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	0	0	1	0	0	1
3	1-day	0	0	0	5	7	9
4	1-day	0	0	0	5	7	9
5	1-day	0	0	1	0	0	1
6	1-day	0	0	0	0	0	1
7	1-day	0	0	0	0	0	1

2	4-day	0	0	0	0	0	1
3	4-day	0	0	0	4	5	6
4	4-day	0	0	0	3	5	6
5	4-day	0	0	0	0	0	1
6	4-day	0	0	0	0	0	1
7	4-day	0	0	0	0	0	1

Table 105. Steelhead, Middle Columbia River ESU; Mortality; Diazinon

Table 106. Steelhead, Middle Columbia River ESU; Prey; Diazinon

Table 107. Steelhead, Northern California ESU; Mortality; Diazinon

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	0	0	0
3	1-day	0	0	0
4	1-day	0	0	0
5	1-day	0	0	0
6	1-day	0	0	0
7	1-day	0	0	0
2	4-day	0	0	0
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	0	0	0
6	4-day	0	0	0
7	4-day	0	0	0

Table 108. Steelhead, Northern California ESU; Prey; Diazinon

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	0	0	0	0	0	0
3	1-day	0	0	0	0	0	2
4	1-day	0	0	0	0	0	2
5	1-day	0	0	0	0	0	0

6	1-day	0	0	0	0	0	0
7	1-day	0	0	0	0	0	0
2	4-day	0	0	0	0	0	0
3	4-day	0	0	0	0	0	1
4	4-day	0	0	0	0	0	1
5	4-day	0	0	0	0	0	0
6	4-day	0	0	0	0	0	0
7	4-day	0	0	0	0	0	0

Table 109. Steelhead, Puget Sound ESU; Mortality; Diazinon

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	0	1	1
3	1-day	0	0	0
4	1-day	0	0	0
5	1-day	0	1	1
6	1-day	0	0	1
7	1-day	0	0	1
2	4-day	0	1	1
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	0	1	1
6	4-day	0	0	1
7	4-day	0	0	1

Table 110. Steelhead, Puget Sound ESU; Prey; Diazinon

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	0	1	1	0	1	1
3	1-day	0	0	0	6	9	11
4	1-day	0	0	0	6	9	11
5	1-day	0	1	1	0	1	1
6	1-day	0	0	1	0	1	1
7	1-day	0	0	0	0	1	1
2	4-day	0	1	1	0	1	1
3	4-day	0	0	0	5	6	9

4	4-day	0	0	0	5	6	9
5	4-day	0	1	1	0	1	1
6	4-day	0	0	1	0	1	1
7	4-day	0	0	0	0	1	1

Table 111. Steelhead, Snake River Basin ESU; Mortality; Diazinon

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	1	1	1
3	1-day	0	0	0
4	1-day	0	0	0
5	1-day	1	1	1
6	1-day	0	0	1
7	1-day	0	0	0
2	4-day	1	1	1
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	1	1	1
6	4-day	0	0	1
7	4-day	0	0	0

Table 112. Steelhead, Snake River Basin ESU; Prey; Diazinon

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	1	1	1	1	1	1
3	1-day	0	0	0	11	13	14
4	1-day	0	0	0	11	13	14
5	1-day	1	1	1	1	1	1
6	1-day	0	0	0	1	1	1
7	1-day	0	0	0	1	1	1
2	4-day	1	1	1	1	1	1
3	4-day	0	0	0	9	11	12
4	4-day	0	0	0	9	11	12
5	4-day	1	1	1	1	1	1
6	4-day	0	0	0	1	1	1
7	4-day	0	0	0	1	1	1

Table 113. Steelhead, South-Central California Coast ESU; Mortality; Diazinon

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	2	3	4
3	1-day	0	0	0
4	1-day	0	0	0
5	1-day	2	3	4
6	1-day	0	0	2
7	1-day	0	0	0
2	4-day	2	3	4
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	2	3	4
6	4-day	0	0	2
7	4-day	0	0	0

Table 114. Steelhead, South-Central California Coast ESU; Prey; Diazinon

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	2	3	4	2	3	4
3	1-day	0	0	0	35	45	54
4	1-day	0	0	0	35	46	55
5	1-day	2	3	4	2	3	4
6	1-day	0	0	1	2	3	4
7	1-day	0	0	0	2	3	4
2	4-day	1	3	4	2	3	4
3	4-day	0	0	0	28	37	45
4	4-day	0	0	0	27	35	44
5	4-day	2	3	4	2	3	4
6	4-day	0	0	0	2	3	4
7	4-day	0	0	0	2	3	4

Table 115. Steelhead, Southern California ESU; Mortality; Diazinon

Mortality	HC05 LC50 % mortality

Bin	Avg period	5th %	50th %	95th %
2	1-day	1	1	2
3	1-day	0	0	0
4	1-day	0	0	0
5	1-day	1	1	2
6	1-day	0	0	1
7	1-day	0	0	0
2	4-day	0	1	2
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	1	1	2
6	4-day	0	0	1
7	4-day	0	0	0

Table 116. Steelhead, Southern California ESU; Prey; Diazinon

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	0	1	1	1	1	2
3	1-day	0	0	0	14	33	46
4	1-day	0	0	0	14	34	47
5	1-day	1	1	2	1	1	2
6	1-day	0	0	0	1	1	2
7	1-day	0	0	0	1	1	2
2	4-day	0	1	1	1	1	2
3	4-day	0	0	0	10	18	28
4	4-day	0	0	0	10	18	29
5	4-day	0	1	1	1	1	2
6	4-day	0	0	0	1	1	2
7	4-day	0	0	0	1	1	2

Table 117. Steelhead, Upper Columbia River ESU; Mortality; Diazinon

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	3	5	5
3	1-day	0	0	0

4	1-day	0	0	0
5	1-day	3	5	5
6	1-day	0	1	1
7	1-day	0	0	0
2	4-day	3	5	5
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	3	5	5
6	4-day	0	0	1
7	4-day	0	0	0

Table 118. Steelhead, Upper Columbia River ESU; Prey; Diazinon

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	3	5	5	3	5	5
3	1-day	0	0	0	29	36	38
4	1-day	0	0	0	26	32	37
5	1-day	3	5	5	3	5	5
6	1-day	0	0	0	3	5	5
7	1-day	0	0	0	3	5	5
2	4-day	3	4	4	3	5	5
3	4-day	0	0	0	24	30	32
4	4-day	0	0	0	22	25	29
5	4-day	3	4	5	3	5	5
6	4-day	0	0	0	3	5	5
7	4-day	0	0	0	3	5	5

Table 119. Steelhead, Upper Willamette River ESU; Mortality; Diazinon

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	2	2	3
3	1-day	0	0	0
4	1-day	0	0	0
5	1-day	2	3	3
6	1-day	1	1	2
7	1-day	0	0	1

2	4-day	2	2	3
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	2	2	3
6	4-day	1	1	2
7	4-day	0	0	1

Table 120. Steelhead, Upper Willamette River ESU; Prey; Diazinon

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	2	2	3	2	3	3
3	1-day	0	0	0	36	38	42
4	1-day	0	0	0	35	38	42
5	1-day	2	2	3	2	3	3
6	1-day	0	0	1	2	3	3
7	1-day	0	0	1	2	3	3
2	4-day	2	2	3	2	3	3
3	4-day	0	0	0	28	32	37
4	4-day	0	0	0	25	32	36
5	4-day	2	2	3	2	3	3
6	4-day	0	0	1	2	3	3
7	4-day	0	0	0	2	3	3

Table 121. Shortnose Sturgeon; Mortality; Diazinon

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	0	0	0
3	1-day	0	0	0
4	1-day	0	0	0
5	1-day	0	0	0
6	1-day	0	0	0
7	1-day	0	0	0
2	4-day	0	0	0
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	0	0	0

6	4-day	0	0	0
7	4-day	0	0	0

Table 122. Shortnose Sturgeon; Prey; Diazinon

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	0	0	0	0	0	0
3	1-day	0	0	0	8	9	11
4	1-day	0	0	0	7	8	10
5	1-day	0	0	0	0	0	0
6	1-day	0	0	0	0	0	0
7	1-day	0	0	0	0	0	0
2	4-day	0	0	0	0	0	0
3	4-day	0	0	0	4	5	7
4	4-day	0	0	0	3	4	6
5	4-day	0	0	0	0	0	0
6	4-day	0	0	0	0	0	0
7	4-day	0	0	0	0	0	0

Table 123. Gulf Sturgeon; Mortality; Diazinon

Table 124. Gulf Sturgeon; Prey; Diazinon

Table 125. Smalltooth sawfish; Mortality; Diazinon; Full Range

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	1	1	1
3	1-day	0	0	0
4	1-day	0	0	0
5	1-day	1	1	1
6	1-day	0	0	0
7	1-day	0	0	0
2	4-day	1	1	1
3	4-day	0	0	0

4	4-day	0	0	0
5	4-day	1	1	1
6	4-day	0	0	0
7	4-day	0	0	0

Table 126. Smalltooth sawfish; Prey; Diazinon; Full Range

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	1	1	1	1	1	1
3	1-day	0	0	0	9	13	15
4	1-day	0	0	0	8	13	15
5	1-day	1	1	1	1	1	1
6	1-day	0	0	0	1	1	1
7	1-day	0	0	0	1	1	1
2	4-day	1	1	1	1	1	1
3	4-day	0	0	0	5	7	10
4	4-day	0	0	0	5	7	9
5	4-day	1	1	1	1	1	1
6	4-day	0	0	0	1	1	1
7	4-day	0	0	0	1	1	1

Table 127. Smalltooth sawfish; Mortality; Diazinon; Nursery Areas

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	1	1	1
3	1-day	0	0	0
4	1-day	0	0	0
5	1-day	1	1	1
6	1-day	0	0	0
7	1-day	0	0	0
2	4-day	1	1	1
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	1	1	1
6	4-day	0	0	0
7	4-day	0	0	0

Table 128. Smalltooth sawfish; Prey; Diazinon; Nursery Areas

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	1	1	1	1	1	1
3	1-day	0	0	0	7	11	16
4	1-day	0	0	0	6	11	16
5	1-day	1	1	1	1	1	1
6	1-day	0	0	0	1	1	1
7	1-day	0	0	0	1	1	1
2	4-day	0	1	1	1	1	1
3	4-day	0	0	0	3	6	10
4	4-day	0	0	0	3	5	8
5	4-day	0	1	1	1	1	1
6	4-day	0	0	0	1	1	1
7	4-day	0	0	0	1	1	1

Table 129. Chum salmon, Columbia River ESU; Mortality; Malathion

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	12	15	18
3	1-day	2	8	14
4	1-day	1	5	12
5	1-day	11	12	14
6	1-day	11	15	21
7	1-day	1	7	15
2	4-day	11	12	14
3	4-day	0	1	1
4	4-day	0	0	1
5	4-day	11	12	14
6	4-day	10	15	21
7	4-day	1	6	15

Table 130. Chum salmon, Columbia River ESU; Prey; Malathion

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	11	13	15	19	20	22
3	1-day	0	2	5	48	68	82
4	1-day	0	2	4	35	64	79
5	1-day	11	12	14	12	17	21
6	1-day	8	12	19	17	20	22
7	1-day	0	3	12	14	20	22
2	4-day	11	12	14	19	20	22
3	4-day	0	0	0	32	45	57
4	4-day	0	0	0	16	39	52
5	4-day	11	12	14	11	16	21
6	4-day	8	11	18	17	20	22
7	4-day	0	3	12	14	20	22

Table 131. Chum salmon, Hood Canal summer-run ESU; Mortality; Malathion

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	3	5	7
3	1-day	0	0	0
4	1-day	0	0	0
5	1-day	3	4	6
6	1-day	3	5	7
7	1-day	0	1	4
2	4-day	3	4	6
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	3	4	6
6	4-day	3	5	7
7	4-day	0	1	4

Table 132. Chum salmon, Hood Canal summer-run ESU; Prey; Malathion

Prey	All fish HC10 % mortality	All invert HC10 % mortality

Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	3	5	7	6	7	10
3	1-day	0	0	0	14	32	63
4	1-day	0	0	0	8	26	58
5	1-day	3	4	6	3	5	8
6	1-day	2	4	6	5	7	8
7	1-day	0	1	3	4	6	8
2	4-day	3	4	6	6	7	9
3	4-day	0	0	0	6	10	23
4	4-day	0	0	0	1	5	16
5	4-day	3	4	6	3	5	8
6	4-day	2	4	6	5	6	8
7	4-day	0	1	3	4	6	8

Table 133. Chinook salmon, California Coastal ESU; Mortality; Malathion

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	8	11	32
3	1-day	2	12	59
4	1-day	1	14	59
5	1-day	8	11	32
6	1-day	8	10	31
7	1-day	0	1	18
2	4-day	8	11	31
3	4-day	0	4	28
4	4-day	0	2	28
5	4-day	8	11	32
6	4-day	7	10	31
7	4-day	0	1	17

Table 134. Chinook salmon, California Coastal ESU; Prey; Malathion

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	8	11	32	9	12	33
3	1-day	0	6	44	41	79	98

4	1-day	0	6	44	16	76	98
5	1-day	8	11	32	9	12	33
6	1-day	6	8	29	8	11	33
7	1-day	0	0	10	8	11	32
2	4-day	8	11	31	9	12	33
3	4-day	0	1	14	27	57	92
4	4-day	0	1	14	10	54	92
5	4-day	8	11	31	9	11	33
6	4-day	6	8	28	8	11	33
7	4-day	0	0	9	8	11	32

Table 135. Chinook salmon, Central Valley spring-run ESU; Mortality; Malathion

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	63	65	69
3	1-day	55	79	89
4	1-day	42	76	89
5	1-day	63	65	69
6	1-day	57	60	64
7	1-day	9	20	42
2	4-day	63	64	68
3	4-day	34	54	76
4	4-day	12	40	74
5	4-day	63	65	69
6	4-day	55	58	63
7	4-day	7	17	40

Table 136. Chinook salmon, Central Valley spring-run ESU; Prey; Malathion

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	63	64	68	68	70	74
3	1-day	38	66	85	91	94	98
4	1-day	29	63	85	86	94	98
5	1-day	63	64	68	64	68	73
6	1-day	45	51	58	64	68	72
7	1-day	3	8	35	63	66	71

2	4-day	63	64	68	66	69	73
3	4-day	17	32	61	88	92	96
4	4-day	4	21	58	81	92	96
5	4-day	63	64	68	64	68	73
6	4-day	41	47	56	64	67	71
7	4-day	2	7	32	62	66	70

Table 137. Chinook salmon, Lower Columbia River ESU; Mortality; Malathion

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	7	9	11
3	1-day	1	5	9
4	1-day	1	4	8
5	1-day	6	7	9
6	1-day	6	10	13
7	1-day	1	5	11
2	4-day	6	7	9
3	4-day	0	0	1
4	4-day	0	0	1
5	4-day	6	7	9
6	4-day	6	9	13
7	4-day	1	5	10

Table 138. Chinook salmon, Lower Columbia River ESU; Prey; Malathion

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	7	8	10	12	12	14
3	1-day	0	2	3	30	48	62
4	1-day	0	1	3	21	44	61
5	1-day	6	7	9	7	11	14
6	1-day	5	8	12	11	12	14
7	1-day	0	3	9	9	12	14
2	4-day	6	7	9	12	12	14
3	4-day	0	0	0	20	29	39
4	4-day	0	0	0	10	26	36
5	4-day	6	7	9	6	10	14

6	4-day	5	8	12	10	12	14
7	4-day	0	2	9	8	12	14

Table 139. Chinook salmon, Puget Sound ESU; Mortality; Malathion

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	7	11	14
3	1-day	1	5	9
4	1-day	1	4	8
5	1-day	6	8	9
6	1-day	6	12	18
7	1-day	1	5	14
2	4-day	6	8	9
3	4-day	0	1	2
4	4-day	0	0	1
5	4-day	6	7	9
6	4-day	6	11	18
7	4-day	1	5	14

Table 140. Chinook salmon, Puget Sound ESU; Prey; Malathion

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	7	9	11	16	17	19
3	1-day	0	2	4	35	53	69
4	1-day	0	1	4	26	50	67
5	1-day	6	7	9	7	13	18
6	1-day	5	8	16	12	17	19
7	1-day	0	2	10	9	17	19
2	4-day	6	7	9	16	17	19
3	4-day	0	0	0	21	34	45
4	4-day	0	0	0	10	30	42
5	4-day	6	7	9	7	12	18
6	4-day	5	8	16	12	17	19
7	4-day	0	2	10	9	17	19

Table 141. Chinook salmon, Sacramento River winter-run ESU; Mortality; Malathion

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	49	51	56
3	1-day	42	70	80
4	1-day	30	70	81
5	1-day	49	51	57
6	1-day	44	47	51
7	1-day	5	10	42
2	4-day	49	50	52
3	4-day	20	43	68
4	4-day	5	32	68
5	4-day	49	51	56
6	4-day	42	45	50
7	4-day	4	9	41

Table 142. Chinook salmon, Sacramento River winter-run ESU; Prey; Malathion

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	49	50	53	58	59	62
3	1-day	23	56	75	84	90	91
4	1-day	15	57	76	81	90	91
5	1-day	49	50	53	49	59	62
6	1-day	34	37	48	49	58	62
7	1-day	2	4	31	48	54	61
2	4-day	49	50	52	53	59	62
3	4-day	8	24	54	79	86	90
4	4-day	1	16	56	73	86	90
5	4-day	49	50	52	49	59	62
6	4-day	30	35	47	49	58	62
7	4-day	1	3	28	48	53	61

Table 143. Chinook salmon, Snake River fall-run ESU; Mortality; Malathion

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %

2	1-day	31	35	41
3	1-day	5	8	19
4	1-day	0	2	13
5	1-day	30	35	40
6	1-day	26	31	37
7	1-day	1	2	6
2	4-day	30	35	40
3	4-day	0	0	2
4	4-day	0	0	1
5	4-day	30	35	40
6	4-day	24	29	34
7	4-day	1	2	6

Table 144. Chinook salmon, Snake River fall-run ESU; Prey; Malathion

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	30	35	40	34	38	44
3	1-day	1	2	7	74	82	91
4	1-day	0	1	4	52	67	86
5	1-day	30	35	40	31	36	42
6	1-day	18	22	27	33	38	43
7	1-day	0	1	4	32	37	42
2	4-day	30	35	40	34	38	44
3	4-day	0	0	0	60	68	77
4	4-day	0	0	0	21	30	68
5	4-day	30	35	40	31	36	42
6	4-day	15	19	24	33	38	43
7	4-day	0	1	4	32	37	42

Table 145. Chinook salmon, Snake River spring/summer-run ESU; Mortality; Malathion

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	19	22	27
3	1-day	3	4	9
4	1-day	0	1	6
5	1-day	18	21	27

6	1-day	16	19	24
7	1-day	0	2	4
2	4-day	18	21	27
3	4-day	0	0	1
4	4-day	0	0	0
5	4-day	18	21	27
6	4-day	14	18	23
7	4-day	0	1	4

Table 146. Chinook salmon, Snake River spring/summer-run ESU; Prey; Malathion

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	19	21	27	20	22	28
3	1-day	1	1	3	39	60	73
4	1-day	0	0	2	27	42	67
5	1-day	18	21	27	19	22	27
6	1-day	11	14	18	19	22	27
7	1-day	0	1	3	19	22	27
2	4-day	18	21	27	20	22	28
3	4-day	0	0	0	31	42	56
4	4-day	0	0	0	11	20	45
5	4-day	18	21	27	19	22	27
6	4-day	9	12	16	19	22	27
7	4-day	0	1	3	19	22	27

Table 147. Chinook salmon, upper Columbia spring-run ESU; Mortality; Malathion

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	17	20	23
3	1-day	4	6	12
4	1-day	0	2	9
5	1-day	16	19	22
6	1-day	15	18	21
7	1-day	1	3	6
2	4-day	16	19	22
3	4-day	0	0	2

4	4-day	0	0	1
5	4-day	16	19	22
6	4-day	14	17	20
7	4-day	1	2	6

Table 148. Chinook salmon, upper Columbia spring-run ESU; Prey; Malathion

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	16	19	22	21	23	26
3	1-day	1	2	5	54	70	79
4	1-day	0	1	4	38	54	73
5	1-day	16	19	22	17	20	24
6	1-day	11	13	16	19	22	25
7	1-day	0	1	5	18	21	24
2	4-day	16	19	22	20	23	26
3	4-day	0	0	0	41	49	58
4	4-day	0	0	0	16	27	47
5	4-day	16	19	22	17	20	24
6	4-day	9	12	15	19	21	25
7	4-day	0	1	4	18	21	24

Table 149. Chinook salmon, upper Willamette River ESU; Mortality; Malathion

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	25	27	29
3	1-day	10	24	32
4	1-day	4	21	30
5	1-day	24	25	26
6	1-day	22	27	31
7	1-day	3	14	26
2	4-day	24	25	27
3	4-day	2	6	11
4	4-day	0	4	9
5	4-day	24	25	26
6	4-day	22	26	31
7	4-day	3	13	25

Table 150. Chinook salmon, upper Willamette River ESU; Prey; Malathion

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	24	25	27	30	31	33
3	1-day	3	14	21	51	63	74
4	1-day	1	12	19	43	61	73
5	1-day	24	25	26	25	29	32
6	1-day	18	23	29	28	31	33
7	1-day	1	8	22	25	31	33
2	4-day	24	25	26	30	31	33
3	4-day	0	2	4	43	51	59
4	4-day	0	1	3	32	48	57
5	4-day	24	25	26	25	28	32
6	4-day	16	22	29	27	31	33
7	4-day	1	5	22	25	31	33

Table 151. Coho salmon, Central California Coast ESU; Mortality; Malathion

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	13	17	23
3	1-day	5	22	46
4	1-day	3	22	46
5	1-day	13	16	23
6	1-day	12	15	20
7	1-day	1	2	14
2	4-day	13	15	21
3	4-day	1	8	23
4	4-day	0	6	23
5	4-day	13	15	22
6	4-day	12	14	20
7	4-day	0	2	14

Table 152. Coho salmon, Central California Coast ESU; Prey; Malathion

Prey Bin	Avg period	All fish HC10 % mortality 5th %	50th %	95th %	All invert HC10 % mortality 5th %	50th %	95th %
2	1-day	13	15	21	23	26	31
3	1-day	1	12	35	53	81	94
4	1-day	1	12	36	39	82	94
5	1-day	13	15	21	15	25	31
6	1-day	10	12	19	15	23	31
7	1-day	0	1	11	13	20	29
2	4-day	13	15	20	18	25	31
3	4-day	0	3	13	39	63	85
4	4-day	0	2	13	25	60	85
5	4-day	13	15	21	15	25	31
6	4-day	9	12	18	15	23	31
7	4-day	0	1	10	13	20	29

Table 153. Coho salmon, lower Columbia River ESU; Mortality; Malathion

Mortality Bin	Avg period	HC05 LC50 % mortality 5th %	50th %	95th %
2	1-day	7	9	11
3	1-day	1	5	9
4	1-day	1	4	8
5	1-day	7	7	9
6	1-day	6	10	14
7	1-day	1	5	11
2	4-day	7	7	9
3	4-day	0	0	1
4	4-day	0	0	1
5	4-day	7	7	9
6	4-day	6	10	14
7	4-day	1	5	11

Table 154. Coho salmon, lower Columbia River ESU; Prey; Malathion

Prey	All fish HC10 % mortality	All invert HC10 % mortality

Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	7	8	10	12	12	15
3	1-day	0	2	3	30	49	63
4	1-day	0	1	3	21	44	62
5	1-day	7	7	9	7	11	14
6	1-day	5	8	13	11	12	15
7	1-day	0	3	9	9	12	15
2	4-day	7	7	9	12	12	15
3	4-day	0	0	0	20	29	39
4	4-day	0	0	0	10	26	36
5	4-day	7	7	9	7	10	14
6	4-day	5	8	13	10	12	15
7	4-day	0	2	9	9	12	15

Table 155. Coho salmon, Oregon coast ESU; Mortality; Malathion

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	6	9	9
3	1-day	0	3	6
4	1-day	0	2	6
5	1-day	5	9	9
6	1-day	6	9	10
7	1-day	0	5	9
2	4-day	6	9	9
3	4-day	0	0	1
4	4-day	0	0	1
5	4-day	5	9	9
6	4-day	6	9	10
7	4-day	0	5	9

Table 156. Coho salmon, Oregon coast ESU; Prey; Malathion

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	6	9	9	6	9	10
3	1-day	0	1	2	25	48	65

4	1-day	0	1	2	9	46	64
5	1-day	5	9	9	6	9	10
6	1-day	5	8	9	6	9	10
7	1-day	0	3	9	6	9	10
2	4-day	5	9	9	6	9	10
3	4-day	0	0	0	14	26	39
4	4-day	0	0	0	4	22	37
5	4-day	5	9	9	6	9	10
6	4-day	5	8	9	6	9	10
7	4-day	0	2	9	6	9	10

Table 157. Coho salmon, southern Oregon/northern California coast ESU; Mortality; Malathion

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	6	7	19
3	1-day	1	6	32
4	1-day	0	7	32
5	1-day	6	7	19
6	1-day	5	7	19
7	1-day	0	2	11
2	4-day	6	7	19
3	4-day	0	1	14
4	4-day	0	1	14
5	4-day	6	7	19
6	4-day	5	7	19
7	4-day	0	1	10

Table 158. Coho salmon, southern Oregon/northern California coast ESU; Prey; Malathion

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	6	7	19	6	8	20
3	1-day	0	3	22	25	45	76
4	1-day	0	3	22	11	43	74
5	1-day	6	7	19	6	8	19
6	1-day	4	6	17	6	8	20
7	1-day	0	1	5	6	8	19

2	4-day	6	7	19	6	8	20
3	4-day	0	0	7	16	29	64
4	4-day	0	0	7	5	26	62
5	4-day	6	7	19	6	8	19
6	4-day	4	5	17	6	8	20
7	4-day	0	1	5	6	8	19

Table 159. Sockeye salmon, Ozette Lake ESU; Mortality; Malathion

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	0	3	5
3	1-day	0	0	0
4	1-day	0	0	0
5	1-day	0	3	5
6	1-day	0	3	5
7	1-day	0	1	4
2	4-day	0	3	5
3	4-day	0	0	0
4	4-day	0	0	0
5	4-day	0	3	5
6	4-day	0	3	5
7	4-day	0	1	4

Table 160. Sockeye salmon, Ozette Lake ESU; Prey; Malathion

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	0	3	5	0	3	5
3	1-day	0	0	0	0	15	52
4	1-day	0	0	0	0	11	50
5	1-day	0	3	5	0	3	5
6	1-day	0	2	5	0	3	5
7	1-day	0	0	3	0	3	5
2	4-day	0	3	5	0	3	5
3	4-day	0	0	0	0	2	19
4	4-day	0	0	0	0	1	16
5	4-day	0	3	5	0	3	5

6	4-day	0	2	5	0	3	5
7	4-day	0	0	3	0	3	5

Table 161. Sockeye salmon, Snake River ESU; Mortality; Malathion

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	22	26	32
3	1-day	4	6	14
4	1-day	0	2	9
5	1-day	22	25	31
6	1-day	19	22	28
7	1-day	1	2	6
2	4-day	22	25	31
3	4-day	0	0	2
4	4-day	0	0	0
5	4-day	22	25	31
6	4-day	18	21	27
7	4-day	1	2	5

Table 162. Sockeye salmon, Snake River ESU; Prey; Malathion

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	22	25	31	25	28	34
3	1-day	1	2	5	52	68	80
4	1-day	0	1	3	38	51	76
5	1-day	22	25	31	23	26	33
6	1-day	13	16	21	24	28	33
7	1-day	0	1	4	24	27	33
2	4-day	22	25	31	25	28	34
3	4-day	0	0	0	42	50	64
4	4-day	0	0	0	17	24	52
5	4-day	22	25	31	22	26	33
6	4-day	11	14	18	24	27	33
7	4-day	0	1	4	24	27	33

Table 163. Steelhead, California Central Valley ESU; Mortality; Malathion

Mortality Bin	Avg period	HC05 LC50 % mortality 5th %	50th %	95th %
2	1-day	60	62	67
3	1-day	50	74	86
4	1-day	37	70	86
5	1-day	59	62	66
6	1-day	54	57	62
7	1-day	8	18	38
2	4-day	59	61	65
3	4-day	29	50	72
4	4-day	10	36	70
5	4-day	59	61	66
6	4-day	51	55	60
7	4-day	6	16	36

Table 164. Steelhead, California Central Valley ESU; Prey; Malathion

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	59	61	66	65	67	72
3	1-day	34	62	81	89	94	96
4	1-day	26	57	81	83	94	96
5	1-day	59	61	65	61	66	71
6	1-day	42	48	55	60	65	70
7	1-day	3	7	32	59	64	69
2	4-day	59	61	65	63	66	71
3	4-day	15	29	56	85	91	95
4	4-day	3	20	55	77	90	95
5	4-day	59	61	65	61	66	71
6	4-day	38	45	52	60	65	70
7	4-day	2	6	30	59	63	68

Table 165. Steelhead, Central California Coast ESU; Mortality; Malathion

Mortality Bin	Avg period	HC05 LC50 % mortality 5th %	50th %	95th %

2	1-day	18	23	29
3	1-day	8	31	58
4	1-day	5	32	58
5	1-day	18	22	30
6	1-day	17	20	25
7	1-day	1	3	19
2	4-day	18	21	25
3	4-day	1	12	32
4	4-day	0	8	32
5	4-day	18	21	28
6	4-day	16	19	24
7	4-day	1	3	19

Table 166. Steelhead, Central California Coast ESU; Prey; Malathion

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	18	21	26	32	35	39
3	1-day	2	17	46	67	87	92
4	1-day	2	18	46	54	87	92
5	1-day	18	21	26	20	35	39
6	1-day	14	17	23	20	32	39
7	1-day	0	1	15	18	26	37
2	4-day	18	21	25	25	35	39
3	4-day	0	5	19	53	74	87
4	4-day	0	3	19	36	73	87
5	4-day	18	21	25	20	34	39
6	4-day	13	16	22	20	32	39
7	4-day	0	1	14	18	26	37

Table 167. Steelhead, Lower Columbia River ESU; Mortality; Malathion

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	7	9	11
3	1-day	1	5	9
4	1-day	1	4	8
5	1-day	6	7	9

6	1-day	6	10	14
7	1-day	1	5	11
2	4-day	6	7	9
3	4-day	0	0	1
4	4-day	0	0	1
5	4-day	6	7	9
6	4-day	6	9	14
7	4-day	1	5	11

Table 168. Steelhead, Lower Columbia River ESU; Prey; Malathion

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	7	8	10	12	12	15
3	1-day	0	2	3	30	47	60
4	1-day	0	1	3	22	43	59
5	1-day	6	7	9	7	11	14
6	1-day	5	8	13	11	12	15
7	1-day	0	3	9	9	12	15
2	4-day	6	7	9	12	12	15
3	4-day	0	0	0	20	30	39
4	4-day	0	0	0	10	26	36
5	4-day	6	7	9	7	10	14
6	4-day	5	8	13	10	12	15
7	4-day	0	2	9	9	12	15

Table 169. Steelhead, Middle Columbia River ESU; Mortality; Malathion

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	17	20	36
3	1-day	3	5	11
4	1-day	0	1	8
5	1-day	17	20	36
6	1-day	14	17	31
7	1-day	1	1	3
2	4-day	17	20	36
3	4-day	3	5	11

4	4-day	0	1	8
5	4-day	17	20	36
6	4-day	14	17	31
7	4-day	1	1	3

Table 170. Steelhead, Middle Columbia River ESU; Prey; Malathion

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	17	20	36	19	21	37
3	1-day	1	2	4	41	46	70
4	1-day	0	0	3	27	36	60
5	1-day	17	20	36	18	20	36
6	1-day	9	11	22	18	21	37
7	1-day	0	1	2	18	20	36
2	4-day	17	20	36	19	21	37
3	4-day	1	2	4	41	46	70
4	4-day	0	0	3	27	36	60
5	4-day	17	20	36	18	20	36
6	4-day	9	11	22	18	21	37
7	4-day	0	1	2	18	20	36

Table 171. Steelhead, Northern California ESU; Mortality; Malathion

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	6	8	31
3	1-day	0	9	57
4	1-day	0	9	57
5	1-day	6	8	31
6	1-day	6	8	31
7	1-day	0	1	18
2	4-day	6	8	31
3	4-day	0	1	28
4	4-day	0	1	28
5	4-day	6	8	31
6	4-day	6	8	31
7	4-day	0	1	16

Table 172. Steelhead, Northern California ESU; Prey; Malathion

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	6	8	31	7	9	32
3	1-day	0	3	43	34	76	97
4	1-day	0	3	43	8	72	97
5	1-day	6	8	31	6	9	32
6	1-day	4	6	29	6	9	32
7	1-day	0	0	8	6	8	31
2	4-day	6	8	31	7	9	32
3	4-day	0	0	14	21	51	90
4	4-day	0	0	14	3	47	90
5	4-day	6	8	31	6	9	32
6	4-day	4	6	28	6	9	32
7	4-day	0	0	8	6	8	31

Table 173. Steelhead, Puget Sound ESU; Mortality; Malathion

Table 174. Steelhead, Puget Sound ESU; Prey; Malathion

Table 175. Steelhead, Snake River Basin ESU; Mortality; Malathion

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	19	22	27
3	1-day	3	4	9
4	1-day	0	1	6
5	1-day	18	21	27
6	1-day	16	19	24
7	1-day	0	2	4
2	4-day	18	21	27
3	4-day	0	0	1
4	4-day	0	0	0
5	4-day	18	21	27

6	4-day	14	18	23
7	4-day	0	1	4

Table 176. Steelhead, Snake River Basin ESU; Prey; Malathion

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	19	21	27	20	22	28
3	1-day	1	1	3	39	60	73
4	1-day	0	0	2	27	42	67
5	1-day	18	21	27	19	22	27
6	1-day	11	14	18	19	22	27
7	1-day	0	1	3	19	22	27
2	4-day	18	21	27	20	22	28
3	4-day	0	0	0	31	42	56
4	4-day	0	0	0	11	20	45
5	4-day	18	21	27	19	22	27
6	4-day	9	12	16	19	22	27
7	4-day	0	1	3	19	22	27

Table 177. Steelhead, South-Central California Coast ESU; Mortality; Malathion

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	36	40	50
3	1-day	20	54	77
4	1-day	9	56	77
5	1-day	36	40	50
6	1-day	33	38	49
7	1-day	2	5	37
2	4-day	36	40	49
3	4-day	7	26	59
4	4-day	1	20	59
5	4-day	36	40	50
6	4-day	32	37	48
7	4-day	1	4	36

Table 178. Steelhead, South-Central California Coast ESU; Prey; Malathion

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	36	40	50	38	42	52
3	1-day	9	36	70	80	91	98
4	1-day	3	38	70	68	91	98
5	1-day	36	40	50	38	42	52
6	1-day	26	32	45	36	42	52
7	1-day	0	2	28	36	41	52
2	4-day	36	40	49	38	42	52
3	4-day	2	11	42	74	83	92
4	4-day	0	7	43	57	82	93
5	4-day	36	40	50	37	42	52
6	4-day	24	30	44	36	42	52
7	4-day	0	2	26	36	41	52

Table 179. Steelhead, Southern California ESU; Mortality; Malathion

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	10	16	22
3	1-day	3	19	44
4	1-day	1	19	45
5	1-day	9	15	24
6	1-day	8	13	17
7	1-day	0	3	11
2	4-day	9	13	17
3	4-day	1	4	17
4	4-day	0	3	17
5	4-day	9	15	21
6	4-day	8	13	16
7	4-day	0	2	11

Table 180. Steelhead, Southern California ESU; Prey; Malathion

Prey	All fish HC10 % mortality	All invert HC10 % mortality

Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	9	14	18	29	35	39
3	1-day	1	10	29	64	85	95
4	1-day	0	10	29	51	84	96
5	1-day	9	14	19	13	26	37
6	1-day	7	11	15	13	23	35
7	1-day	0	1	9	9	20	32
2	4-day	9	13	17	22	31	37
3	4-day	0	1	9	40	66	84
4	4-day	0	1	9	23	61	85
5	4-day	9	14	18	13	25	36
6	4-day	6	10	14	12	22	35
7	4-day	0	1	8	9	20	30

Table 181. Steelhead, Upper Columbia River ESU; Mortality; Malathion

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	17	20	23
3	1-day	4	6	13
4	1-day	0	2	10
5	1-day	17	19	22
6	1-day	15	18	22
7	1-day	1	3	6
2	4-day	17	19	22
3	4-day	0	1	2
4	4-day	0	0	1
5	4-day	17	19	22
6	4-day	14	17	21
7	4-day	1	2	6

Table 182. Steelhead, Upper Columbia River ESU; Prey; Malathion

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	17	20	23	21	23	27
3	1-day	1	2	6	54	71	79

4	1-day	0	1	4	39	54	74
5	1-day	17	19	22	18	21	24
6	1-day	11	14	17	19	22	26
7	1-day	0	1	5	19	22	25
2	4-day	17	19	22	21	23	27
3	4-day	0	0	1	42	50	59
4	4-day	0	0	0	17	28	48
5	4-day	17	19	22	17	21	24
6	4-day	10	12	15	19	22	25
7	4-day	0	1	4	19	21	25

Table 183. Steelhead, Upper Willamette River ESU; Mortality; Malathion

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	32	35	38
3	1-day	13	33	42
4	1-day	5	30	39
5	1-day	30	32	33
6	1-day	29	35	40
7	1-day	4	18	34
2	4-day	30	32	34
3	4-day	2	9	15
4	4-day	0	5	12
5	4-day	30	32	33
6	4-day	28	34	40
7	4-day	4	16	32

Table 184. Steelhead, Upper Willamette River ESU; Prey; Malathion

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	31	33	35	39	41	43
3	1-day	4	19	27	69	82	91
4	1-day	1	15	25	60	81	91
5	1-day	30	32	33	32	38	41
6	1-day	23	29	38	36	41	43
7	1-day	1	10	28	33	41	43

2	4-day	30	32	34	39	41	43
3	4-day	0	2	5	58	68	76
4	4-day	0	1	4	45	65	74
5	4-day	30	32	33	32	37	41
6	4-day	21	28	37	36	41	43
7	4-day	1	7	28	33	41	43

Table 185. Shortnose Sturgeon; Mortality; Malathion

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	7	9	14
3	1-day	2	5	15
4	1-day	2	5	14
5	1-day	0	0	0
6	1-day	5	7	10
7	1-day	0	0	1
2	4-day	7	8	12
3	4-day	0	0	2
4	4-day	0	0	2
5	4-day	0	0	0
6	4-day	4	6	9
7	4-day	0	0	0

Table 186. Shortnose Sturgeon; Prey; Malathion

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	7	9	13	13	15	18
3	1-day	1	2	7	51	60	70
4	1-day	0	2	7	42	55	67
5	1-day	0	0	0	0	0	0
6	1-day	3	5	7	7	9	12
7	1-day	0	0	0	6	8	12
2	4-day	7	8	12	13	14	18
3	4-day	0	0	0	28	38	52
4	4-day	0	0	0	20	31	44
5	4-day	0	0	0	0	0	0

6	4-day	3	4	6	7	9	12
7	4-day	0	0	0	6	8	12

Table 187. Gulf Sturgeon; Mortality; Malathion

Table 188. Gulf Sturgeon; Prey; Malathion

Table 189. Smalltooth sawfish; Mortality; Malathion; Full Range

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	4	7	13
3	1-day	2	5	16
4	1-day	1	5	15
5	1-day	3	4	6
6	1-day	3	4	5
7	1-day	0	0	1
2	4-day	3	4	6
3	4-day	0	1	2
4	4-day	0	1	2
5	4-day	3	4	6
6	4-day	3	4	5
7	4-day	0	0	0

Table 190. Smalltooth sawfish; Prey; Malathion; Full Range

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	3	5	8	18	19	21
3	1-day	1	2	8	32	50	66
4	1-day	0	2	8	26	49	66
5	1-day	3	4	6	3	4	17
6	1-day	2	3	4	3	4	10
7	1-day	0	0	0	3	4	6
2	4-day	3	4	6	16	19	21
3	4-day	0	0	1	13	30	45

4	4-day	0	0	1	9	27	45
5	4-day	3	4	6	3	4	15
6	4-day	2	3	4	3	4	9
7	4-day	0	0	0	3	4	6

Table 191. Smalltooth sawfish; Mortality; Malathion; Nursery Areas

Mortality		HC05 LC50 % mortality		
Bin	Avg period	5th %	50th %	95th %
2	1-day	3	4	6
3	1-day	1	2	8
4	1-day	1	2	8
5	1-day	2	3	3
6	1-day	2	2	3
7	1-day	0	0	0
2	4-day	2	3	3
3	4-day	0	0	1
4	4-day	0	0	1
5	4-day	2	3	3
6	4-day	2	2	3
7	4-day	0	0	0

Table 192. Smalltooth sawfish; Prey; Malathion; Nursery Areas

Prey		All fish HC10 % mortality			All invert HC10 % mortality		
Bin	Avg period	5th %	50th %	95th %	5th %	50th %	95th %
2	1-day	2	3	4	8	8	8
3	1-day	0	1	4	16	28	48
4	1-day	0	1	4	13	28	48
5	1-day	2	3	3	2	3	7
6	1-day	2	2	2	2	3	5
7	1-day	0	0	0	2	3	3
2	4-day	2	3	3	7	8	8
3	4-day	0	0	0	7	14	20
4	4-day	0	0	0	4	13	20
5	4-day	2	3	3	2	3	6
6	4-day	2	2	2	2	3	4
7	4-day	0	0	0	2	3	3

B. APPENDIX: PACIFIC SALMON POPULATION MODELING

Introduction

To assess the potential for adverse impacts of the anticholinesterase insecticides on Pacific salmon populations, a model was developed that explicitly links impairments in the biochemistry, behavior, prey availability and somatic growth of individual salmon to the productivity of salmon populations. More specifically, the model connects known effects of the pesticides on salmon physiology and behavior with community-level effects on salmon prey to estimate population-level effects on salmon. The model used here is an extension of one developed for investigating the direct effects of pesticides on the biochemistry, behavior and growth of ocean-type Chinook salmon (Baldwin et al., 2009) and includes indirect impacts on prey base (Macneale et al, 2014).

In the freshwater portion of their life, Pacific salmon may be exposed to insecticides that act by inhibiting acetylcholinesterase (AChE). Acetylcholinesterase is a crucial enzyme in the proper functioning of cholinergic synapses in the central and peripheral nervous systems of vertebrates and invertebrates. Of consequence to salmon, anticholinesterase insecticides have been shown to interfere with salmon swimming behavior (Beauvais et al. 2000, Brewer et al. 2001, Sandahl et al. 2005), feeding behavior (Sandahl et al. 2005), foraging behavior (Morgan and Kiceniuk 1990), homing behavior (Scholz et al. 2000), antipredator behaviors (Scholz et al. 2000) and reproductive physiology (Moore and Waring 1996, Waring and Moore 1997, Scholz et al. 2000).

Anticholinesterase insecticides also reduce benthic densities of aquatic invertebrates and alter the composition of aquatic communities (Liess and Schulz 1999, Schulz and Liess 1999, Schulz et al. 2002, Fleeger et al. 2003, Schulz 2004, Chang et al. 2005, Relyea 2005). Spray drift and runoff from agricultural and urban areas can expose aquatic invertebrates to relatively low concentrations of insecticides for as little as minutes or hours, but populations of many taxa can take months or even years to recover to pre-exposure or reference densities (Wallace et al. 1991, Liess and Schulz 1999, Anderson et al. 2003, Stark et al. 2004). For example, when an aquatic macroinvertebrate community in a German stream was exposed to runoff containing parathion (an acetylcholinesterase inhibitor) and fenvalerate (another commonly used insecticide), eight of eleven abundant species disappeared and the remaining three were reduced in abundance (Liess and Schulz 1999). Long-term changes in invertebrate densities and community composition likely result in reductions in salmon prey availability. Therefore, in addition to the direct impacts that acetylcholinesterase inhibitors have on salmon, there may also be, independently, significant indirect effects to salmon via their prey (Peterson et al. 2001a). Wild juvenile salmon feed primarily on invertebrates in the water column and those trapped on the water's surface, actively selecting the largest items available (Healey 1991, Quinn 2005). Salmon are often found to be food limited (Quinn 2005), suggesting that a reduction in prey number or size due to insecticide exposure may further stress salmon. For example, Davies and Cook (1993) found that several months following a spray drift event, benthic and drift densities were still reduced in exposed stream reaches. Consequently, brown trout in the exposed reaches fed less and grew at a slower rate compared to those in unexposed stream reaches (Davies and Cook 1993). Although the insecticide in their study was cypermethrin (a pyrethroid), similar reductions in macroinvertebrate density and recovery times have been found in studies with acetylcholinesterase inhibitors (Liess and Schulz 1999, Schulz et al. 2002), suggesting indirect effects to salmon via prey availability may be similar.

One likely biological consequence of reduced swimming, feeding, foraging, and prey availability is a reduction in food uptake and, subsequently, a reduction in somatic growth of exposed fish. Juvenile growth is a critical determinant of freshwater and marine survival for Chinook salmon (Higgs et al. 1995). Reductions in the somatic growth rate of salmon fry and smolts are believed to result in increased size-dependent mortality (Healey 1982, West and Larkin 1987, Zabel and Achord 2004). Zabel and Achord (2004) observed size-dependent survival for juvenile salmon during the freshwater phase of their outmigration. Mortality is also higher among smaller and slower growing salmon because they are more susceptible to predation during their first winter (Healey 1982, Holtby et al. 1990, Beamish and Mahnken 2001). These studies suggest that factors affecting the organism and reducing somatic growth, such as anticholinesterase insecticide exposure, could result in decreased first-year survival and, thus, reduce population productivity.

Changes to the size of juvenile salmon from exposure to anticholinesterase pesticides were linked to salmon population demographics (Baldwin et al., 2009). We used size-dependent survival of juveniles during a period of their first year of life. We did this by constructing and analyzing general life-history matrix models for coho salmon (*Oncorhynchus kisutch*), sockeye salmon (*O. nerka*) and ocean-type and stream-type Chinook salmon (*O. tshawytscha*). A steelhead (*O. mykiss*) life-history model was not constructed due to the lack of demographic information relating to the proportions of resident and anadromous individuals, the freshwater residence time of steelhead, and rates of repeated spawning. The basic salmonid life history modeled consisted of hatching and rearing in freshwater, smoltification in estuaries, migration to the ocean, maturation at sea, and returning to the natal freshwater stream for spawning followed shortly by death. Differences between the modeled strategies are lifespan of the female, time to reproductive maturity, and the number and relative contribution of the reproductive age classes (Figure A1-1). The coho females we modeled reach reproductive maturity at age 3 and provide all of the reproductive contribution. Sockeye females reach maturity at age 4 or 5, but the majority of reproductive contributions are provided by age 4 females. Chinook females can mature at age 3, 4 or 5, with the majority of the reproductive contribution from ages 4 and 5. The primary difference between the ocean-type and stream-type Chinook is the juvenile freshwater residence with ocean-type juveniles migrating to the ocean as subyearlings and stream-type overwintering in freshwater and migrating to the ocean as yearlings. The models depicted general populations representing each life-history strategy and were constructed based upon literature data described below. Specific populations were not modeled due to the lack of sufficient demographic and reproductive data for a single population.

A separate acute toxicity model was constructed that estimated the population-level impacts of juvenile mortality resulting from exposure to lethal concentrations of chlorpyrifos, diazinon and malathion. These models excluded sublethal and indirect effects of the pesticide exposures and focused on the population-level outcomes resulting from an annual exposure of juveniles to a pesticide. The lethal impact was implemented as a change in first year survival for each of the salmon life-history strategies.

The overall model endpoint used to assess population-level impacts for both the growth and acute lethality models was the percent change in the intrinsic population growth rate (lambda, λ) resulting from the pesticide exposure. Change in λ is an accepted population parameter often used in evaluating population productivity, status, and viability. The National Marine Fisheries Service uses changes in λ when estimating the status of species, conducting risk and viability assessments, developing Endangered Species Recovery Plans, composing Biological Opinions, and communicating with other federal, state and local agencies (McClure et al. 2003). While values of $\lambda<1.0$ indicate a declining population, negative changes in lambda greater than the natural variability for the population indicate a loss of productivity. This can be a cause for concern since the decline could make a population more susceptible to dropping below 1.0 due to impacts from multiple stressors.

The following models were developed to serve as a means to assess the potential effects on ESA-listed salmon populations from exposure to AChE inhibiting pesticides, including n-methyl carbamates and organophosphorus insecticides. The growth model focuses on the impacts to prey abundance and a salmon's ability to feed which are integrated into reductions in juvenile growth. Assessing the results from different pesticide exposure scenarios relative to a control (i.e. unexposed) scenario can indicate the potential for sublethal pesticide exposures to lead to changes in the somatic growth and survival of individual subyearling salmon. Consequently, subsequent changes in salmon population dynamics as indicated by percent change in a population's intrinsic rate of increase assists in forecasting the potential population-level impacts to listed populations. Also, the model helps us understand the potential influence of life-history strategies that might explain differential results within the species modeled.

Methods

The somatic growth model consists of two parts, an organismal portion and a population portion. The organismal portion of the model links AChE inhibition and reduced prey abundance due to insecticide exposure to potential reductions in the growth of individual fish. The population portion of the model links the sizes of individual subyearling salmon to their survival and the subsequent growth of the population. Models were constructed using MATLAB 7.7.0 (R2008b) (The MathWorks, Inc. Natick, MA).

Organismal Model

The organismal model tracks individual somatic growth of salmonid fingerlings using a series of relationships between pesticide exposure, AChE activity, feeding behavior, food uptake, and somatic growth rate (Figures A1-2-4). The model incorporates empirical data when available (Baldwin et al., 2009). Since growth and toxicity data are limited, extrapolation from one salmon species to the others was done with the assumption that the salmon stocks would exhibit similar physiological and toxicological responses. Sigmoidal dose-response relationships based upon the AChE inhibition EC50 values and their slopes are used to determine the level of AChE activity (Figure A1-2A, 2B, 2C) from the exposure concentration of each pesticide exposure or pulse.

A linear relationship based on empirical data related AChE activity to feeding behavior (Sandahl et al. 2005, Figure A1-2D). Feeding behavior was then assumed to be directly proportional to food uptake, defined as potential ration (Figure A1-2E, Brett 1969). The potential ration expresses the amount of food the organism can consume when prey abundance is not limiting. Potential ration over time (Figure A1-2F) depicts how the food intake of individual fish changes in response to the behavioral effects of the pesticide exposure over the modeled growth period. Potential ration is equal to final ration if no effects on prey abundance are incorporated (Figure A1-4). When effects of pesticide exposure on prey abundance are incorporated, final ration is the product of potential ration (relating to the fish's ability to capture prey, Figure A1-2) and the relative abundance of prey available following exposure (Figure A1-3). Next, additional empirical data (e.g. Weatherley and Gill 1995) defined the relationship between final ration and somatic growth rate (Figure A1-4C). While the empirical relationship is more complex (e.g. somatic growth rate plateaus at rations above maximum feeding), a linear model was considered sufficient for the overall purpose of this model. Finally, the model combines these linear models relating AChE activity to feeding behavior, feeding behavior to potential ration, and final ration to somatic growth rate to produce a linear relationship between AChE activity and somatic growth rate (Figure A1-4D). One important assumption of the model is that the relationships are stable, i.e. do not change with time. The relationships would need to be modified to incorporate time as a variable if, for example, fish are shown to compensate over time for reduced AChE activity to improve their feeding behavior and increase food uptake.

The models allow exposures that can include multiple AChE-inhibiting pesticides over various time pulses. Sigmoidal dose-response relationships, at steady-state, between each single pesticide exposure and 1) AChE activity and 2) relative prey abundance are modeled using specific EC50s and EC50s and slopes (Figure A1-2B and 3B). The timecourse for each exposure was built into the model as a pulse with a defined start and end during which the exposure remained constant (Figure A1-2A and 3A). The timecourse for AChE activity, on the other hand, was modeled using two single-order exponential functions, one for the time required for the exposure to reach full effect and the other for time required for complete recovery following the end of the exposure (time-to-effect$_{\text{AChE activity}}$ and time-to-recovery$_{\text{AChE activity}}$, respectively; Figure A1-2C). The apparent activity level was back-calculated to result in a relative concentration (concentration/ AChE inhibition EC50) for each day of the growth period for each pulse. The relative concentration for each day was summed across all the pulses to result in a total apparent concentration for each day. The sigmoid slope used in the calculation of AChE activity using the apparent concentration was the arithmetic mean of the sigmoid slopes for each pesticide present on each day. The timecourse for relative prey abundance was modeled incorporating a one day spike in prey drift relative to the toxicity and available prey base followed by a drop in abundance due to the toxic impacts (Figure A1-3C). Recovery is assumed to be due to a constant influx of invertebrates from connected habitats (aquatic and terrestrial) that are not exposed to the pesticide. Incoming organisms are subject to toxicity if pesticides are still present and this alters the rate of recovery during exposures. Incorporating dynamic effects and recovery variables allows the model to simulate differences in the pharmacokinetics (e.g. the rates of uptake from the environment and of detoxification) of various pesticides and simulate differences in invertebrate community response and recovery rates (see below).

The relationship between final ration and somatic growth rate (Figure A1-4C) produces a relationship representing somatic growth rate over time (Figure A1-4D), which is then used to model individual growth rate and size over time. The growth models were run for 1000 individual fish, with initial weight selected from a normal distribution with a mean of 1.0 g and standard deviation of 0.1 g. The size of 1.0 g was chosen to represent subyearling size in the spring prior to the onset of pesticide application. For each iteration of the model (one day for the organismal model), the somatic growth rate is calculated for each fish by selecting the parameter values from normal distributions with specified means and standard deviations (Table A1-1). The weight for each fish is then adjusted based on the calculated growth rate to generate a new weight for the next iteration. The length (days) to run the growth portion of the model was selected to represent the time from when the fish enter the linear portion of their growth trajectory in the mid to late spring until they change their growth pattern in the fall due to reductions in temperature and resources or until they migrate out of the system. The outputs of the organismal model that are handed to the population models consist of mean weights (with standard deviations) after the species-appropriate growth period (Table A1-2). A sensitivity analysis was run to determine the influence of the parameter values on the output of the growth model.

The option of exposing only a specified percent of the population to the pesticide(s) during the somatic growth period is provided. The exposed percent of the population is applied to the number of individuals run in the individual growth model. After running all 1000 individual growth trajectories (with X% exposed and 100-X% control) the mean weight and standard deviation of the whole is determined and handed to the population model to run as the size distribution of the impacted population.

The parameter values defining control conditions that are constant for all the modeled species are listed in Table A1-1. Model parameters such as the length of the growth period and control daily growth rate that are species specific are listed in Table A1-2. Each exposure scenario was defined by a concentration and exposure time for each pesticide. The duration of time until full effect for the pesticides was assumed to be within a few days (Ferrari et al. 2004), with a half-life of 0.5 days. Toxicity values describing 50% inhibition of AChE activity (IC_{50}) and the sigmoid slope for each active ingredient are shown in Table A1-3, as reported in the chlorpyrifos, malathion, and diazinon biological evaluations (EPA 2017).

The effects of exposures on the prey base are incorporated in the somatic growth model as the available ration (Macneale et al., 2014). For prey, it is assumed there is a constant, independent influx of prey from upstream habitats that will eventually (depending on the rate selected) return prey abundance to 1. As mentioned above, however, these invertebrates are subject to exposure once added to the system, and therefore prey recovery rate is a product of the influx rate as well as the exposure scenario. While recovery rates reported in the literature vary, it is assumed a 1% recovery rate is ecologically realistic (Ward et al. 1995, Van den Brink et al. 1996, Colville et al. 2008). It was also assumed that regardless of the exposure scenario, relative prey abundance would not drop below a specific floor (Figure A1-3B). This assumption depends on a minimal yet constant terrestrial subsidy of prey and/or an aquatic community with tolerant individuals that would be available as prey, regardless of pesticide exposure and in addition to the constant recovery rate. No studies specify floors per se, but studies quantifying invertebrate densities following highly toxic exposures indicate a floor of 0.2 is ecologically realistic (i.e. regardless of the exposure, 20% of a fish's ration will be available daily; e.g., Cuffney et al. 1984). Finally, because prey availability has been found to increase dramatically albeit briefly following pesticide exposures (due to immediate mortality and/or emigration of benthic prey into the water column; Davies and Cook 1993, Schulz 2004), a one-day prey spike is included for the day following an exposure. The relative magnitude of the spike is calculated as the product of the standing prey availability the day prior to exposure (minus the floor), the toxicity of the exposure, and a constant of 20. This calculation therefore accounts for the potential prey that are available and the severity of the exposure. The spike will be greater when more prey are available and/or the toxicity of the exposure is greater; alternatively, the spike will be small when few prey are available and/or the exposure toxicity is low. The toxicity values for prey abundance (EC_{50} and sigmoid slope) were calculated as the lower 5^{th} percentile of the invertebrate species sensitivity distribution from the USEPA BE (Table A1-3).

Below are the mathematical equations used to derive Figures A1-2, 3, and 4.

Figures A1-2A and 3A use a step function:

time < start; exposure = 0
start ≤ time ≤ end; exposure = exposure concentration(s)
time > end; exposure = 0.

Figures A1-2B and 3B use a sigmoid function:

y = bottom + (top – bottom)/(1 + (exposure concentration/EC50)^slope).
For 2B, y = AChE activity, top = Ac, bottom = 0.
For Figure 3B, y = prey abundance, top = Pc (in this case 1), bottom = Pf.

Figures A1-2D, 2E, and 4C use a linear function (the point-slope form of a line):

y = m*(x – x1) + y1.
For 2D, m = Mfa, x1 = Ac, and y1 = Fc.
For 2E, m = Mrf (computed as Rc/Fc), x1 = Fc, and y1 = Rc.
For 4C, m = Mgr, x1 = Rc, and y1 = Gc.

Figure A1-2C uses a series of exponential functions:

time < start; y = c
start ≤ time ≤ end; y = c – (c – i)*(1 – exp(-ke*(time – start)))
time > end; ye = c – (c – i)*(1 – exp(-ke*(end – start)))
y = ye + (c – ye)*(1 – exp(-kr*(time – end))).

For Figure 2C, c = Ac, i = Ai, ke = ln(2)/AChE effect half-life, kr = ln(2)/AChE recovery half-life. For Figure 2C the value of ye is calculated to determine the amount of inhibition that is reached during the exposure time, which may not be long enough to reach the maximum level of inhibition.

For Figure A1-3C, an exposure pulse would result in a 1-day spike followed by a decline to the impacted level based upon the prey toxicity. During exposures resulting in low prey toxicity, toxicity-limited recovery can occur. After exposure ends, a constant rate of recovery proceeds until control drift is reached or another exposure occurs

preyavail=preydrift(day-1)-floor;
preytox=1/(1+(concentration)^preyslope);
preyrecrate=0.01;
preydriftrec = preyrecrate*preytox.

time=start; spike=(-1+10^(1.654*preyavail))*(1-preytox)
preydrift =preydrift+spike
start ≤ time ≤ end; preydrift=(preyavail*preytox)+preyrdriftrec+floor;
time>end; preydrift = preydrift(day-1)+preydriftrec

Figure A1-2F is generated by using the output of Figure A1-2C for a given time as the input for 2D and using the resulting output of 2D as the input for 2E. The resulting output of 2E produces a single time point in the relationship in 2F. Performing this series of computations across multiple days produces the entire relationship in 2F. 4D is generated by taking the outputs of 4A and 4B for the same day. Note the relationship of 4A is equivalent to 2F. The resulting outputs of 4A and 4B are multiplied to produce a final ration for a given day. The prey abundance (4B) available for consumption during a prey spike is capped at a maximum of 1.5*control drift to provide a limited benefit to the individual fish. The final ration is used as input for 4C to generate 4D.

Salmonid Population Model

The weight distributions from the organismal growth portion of the model are used to calculate size-dependent first-year survival for a life-history matrix population model for each species and life-history type. This incorporates the impact that reductions in size could have on population growth rate and abundance. The first-year survival element of the transition matrix incorporates a size-dependent survival rate for a three- or four-month interval (depending upon the species) which takes the subyearlings up to 12 months of age. This time represents the 4-month early winter survival in freshwater for stream-type Chinook, coho, and sockeye models. For ocean-type Chinook, it is the 3-month period the subyearling smolt spend in the estuary and nearshore habitats (i.e. estuary survival). The weight distributions from the organismal model are converted to length distributions by applying condition factors from data for each modeled species (cf; 0.0095 for sockeye and 0.0115 for all others) as shown in Equation L.

Equation L: length(mm) = ((fish weight(g)/cf)^(1/3))*10

The relationship between length and early winter or estuary survival rate was adapted from Zabel and Achord (2004) to match the survival rate for each control model population (Howell et al. 1985, Kostow 1995, Myers et al. 2006). The relationship is based on the length of a subyearling salmon relative to the mean length of other competing subyearling salmon of the same species in the system, Equation D, and relates that relative difference to size-dependent survival based upon Equation S. The values for α and resulting size-dependent survival (survival ϕ) for control runs for each species are listed in Table A1-2. The constant α is a species-specific parameter defined such that it produces the correct control survival ϕ value when Δlength equals zero.

Equation D: $\Delta\text{length} = \text{fish length(mm)} - \text{mean length(mm)}$

Equation S: $\text{Survival } \phi = (e^{(\alpha+(0.0329*\Delta\text{length}))}) / (1 + e^{(\alpha+(0.0329*\Delta\text{length}))})$

Randomly selecting length values from the normal distribution calculated from the organismal model output size and applying equations 1 and 2 generates a size-dependent survival probability for each fish. This process was replicated 1000 times for each exposure scenario and simultaneously 1000 times for the paired control scenario and results in a mean size-dependent survival rate for each population. The resulting size-dependent survival rates are inserted in the calculation of first-year survival in the respective control and pesticide-exposed transition matrices.

The investigation of population-level responses to pesticide exposures uses life-history projection matrix models. Individuals within a population exhibit various growth, reproduction, and survivorship rates depending on their developmental or life-history stage or age. These age specific characteristics are depicted in the life-history graph (Figure A1-1A-D) in which transitions are depicted as arrows. The nonzero matrix elements represent transitions corresponding to reproductive contribution or survival, located in the top row and the subdiagonal of the matrix, respectively (Figure A1-1E). The survival transitions in the life-history graph are incorporated into the n x n square matrix (A) by assigning each age a number (1 through n) and each transition from age i to age j becomes the element a_{ij} of matrix A (i = row, j = column) and represent the proportion of the individuals in each age passing to the next age as a result of survival. The reproductive element (a_{1j}) gives the number of offspring that hatch per individual in the contributing age, j. The reproductive element value incorporates the proportion of females in each age, the proportion of females in the age that are sexually mature, fecundity, fertilization success, and hatch success.

In order to understand the relative impacts of a short-term pesticide exposure on exposed vs. unexposed fish, we used parameters for an idealized baseline population that exhibits an increasing population growth rate. All characteristics exhibit density independent dynamics. There were no definitive data available on the populations to support specific density dependent relationships, so rather than assign an unsupported relationship, the NAS recommendation was followed to utilize density independent parameters. The models assume closed systems, allowing no migration impact on population size. No stochastic impacts are included beyond natural variability as represented by selecting parameter values from a normal distribution about a mean each model iteration (year). Ocean conditions, freshwater habitat, fishing pressure, and marine resource availability were assumed constant and density independent so that they remain in the range they occupied during the period when demographic data were collected.

In the model an individual fish experiences an exposure scenario once as a subyearling (during its first spring) and never again. The pesticide exposure is assumed to occur annually. All individuals in one cohort within a given population are assumed to be exposed to the pesticide during their subyearling spring-summer growth period. No other age classes experience the exposure. Regardless of the level of AChE inhibition due to the direct exposure, only the sublethal effects related to somatic growth are incorporated in the models.

The model recalculates first-year survival for each run using a size-dependent survival value selected from a normal distribution with the mean and standard deviation produced by Equation S. Population model output consists of the percent change in lambda from the unexposed control populations derived from the mean of two thousand calculations of both the unexposed control population and the pesticide exposed population. Change in lambda, representing alterations to the population productivity, was selected as the primary model output for reasons outlined previously.

A prospective analysis of the transition matrix, A, (Caswell 2001) explored the intrinsic population growth rate as a function of the vital rates. The intrinsic population growth rate, λ, equals the dominant eigenvalue of A and was calculated using matrix analysis software (MATLAB version 7.7.0 by The Math Works Inc., Natick, MA). Therefore λ is calculated directly from the matrix and running projections of abundances over time is redundant and unnecessary. The stable age distribution, the proportional distribution of individuals among the ages when the population is at equilibrium, is calculated as the right normalized eigenvector corresponding to the dominant eigenvalue λ. Variability was integrated by repeating the calculation of λ 2000 times selecting the values in the transition matrix from their normal distribution defined by the mean standard deviation. The influence of each matrix element, a_{ij}, on λ was assessed by calculating the sensitivity values for A. The sensitivity of matrix element a_{ij} equals the rate of change in λ with respect to a_{ij}, defined by $\delta\lambda / \delta a_{ij}$. Higher sensitivity values indicate greater influence on λ. The elasticity of matrix element a_{ij} is defined as the proportional change in λ relative to the proportional change in a_{ij}, and equals (a_{ij}/λ) times the sensitivity of a_{ij}. One characteristic of elasticity analysis is that the elasticity values for a transition matrix sum to unity (one). The unity characteristic also allows comparison of the influence of transition elements and comparison across matrices.

Due to differences in the life-history strategies, specifically lifespan, age at reproduction and first year residence and migration habits, four life-history models were constructed. This was done to encompass the different responses to freshwater pesticide exposures and assess potentially different population-level responses. Separate models were constructed for coho, sockeye, ocean-type and stream-type Chinook. In all cases, transition values were determined from literature data on survival and reproductive characteristics of each species for populations that exhibit the life history strategy and were listed as endangered, threatened, or a species of concern under the ESA. All transition values are listed in Table A1-4.

A life-history transition matrix was constructed for coho salmon (*O. kisutch*) with a maximum age of 3. Spawning occurs in late fall and early winter with emergence from March to May. Fry spend 14-18 months in freshwater, smolt and spend 16-20 months in the saltwater before returning to spawn (Pess et al. 2002). Survival numbers were summarized in Knudsen et al. (2002) as follows. The average fecundity of each female is 4500 with a standard deviation of 500. The observed number of males:females was 1:1. Survival from spawning to emergence is 0.3 (0.07). Survival from emergence to smolt is 0.0296 (0.00029) and marine survival is 0.05 (0.01). All parameters followed a normal distribution (Knudson et al. 2002). The calculated values used in the matrix are listed in Table A1-4. The growth period for first year coho was set at 180 days to represent the time from mid-spring to mid-fall when the temperatures and resources drop and somatic growth slows (Knudson et al. 2002).

The life-history matrix for sockeye salmon (*O. nerka*) were based upon the lake wintering populations of Lake Washington, Washington, USA. These female sockeye salmon spend one winter in freshwater, then migrate to the ocean to spend three to four winters before returning to spawn at ages 4 or 5. Jacks return at age 2 after only one winter in the ocean. The age proportion of returning adults is 0.03, 0.82, and 0.15 for ages 3, 4 and 5, respectively (Gustafson et al.1997). All age 3 returning adults are males. Hatch rate and first year survival were calculated from brood year data on escapement, resulting presmolts and returning adults (Pauley et al. 1989) and fecundity (McGurk 2000). Fecundity values for age 4 females were 3374 (473) and for age 5 females were 4058 (557) (McGurk 2000). First year survival rates were 0.737/month (Gustafson et al. 1997). Ocean survival rates were calculated based upon brood data and the findings that 90% of ocean mortality occurs during the first 4 months of ocean residence (Pauley et al. 1989). Matrix values used in the sockeye baseline model are listed in Table A1-4. The 168 day growth period represents the time from lake entry to early fall when the temperature drops and somatic growth slows (Gustafson et al. 1997).

A life-history matrix was constructed for ocean-type Chinook salmon (*O. tshawytscha*) with a maximum female age of 5 and reproductive maturity at ages 3, 4 or 5. Ocean-type Chinook migrate from their natal stream within a couple months of hatching and spend several months rearing in estuary and nearshore habitats before continuing on to the open ocean. Transition values were determined from literature data on survival and reproductive characteristics from several ocean-type Chinook populations in the Columbia River system (Healey and Heard 1984, Howell et al. 1985, Roni and Quinn 1995, Ratner et al. 1997, PSCCTC 2002, Green and Beechie 2004). The sex ratio of spawners was approximately 1:1. Estimated size-based fecundity of 4511(65), 5184(89), and 5812(102) was calculated based on data from Howell et al., 1985, using length-fecundity relationships from Healy and Heard (1984). Control matrix values for the Chinook model are listed in Table A1-4. The growth period of 140 days encompasses the time the fish rear in freshwater prior to entering the estuary and open ocean. The first three months of estuary/ocean survival are the size-dependent stage. Size data for determining subyearling Chinook condition indices came from data collected in the lower Columbia River and estuary (Johnson et al. 2007).

An age-structured life-history matrix for stream-type Chinook salmon with a maximum age of 5 was defined based upon literature data on Yakima River spring Chinook from Knudsen et al. (2006) and Fast et al. (1988), with sex ratios of 0.035, 0.62 and 0.62 for females spawning at ages 3, 4, and 5, respectively. Length data from Fast et al. (1988) was used to calculate fecundity from the length-fecundity relationships in Healy and Heard (1984). The 184-day growth period produces control fish with a mean size of 96mm, within the observed range documented in the fall prior to the first winter (Beckman et al. 2000). The size-dependent survival encompasses the 4 early winter months, up until the fish are 12 months old.

Acute Toxicity Model

In order to estimate the population-level responses of exposure to lethal pesticide concentrations, acute mortality models were constructed based upon the control life-history matrices described above. The acute responses are modeled as direct reduction in the first year survival rate (S1). Two options are available to run, direct mortality estimates and exposure scenarios. Direct mortality can be input as percent mortality and is multiplied by the first-year survival rate in the transition matrix. Exposures are assumed to result in a cumulative reduction in survival as defined by the concentration and the dose-response curve as defined by the LC_{50} and slope for each pesticide. A sigmoid dose-response relationship is used to accurately handle responses well away from LC_{50} and to be consistent with other does-response relationships. The model inputs for each scenario are the exposure concentration and acute fish LC_{50}, as well as the sigmoid slope for the LC_{50} from the USEPA BE (Table A1-3). For a given concentration, a pesticide survival rate (1-mortality) is calculated and is multiplied by the control first-year survival rate, producing an exposed scenario first-year survival for the life-history matrix. The model allows for a specified percentage of the population (0-100%) to experience the exposure. A uniform distribution of percentage impacted scenarios were run to explore the effects of this variable (25%, 50%, 75%, 100%). Demographic variability is incorporated as described above using mean and standard deviation of normally distributed survival and reproductive rates and model output consists of the percent change in lambda from unexposed control populations derived from the mean of 10000 calculations of both the unexposed control population and the pesticide exposed population. For the purposes of this assessment, the percent change in lambda is defined as different from control when the difference between the mean percent change is greater than the percent of one standard deviation from the control lambda.

Results

Sensitivity Analysis

A sensitivity analysis conducted on the organismal model revealed that changes in the control somatic growth rate had the greatest influence on the final weights (Table A1-1). While this parameter value was experimentally derived for another species (sockeye salmon; Brett et al. 1969), this value was adapted for each model species and is within the variability reported in the literature for other salmonids (reviewed in Weatherley and Gill 1995). Other parameters related to the daily growth rate calculation, including the growth to ration slope (Mgr) and the control ration produced strong sensitivity values. Initial weight, the prey recovery rate and the prey floor also strongly influenced the final weight values (Table A1-1). Large changes (0.5 to 2X) in the other key parameters produced proportionate changes in final weight.

The sensitivity analysis of all four of the control population matrices predicted the greatest changes in population growth rate (λ) result from changes in first-year survival. Parameter values and their corresponding sensitivity values are listed in Table A1-4. The elasticity values for the transition matrices also corresponded to the driving influence of first-year survival, with contributions to lambda of 0.33 for coho, 0.29 for ocean-type Chinook, 0.25 for stream-type Chinook, and 0.24 for sockeye.

Model Output

Organismal and population model outputs for all growth model scenarios are shown in Tables A1-5-7 and Figure A1-5. Toxicity values were taken from EPA's Biological Evaluations (EPA 2017). The factors driving the level of change in lambda were the Prey Drift and relative AChE Activity parameters determined by the toxicity values for each pesticide (Table A1-3). Increases in direct mortality during the first year of life produced large impacts on the population growth rates for all the life-history strategies (Tables A1-8-19, Figures A1-6-9).

While strong trends in effects were seen for each pesticide across all four life-history strategies modeled, some slight differences were apparent. The similarity in patterns likely stems from using the same toxicity values for all four salmon, while the differences are consequences of distinctions between the life-history matrices. The stream-type Chinook and sockeye models produced very similar results as measured as the percent change in population growth rate. The ocean-type Chinook and coho models output produced the greatest changes in lambda resulting from the pesticide exposures. When looking for similarities in parameters to explain the ranking, no single life history parameter or characteristic, such as lifespan, reproductive ages, age distribution, lambda and standard deviation, or first-year survival show a pattern that matches this consistent output. Combining these factors into the transition matrix for each life-history and conducting the sensitivity and elasticity analyses revealed that changes in first-year survival produced the greatest changes in lambda. In addition, the elasticity analysis can be used to predict relative contribution to lambda from changes in first-year survival on a per unit basis. As detailed by the elasticity values reported above, the same change in first-year survival will produce a slightly greater change in the population growth rate for coho and ocean-type Chinook than for stream-type Chinook and sockeye. While some life-history characteristics may lead a population to be more vulnerable to an impact, the culmination of age structure, survival and reproductive rates as a whole strongly influences the population-level response.

The percent changes in lambdas increased as concentrations of the three organophospates increased. Increases in direct mortality during the first year of life produced large impacts on the population growth rates for all the life-history strategies. Model results for stream-type Chinook salmon showed significant impacts at lower concentrations than the other modeled populations. This result is primarily due to the size of the standard deviation of the unexposed population. Percent changes in lambda were deemed significant if they were outside of one standard deviation from the unexposed population. The relative sensitivity of the life-history models producing the greatest to the least changes in population growth rate for equivalent impact on survival rates was coho salmon, ocean-type Chinook salmon, stream-type Chinook salmon, and sockeye salmon. We note that the choice of LC_{50} is an important driver for these results. Therefore, an LC_{50} above or below the ones used here will result in a different dose-response. However, if the actual environmental 96 hour LC_{50} is lower, then the model will under predict mortality. If the actual environmental acute LC_{50} is higher, then the model will over-predict mortality.

These results indicate that exposure of salmonid populations to chlorpyrifos, diazinon, and malathion for four days at the reported LC_{50}s would have consequences to the population’s growth rate. If exposure occurred every year for each new cohort, population abundance would decline and recovery efforts would be slowed. For each of the combinations of species, insecticide, and percent of the population exposed, we denoted the relative concentration at which the percent change in lambda is deemed significantly different from the unexposed populations.

When we compare the model output concentrations to expected levels in salmonid habitats described in the exposure section, it is likely that some individuals within a population will be exposed during their freshwater juvenile lifestage, particularly those juveniles exposed while utilizing off-channel habitats. The likelihood of population effects from death of juveniles increases for those populations that spend longer periods in freshwaters such as stream-type Chinook, sockeye, and coho salmon. For those populations with lambdas greater than one, reductions in lambda from death of subyearlings can also lead to consequences to abundance and productivity. Attainment of recovery and time-associated goals would likely not be met for populations with reduced lambdas. For those natural populations with current lambdas of less than one, risk of extinction would increase substantially, especially if several successive generations were exposed.Many of the populations that are categorized as core populations or are important to individual strata, have lambdas just above one and are essential to survival and recovery goals. Slight changes in lambda, even as small as 3-4%, would result in reduced abundances and increased time to meet population recovery goals. For those natural populations with current lambdas of less than one, risk of extinction would increase, especially if several successive generations were exposed.

We integrated two avenues of effect to subyearling salmonids' growth from exposure to the three organophosphates. The first avenue is a result of AChE inhibition on the feeding success and subsequent effects to growth of juvenile salmonids. Study results with juvenile salmonids show that feeding success is reduced following exposures to AChE inhibitors (Sandahl, Baldwin et al. 2005). Salmon are often food limited in freshwater aquatic habitats, suggesting that a reduction in prey due to insecticide exposure may further stress salmon and lead to reduced growth rates. Field mesocosm data support this assertion, showing reduced growth of juvenile fish following exposure to the AChE inhibitor, chlorpyrifos (Brazner and Kline 1990). Furthermore, based on our review of the sensitivities of aquatic invertebrates to the three insecticides, we expect reductions in densities and altered composition of the salmonid prey communities. Therefore, the second avenue the model addresses the potential for reductions in juvenile growth due to reductions in available prey.

Reductions in aquatic prey are included in the model because of the high relative toxicity of pesticides to salmonid prey and the extended duration of effects on prey communities. Juvenile salmonids are largely opportunistic, feeding on a diverse community of aquatic and terrestrial invertebrate taxa that are entrained in the water column or on the surface (Higgs, Macdonald et al. 1995). As a group, these invertebrates are among the more sensitive taxa for which there is toxicity data, but within this group, there is a wide range of sensitivities. The three insecticides are highly toxic to aquatic macroinvertebrates; concentrations that are not expected to kill salmonids are often lethal for their invertebrate prey. In particular, prey items that are preferred by small juvenile salmonids (including midge larvae, water fleas, mayflies, caddisflies, and stoneflies) are among the most sensitive aquatic macroinvertebrates. In addition, effects on the prey community can persist for extended periods of time (weeks, months, years), resulting in effects on fish feeding and growth long after an exposure has ended (Ward, Arthington et al. 1995; Van den Brink, van Wijngaarden et al. 1996; Liess and Schulz 1999; Colville, Jones et al. 2008).

These results show that all four species can be severely affected by changes in juvenile growth resulting from AChE inhibition and reduced prey availability. The concentrations that elicit reductions in lambdas are expected to occur in salmonid habitats. The degree to which an actual threatened or endangered population is affected will depend on a host of factors including the number of individuals exposed, the duration of exposure, when they are exposed, and if they are exposed more than once. It is also important to realize that these are idealized populations and we did not incorporate other factors that can affect the sensitivity of exposed salmonids such as elevated temperatures, presence of mixtures of OPs and carbamates, and the condition of the fish. We also did not incorporate incidences of death due to acute toxicity in the growth model. We show however, that even without these other stressors taken into account there is strong evidence that given the expected concentrations in salmonid habitats that populations will be adversely affected if juvenile life stages are exposed.

Table A1-1. List of values used for control parameters to model organismal growth and the model sensitivity to changes in the parameter.

Parameter	Value[1]	Error[2]	Sensitivity[3]
acetylcholinesterase activity (Ac)	1.0[4,5]	0.06[5]	-0.167
feeding (Fc)	1.0[4,5]	0.05[5]	0.088
ration (Rc)	5% weight/day[6]	0.05[7]	-0.547
feeding vs. activity slope (Mfa)	1.0[5]	0.1[5]	-0.047
ration vs. feeding slope (Mrf)	5 (Rc/Fc)	-	-
growth vs. ration slope (Mgr)	0.35[6]	0.02[6]	-0.547
growth vs. activity slope (Mga)	1.75 (Mfa*Mrf*Mgr)	-	-
initial weight	1 gram[8]	0.1[8]	1.00
control prey drift	1.0[4]	0.05[11]	0.116
AChE impact time-to-effect ($t_{1/2}$)	0.5 day[9]	n/a	0.005
AChE time-to-recovery ($t_{1/2}$)	30 days[10]	n/a	-0.0001
prey floor	0.20[11]	n/a	0.178
prey recovery rate	0.01[12]	n/a	0.323
somatic growth rate (Gc)	1.3[13]	0.06[6]	2.531

[1] mean value of a normal distribution used in the model or constant value when no corresponding error is listed
[2] standard deviation of the normal distribution used in the model
[3] mean sensitivity when baseline parameter is changed over range of 0.5 to 2-fold
[4] other values relative to control
[5] derived from Sandahl et al. 2005
[6] derived from Brett et al. 1969
[7] data from Brett et al. 1969 has no variability (ration was the independent variable) so a variability of 1% was selected to introduce some variability
[8] consistent with field-collected data for juvenile Chinook (Nelson et al. 2004)
[9] estimated from Ferrari et al. 2004
[10] consistent with Eder et al., 2007; Ferrari et al., 2004; Chambers et al., 2002
[11] estimated from Van den Brink et al. 1996
[12] derived from Ward et al. 1995, Van den Brink et al. 1996, Colville et al. 2008
[13] derived from Brett et al. 1969 and adapted for ocean-type Chinook, used for sensitivity analysis

Table A1-2. Species specific control parameters to model organismal growth and survival rates. Growth period and survival rate are determined from the literature data listed for each species. Gc and α were calculated to make the basic model produce the appropriate size and survival values from the literature.

	Chinook Stream-type[1]	Chinook Ocean-type[2]	Coho[3]	Sockeye[4]
days to run organismal growth model	184	140	184	168
growth rate % body wt/day (Gc)	1.28	1.30	0.90	1.183
α from equation S	-0.33	-1.99	-0.802	-0.871
Control Survival ϕ	0.418	0.169	0.310	0.295

[1] Values from data in Healy and Heard 1984, Fast et al. 1988, Beckman et al. 2000, Knudsen et al. 2006
[2] Values from data in Healey and Heard 1984, Howell et al. 1985, Roni and Quinn 1995, Ratner et al. 1997, PSCCTC 2002, Green and Beechie 2004, Johnson et al. 2007
[3] Values from data in Pess et al. 2002, Knudsen et al. 2002
[4] Values from data in Pauley et al. 1989, Gustafson et al. 1997, McGurk 2000

Table A1-3. Effects values (ug/L) and slopes for AChE activity, acute fish lethality, and prey abundance dose-response curves.

compound	AChE Activity EC_{50}[1] ug/L	AChE Activity slope	Fish lethality LC_{50}[2] ug/L	Fish lethality slope[3]	Prey Abundance EC_{50}[4] ug/L	Prey Abundance Slope[3]
Chlorpyrifos	3.54	1.5	1.44	3.6	0.041	3.6
Malathion	74.5	1.32	19.4	3.6	1	3.6
Diazinon	65.95	0.79	237.9	3.6	0.5	3.6

[1] Values are geometric means of those reported in EPA Biological Evaluations.
[2] Values from EPA Biological Evaluations and are the 5th percentile of the LC50 SSD.
[3] sigmoidal slope that produces responses with a probit slope of 4.5.
[4] Values from analysis of global search of reported LC50 and EC50s reported in EPA's Ecotox database. See text.

Table A1-4. Matrix transition element (standard deviation) and sensitivity (S) and elasticity (E) values for each model species. These control values are listed by the transition element taken from the life-history graphs as depicted in Figure A1-1 and the literature data described in the method text. Blank cells indicate elements that are not in the transition matrix for a particular species. The influence of each matrix element on λ was assessed by calculating the sensitivity (S) and elasticity (E) values for A. The sensitivity of matrix element a_{ij} equals the rate of change in λ with respect to the transition element, defined by $\delta\lambda / \delta a$. The elasticity of transition element a_{ij} is defined as the proportional change in λ relative to the proportional change in a_{ij}, and equals (a_{ij}/λ) times the sensitivity of a_{ij}. Elasticity values allow comparison of the influence of individual transition elements and comparison across matrices.

Transition Element	Chinook Stream-type			Chinook Ocean-type			Coho			Sockeye		
	Value[1] (std)	S	E	Value[2] (std)	S	E	Value[3] (std)	S	E	Value[4]	S	E
S1	0.0643 (0.003)	3.844	0.247	0.0056 (0.001)	57.13	0.292	0.0296 (0.002)	11.59	0.333	0.0257 (0.003)	9.441	0.239
S2	0.1160 (0.002)	2.132	0.247	0.48 (0.097)	0.670	0.292	0.0505 (0.005)	6.809	0.333	0.183 (0.003)	1.326	0.239
S3	0.17006 (0.004)	1.448	0.246	0.246 (0.050)	0.476	0.106				0.499 (0.003)	0.486	0.239
S4	0.04 (0.002)	0.319	0.0127	0.136 (0.023)	0.136	0.0168				0.1377 (0.003)	0.322	0.0437
R3	0.5807 (0.089)	0.00184	0.0011	313.8 (38.1)	0.0006	0.186	732.8 (75.0)	0.000469	0.333			
R4	746.73 (86.62)	0.000313	0.233	677.1 (80.7)	0.000146	0.0896				379.57 (53.2)	0.000537	0.195
R5	1020.36 (101.33)	1.25E-05	0.0127	1028 (117.5)	1.80E-05	0.0168				608.7 (83.0)	7.28E-05	0.0437

[1] Value calculated from data in Healy and Heard 1984, Fast et al. 1988, Beckman et al. 2000, Knudsen et al. 2006
[2] Value calculated from data in Healey and Heard 1984, Howell et al. 1985, Roni and Quinn 1995, Ratner et al. 1997, PSCCTC 2002, Green and Beechie 2004, Johnson et al. 2007
[3] Value calculated from data in Pess et al. 2002, Knudsen et al. 2002
[4] Value calculated from data in Pauley et al. 1989, Gustafson et al. 1997, McGurk 2000

Table A1-5. Somatic growth model output for chlorpyrifos. Scenario used to generate output was a single, 4-d exposure beginning on day 30 of the somatic growth period with 100% of the population exposed. AChE IC_{50}=3.54, AChE slope = 1.5, Prey EC_{50} = 0.041, Prey Slope 3.6. Prey floor 20%. Values in bold exceed the significant percent change (one standard deviation of the percent change in growth rate, lambda) for the control matrix. S1 indicates first year survival rate.

Species	***Concentration(μg/L)***	***0.0***	***0.05***	***0.1***	***1***	***10***	***25***	***75***	***150***
Chinook Ocean-type	% change lambda	na	-5	**-10**	**-11**	**-18**	**-23**	**-26**	**-27**
	% change lambda std	na	10	**9**	**9**	**8**	**8**	**7**	**7**
	lambda mean	1.09	1.04	0.98	0.97	0.89	0.85	0.81	0.8
	lambda std	0.08	0.08	0.07	0.07	0.06	0.06	0.06	0.06
	S1	0.00564	4.73E-03	3.86E-03	3.69E-03	2.80E-03	2.30E-03	1.96E-03	1.88E-03
7	Significant % change								
Chinook Stream-type	% change lambda	na	**-4**	**-8**	**-9**	**-15**	**-21**	**-26**	**-28**
	% change lambda std	na	**4**	**4**	**4**	**4**	**4**	**3**	**3**
	lambda mean	1	0.96	0.92	0.91	0.85	0.79	0.74	0.72
	lambda std	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.02
	S1	0.0643	5.49E-02	4.65E-02	4.39E-02	3.26E-02	2.53E-02	1.90E-02	1.69E-02
3	Significant % change								
Sockeye	% change lambda	na	-4	**-8**	**-10**	**-16**	**-20**	**-25**	**-27**
	% change lambda std	na	6	**6**	**6**	**5**	**5**	**4**	**4**
	lambda mean	1.01	0.97	0.93	0.92	0.85	0.8	0.76	0.74
	lambda std	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03
	S1	0.0257	2.15E-02	1.79E-02	1.69E-02	1.25E-02	9.78E-03	7.60E-03	6.96E-03
4	Significant % change								
Coho	% change lambda	na	-5	**-10**	**-11**	**-18**	**-24**	**-30**	**-32**
	% change lambda std	na	8	**7**	**7**	**7**	**7**	**7**	**7**
	lambda mean	1.03	0.98	0.93	0.91	0.84	0.78	0.72	0.7
	lambda std	0.06	0.06	0.06	0.05	0.05	0.06	0.06	0.06
	S1	0.0297	2.57E-02	2.18E-02	2.09E-02	1.63E-02	1.31E-02	1.05E-02	9.35E-03
6	Significant % change								

Table A1-6. Somatic growth model output for diazinon. Scenario used to generate output was a single, 4-d exposure beginning on day 30 of the somatic growth period with 100% of the population exposed. AChE IC_{50}=65.95, AChE slope = 0.79, Prey EC_{50} = 0.5, Prey Slope 3.6. Prey floor 20%. Values in bold exceed the significant percent change (one standard deviation of the percent change in growth rate, lambda) for the control matrix. S1 indicates first year survival rate.

Species	***Concentration(µg/L)***	***0.0***	***0.5***	***1***	***10***	***75***	***150***	***250***	***500***	***1000***
Chinook Ocean-type	% change lambda	na	-3	**-10**	**-12**	**-16**	**-18**	**-20**	**-22**	**-24**
	% change lambda std	na	10	**9**	**9**	**8**	**8**	**8**	**8**	**8**
	lambda mean	1.09	1.06	0.99	0.96	0.92	0.89	0.88	0.85	0.83
	lambda std	0.08	0.08	0.07	0.07	0.06	0.06	0.06	0.06	0.06
	S1	0.00564	5.05E-03	3.96E-03	3.54E-03	3.02E-03	2.78E-03	2.60E-03	2.37E-03	2.18E-03
7	Significant % change									
Chinook Stream-type	% change lambda	na	-2	**-8**	**-10**	**-14**	**-17**	**-18**	**-21**	**-23**
	% change lambda std	na	5	**4**	**4**	**4**	**4**	**4**	**3**	**3**
	lambda mean	1	0.98	0.92	0.9	0.86	0.83	0.82	0.79	0.76
	lambda std	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02
	S1	0.0643	5.86E-02	4.67E-02	4.17E-02	3.47E-02	3.07E-02	2.82E-02	2.47E-02	2.18E-02
3	Significant % change									
Sockeye	% change lambda	na	-2	**-8**	**-11**	**-15**	**-17**	**-18**	**-21**	**-23**
	% change lambda std	na	6	**6**	**5**	**5**	**5**	**5**	**5**	**4**
	lambda mean	1.01	0.99	0.93	0.91	0.86	0.84	0.83	0.8	0.78
	lambda std	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03
	S1	0.0257	2.32E-02	1.82E-02	1.62E-02	1.33E-02	1.19E-02	1.09E-02	9.65E-03	8.69E-03
4	Significant % change									
Coho	% change lambda	na	-3	**-9**	**-13**	**-18**	**-20**	**-22**	**-25**	**-27**
	% change lambda std	na	8	**8**	**7**	**7**	**7**	**7**	**7**	**7**
	lambda mean	1.03	1	0.93	0.9	0.85	0.83	0.81	0.78	0.75
	lambda std	0.06	0.06	0.06	0.06	0.05	0.06	0.06	0.06	0.06
	S1	0.0297	2.72E-02	2.22E-02	2.01E-02	1.69E-02	1.55E-02	1.44E-02	1.29E-02	1.17E-02
6	Significant % change									

Table A1-7. Somatic growth model output for malathion. Scenario used to generate output was a single, 4-d exposure beginning on day 30 of the somatic growth period with 100% of the population exposed. AChE IC_{50}=74.5, AChE slope = 1.32, Prey EC_{50} = 1, Prey Slope 3.6. Prey floor 20%. Values in bold exceed the significant percent change (one standard deviation of the percent change in growth rate, lambda) for the control matrix. S1 indicates first year survival rate.

Species	***Concentration(µg/L)***	***0.0***	***1***	***10***	***25***	***50***	***75***	***100***	***150***	***250***	***500***	***1000***
Chinook Ocean-type	% change lambda	na	-3	**-11**	**-12**	**-13**	**-14**	**-15**	**-17**	**-19**	**-22**	**-25**
	% change lambda std	na	10	**9**	**9**	**9**	**9**	**9**	**8**	**8.**	**8**	**8**
	lambda mean	1.09	1.06	0.97	0.96	0.95	0.94	0.93	0.91	0.88	0.85	0.82
	lambda std	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.06	0.06	0.06
	S1	0.00564	5.09E-03	3.71E-03	3.64E-03	3.46E-03	3.30E-03	3.17E-03	2.96E-03	2.70E-03	2.34E-03	2.09E-03
7	Significant % change											
Chinook Stream-type	% change lambda	na	-2	**-9**	**-9**	**-10**	**-12**	**-13**	**-14**	**-17**	**-20**	**-24**
	% change lambda std	na	4	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**3**
	lambda mean	1	0.98	0.91	0.91	0.89	0.88	0.87	0.86	0.83	0.8	0.76
	lambda std	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02
	S1	0.0643	5.90E-02	4.44E-02	4.35E-02	4.11E-02	3.91E-02	3.74E-02	3.46E-02	3.10E-02	2.58E-02	2.14E-02
3	Significant % change											
Sockeye	% change lambda	na	-2	**-9**	**-10**	**-11**	**-12**	**-13**	**-15**	**-17**	**-21**	**-24**
	% change lambda std	na	6	**6**	**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
	lambda mean	1.01	0.99	0.92	0.91	0.9	0.89	0.88	0.86	0.84	0.81	0.77
	lambda std	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03
	S1	0.0257	2.35E-02	1.70E-02	1.66E-02	1.57E-02	1.50E-02	1.43E-02	1.32E-02	1.17E-02	9.89E-03	8.32E-03
4	Significant % change											
Coho	% change lambda	na	-3	**-11**	**-11**	**-12**	**-14**	**-15**	**-17**	**-20**	**-24**	**-27**
	% change lambda std	na	8	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**
	lambda mean	1.03	1	0.92	0.91	0.9	0.88	0.87	0.85	0.83	0.79	0.75
	lambda std	0.06	0.06	0.06	0.05	0.05	0.06	0.06	0.05	0.05	0.06	0.06
	S1	0.0297	2.74E-02	2.13E-02	2.07E-02	1.99E-02	1.88E-02	1.83E-02	1.71E-02	1.55E-02	1.32E-02	1.16E-02
6	Significant % change											

Table A1-8. Acute mortality model output for ocean-type Chinook exposed to chlorpyrifos. The percent change in population growth rate (lambda), the population growth rate mean values (lambda mean), and the variability (standard deviations) are shown, along with the mean first year survival rate (S1). The toxicity values were LC_{50}=1.44, slope 3.6. The percent of the population exposed was also varied (left column). Bold indicates a percent change in population growth rage of greater than 1 standard deviation from control values (second column).

% exposed	Chinook ocean-type	***Concentration(μg/L)***	***0.75***	***1.25***	***1.5***	***3***	***6***	***15***	***30***	***100***
100		% change lambda	-3	**-13**	**-20**	**-53**	**-75**	**-88**	**-93**	**-97**
	9	% change lambda std	13	**11**	**10**	**6**	**3**	**1**	**1**	**0.3**
	1.09	lambda mean	1.06	0.95	0.87	0.51	0.27	0.13	0.07	0.03
	0.08	lambda std	0.1	0.09	0.08	0.04	0.02	0.01	0.01	0
	5.64E-03	S1	5.12E-03	3.52E-03	2.60E-03	3.74E-04	3.29E-05	1.22E-06	1.01E-07	1.32E-09
75		% change lambda	-2	**-10**	**-16**	**-33**	**-34**	**-35**	**-35**	**-35**
		% change lambda std	13	**14**	**17**	**24**	**24**	**24**	**24**	**24**
		lambda mean	1.07	0.98	0.92	0.73	0.71	0.71	0.71	0.71
		lambda std	0.1	0.12	0.16	0.25	0.26	0.25	0.26	0.26
		S1	5.26E-03	4.04E-03	3.36E-03	1.68E-03	1.43E-03	1.40E-03	1.41E-03	1.41E-03
50		% change lambda	-1	-6	**-10**	**-22**	**-22**	**-23**	**-23**	**-23**
		% change lambda std	13	14	**17**	**25**	**26**	**26**	**26**	**26**
		lambda mean	1.07	1.02	0.98	0.85	0.85	0.84	0.84	0.84
		lambda std	0.1	0.12	0.16	0.27	0.27	0.27	0.27	0.27
		S1	5.39E-03	4.57E-03	4.13E-03	2.99E-03	2.84E-03	2.82E-03	2.82E-03	2.82E-03
25		% change lambda	-1	-3	-5	**-11**	**-12**	**-12**	**-12**	**-12**
		% change lambda std	13	14	15	**22**	**23**	**23**	**23**	**23**
		lambda mean	1.08	1.06	1.03	0.97	0.96	0.96	0.96	0.96
		lambda std	0.1	0.12	0.14	0.22	0.23	0.24	0.23	0.24
		S1	5.51E-03	5.12E-03	4.87E-03	4.31E-03	4.22E-03	4.24E-03	4.22E-03	4.23E-03

Table A1-9. Acute mortality model output for stream-type Chinook exposed to chlorpyrifos. The percent change in population growth rate (lambda), the population growth rate mean values (lambda mean), and the variability (standard deviations) are shown, along with the mean first year survival rate (S1). The toxicity values were LC_{50}=1.44, slope 3.6. The percent of the population exposed was also varied (left column). Bold indicates a percent change in population growth rage of greater than 1 standard deviation from control values (second column).

% exposed	Chinook stream-type	***Concentration(µg/L)***	***0.75***	***1.25***	***1.5***	***3***	***6***	***15***	***30***	***100***
100		% change lambda	-2	**-11**	**-17**	**-49**	**-72**	**-87**	**-93**	**-97**
	3	% change lambda std	4	**4**	**4**	**2**	**1**	**0.5**	**0.3**	**0.1**
	1	lambda mean	0.98	0.89	0.83	0.51	0.28	0.13	0.07	0.03
	0.03	lambda std	0.03	0.03	0.03	0.02	0.01	0	0	0
	6.43E-02	S1	5.87E-02	4.02E-02	2.98E-02	4.27E-03	3.76E-04	1.39E-05	1.15E-06	1.51E-08
75		% change lambda	-2	**-8**	**-14**	**-29**	**-30**	**-31**	**-31**	**-31**
		% change lambda std	4	**7**	**11**	**20**	**20**	**21**	**20**	**21**
		lambda mean	0.98	0.92	0.86	0.71	0.7	0.69	0.69	0.69
		lambda std	0.03	0.06	0.11	0.2	0.2	0.21	0.2	0.2
		S1	6.01E-02	4.62E-02	3.84E-02	1.93E-02	1.64E-02	1.61E-02	1.61E-02	1.61E-02
50		% change lambda	-1	**-6**	**-9**	**-19**	**-20**	**-20**	**-21**	**-21**
		% change lambda std	5	**7**	**11**	**21**	**21**	**22**	**22**	**22**
		lambda mean	0.99	0.94	0.91	0.81	0.8	0.79	0.79	0.79
		lambda std	0.03	0.06	0.1	0.21	0.21	0.21	0.21	0.21
		S1	6.15E-02	5.23E-02	4.71E-02	3.43E-02	3.23E-02	3.21E-02	3.22E-02	3.21E-02
25		% change lambda	-1	-3	**-4**	**-10**	**-10**	**-11**	**-11**	**-11**
		% change lambda std	5	6	**8**	**16**	**18**	**18**	**18**	**18**
		lambda mean	0.99	0.97	0.96	0.9	0.89	0.89	0.89	0.89
		lambda std	0.03	0.05	0.08	0.16	0.17	0.17	0.17	0.17
		S1	6.30E-02	5.83E-02	5.57E-02	4.93E-02	4.83E-02	4.83E-02	4.82E-02	4.82E-02

Table A1-10. Acute mortality model output for sockeye exposed to chlorpyrifos. The percent change in population growth rate (lambda), the population growth rate mean values (lambda mean), and the variability (standard deviations) are shown, along with the mean first year survival rate (S1). The toxicity values were LC_{50}=1.44, slope 3.6. The percent of the population exposed was also varied (left column). Bold indicates a percent change in population growth rage of greater than 1 standard deviation from control values (second column).

% exposed	Sockeye	***Concentration(μg/L)***	***0.75***	***1.25***	***1.5***	***3***	***6***	***15***	***30***	***100***
100		% change lambda	-2	**-11**	**-17**	**-47**	**-70**	**-85**	**-91**	**-97**
	6	% change lambda std	8	**7**	**7**	**4**	**2**	**1**	**0.6**	**0.3**
	1.01	lambda mean	0.99	0.9	0.84	0.53	0.31	0.15	0.09	0.03
	0.04	lambda std	0.06	0.05	0.05	0.03	0.02	0.01	0	0
	2.57E-02	S1	2.35E-02	1.60E-02	1.19E-02	1.71E-03	1.50E-04	5.57E-06	4.61E-07	6.02E-09
75		% change lambda	-2	**-8**	**-13**	**-28**	**-29**	**-29**	**-29**	**-29**
		% change lambda std	8	**9**	**13**	**20**	**20**	**20**	**20**	**20**
		lambda mean	0.99	0.93	0.88	0.73	0.71	0.71	0.71	0.72
		lambda std	0.06	0.08	0.12	0.2	0.2	0.2	0.2	0.2
		S1	2.41E-02	1.84E-02	1.54E-02	7.71E-03	6.47E-03	6.39E-03	6.39E-03	6.44E-03
50		% change lambda	-1	-5	**-9**	**-18**	**-19**	**-19**	**-20**	**-20**
		% change lambda std	8	10	**13**	**21**	**21**	**21**	**22**	**22**
		lambda mean	1	0.96	0.92	0.83	0.82	0.81	0.81	0.81
		lambda std	0.06	0.08	0.12	0.21	0.21	0.21	0.21	0.21
		S1	2.46E-02	2.09E-02	1.88E-02	1.36E-02	1.29E-02	1.28E-02	1.28E-02	1.28E-02
25		% change lambda	-1	-3	-4	**-10**	**-10**	**-10**	**-10**	**-11**
		% change lambda std	8	9	11	**18**	**19**	**18**	**19**	**19**
		lambda mean	1	0.98	0.97	0.91	0.9	0.91	0.91	0.9
		lambda std	0.06	0.07	0.1	0.17	0.18	0.18	0.18	0.18
		S1	2.52E-02	2.33E-02	2.22E-02	1.97E-02	1.93E-02	1.94E-02	1.93E-02	1.92E-02

Table A1-11. Acute mortality model output for coho exposed to chlorpyrifos. The percent change in population growth rate (lambda), the population growth rate mean values (lambda mean), and the variability (standard deviations) are shown, along with the mean first year survival rate (S1). The toxicity values were LC_{50}=1.44, slope 3.6. The percent of the population exposed was also varied (left column). Bold indicates a percent change in population growth rage of greater than 1 standard deviation from control values (second column).

% exposed	Coho	***Concentration(μg/L)***	***0.75***	***1.25***	***1.5***	***3***	***6***	***15***	***30***	***100***
100		% change lambda	-3	**-15**	**-23**	**-59**	**-82**	**-94**	**-97**	**-99**
	5	% change lambda std	7	**6**	**6**	**3**	**1**	**0.4**	**0.2**	**0**
	1.03	lambda mean	1	0.88	0.8	0.42	0.19	0.06	0.03	0.01
	0.06	lambda std	0.05	0.05	0.04	0.02	0.01	0	0	0
	2.97E-02	S1	2.71E-02	1.85E-02	1.38E-02	1.97E-03	1.73E-04	6.43E-06	5.31E-07	6.95E-09
75		% change lambda	-2	**-11**	**-17**	**-38**	**-40**	**-40**	**-40**	**-40**
		% change lambda std	7	**10**	**14**	**26**	**26**	**26**	**26**	**27**
		lambda mean	1.01	0.92	0.85	0.64	0.61	0.61	0.62	0.62
		lambda std	0.06	0.09	0.14	0.27	0.27	0.27	0.27	0.27
		S1	2.77E-02	2.13E-02	1.77E-02	8.89E-03	7.55E-03	7.42E-03	7.43E-03	7.42E-03
50		% change lambda	-1	**-7**	**-12**	**-25**	**-27**	**-27**	**-27**	**-27**
		% change lambda std	8	**10**	**15**	**27**	**28**	**28**	**28**	**28**
		lambda mean	1.01	0.95	0.91	0.77	0.76	0.75	0.75	0.75
		lambda std	0.06	0.09	0.14	0.27	0.28	0.29	0.29	0.28
		S1	2.84E-02	2.41E-02	2.17E-02	1.58E-02	1.49E-02	1.48E-02	1.48E-02	1.48E-02
25		% change lambda	-1	-4	**-6**	**-12**	**-13**	**-14**	**-14**	**-14**
		% change lambda std	8	9	**12**	**21**	**23**	**23**	**23**	**23**
		lambda mean	1.02	0.99	0.97	0.9	0.89	0.89	0.89	0.89
		lambda std	0.06	0.08	0.11	0.21	0.23	0.23	0.23	0.23
		S1	2.90E-02	2.69E-02	2.57E-02	2.28E-02	2.23E-02	2.23E-02	2.22E-02	2.23E-02

Table A1-12. Acute mortality model output for ocean-type Chinook exposed to diazinon. The percent change in population growth rate (lambda), the population growth rate mean values (lambda mean), and the variability (standard deviations) are shown, along with the mean first year survival rate (S1). The toxicity values were LC_{50}=237.9, slope 3.6. The percent of the population exposed was also varied (left column). Bold indicates a percent change in population growth rage of greater than 1 standard deviation from control values (second column).

% exposed	Chinook ocean-type	***Concentration(μg/L)***	***100***	***200***	***250***	***300***	***400***	***600***	***1000***	***2000***
100		% change lambda	-1	**-12**	**-20**	**-29**	**-43**	**-61**	**-75**	**-86**
	9	% change lambda std	13	**11**	**10**	**9**	**7**	**5**	**3**	**2**
	1.09	lambda mean	1.08	0.96	0.87	0.77	0.62	0.43	0.27	0.15
	0.08	lambda std	0.1	0.09	0.08	0.07	0.05	0.04	0.02	0.01
	5.64E-03	S1	5.39E-03	3.67E-03	2.56E-03	1.70E-03	7.52E-04	1.94E-04	3.18E-05	2.64E-06
75		% change lambda	-1	-9	**-16**	**-23**	**-31**	**-34**	**-35**	**-35**
		% change lambda std	13	13	**17**	**21**	**24**	**24**	**25**	**24**
		lambda mean	1.08	0.99	0.92	0.84	0.75	0.72	0.71	0.71
		lambda std	0.1	0.11	0.16	0.22	0.25	0.26	0.26	0.26
		S1	5.43E-03	4.15E-03	3.33E-03	2.68E-03	1.97E-03	1.55E-03	1.42E-03	1.42E-03
50		% change lambda	-1	-6	**-10**	**-15**	**-20**	**-22**	**-23**	**-23**
		% change lambda std	13	14	**17**	**21**	**24**	**26**	**26**	**26**
		lambda mean	1.08	1.03	0.98	0.93	0.87	0.85	0.84	0.84
		lambda std	0.1	0.12	0.17	0.21	0.25	0.27	0.27	0.27
		S1	5.52E-03	4.66E-03	4.11E-03	3.68E-03	3.19E-03	2.91E-03	2.84E-03	2.82E-03
25		% change lambda	0	-3	-5	-7	**-10**	**-11**	**-12**	**-12**
		% change lambda std	13	14	15	18	**21**	**22**	**23**	**23**
		lambda mean	1.09	1.06	1.04	1.01	0.98	0.97	0.96	0.96
		lambda std	0.1	0.11	0.14	0.17	0.21	0.23	0.23	0.23
		S1	5.59E-03	5.14E-03	4.87E-03	4.64E-03	4.41E-03	4.26E-03	4.22E-03	4.22E-03

Table A1-13. Acute mortality model output for stream-type Chinook exposed to diazinon. The percent change in population growth rate (lambda), the population growth rate mean values (lambda mean), and the variability (standard deviations) are shown, along with the mean first year survival rate (S1). The toxicity values were LC_{50}=237.9, slope 3.6. The percent of the population exposed was also varied (left column). Bold indicates a percent change in population growth rage of greater than 1 standard deviation from control values (second column).

% exposed	Chinook stream-type	***Concentration(µg/L)***	***100***	***200***	***250***	***300***	***400***	***600***	***1000***	***2000***
100		% change lambda	-1	**-10**	**-18**	**-26**	**-39**	**-56**	**-72**	**-84**
	3	% change lambda std	4	**4**	**4**	**3**	**3**	**2**	**1**	**0.6**
	1	lambda mean	0.99	0.9	0.82	0.74	0.61	0.44	0.28	0.16
	0.03	lambda std	0.03	0.03	0.03	0.02	0.02	0.01	0.01	0
	6.43E-02	S1	6.16E-02	4.19E-02	2.93E-02	1.95E-02	8.59E-03	2.22E-03	3.64E-04	3.02E-05
75		% change lambda	-1	**-8**	**-14**	**-20**	**-27**	**-30**	**-31**	**-31**
		% change lambda std	4	**6**	**11**	**17**	**20**	**21**	**21**	**21**
		lambda mean	0.99	0.92	0.86	0.79	0.73	0.7	0.69	0.69
		lambda std	0.03	0.06	0.11	0.17	0.2	0.21	0.2	0.2
		S1	6.23E-02	4.75E-02	3.80E-02	3.07E-02	2.25E-02	1.77E-02	1.63E-02	1.61E-02
50		% change lambda	0	**-5**	**-9**	**-13**	**-18**	**-20**	**-20**	**-20**
		% change lambda std	4	**7**	**11**	**16**	**20**	**21**	**22**	**21**
		lambda mean	0.99	0.95	0.91	0.87	0.82	0.8	0.8	0.8
		lambda std	0.03	0.06	0.11	0.16	0.2	0.21	0.21	0.21
		S1	6.30E-02	5.31E-02	4.68E-02	4.19E-02	3.64E-02	3.33E-02	3.24E-02	3.22E-02
25		% change lambda	0	-2	**-4**	**-6**	**-8**	**-10**	**-10**	**-11**
		% change lambda std	4	6	**8**	**11**	**15**	**17**	**18**	**18**
		lambda mean	1	0.97	0.96	0.94	0.92	0.9	0.89	0.89
		lambda std	0.03	0.05	0.08	0.11	0.15	0.17	0.17	0.17
		S1	6.36E-02	5.87E-02	5.56E-02	5.31E-02	5.04E-02	4.88E-02	4.83E-02	4.82E-02

Table A1-14. Acute mortality model output for sockeye exposed to diazinon. The percent change in population growth rate (lambda), the population growth rate mean values (lambda mean), and the variability (standard deviations) are shown, along with the mean first year survival rate (S1). The toxicity values were LC_{50}=237.9, slope 3.6. The percent of the population exposed was also varied (left column). Bold indicates a percent change in population growth rage of greater than 1 standard deviation from control values (second column).

% exposed	Sockeye	***Concentration(μg/L)***	***100***	***200***	***250***	***300***	***400***	***600***	***1000***	***2000***
100		% change lambda	-1	**-10**	**-17**	**-25**	**-38**	**-55**	**-70**	**-83**
	6	% change lambda std	8	**7**	**7**	**6**	**5**	**4**	**2**	**1**
	1.01	lambda mean	1	0.91	0.84	0.76	0.63	0.46	0.3	0.17
	0.04	lambda std	0.06	0.05	0.05	0.04	0.03	0.02	0.02	0.01
	2.57E-02	S1	2.46E-02	1.68E-02	1.17E-02	7.78E-03	3.43E-03	8.89E-04	1.46E-04	1.21E-05
75		% change lambda	-1	**-7**	**-14**	**-20**	**-26**	**-28**	**-29**	**-29**
		% change lambda std	8	**9**	**13**	**18**	**20**	**21**	**20**	**21**
		lambda mean	1	0.94	0.87	0.81	0.75	0.72	0.72	0.71
		lambda std	0.06	0.07	0.12	0.17	0.2	0.2	0.2	0.2
		S1	2.48E-02	1.90E-02	1.52E-02	1.23E-02	9.04E-03	7.10E-03	6.54E-03	6.42E-03
50		% change lambda	-1	-5	**-9**	**-13**	**-17**	**-19**	**-20**	**-19**
		% change lambda std	8	10	**13**	**17**	**20**	**21**	**22**	**21**
		lambda mean	1	0.96	0.92	0.88	0.84	0.82	0.81	0.82
		lambda std	0.06	0.08	0.12	0.16	0.2	0.21	0.21	0.21
		S1	2.51E-02	2.12E-02	1.87E-02	1.67E-02	1.46E-02	1.33E-02	1.29E-02	1.29E-02
25		% change lambda	0	-2	-4	-6	**-8**	**-10**	**-10**	**-10**
		% change lambda std	8	9	11	14	**16**	**18**	**18**	**19**
		lambda mean	1.01	0.99	0.97	0.95	0.93	0.91	0.91	0.91
		lambda std	0.06	0.07	0.1	0.13	0.16	0.18	0.18	0.18
		S1	2.54E-02	2.35E-02	2.22E-02	2.12E-02	2.01E-02	1.95E-02	1.93E-02	1.93E-02

Table A1-15. Acute mortality model output for coho exposed to diazinon. The percent change in population growth rate (lambda), the population growth rate mean values (lambda mean), and the variability (standard deviations) are shown, along with the mean first year survival rate (S1). The toxicity values were LC_{50}=237.9, slope 3.6. The percent of the population exposed was also varied (left column). Bold indicates a percent change in population growth rage of greater than 1 standard deviation from control values (second column).

% exposed	Coho	***Concentration(μg/L)***	***100***	***200***	***250***	***300***	***400***	***600***	***1000***	***2000***
100		% change lambda	-1	**-13**	**-23**	**-33**	**-49**	**-67**	**-82**	**-92**
	5	% change lambda std	7	**6**	**6**	**5**	**4**	**2**	**1**	**1**
	1.03	lambda mean	1.01	0.89	0.79	0.69	0.53	0.34	0.18	0.08
	0.06	lambda std	0.05	0.05	0.04	0.04	0.03	0.02	0.01	0
	2.97E-02	S1	2.84E-02	1.93E-02	1.35E-02	8.97E-03	3.96E-03	1.03E-03	1.68E-04	1.39E-05
75		% change lambda	-1	**-10**	**-18**	**-26**	**-35**	**-39**	**-40**	**-40**
		% change lambda std	7	**9**	**15**	**21**	**26**	**26**	**27**	**26**
		lambda mean	1.02	0.93	0.84	0.76	0.67	0.63	0.62	0.62
		lambda std	0.05	0.08	0.15	0.21	0.26	0.27	0.27	0.27
		S1	2.87E-02	2.19E-02	1.75E-02	1.42E-02	1.04E-02	8.18E-03	7.55E-03	7.44E-03
50		% change lambda	-1	**-7**	**-12**	**-17**	**-23**	**-25**	**-27**	**-27**
		% change lambda std	8	**10**	**15**	**20**	**25**	**27**	**28**	**28**
		lambda mean	1.02	0.96	0.91	0.86	0.79	0.77	0.76	0.75
		lambda std	0.06	0.09	0.15	0.2	0.26	0.28	0.28	0.28
		S1	2.90E-02	2.45E-02	2.16E-02	1.93E-02	1.68E-02	1.53E-02	1.49E-02	1.48E-02
25		% change lambda	0	-3	**-6**	**-8**	**-11**	**-13**	**-14**	**-14**
		% change lambda std	7	9	**12**	**15**	**20**	**22**	**23**	**23**
		lambda mean	1.03	1	0.97	0.95	0.92	0.89	0.89	0.89
		lambda std	0.05	0.08	0.11	0.14	0.19	0.22	0.23	0.23
		S1	2.94E-02	2.71E-02	2.56E-02	2.45E-02	2.32E-02	2.25E-02	2.23E-02	2.23E-02

Table A1-16. Acute mortality model output for ocean-type Chinook exposed to malathion. The percent change in population growth rate (lambda), the population growth rate mean values (lambda mean), and the variability (standard deviations) are shown, along with the mean first year survival rate (S1). The toxicity values were LC_{50}=19.4, slope 3.6. The percent of the population exposed was also varied (left column). Bold indicates a percent change in population growth rage of greater than 1 standard deviation from control values (second column).

% exposed	Chinook ocean-type	***Concentration(µg/L)***	***10***	***20***	***25***	***50***	***75***	***150***	***250***	***1000***
100		% change lambda	-3	**-19**	**-30**	**-61**	**-73**	**-85**	**-90**	**-97**
	9	% change lambda std	13	**10**	**9**	**5**	**3**	**2**	**1**	**0.4**
	1.09	lambda mean	1.06	0.88	0.76	0.42	0.29	0.16	0.11	0.04
	0.08	lambda std	0.1	0.08	0.07	0.04	0.03	0.01	0.01	0
	5.64E-03	S1	5.17E-03	2.66E-03	1.62E-03	1.81E-04	4.29E-05	3.57E-06	5.67E-07	3.86E-09
75		% change lambda	-2	**-15**	**-24**	**-34**	**-35**	**-34**	**-35**	**-35**
		% change lambda std	13	**16**	**21**	**25**	**24**	**24**	**24**	**24**
		lambda mean	1.07	0.92	0.83	0.72	0.71	0.71	0.71	0.71
		lambda std	0.1	0.16	0.22	0.26	0.26	0.26	0.26	0.26
		S1	5.25E-03	3.41E-03	2.62E-03	1.55E-03	1.43E-03	1.41E-03	1.41E-03	1.41E-03
50		% change lambda	-1	**-10**	**-16**	**-22**	**-23**	**-23**	**-23**	**-23**
		% change lambda std	13	**17**	**21**	**26**	**26**	**26**	**26**	**26**
		lambda mean	1.08	0.98	0.92	0.85	0.84	0.84	0.84	0.84
		lambda std	0.1	0.16	0.22	0.27	0.27	0.27	0.28	0.27
		S1	5.40E-03	4.13E-03	3.62E-03	2.90E-03	2.82E-03	2.83E-03	2.82E-03	2.82E-03
25		% change lambda	-1	-5	-7	**-11**	**-12**	**-12**	**-12**	**-12**
		% change lambda std	13	15	18	**23**	**23**	**23**	**23**	**23**
		lambda mean	1.08	1.04	1.01	0.96	0.96	0.96	0.96	0.96
		lambda std	0.1	0.14	0.17	0.23	0.23	0.23	0.23	0.24
		S1	5.50E-03	4.89E-03	4.63E-03	4.27E-03	4.21E-03	4.21E-03	4.21E-03	4.22E-03

Table A1-17. Acute mortality model output for stream-type Chinook exposed to malathion. The percent change in population growth rate (lambda), the population growth rate mean values (lambda mean), and the variability (standard deviations) are shown, along with the mean first year survival rate (S1). The toxicity values were LC_{50}=19.4, slope 3.6. The percent of the population exposed was also varied (left column). Bold indicates a percent change in population growth rage of greater than 1 standard deviation from control values (second column).

% exposed	Chinook stream-type	***Concentration(µg/L)***	***10***	***20***	***25***	***50***	***75***	***150***	***250***	***1000***
100		% change lambda	-2	**-17**	**-26**	**-57**	**-70**	**-83**	**-89**	**-96**
	3	% change lambda std	4	**4**	**3**	**2**	**1**	**1**	**0.4**	**0.1**
	1	lambda mean	0.98	0.83	0.73	0.43	0.3	0.17	0.11	0.04
	0.03	lambda std	0.03	0.03	0.02	0.01	0.01	0	0	0
	6.43E-02	S1	5.90E-02	3.04E-02	1.84E-02	2.06E-03	4.91E-04	4.08E-05	6.48E-06	4.41E-08
75		% change lambda	-2	**-13**	**-21**	**-30**	**-30**	**-31**	**-31**	**-31**
		% change lambda std	4	**10**	**17**	**21**	**21**	**21**	**21**	**21**
		lambda mean	0.98	0.87	0.79	0.7	0.69	0.69	0.69	0.69
		lambda std	0.03	0.1	0.17	0.2	0.2	0.2	0.21	0.21
		S1	6.02E-02	3.89E-02	2.99E-02	1.76E-02	1.64E-02	1.61E-02	1.60E-02	1.61E-02
50		% change lambda	-1	**-9**	**-14**	**-20**	**-20**	**-20**	**-21**	**-21**
		% change lambda std	5	**11**	**16**	**21**	**22**	**21**	**22**	**22**
		lambda mean	0.99	0.91	0.86	0.8	0.79	0.8	0.79	0.79
		lambda std	0.03	0.1	0.16	0.21	0.21	0.21	0.21	0.21
		S1	6.16E-02	4.74E-02	4.14E-02	3.32E-02	3.24E-02	3.22E-02	3.21E-02	3.22E-02
25		% change lambda	-1	**-4**	**-6**	**-10**	**-11**	**-11**	**-11**	**-11**
		% change lambda std	5	**8**	**12**	**17**	**17**	**18**	**18**	**18**
		lambda mean	0.99	0.96	0.94	0.9	0.89	0.89	0.89	0.89
		lambda std	0.03	0.07	0.11	0.17	0.17	0.17	0.17	0.18
		S1	6.30E-02	5.59E-02	5.29E-02	4.87E-02	4.83E-02	4.82E-02	4.82E-02	4.82E-02

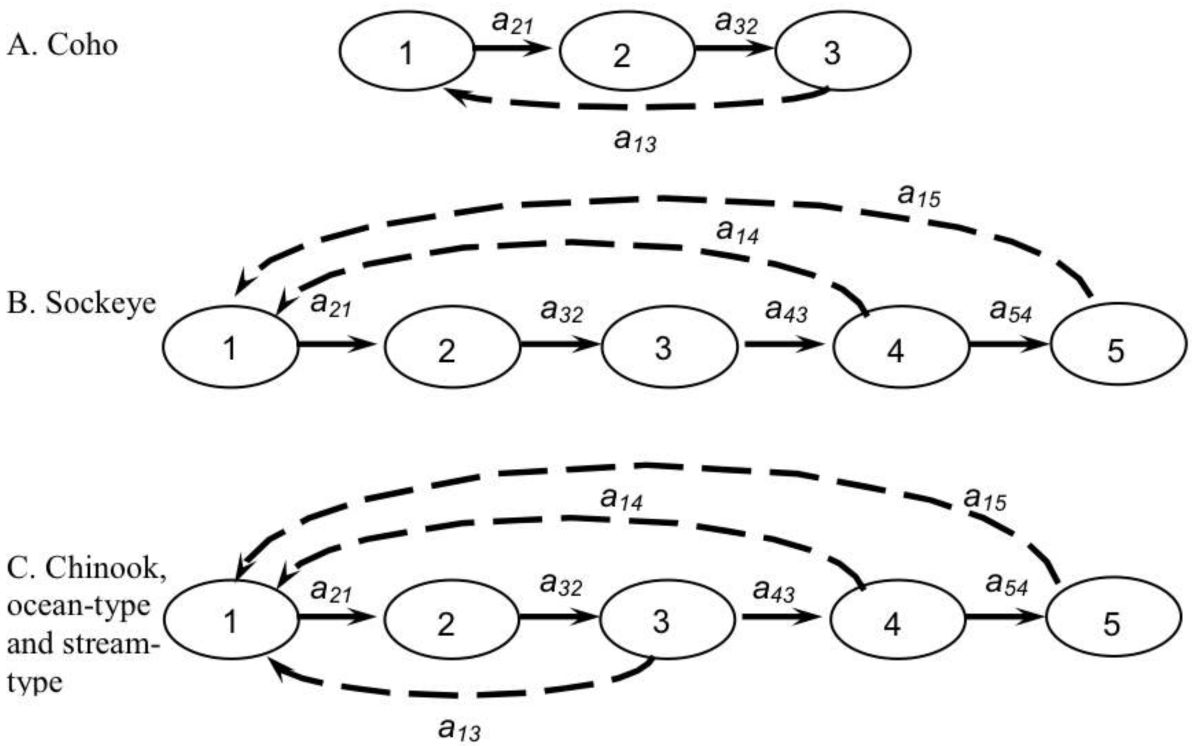
Table A1-18. Acute mortality model output for sockeye exposed to malathion. The percent change in population growth rate (lambda), the population growth rate mean values (lambda mean), and the variability (standard deviations) are shown, along with the mean first year survival rate (S1). The toxicity values were LC_{50}=19.4, slope 3.6. The percent of the population exposed was also varied (left column). Bold indicates a percent change in population growth rage of greater than 1 standard deviation from control values (second column).

% exposed	Sockeye	***Concentration(µg/L)***	***10***	***20***	***25***	***50***	***75***	***150***	***250***	***1000***
100		% change lambda	-2	**-16**	**-26**	**-56**	**-68**	**-82**	**-88**	**-96**
	6	% change lambda std	8	**7**	**6**	**3**	**2**	**1**	**1**	**0**
	1.01	lambda mean	0.99	0.84	0.75	0.45	0.32	0.19	0.12	0.04
	0.04	lambda std	0.06	0.05	0.04	0.02	0.02	0.01	0.01	0
	2.57E-02	S1	2.36E-02	1.21E-02	7.36E-03	8.21E-04	1.96E-04	1.63E-05	2.59E-06	1.77E-08
75		% change lambda	-2	**-13**	**-20**	**-29**	**-29**	**-29**	**-29**	**-29**
		% change lambda std	8	**13**	**18**	**20**	**21**	**20**	**21**	**20**
		lambda mean	0.99	0.88	0.8	0.72	0.71	0.72	0.71	0.72
		lambda std	0.06	0.12	0.17	0.2	0.2	0.2	0.2	0.2
		S1	2.41E-02	1.56E-02	1.19E-02	7.04E-03	6.56E-03	6.43E-03	6.46E-03	6.44E-03
50		% change lambda	-1	**-8**	**-14**	**-19**	**-19**	**-19**	**-19**	**-20**
		% change lambda std	8	**13**	**17**	**21**	**22**	**22**	**22**	**21**
		lambda mean	1	0.93	0.87	0.82	0.81	0.81	0.81	0.81
		lambda std	0.06	0.12	0.17	0.21	0.21	0.21	0.21	0.21
		S1	2.46E-02	1.89E-02	1.65E-02	1.33E-02	1.29E-02	1.28E-02	1.29E-02	1.28E-02
25		% change lambda	-1	-4	-6	**-10**	**-10**	**-10**	**-10**	**-11**
		% change lambda std	8	11	14	**18**	**19**	**19**	**18**	**19**
		lambda mean	1	0.97	0.95	0.91	0.91	0.91	0.91	0.9
		lambda std	0.06	0.09	0.13	0.18	0.18	0.18	0.18	0.18
		S1	2.51E-02	2.23E-02	2.11E-02	1.95E-02	1.93E-02	1.93E-02	1.92E-02	1.92E-02

Table A1-19. Acute mortality model output for coho exposed to malathion. The percent change in population growth rate (lambda), the population growth rate mean values (lambda mean), and the variability (standard deviations) are shown, along with the mean first year survival rate (S1). The toxicity values were LC_{50}=19.4, slope 3.6. The percent of the population exposed was also varied (left column). Bold indicates a percent change in population growth rage of greater than 1 standard deviation from control values (second column).

% exposed	Coho	***Concentration(µg/L)***	***10***	***20***	***25***	***50***	***75***	***150***	***250***	***1000***
100		% change lambda	-3	**-22**	**-34**	**-68**	**-80**	**-91**	**-95**	**-99**
	5	% change lambda std	7	**6**	**5**	**2**	**2**	**1**	**0.3**	**0.1**
	1.03	lambda mean	1	0.8	0.68	0.33	0.2	0.09	0.05	0.01
	0.06	lambda std	0.05	0.04	0.04	0.02	0.01	0	0	0
	2.97E-02	S1	2.72E-02	1.40E-02	8.50E-03	9.51E-04	2.26E-04	1.88E-05	2.99E-06	2.03E-08
75		% change lambda	-2	**-17**	**-27**	**-39**	**-40**	**-40**	**-40**	**-40**
		% change lambda std	8	**14**	**22**	**26**	**26**	**26**	**26**	**26**
		lambda mean	1.01	0.85	0.75	0.63	0.62	0.61	0.62	0.61
		lambda std	0.06	0.14	0.22	0.27	0.27	0.27	0.27	0.27
		S1	2.78E-02	1.79E-02	1.38E-02	8.13E-03	7.59E-03	7.42E-03	7.41E-03	7.43E-03
50		% change lambda	-1	**-11**	**-18**	**-25**	**-26**	**-26**	**-27**	**-27**
		% change lambda std	8	**14**	**21**	**27**	**28**	**28**	**28**	**28**
		lambda mean	1.01	0.91	0.85	0.77	0.76	0.76	0.75	0.75
		lambda std	0.06	0.14	0.21	0.28	0.28	0.28	0.28	0.28
		S1	2.84E-02	2.18E-02	1.91E-02	1.53E-02	1.50E-02	1.48E-02	1.48E-02	1.48E-02
25		% change lambda	-1	-5	**-8**	**-13**	**-13**	**-14**	**-14**	**-14**
		% change lambda std	8	12	**16**	**22**	**22**	**23**	**23**	**23**
		lambda mean	1.02	0.97	0.94	0.89	0.89	0.89	0.89	0.89
		lambda std	0.06	0.11	0.15	0.23	0.22	0.23	0.23	0.23
		S1	2.90E-02	2.57E-02	2.44E-02	2.25E-02	2.23E-02	2.22E-02	2.23E-02	2.22E-02

Figure A1-1: Life-History Graphs and Transition Matrix for coho (A), sockeye (B) and Chinook (C) salmon. The life-history graph for a population labeled by age, with each transition element labeled according to the matrix position, a_{ij}, i row and j column. Dashed lines represent reproductive contribution and solid lines represent survival transitions. D) The transition matrix for the life-history graph depicted in C.



D. Transition Matrix

$$A=\begin{bmatrix} 0 & 0 & R3=a_{13} & R4=a_{14} & R5=a_{15} \\ S1=a_{21} & 0 & 0 & 0 & 0 \\ 0 & S2=a_{32} & 0 & 0 & 0 \\ 0 & 0 & S3=a_{43} & 0 & 0 \\ 0 & 0 & 0 & S4=a_{54} & 0 \end{bmatrix}$$

Figure A1-2: Relationships used to link anticholinesterase exposure to the organism's ability to acquire food (potential ration). See text for details. Relationships in B, C, and D utilize empirical data. Closed circles represent control conditions. Open circles represent the exposed (inhibited) condition. A) Representation of a constant level of anticholinesterase pesticide exposure (either a single compound or mixtures). B) Sigmoidal relationship between exposure concentration and steady-state acetylcholinesterase (AChE) activity showing a dose-dependent reduction defined by control activity (horizontal line, Ac), sigmoidal (i.e. hille) slope (AChE slope), and the concentration producing 50% inhibition (vertical line, EC50). C) Timecourse of acetylcholinesterase inhibition based on modeling the time-to-effect and time-to-recovery as single exponential curves with different time-constants. At the start of the exposure AChE activity will be at control and then decline toward the inhibited activity (Ai) based on Panel B. D) Linear model relating acetylcholinesterase activity to feeding behavior using a line that passes through the feeding (Fc) and activity (Ac) control conditions with a slope of Mfa. E) The relationship between feeding behavior and the potential ratio an organism could acquire (if not food limited) used a line passing through the control conditions (Fc as in Panel D and the control ration, Rc) and through the origin producing a slope (Mrf) equal to Rc/Fc. F) Timecourse for effect of exposure to anticholinesterase on potential ration produced by combining C & E.

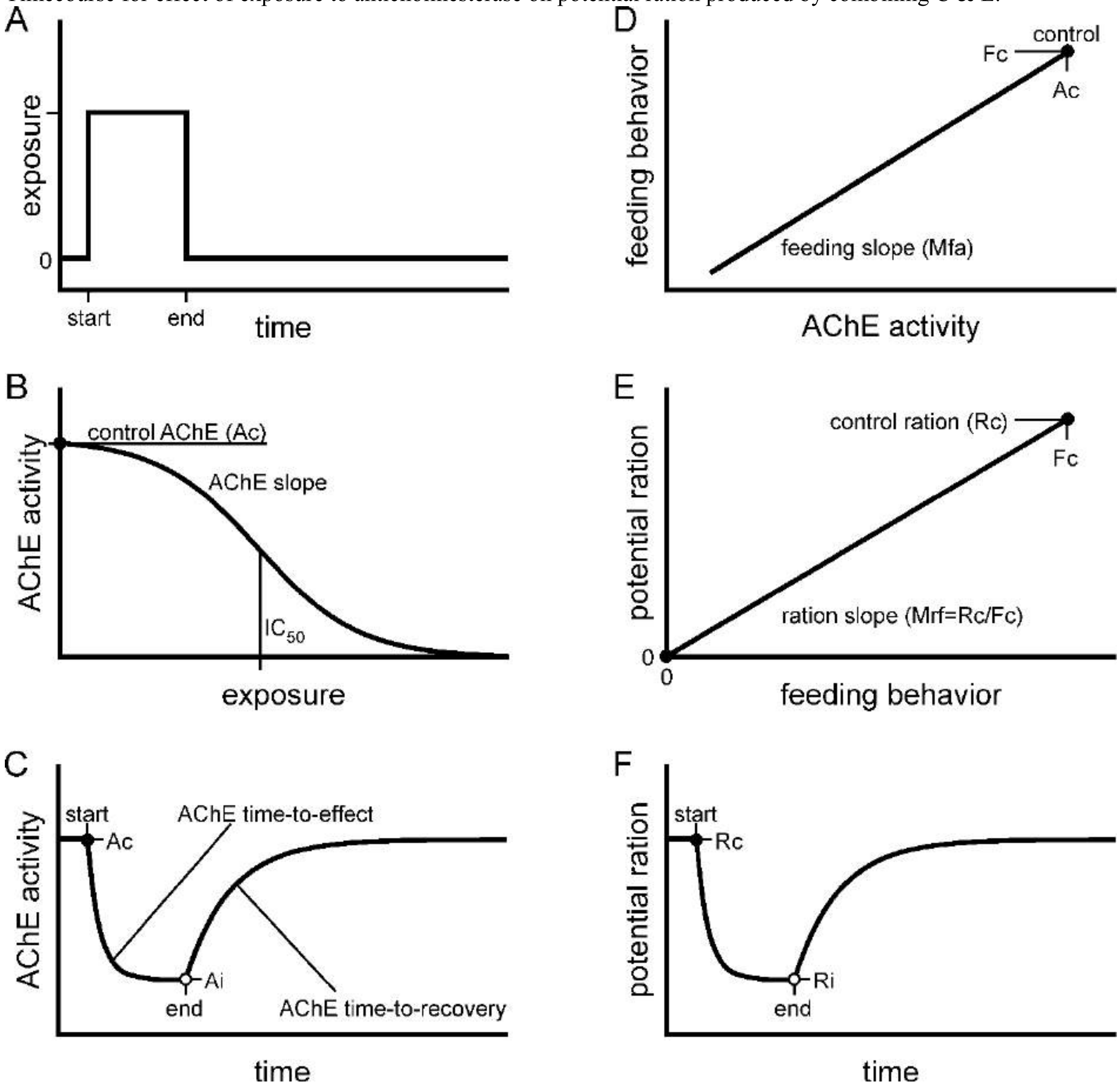


Figure A1-3: Relationships used to link anticholinesterase exposure to the availability of prey. See text for details. Relationships in B and C utilize empirical data. Closed circles represent control conditions. Open circles represent the exposed (inhibited) condition. A) Representation of a constant level of anticholinesterase pesticide exposure (either single compound or mixtures). B) Sigmoidal relationship between exposure concentration and relative prey abundance showing a dose-dependent reduction defined by control abundance (horizontal line at 1, Pc), sigmoid (i.e. hille) slope (prey slope), the concentration producing a 50% reduction in prey (vertical line, EC_{50}), and a minimum abundance always present (horizontal line denoted as floor, Pf). C) Timecourse of prey abundance including a 1-day spike in prey drift relative to the available prey and the level of toxicity followed by a drop to the level of impact or the floor whichever is greater. During extended exposures at low toxicity recovery can begin at the constant prey influx rate multiplied by the current level of toxicity. After exposure recovery to control prey drift is at the constant rate of influx from upstream habitats.

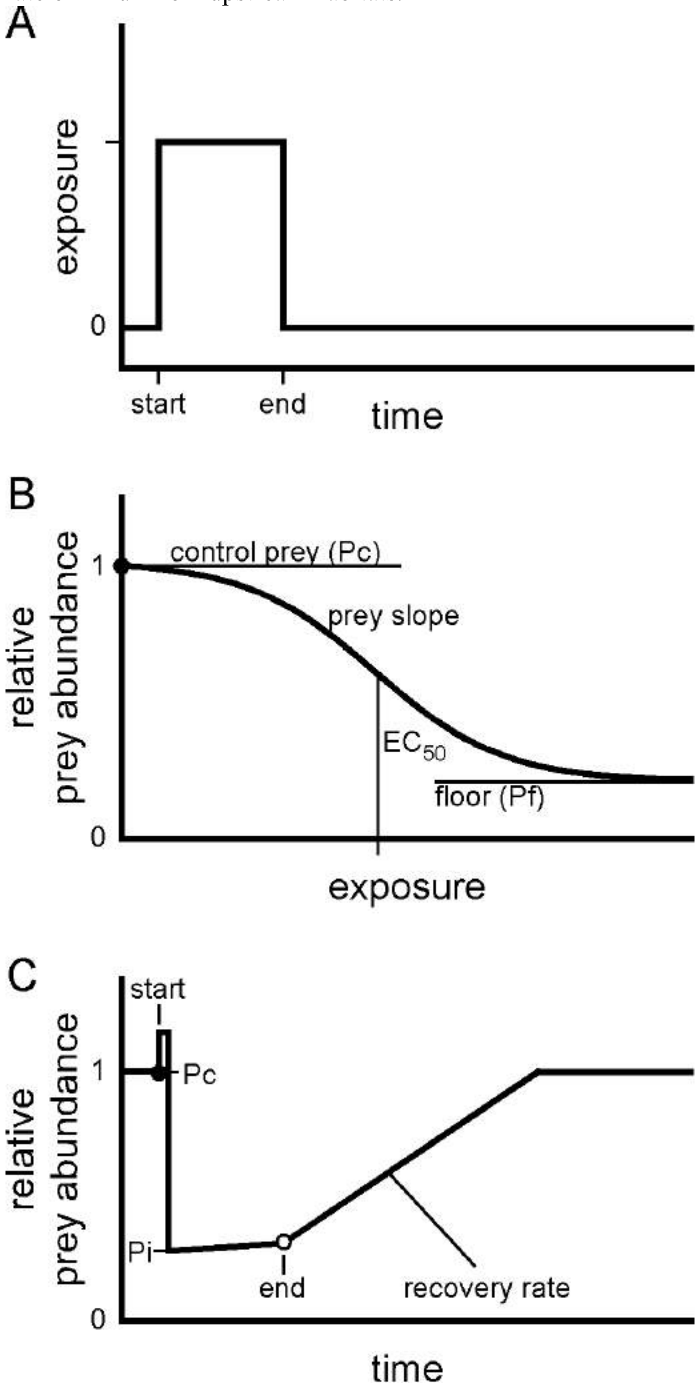


Figure A1-4: Relationships used to link anticholinesterase exposure to growth rate relating to long-term weight gain of each fish. See text for details. Relationships in A, B, and C utilize empirical data. Closed circles represent control conditions. Open circles (e.g. Ai) represent the exposed (inhibited) condition. A&B) Relationships describing the Timecourse of the effects of anticholinesterase exposure on the organisms ability to capture food (Panel A, potential ration) and the availability of food to capture (Panel B, relative prey abundance). The figures are the same as those in Figures A1-2F and 3C, respectively. For a given exposure concentration and time, multiplying potential ration by relative prey abundance yields the final ration acquired by the organism. C) A linear model was used to relate final ration to growth rate using a line passing through the control conditions and through the maintenance condition with a slope denoted by Mgr. D) Timecourse for effect of exposure to anticholinesterase on growth rate produced by combining A, B, & C.

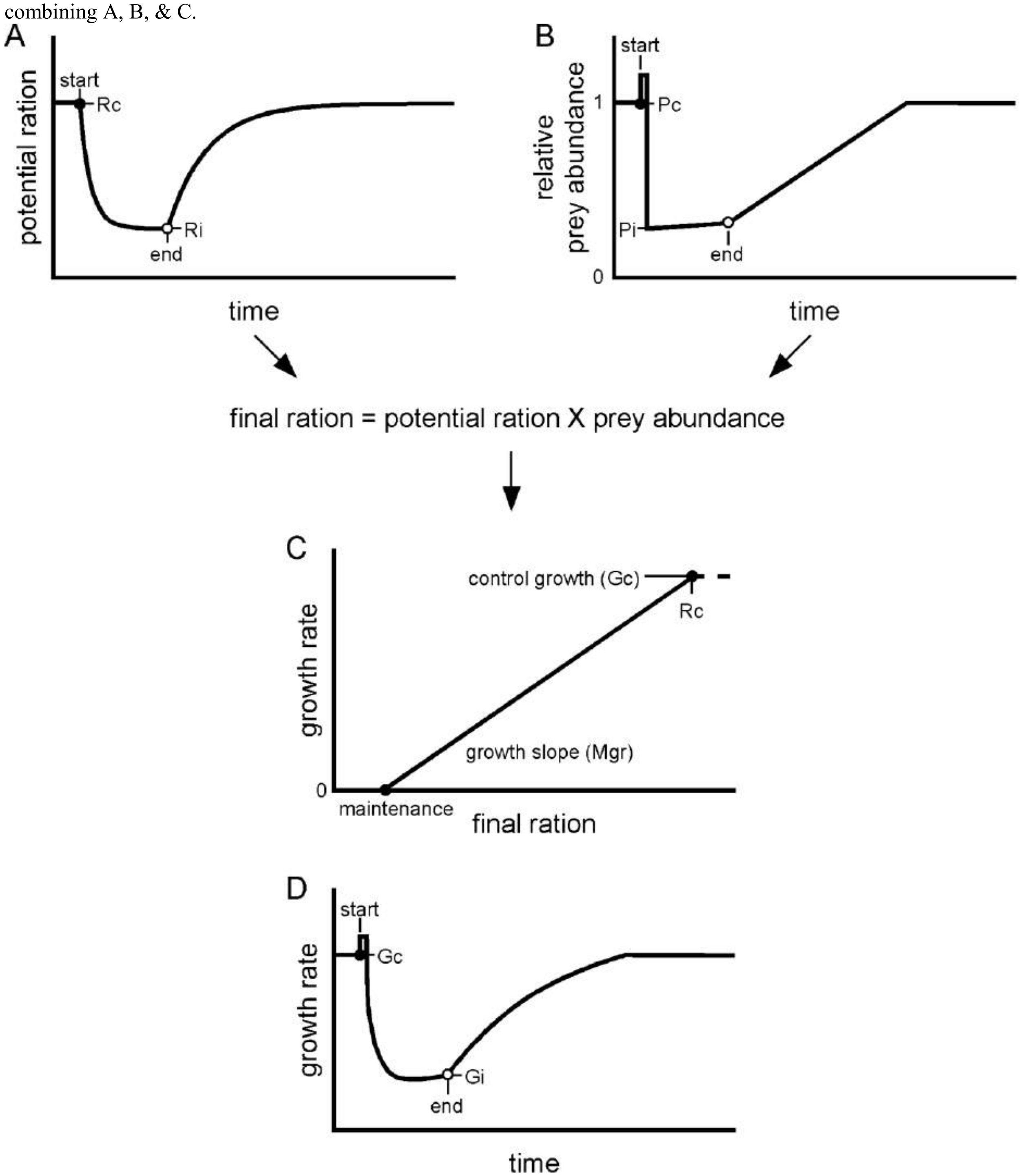
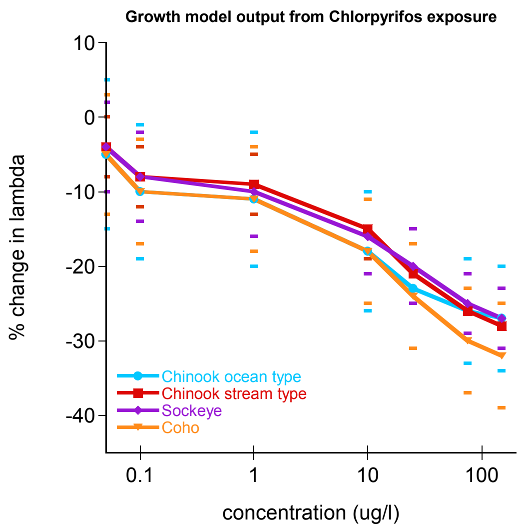
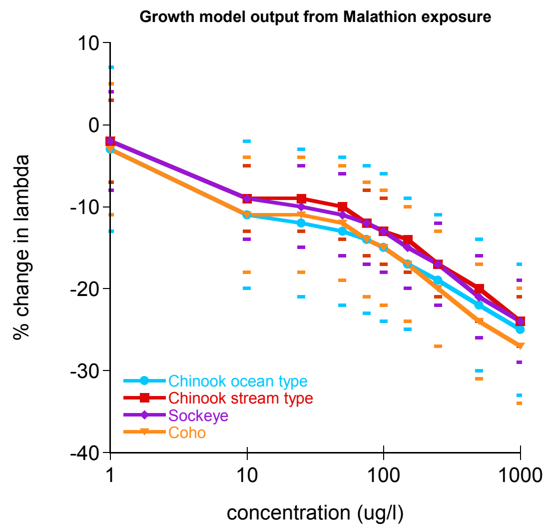


Figure A1-5: Somatic growth model output for chlorpyrifos, malathion and diazinon. Scenario used to generate output was a single, 4-d exposure beginning on day 30 of the somatic growth period with 100% of the population exposed. Lines indicate mean percent change in lambda and caps show one standard deviation.





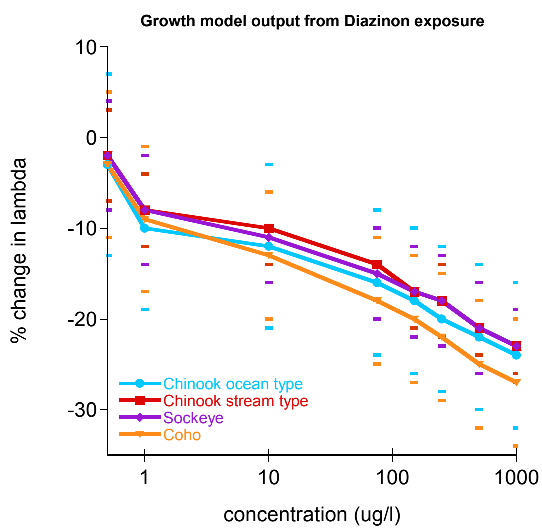


Figure A1-6: Percent change in population growth rate (lambda) for salmon populations exposed to malathion at concentrations across the range of EECs which resulted in acute mortality. Each line represents the mean percent change in lambda for different percentages of the population exposed (100%, 75%, 50%, and 25%) and caps show one standard deviation.

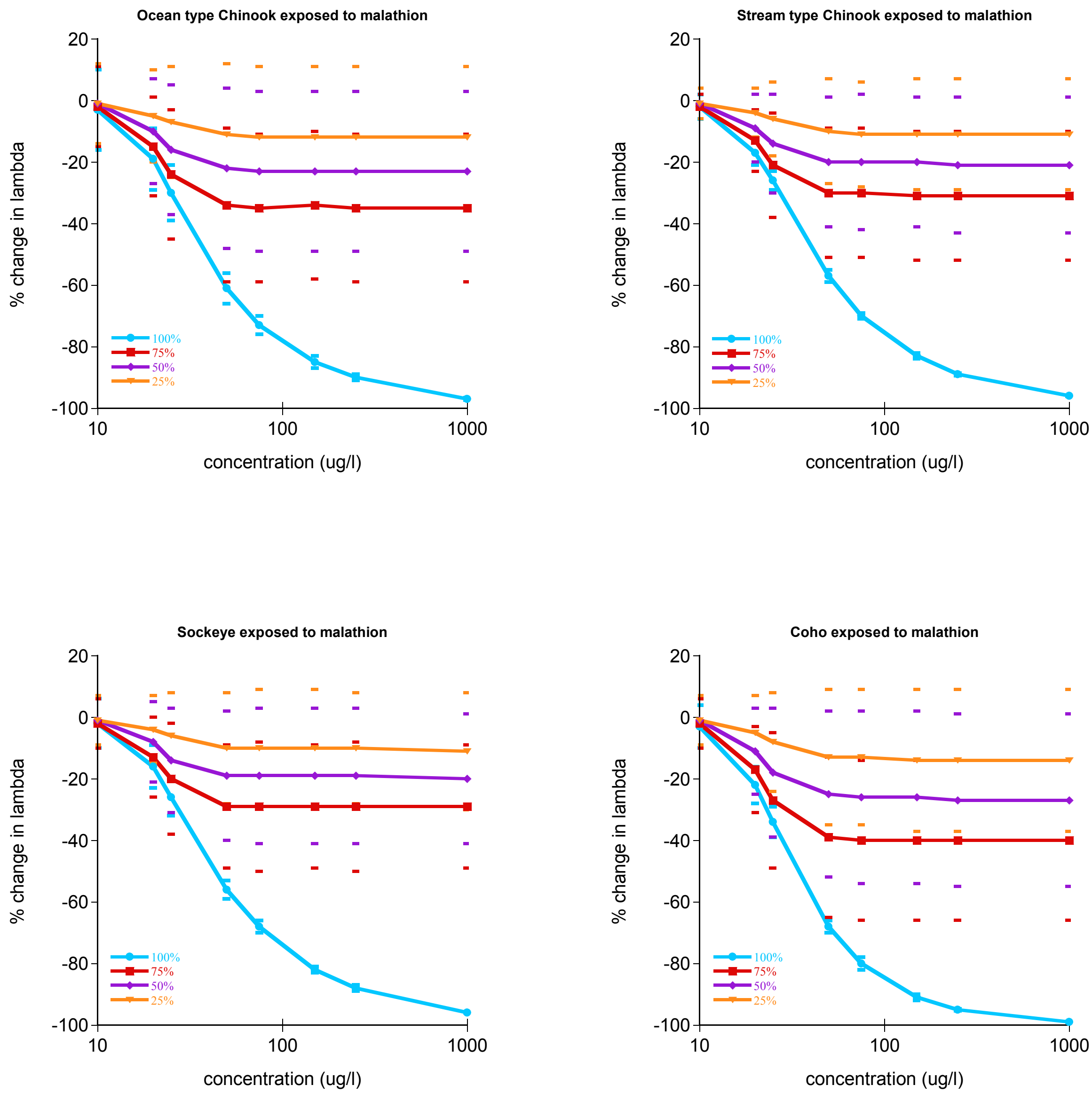


Figure A1-7: Percent change in population growth rate (lambda) for salmon populations exposed to chlorpyrifos at concentrations across the range of EECs which resulted in acute mortality. Each line represents the mean percent change in lambda for different percentages of the population exposed (100%, 75%, 50%, and 25%) and caps show one standard deviation.

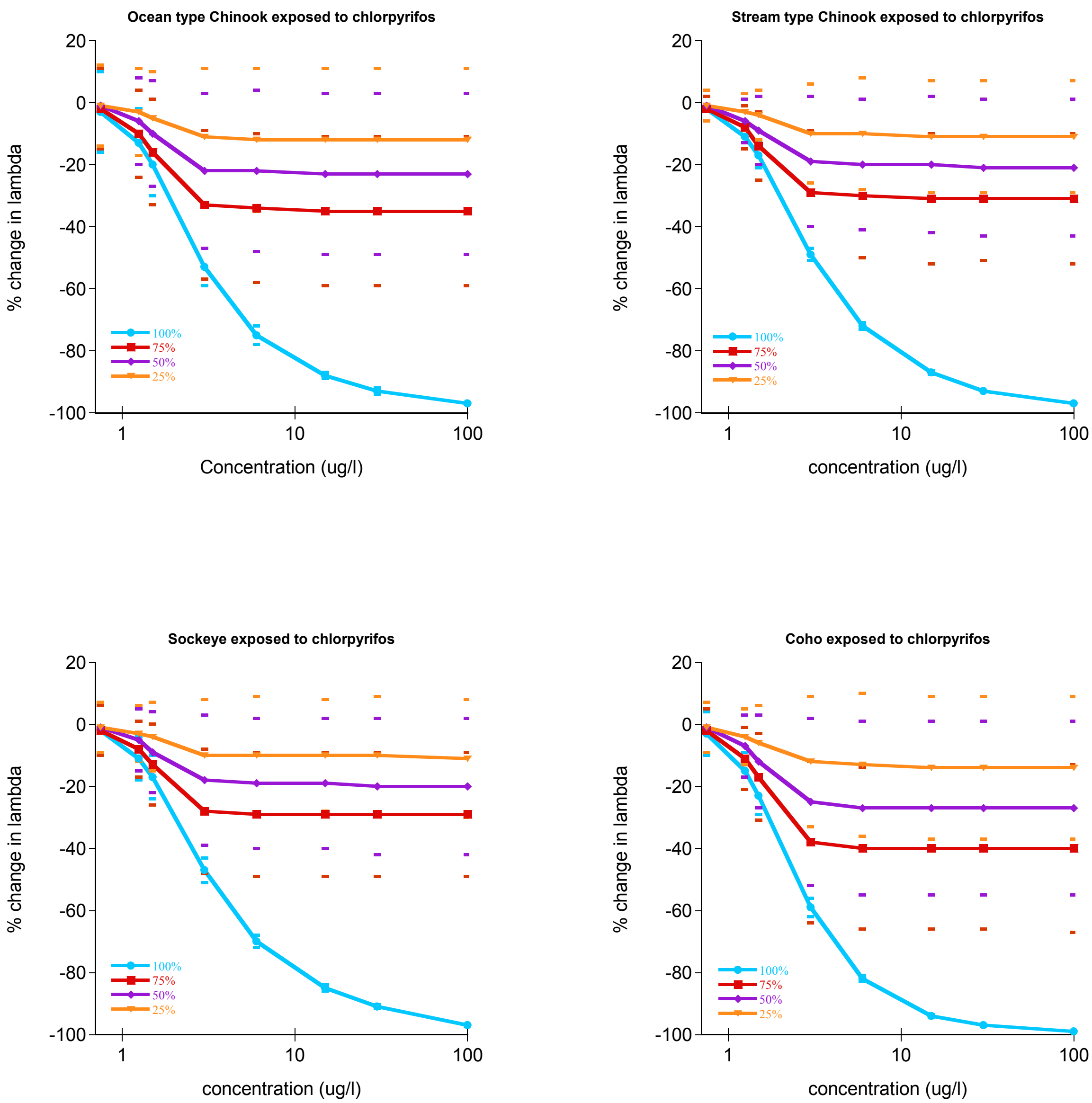
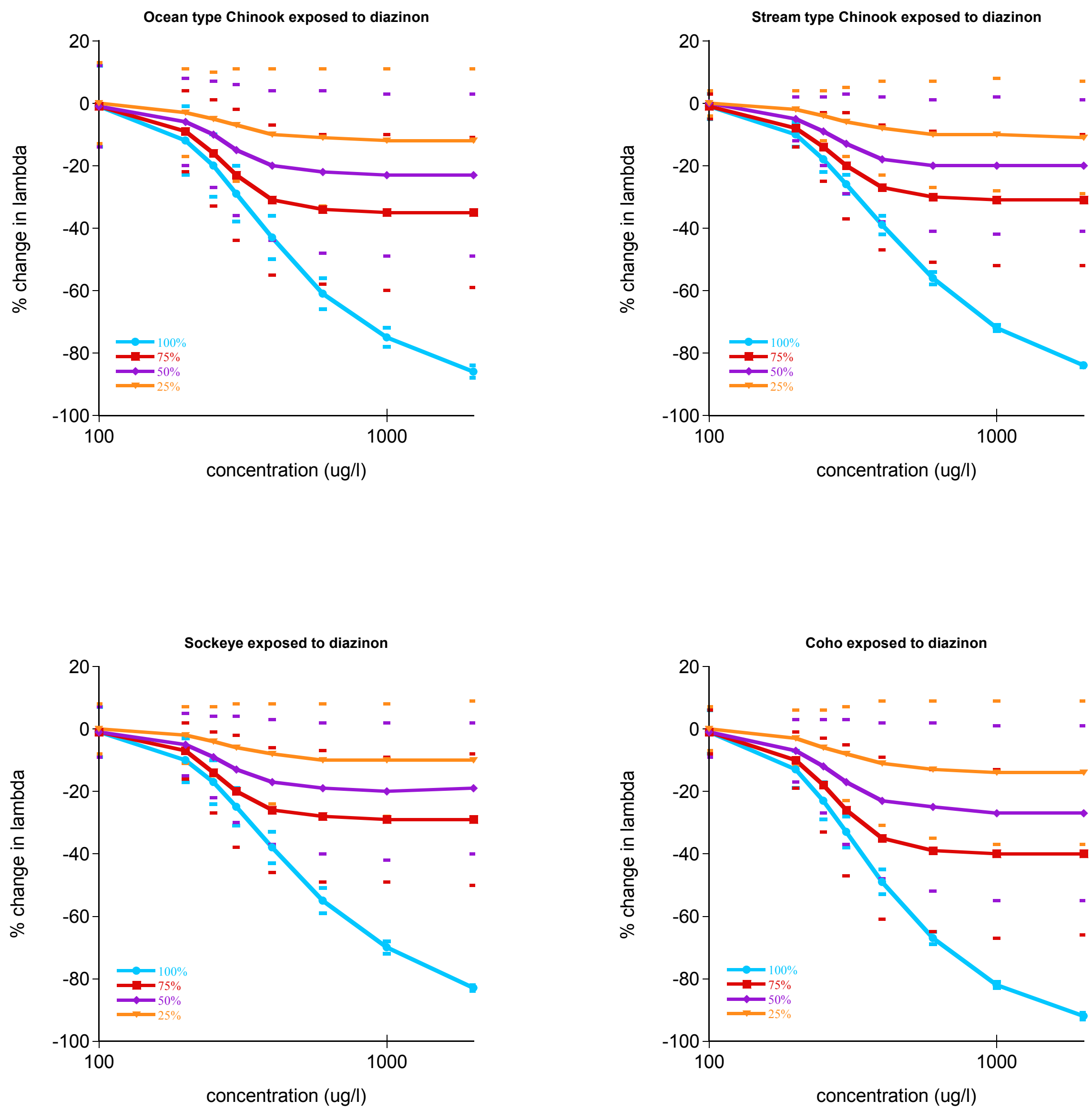


Figure A1-8: Percent change in population growth rate (lambda) for salmon populations exposed to diazinon at concentrations across the range of EECs which resulted in acute mortality. Each line represents the mean percent change in lambda for different percentages of the population exposed (100%, 75%, 50%, and 25%) and caps show one standard deviation.



C. APPENDIX: PHYSICAL OR BIOLOGICAL FEATURES ESSENTIAL FOR THE CONSERVATION OF THE SPECIES

Table 1. Physical or biological features essential for the conservation of the species for NMFS ESA listed species under consultation (pacific salmonids not included in this table).

Species	FR Notice /Date	Physical or Biological Features Essential for the Conservation of the Species
Black Abalone *Haliotis cracherodii*	76 FR66806 10/27/2011	• Rocky substrate: Rocky benches, crevices, large boulders • Food resources: Bacterial and diatom films, algae • Juvenile settlement habitat: Rocky habitat with coralline algae and/or crevices, cryptic biogenic structures • Suitable water quality • Suitable nearshore circulation patterns
White Abalone *Haliotis sorenseni*	66 FR29046 05/29/2001	NO DESIGNATED CRITICAL HABITAT. A designation was deemed not prudent because it was expected to increase risk of poaching
Elkhorn Coral *Acropora palmate* & Staghorn Coral *Acropora cervicornis*	73 FR 72210 11/26/2008	Substrate of suitable quality and availability to support successful larval settlement and recruitment, and reattachment and recruitment of fragments
Johnson's seagrass *Halophila johnsonii*	65 FR 17768 04/05/2000	• Adequate water quality, salinity levels, water transparency • Stable, unconsolidated sediments free from disturbance
Green Turtle Chelonia mydas: Florida & Mexico Pacific coast breeding colonies; all other areas	63 FR 46693 09/02/1998	Activities requiring special management considerations include: • Vessel traffic • Coastal construction • Point and non-point source pollution • Fishing activities • Dredge and fill activities • Habitat restoration
Hawksbill Turtle	63 FR 46693	

Species	FR Notice /Date	Physical or Biological Features Essential for the Conservation of the Species
Eretmochelys imbricata	09/02/1998	
Leatherback Turtle *Dermochelys coriacea*	44 FR 17710 03/23/1979 77 FR 4170 01/26/2012	Activities identified as modifying CH include: recreational boating • swimming, • sandmining (see 77 FR 32909 for the 6/4/2012 determination on Sierra Club's petition to revise the CH) • Occurrence of prey species, primarily Scyphomedusae of the order Semaeostomeae (*Chrysaora, Aurelia, Phacellophora, and Cyanea*) of sufficient condition, distribution, diversity, and abundance to support individual as well as population growth, reproduction, and development • Migratory pathway conditions to allow for safe and timely passage and access to/from/within high use foraging areas
Loggerhead Turtle Caretta caretta: Northwest Atlantic Ocean Loggerhead Turtle *Caretta caretta*: Northwest Atlantic Ocean (continued)	79 FR 39855 07/10/2014 79 FR 39855 07/10/2014	**Nearshore Reproductive Habitat** • Nearshore waters directly off the highest density nesting beaches and their adjacent beaches as identified in 50 CFR 17.95(c) to 1.6 km (1 mile) offshore; • Waters sufficiently free of obstructions or artificial lighting to allow transit through the surf zone and outward toward open water. • Waters with minimal manmade structures that could promote predators (i.e., nearshore predator concentration caused by submerged and emergent offshore structures), disrupt wave patterns necessary for orientation, and/or create excessive longshore currents. **Winter Habitat** • Water temperatures above 10° C from • November through April; • Continental shelf waters in proximity to the western boundary of the Gulf Stream; and • Water depths between 20 and 100 m.

Species	FR Notice /Date	Physical or Biological Features Essential for the Conservation of the Species
Loggerhead Turtle *Caretta caretta*: Northwest		**Breeding Habitat** • High densities of reproductive male and female loggerheads; • Proximity to primary Florida migratory corridor; and • Proximity to Florida nesting grounds. **Migratory Habitat** • Constricted continental shelf area relative to nearby continental shelf waters that concentrate migratory pathways; and • Passage conditions to allow for migration to and from nesting, breeding, and/or foraging areas. **Sargassum Habitat** • Convergence zones, surface-water downwelling areas, the margins of major boundary currents (Gulf Stream), and other locations where there are concentrated components of the Sargassum community in water temperatures suitable for the optimal growth of Sargassum and inhabitance of loggerheads; • Sargassum in concentrations that support adequate prey abundance and cover; • Available prey and other material associated with Sargassum habitat including, but not limited to, plants and cyanobacteria and animals native to the Sargassum community such as hydroids and copepods; and • Sufficient water depth and proximity to available currents to ensure offshore transport (out of the surf zone), and foraging and cover requirements by Sargassum for post-hatchling loggerheads, i.e., >10 m depth.

Species	FR Notice /Date	Physical or Biological Features Essential for the Conservation of the Species
Atlantic Ocean (continued)		
Killer Whale Orcinus orca: Southern Resident	71 FR 69054 11/29/2006	• Water quality to support growth and development; • Prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth; and • Passage conditions to allow for migration, resting, and foraging.
Hawaiian Monk Seal *Neomonachus schauinslandi*	51 FR 16047 04/30/1986 53 FR 18988 05/26/1988 extended CH from 10 to 20 fathoms deep around NWHI 80 FR 50925 8/21/2015	• Pupping and major hauling beaches including the vegetation immediately backing the beaches (coral sand beaches and lava benches). • Shallow protected water adjacent to the above (tide pools, inner reef waters, shoal areas, and near shore shallows). • Deeper inner reef areas and lagoon waters. • Other waters surrounding the NWHI to at least 80 fathoms. • Banks and shoals without emergent lands and pelagic waters. • Terrestrial areas and adjacent shallow, sheltered aquatic areas with characteristics preferred by monk seals for pupping and nursing • Marine areas from 0 to 200 m in depth that support adequate prey quality and quantity for juvenile and adult monk seal foraging • Significant areas used by monk seals for hauling out, resting, or molting
Stellar Sea Lion *Eumetopias jubatus:* (Eastern DPS delisted, but CH still in effect; see 78 FR 66139)	58 FR 45269 8/27/1993	**Terrestrial, air, and aquatic areas that support:** • Reproduction • Foraging • Rest • Refuge

Species	FR Notice /Date	Physical or Biological Features Essential for the Conservation of the Species
Atlantic Salmon Salmo salar: Gulf of Maine	74 FR 29300 6/19/2009	**Spawning and Rearing** • Deep, oxygenated pools and cover (e.g., boulders, woody debris, vegetation, etc.), near freshwater spawning sites, necessary to support adult migrants during summer while they await spawning in the fall. • Freshwater spawning sites that contain clean, permeable gravel and cobble substrate with oxygenated water and cool water temperatures to support spawning activity, egg incubation, and larval development. • Freshwater spawning and rearing sites with clean, permeable gravel and cobble substrate with oxygenated water and cool water temperatures to support emergence, territorial development and feeding activities of Atlantic salmon fry. • Freshwater rearing sites with space to accommodate growth and survival of Atlantic parr. • Freshwater rearing sites with a combination of river, stream, and lake habitats that accommodate parr's ability to occupy many niches and maximize parr production. **Migration** • Freshwater and estuary migratory sites free from physical and biological barriers that delay or prevent access of adult seeking spawning grounds needed to support recovered populations. • Freshwater and estuary migration sites with pool, lake, and instream habitat that provide cool, oxygenated water and cover items (e.g., boulders, woody debris, and vegetation) to serve as temporary holding and resting areas during upstream migration of adult Atlantic salmon. • Freshwater and estuary migration sites with abundant, diverse native fish communities to serve as a protective buffer against predation. • Freshwater and estuary migration sites free from physical and biological barriers that delay or

Species	FR Notice /Date	Physical or Biological Features Essential for the Conservation of the Species
Atlantic Salmon *Salmo salar* (continued)	74 FR 29300 6/19/2009	prevent emigration of smolts to the marine environment. • Freshwater and estuary migration sites with sufficiently cool water temperatures and water flows that coincide with diurnal cues to stimulate smolt migration.
Smalltooth Sawfish Pristis pectinata	74 FR 45353 09/02/2009	**Juvenile Nursery Habitat** • Red mangroves, and • Adjacent shallow euryhaline habitats and • the nursery area functions they provide to facilitate recruitment of juveniles into the adult population.
Gulf Sturgeon Acipenser oxyrinchus desotoi	68 FR 13370 03/19/2003	• Abundant food items, such as detritus, aquatic insects, worms, and/or molluscs, within riverine habitats for larval and juvenile life stages; and abundant prey items, such as amphipods, lancelets, polychaetes, gastropods, ghost shrimp, isopods, molluscs and/or crustaceans, within estuarine and marine habitats and substrates for subadult and adult life stages. • Riverine spawning sites with substrates suitable for egg deposition and development, such as limestone outcrops and cut limestone banks, bedrock, large gravel or cobble beds, marl, soapstone, or hard clay; • Riverine aggregation areas, also referred to as resting, holding, and staging areas, used by adult, subadult, and/or juveniles, generally, but not always, located in holes below normal riverbed depths, believed necessary for minimizing energy expenditures during fresh water residency and possibly for osmoregulatory functions; • A flow regime (i.e., the magnitude, frequency, duration, seasonality, and rate-of-change of fresh water discharge over time) necessary for normal behavior, growth, and survival of all life stages in the riverine environment, including migration, breeding site selection, courtship, egg fertilization, resting, and staging, and for

Species	FR Notice /Date	Physical or Biological Features Essential for the Conservation of the Species
Gulf Sturgeon Acipenser oxyrinchus desotoi (continued)	68 FR 13370 03/19/2003	maintaining spawning sites in suitable condition for egg attachment, egg sheltering, resting, and larval staging; • Water quality, including temperature, salinity, pH, hardness, turbidity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages; • Sediment quality, including texture and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages; and • Safe and unobstructed migratory pathways necessary for passage within and between riverine, estuarine, and marine habitats (e.g., an unobstructed river or a dammed river that still allows for passage).
Green Sturgeon Acipenser medirostris: *Southern*	74 FR 52300 10/9/2009	**Freshwater areas** • *Food resources.* Abundant prey items for larval, juvenile, subadult, and adult life stages. • Substrate type or size (i.e., structural features of substrates) • Water flow. A flow regime (i.e., the magnitude, frequency, duration, seasonality, and rate-of-change of fresh water discharge over time) necessary for normal behavior, growth, and survival of all life stages. • Water quality. Water quality, including temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages. • Migratory corridor. A migratory pathway necessary for the safe and timely passage of Southern DPS fish within riverine habitats and between riverine and estuarine habitats (e.g., an unobstructed river or dammed river that still allows for safe and timely passage). • Water depth. Deep (≥5 m) holding pools for both upstream and downstream holding of adult or subadult fish, with adequate water quality and flow to maintain the physiological needs of the holding adult or subadult fish.

Species	FR Notice /Date	Physical or Biological Features Essential for the Conservation of the Species
Green Sturgeon Acipenser medirostris *(continued)*	74 FR 52300 10/9/2009	• Sediment quality. Sediment quality (i.e., chemical characteristics) necessary for normal behavior, growth, and viability of all life stages. **Estuarine areas** • Food resources. Abundant prey items within estuarine habitats and substrates for juvenile, subadult, and adult life stages. • Water flow. Within bays and estuaries adjacent to the Sacramento River (*i.e.,* the Sacramento-San Joaquin Delta and the Suisun, San Pablo, and San Francisco bays), sufficient flow into the bay and estuary to allow adults to successfully orient to the incoming flow and migrate upstream to spawning grounds. • *Water quality.* Water quality, including temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages. • Migratory corridor. A migratory pathway necessary for the safe and timely passage of Southern DPS fish within estuarine habitats and between estuarine and riverine or marine habitats. • Water depth. A diversity of depths necessary for shelter, foraging, and migration of juvenile, subadult, and adult life stages. • Sediment quality. Sediment quality (i.e., chemical characteristics) necessary for normal behavior, growth, and viability of all life stages. This includes sediments free of elevated levels of contaminants **Coastal Marine Areas** • Migratory corridor. A migratory pathway necessary for the safe and timely passage of Southern DPS fish within marine and between estuarine and marine habitats. • Water quality. Coastal marine waters with adequate dissolved oxygen levels and acceptably low levels of contaminants (e.g., pesticides, PAHs, heavy metals that may disrupt the normal

Species	FR Notice /Date	Physical or Biological Features Essential for the Conservation of the Species
Green Sturgeon Acipenser medirostris *(continued)*	74 FR 52300 10/9/2009	behavior, growth, and viability of subadult and adult green sturgeon). • Food resources. Abundant prey items for subadults and adults, which may include benthic invertebrates and fish.
Atlantic sturgeon *Acipenser oxyrinchus oxyrinchus* Gulf of Maine DPS	81 FR 35701 6/3/2016 PROPOSED	• Hard bottom substrate (*e.g.,* rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (*i.e.,* 0.0 to 0.5 parts per thousand range) for settlement of fertilized eggs, refuge, growth, and development of early life stages • Aquatic habitat with a gradual downstream salinity gradient of 0.5 to 30 parts per thousand and soft substrate (*e.g.,* sand, mud) downstream of spawning sites for juvenile foraging and physiological development • Water of appropriate depth and absent physical barriers to passage (*e.g.,* locks, dams, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support: (1) Unimpeded movement of adults to and from spawning sites; (2) seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and (3) staging, resting, or holding of subadults or spawning condition adults. Water depths in main river channels must also be deep enough (*e.g.,* ≥1.2 m) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river • Water, especially in the bottom meter of the water column, with the temperature, salinity,
Atlantic sturgeon *Acipenser oxyrinchus oxyrinchus* New York Bight DPS	81 FR 35701 6/3/2016 PROPOSED	
Atlantic sturgeon *Acipenser oxyrinchus oxyrinchus*	81 FR 35701 6/3/2016 PROPOSED	

Species	FR Notice /Date	Physical or Biological Features Essential for the Conservation of the Species
Chesapeake Bay DPS		and oxygen values that, combined, support: (1) Spawning; (2) annual and interannual adult, subadult, larval, and juvenile survival; and (3) larval, juvenile, and subadult growth, development, and recruitment (*e.g.,* 13 °C to 26 °C for spawning habitat and no more than 30° C for juvenile rearing habitat, and 6 mg/L dissolved oxygen for juvenile rearing habitat)
Atlantic sturgeon *Acipenser oxyrinchus oxyrinchus* Carolina DPS	81 FR 36077 6/3/2016 PROPOSED	• Suitable hard bottom substrate (*e.g.,* rock, cobble, gravel, limestone, boulder, etc.) in low salinity waters (*i.e.,* 0.0-0.5 ppt range) for settlement of fertilized eggs and refuge, growth, and development of early life stages • Transitional salinity zones inclusive of waters with a gradual downstream gradient of 0.5-30 ppt and soft substrate (*e.g.,* sand, mud) downstream of spawning sites for juvenile foraging and physiological development • Water of appropriate depth and absent physical barriers to passage (*e.g.,* locks, dams, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support: (1) Unimpeded movement of adults to and from spawning sites; (2) seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary; and (3) staging, resting, or holding of subadults and spawning condition adults. Water depths in main river channels must be deep enough to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river. Water depths of at least 1.2 m are generally deep enough to facilitate effective adult migration and spawning behavior • Water quality conditions, especially in the bottom meter of the water column, with temperature and oxygen values that support: (1) Spawning; (2) annual and inter-annual adult, subadult, larval, and juvenile survival; and (3) larval, juvenile, and subadult growth, development, and recruitment. Appropriate temperature and oxygen values will vary
Atlantic sturgeon *Acipenser oxyrinchus oxyrinchus* South Atlantic DPS	81 FR 36077 6/3/2016 PROPOSED	

Species	FR Notice /Date	Physical or Biological Features Essential for the Conservation of the Species
		interdependently, and depending on salinity in a particular habitat. For example, 6.0 mg/L D.O. for juvenile rearing habitat is considered optimal, whereas D.O. less than 5.0 mg/L for longer than 30 days is considered suboptimal when water temperature is greater than 25 °C. In temperatures greater than 26 °C, D.O. greater than 4.3 mg/L is needed to protect survival and growth. Temperatures of 13 °C to 26 °C for spawning habitat are considered optimal
Eulachon Thaleichthys pacificus*:* *Southern*	76 FR 65323 10/20/2011	• Freshwater spawning and incubation sites with water flow, quality and temperature conditions and substrate supporting spawning and incubation, and with migratory access for adults and juveniles. ° Flow: A flow regime (i.e., the magnitude, frequency, duration, seasonality, and rate-of-change of freshwater discharge over time) that supports spawning, and survival of all life stages. ° Water Quality: Water quality suitable for spawning and viability of all eulachon life stages. Sublethal concentrations of contaminants affect the survival of aquatic species by increasing stress, predisposing organisms to disease, delaying development, and disrupting physiological processes, including reproduction. ° Water Temperature: Suitable water temperatures, within natural ranges, in eulachon spawning reaches. ° Substrate: Spawning substrates for eulachon egg deposition and development. • Freshwater and estuarine migration corridors associated with spawning and incubation sites that are free of obstruction and with water flow, quality and temperature conditions supporting larval and adult mobility, and with abundant prey items supporting larval feeding after the yolk sac is depleted. ° Migratory Corridor: Safe and unobstructed migratory pathways for eulachon adults to

Species	FR Notice /Date	Physical or Biological Features Essential for the Conservation of the Species
Eulachon Thaleichthys pacificus (continued)	76 FR 65323 10/20/2011	pass from the ocean through estuarine areas to riverine habitats in order to spawn, and for larval eulachon to access rearing habitats within the estuaries and juvenile and adults to access habitats in the ocean. ◦ Flow: A flow regime (i.e., the magnitude, frequency, duration, seasonality, and rate-of-change of freshwater discharge over time) that supports spawning migration and outmigration of larval eulachon from spawning sites. ◦ Water Quality: Water quality suitable for survival and migration of spawning adults and larval eulachon. ◦ Water Temperature: Water temperature suitable for survival and migration. ◦ Food: Prey resources to support larval eulachon survival. • Nearshore and offshore marine foraging habitat with water quality and available prey, supporting juveniles and adult survival. ◦ Food: Prey items, in a concentration that supports foraging leading to adequate growth and reproductive development for juveniles and adults in the marine environment. ◦ Water Quality: Water quality suitable for adequate growth and reproductive development.
Puget Sound / Georgia Basin Rockfish species Yelloweye Sebastes ruberrimus Boccacio	78 FR 47635 8/6/2013	**Adults** • Quantity, quality, and availability of prey species to support individual growth, survival, reproduction, and feeding opportunities, • water quality and sufficient levels of dissolved oxygen to support growth, survival, reproduction, and feeding opportunities, and • the type and amount of structure and rugosity that supports feeding opportunities and predator avoidance. **Juvenile canary and boccacio**

Species	FR Notice /Date	Physical or Biological Features Essential for the Conservation of the Species
Sebastes paucispinis		• Quantity, quality, and availability of prey species to support individual growth, survival, reproduction, and feeding opportunities; and • water quality and sufficient levels of dissolved oxygen to support growth, survival, reproduction, and feeding opportunities.

Table 2. Physical or biological features essential for the conservation of the species for NMFS ESA listed pacific salmonids under consultation.

Species	ESU/DPS	FR Notice /Date	Physical or Biological Features Essential for the Conservation of the Species
All of the following Pacific salmon species: Chum Salmon *Oncorhynchus keta* Sockeye Oncorhynchus nerka *Chinook Salmon* Oncorhynchus tshawytscha	Hood Canal Summer-run Lower Columbia River Ozette Lake Puget Sound Lower Columbia River Upper Columbia River Upper Willamette River	70 FR 52630 09/02/2005	• Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development; • Freshwater rearing sites with: ◦ Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; ◦ Water quality and forage supporting juvenile development; ◦ Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. • Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival;

Species	ESU/DPS	FR Notice /Date	Physical or Biological Features Essential for the Conservation of the Species
Steelhead Oncorhynchus mykiss *Steelhead* Oncorhynchus mykiss *(continued)*	Upper Columbia River Snake River Basin Middle Columbia River Lower Columbia River Upper Willamette River	70 FR 52630 09/02/2005	• Estuarine areas free of obstruction and excessive predation with: ◦ Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh & saltwater; ◦ Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; ◦ Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation. • Nearshore marine areas free of obstruction and excessive predation with: ◦ Water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and ◦ Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels. • Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.
Coho Salmon *Oncorhynchus kisutch*	Central California Coast	64 FR 24049 05/05/1999	• Within the range of both ESUs, the species' life cycle can be separated into 5 essential habitat types: (1) Juvenile summer and winter rearing areas; (2) juvenile migration corridors;

Species	ESU/DPS	FR Notice /Date	Physical or Biological Features Essential for the Conservation of the Species
	Southern Oregon, Northern California Coast		(3) areas for growth and development to adulthood; (4) adult migration corridors; and (5) spawning areas. • Essential features of coho critical habitat include adequate (1) substrate, (2) water quality, (3) water quantity, (4) water temperature, (5) water velocity, (6) cover/shelter, (7) food, (8) riparian vegetation, (9) space, and (10) safe passage conditions.
Steelhead Oncorhynchus mykiss & Coho Salmon Oncorhynchus kisutch	Puget Sound Lower Columbia River	81 FR 9251 03/25/2016	• Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development. • Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. • Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival. • Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions

Species	ESU/DPS	FR Notice /Date	Physical or Biological Features Essential for the Conservation of the Species
Steelhead Oncorhynchus mykiss & Coho Salmon *Oncorhynchus kisutch* (Continued)	Puget Sound Lower Columbia River	81 FR 9251 03/25/2016	between fresh- and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation. • Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels. • Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.
Steelhead Oncorhynchus mykiss	Northern California		• Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development. • Freshwater rearing sites with water quantity and floodplain connectivity to

Species	ESU/DPS	FR Notice /Date	Physical or Biological Features Essential for the Conservation of the Species
	California Central Valley Central California Coast South-Central California coast Southern California		form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. • Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival. • Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation. • Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels. • Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

Species	ESU/DPS	FR Notice /Date	Physical or Biological Features Essential for the Conservation of the Species
Coho Salmon Oncorhynchus kisutch	Oregon Coast	73 FR 7816 2/11/2008	• Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. • Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. • Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival. • Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation. • Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic
Coho Salmon	Oregon Coast	73 FR 7816 2/11/2008	

Species	ESU/DPS	FR Notice /Date	Physical or Biological Features Essential for the Conservation of the Species
Oncorhynchus kisutch (continued)			vegetation, large rocks and boulders, and side channels. • Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.
Chinook Salmon	Snake River fall-run Snake River Spring/Summer	58 FR 68543 12/28/1993	**juvenile rearing areas include adequate:** • Spawning gravel • Water quality • Water quantity • Water temperature • Cover/shelter • Food • Riparian vegetation • Space **juvenile and adult migration corridors are the same as for Snake River sockeye salmon**
Sockeye Salmon Sockeye Salmon (continued)	Snake River Snake River	58 FR 68543 12/28/1993 58 FR 68543 12/28/1993	**Spawning and juvenile rearing areas:** • Spawning gravel • Water quality and Water quantity • Water temperature • Food • Riparian vegetation • Access **juvenile migration corridors:** • Substrate • Water quality • Water quantity • Water temperature • Water velocity • Cover/shelter • Food • Riparian vegetation • Space • Safe passage conditions

Species	ESU/DPS	FR Notice /Date	Physical or Biological Features Essential for the Conservation of the Species
			Adult Migration corridor has the same Essential Features, excluding "food"

D. APPENDIX: MAGTOOL DESCRIPTION

MagTool Inputs
The MagTool was used to generate mortality estimates for 30 of the 77 species being consulted on, all of which were anadromous. MagTool estimates were not generated for nine anadromous species due to inaccuracies in the underlying species range data (***Table 1***).

Table 1. Anadromous species under consultation with MagTool estimates

Common Name	DPS/ESU	MagTool Estimates Generated?
Atlantic salmon	Gulf of Maine	No
Chum salmon	Columbia River	Yes
Chum salmon	Hood Canal summer-run	Yes
Chinook salmon	California coastal	Yes
Chinook salmon	Central Valley spring-run	Yes
Chinook salmon	Lower Columbia River	Yes
Chinook salmon	Puget Sound	Yes
Chinook salmon	Sacramento River winter-run	Yes
Chinook salmon	Snake River fall-run	Yes
Chinook salmon	Snake River spring/summer run	Yes
Chinook salmon	Upper Columbia River spring-run	Yes
Chinook salmon	Upper Willamette River	Yes
Coho salmon	Central California coast	Yes
Coho salmon	Lower Columbia River	Yes
Coho salmon	Oregon coast	Yes
Coho salmon	S. Oregon and N. Calif coasts	Yes
Sockeye	Ozette Lake	Yes
Sockeye	Snake River	Yes
Steelhead	California Central Valley	Yes
Steelhead	Central California coast	Yes
Steelhead	Lower Columbia River	Yes
Steelhead	Middle Columbia River	Yes
Steelhead	Northern California	Yes
Steelhead	Puget Sound	Yes
Steelhead	Snake River Basin	Yes
Steelhead	South-Central California coast	Yes
Steelhead	Southern California	Yes
Steelhead	Upper Columbia River	Yes
Steelhead	Upper Willamette River	Yes
Eulachon, Pacific smelt	Southern DPS	No

Green sturgeon	Southern DPS	No
Shortnose sturgeon	NA	Yes
Atlantic sturgeon	Carolina	No
Atlantic sturgeon	Chesapeake Bay	No
Atlantic sturgeon	Gulf of Maine	No
Atlantic sturgeon	New York Bight	No
Atlantic sturgeon	South Atlantic	No
Gulf Sturgeon	NA	No
Smalltooth sawfish	U.S. Portion of Range	Yes

Toxicological Data

The toxicological data used for each of the 30 species assessed are presented in ***Table 2***. Direct mortality was assessed for each compound with comparison to the HC05 LC50 with a standard dose-response slope of 4.5. Species sensitivity distributions (SSD) were generated and described by EPA in the Biological Evaluation's effects characterization (chapter 2). The LC50s used were those associated with the "all fish", "all aquatic vertebrate" and "fish" SSDs for chlorpyrifos, diazinon, and malathion, respectively (BE appendix 2-6).

In addition to assessing direct mortality to listed species, the MagTool was used to generate mortality estimates for prey. Prey mortality was assessed for each compound with comparison to the HC10 LC50, again with a standard dose-response slope of 4.5. Invertebrate "pooled results" SSDs were used for all three compounds (BE appendix 2-8).

Table 2. Toxicological endpoints used to parameterize the MagTool. Values taken directly from EPA's BEs appendix 2-6 and 2-8.

Compound	Endpoint	LC50 value (ppb)	Slope
Chlorpyrifos	Direct mortality - all fish HC05	1.44	4.5
	Indirect (prey) - all fish HC10	2.78	4.5
	Indirect (prey) - Invert HC10	0.072	4.5
Diazinon	Direct mortality – all aquatic vertebrate HC05	237.9	4.5
	Indirect (prey) - all fish HC10	433.2	4.5
	Indirect (prey) - Invert HC10	0.85	4.5
Malathion	Direct – fish HC05	19.4	4.5
	Indirect (prey) - all fish HC10	30.5	4.5
	Indirect (prey) - Invert HC10	1.7	4.5

Time-weighted Average

Toxicological data were compared to EECs representing 1-day and 4-day time-weighted averages for both direct mortality and mortality to prey, as provided in the BEs.

Variability Reported

Probabilistic output is reported reflecting variability in EECs derived by incorporating geographically-specific estimates that account for two sources of variability: (1) the occurrence of pesticide use sites within the species range (six year data set), and (2) daily precipitation (30 year data set). In Appendix A (MagTool Results for Listed Species) NMFS has reported mortality estimates associated with the 5th, 50th, and 95th percentile probabilities for each of the appropriate bins (modeled aquatic habitats).

Adjustment Factors

The MagTool allows for adjustment factors to be applied by use site (e.g. corn, wheat) or by HUC-12 (sub-watershed region). These adjustment factors can be used to either modify the percent overlap or the magnitude of EECs associated with each of the use sites. The adjustment factors also allow the user to customize the distribution of species throughout their range (by HUC-12). NMFS utilized adjustment factors in order to exclude wide area use and mosquito adulticide, but did not use any other adjustment factors in generating estimates for the 30 anadromous species assessed.

Wide Area Use & Mosquito Adulticide

The MagTool relies on spatial data (GIS use-layers) to determine the extent of overlap between the species range and each of the use sites (e.g. corn, wheat). In some cases, data layers for use sites overlap. Use-layer overlap is often appropriate (multiple uses authorized for the same location), however, because the MagTool equates percent overlap with percent exposed, the overlapping layers can lead to difficulty in interpretation. This MagTool assumption can result in either the overestimation or underestimation of risk (see Chapter 11.6.4).

Chlorpyrifos is authorized for two uses which have no restriction on location: wide area use and mosquito adulticide; malathion is authorized for wide area use. NMFS excluded these uses from the MagTool calculations to help simplify the interpretation of the results. While excluded from the MagTool, these uses have been retained in the R-plots and incorporated into the effects analysis. See Appendix D (MagTool Description) for more information on the MagTool and redundancy in spatial overlap between use layers.

MagTool - Conceptual Model Design (Aquatic)

The Magnitude of Effect tool (MagTool) is a provisional model[1] created by the USEPA to assist in the determination of the magnitude of the effect of potential pesticide use to a listed species on a population scale. The MagTool uses the results generated in the Step 2 Biological Evaluation (BE) analysis to carry forward into the Step 3 population-level analysis for multiple lines of evidence, including mortality, growth, reproductive, behavioral and sensory effects. Using dose response relationships, the MagTool predicts the magnitude of mortality for exposed individuals within a population. These individual mortality predictions are combined with information on the percent overlap of specific use sites with the species range and/or critical habitat to predict the percent mortality predicted in the population, using the percent overlap of specified pesticide use sites with the species range and/or critical habitat as a surrogate for the percent of population exposed. Adjustments can be made to the percent of population exposed depending on species and use characteristics, as well as limiting the specific use sites included in the analysis. Potential population impacts due to sublethal effects are made based on estimated exposure concentrations

[1] As a provisional model, the MagTool is still undergoing internal QA/QC at the USEPA.

(EECs) exceeding sublethal toxicity input parameters and the percent of population exposed to these EECs.

The MagTool consists of two separate software tools; one for terrestrial species and a second for aquatic species. Several principles of their model design that are shared are described below. Additional information specific to the Aquatic MagTool is also described. Details specific to the Terrestrial MagTool are not described.

Geospatial Overlap Analysis

Methods for identifying potential pesticide use sites using USDA National Agriculture Statistic Service (NASS) Cropland data layer (CDL) for agricultural uses and other data sources for non-agricultural uses are outlined in the Problem Formulation and Attachment 1-3 (Method for Establishing the Use Site Footprints of the Biological Evaluations) of the BEs (https://www.epa.gov/endangered-species/biological-evaluation-chapters-chlorpyrifos-esa-assessment). Using this methodology, the intersection of the species geospatial range and/or critical habitat with relevant use sites for the pesticide is used to determine a "percent overlap". Major differences between the spatial analyses in the BEs as compared to the analysis used in the provisional MagTool model are discussed here.

One primary difference between the Step 2 and Step 3 overlap analysis is that the individual years of CDL data (2010-2015), summarized to the general agricultural classes, were used in Step 3 as opposed to the temporally aggregated general class layers which were utilized in Step 2 (non-agricultural layers stay the same from 2010 to 2015). This allows for the calculation of percent mortality and a distribution of anticipated effects by individual use footprint for each year. One exception for the MagTool is the calculation of spray drift impacts based on Euclidean distance (described below), which was still based on the aggregated use layers utilized in Step 2. Yearly overlap can only be created for use layers derived from data sources updated on a yearly time step; at this time this only applies to those layers generated from the USDA NASS CDL. The CDL is limited to the contiguous United States (lower 48), so the MagTool is only used for species with ranges in the lower 48. For this reason, results from the MagTool only represent the area of the species files found within the contiguous United States. The area of the species files found partially or completely outside the lower 48 cannot be fully analyzed using the MagTool. The results from the BE describing the overlap for the full range or critical habitat, based on the aggregated layers is available in the tool. Buffered and drift results are also based on the aggregated layers and the full range or critical habitat file.

Another addition in the MagTool geospatial analysis is the use of Hydrologic Unit Code areas at the 12-digit scale (HUC 12s) to spatially define aquatic species. Using the species locations files provided by the Services, all intersecting HUC 12s are identified and used as the master species location file. When instructed by the Services, the master file was not replaced with the HUC 12 intersection; this occurred typically for species with both terrestrial and aquatic phases or primarily marine species. When the master species file is not based on HUC 12s, the reported overlap from the BE may not match the HUC 12 overlap from the MagTool.

Finally, in order to predict species impacts due to off-site transport, the "Euclidean distance" is used to determine the proportion of the species range within each desired distance interval from a use site. The use site may be within the species range or outside the species range. Euclidean distance, or the shortest distance between two points, is defined in GIS modeling as the distance from center point of one pixel (e.g. location within the species range) center point of another pixel (e.g. the location of pesticide use in a raster map). These distances are projected off-site and are used to describe how overlap from spray drift intersects with a species range. At each incremental distance off site (set at 30 m), the % overlap with the species range is determined. The use of Euclidean distance in combination with predicted off-site EECs to predict off-site effects is discussed further in "Spray Drift Effects – Incorporating Euclidean distance overlap with EECs to predict mortality" section below. Examples of Euclidean distances are shown in Figure 1, below.

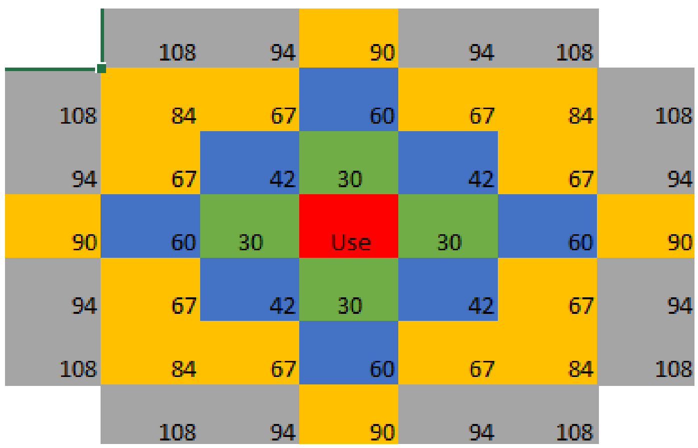


Figure 1. Euclidean distance off-site transport "rings" as determined for use in the MagTool.

Bulleted below are some additional points to consider in the interpretation of the overlap analysis in the MagTool.

- When predicting overall mortality in an exposed population, the tool provides predicted mortality from individual use layers as well as the mortality output of all of the individual use layers for each year combined. When summing the individual results, total overlap likely exceeds 100% when individual uses overlap one another. Without considering unmapped uses such as Mosquito Control, the total percent overlap cannot exceed the percent overlap of the action area. The extent to which individual use layers overlap one another nationally is provided in Attachment 1 and should be considered when interpreting results. Likewise, low overlap for an individual use may not indicate low overall spatial overlap of uses with the species range (*i.e.,* all uses should be considered).
- Given that all use layers are rasters comprised of square pixels, the overlap of the species and use site may include edge effects, potentially resulting in greater than 100% overlap.

The boundaries of the species range files are irregular and do not follow the straight lines and right angles of square. If you were to place a circle on top of a square with the diameter of the circle equal to the edge of the square pixel, the square will cover more area in the four corners. When running a raster analysis that is based on square pixels, the total area may exceed the area of a range that does not have right angle edges, resulting in greater than 100% overlap.

- Euclidean distances, as utilized in ArcGIS, calculate the distance based on the distance from the center point of a pixel in the use raster map to the center point of another pixel location, accounting for diagonal movement. Therefore, as shown in Figure 1 above, the distance for pixels not on a straight line to the use pixel, will actually be more than 30 m because it lies on a diagonal line. For the figure above, the green squares fall in the >0–30 m, the blue squares in the 31-60 m, the orange squares in the 61-90 m, etc. The use of a 30 m increment is based on the pixel size of the CDL use raster maps, but could be established at 20, 50, 100 or any other meter increment.
- Euclidean distance "rings" extend out from all use sites. If a ring from one use site encounters the ring from a different use site, the minimum distance to use is assigned as the distance value for that cell. The proportion of the species range found in each ring is represented by the % overlap at each distance interval, which for the purpose of the MagTool is set to 30 meter increments. These distance intervals are mutually exclusive from each other. This % overlap is used in combination with the predicted EEC at that off-site distance to determine anticipated species impacts, as described further below.
- Buffered overlap (used predominantly in Step 2) is calculated using the Euclidean distance of the aggregated use layers and includes the use sites and spray drift, out to the limits of the drift models, for the specific use application method. The full species range is used in this calculation, the area within and outside the lower 48.
- Spray drift overlap is calculated using the Euclidean distance of the aggregated use layers with the interval set to 30 meters and represents the overlap unique to the interval. The full species range is used in this calculation, the area within and outside the lower 48.

Aquatic MagTool

Aquatic Fish and Invertebrates

Species ranges for aquatic fish, invertebrates, and plants were determined based on HUC 12s which contain the waterbodies associated with the species. The percent overlap is determined for each HUC 12 in the species range with each of the non-ag and yearly ag use sites and is used to adjust the percent of a species population that may be exposed to EECs from that use, or as a means to adjust the EECs for medium and large flowing waterbodies. The 30 annual maximum daily or period (*e.g.*, 4-day, 21-day, or 60-day) average EECs for each Pesticide in Water Calculator (PWC) run for a use are used to simulate the range of exposure concentrations to which the species could be exposed. While the PWC runs are conducted at the larger 2-digit HUC level (HUC 2), HUC 12s are subsets of the HUC 2s and the HUC 2 EECs are intended to represent exposure within the HUC 12 species ranges. All of this information, coupled with the effects endpoints of interest, is used to estimate a distribution of exposure and effects to the species population.

Different methods are used for species depending on if they are in flowing or static waterbodies and if they are in single or multiple HUC 12s.

For static waterbodies and low-flow flowing waterbodies (Bins 2 and 5-7; described in Attachment 3-1 of BEs, https://www.epa.gov/endangered-species/biological-evaluation-chapters-chlorpyrifos-esa-assessment#attachments-3), pesticide loading is assumed to be from local uses (e.g. adjacent fields) and exposure, therefore, will be associated with specific uses within the HUC 12. For the medium and large-flow flowing waterbodies (Bins 3 and 4), pesticide exposure is associated with transport from all uses within an entire watershed (represented in this case the HUC 12). For the static and low-flow flowing waterbodies, the percent overlap was used, as it was in the terrestrial version of the tool, as a surrogate for percent of the species exposed to a use's EECs. For medium and high-flow flowing waterbodies, the EECs were adjusted using the percent overlap, much as a percent crop area adjustment factor would be used, and summed to develop an EEC to which the entire population in the HUC 12 would be exposed.

For a species range which is limited to a single HUC 12, the entire species population is exposed to EECs associated with that HUC 12. For a species range that spans multiple HUC 12s, it is uncertain how much of the species population is associated with each of the HUC 12s. The user can assume a uniform distribution of the species throughout the species range. In this case, the fraction of the area of a HUC 12 in the species range is used as a surrogate for the fraction of the population in the HUC 12. The user can alternatively assume a non-uniform distribution across the HUC 12s. The user may have information on the species' distribution within the range that can inform a species' distribution within their range, including: meta-populations, age cohorts, and other life history characteristics. In these cases, the user will need to specify the percent of the population associated with each HUC 12 in the species range.

Below is a more detailed description of the methodology used to estimate the probability distributions for mortality and sublethal effects for species assumed to have a uniform distribution across the HUC 12s.

For species in static waterbodies and low-flow flowing waterbodies (Bins 2 and 5-7) with a range limited to a single HUC 12:

1. An estimate of the pesticide use footprint within the single HUC 12 watershed corresponding to the species range is developed using the 6 annual summaries of general CDL use site classes and non-ag use sites.
2. The percent mortality is estimated using 30-year annual maximum daily or 4-day average EECs for the uses in the HUC 12. For sublethal endpoints, the 30-year annual maximum daily, 4-day, 21-day, or 60-day average EECs are used for the uses in the HUC 12 to estimate the percent of the population exposed to an EEC that may meet or exceed the sublethal endpoint (exposure periods should be selected that most accurately reflect the duration of study from which toxicity endpoint are derived). If an EEC meets or exceeds

the sublethal endpoint, the entire population exposed to that EEC is exposed to an EEC that meets or exceeds the sublethal endpoint. Otherwise, none of the population is exposed.

3. The percent mortalities and sublethal exceedances are adjusted using the 6 CDL percent use footprints. This results in 180 values (30-year annual maximum values x 6 different CDL percent use layers) for each use.
4. For each year/percent use combination, the percent mortalities and percent meeting or exceeding the sublethal effects are summed across the uses to estimate the effects to the entire population. This results in 180 values for the HUC 12, which is used to develop a probability distribution for the entire population.

For species in static waterbodies and low-flow flowing waterbodies (Bins 2 and 5-7) with a range larger than a single HUC 12, the same process, as discussed above, is used, except each HUC 12 is assigned a weight based on the acreage of the HUC 12 in relation to the entire range. The same steps as discussed above are applied along with:

1. The percent mortalities and percent meeting or exceeding the sublethal effects across uses for each HUC 12 is multiplied by the fraction of the population in the HUC 12 to estimate the effects to the subpopulation in the HUC 12. This results in 180 values for the HUC 12, which is used to develop a probability distribution for the subpopulation in the HUC 12.
2. To determine the population effects distribution across the entire range (all HUC 12s combined), for each year/percent use combination, the weighted percent mortalities and percent meeting or exceeding the sublethal effects are summed across uses for each of the HUC 12s above to estimate the effects to the entire population. This results in 180 values for the species range, which is used to develop a probability distribution for the species population.

For species in medium and high-flow flowing waterbodies (Bins 3 and 4) that have a range limited to a single HUC 12:

1. The individual use footprints within the single HUC 12 watershed corresponding to the species range is estimated using the 6 annual summaries of generalized CDL classes and the non-ag use site.
2. The 30-year annual maximum daily or 4-day average EECs are adjusted for the medium and high-flowing waterbodies (Bins 3 and 4) for each use in HUC 12 based on percent use area. For sublethal effects, the 30-year annual maximum daily, 4-day, 21-day, or 60-day average EECs for each use in the HUC 12 are adjusted based on the percent use area.
3. The adjusted EECs are aggregated.
4. Assuming the entire population in HUC 12 is exposed to the aggregated EEC, the distribution of percent mortality for the population using dose response curve and probability of meeting or exceeding a sublethal endpoint is determined using aggregated EECs in the HUC 12 for each year.

For species in medium and high-flow flowing waterbodies (Bins 3 and 4) that have a range larger than a single HUC 12, the same process, as discussed above, is used, except each HUC 12 is assigned a weight based on the acreage of the HUC 12 in relation to the entire range. The same steps as discussed above are applied along with:

1. The percent mortality is multiplied by the percent of the population in HUC 12. This is repeated for the probability of exceeding a sublethal endpoint.
2. The results from Step 2 are summed to determine the percent mortality/probability of exceeding sublethal effect for total population.

Results for exposures resulting from unmapped uses (i.e. Mosquito Control and Wide Area) were each calculated by separate runs of the MagTool. These uses are considered to have 100% overlaps with species ranges. Therefore, they would overlap with other uses and the MagTool could readily produce difficult to interpret results (e.g. >100% mortalities).

Spray Drift Effects – Incorporating Euclidan distance overlap with EECs to predict mortality

Aquatic

The Aquatic MagTool employs the same algorithm used in AgDRIFT to estimate aquatic EECs resulting from spray drift only. The tool estimates the drift across the waterbody width at 30-meter distances away from a treated field. The product of this average drift and the application rate, divided by the depth of the waterbody, results in a short-term average concentration in the waterbody due to spray drift. This concentration is then used to estimate the percent mortality that could potentially occur in a waterbody exposed to spray drift. Unlike the terrestrial tool, no application of percent overlap from the Euclidean distance is applied to the aquatic EECs.

Attachment 1. Redundancy in spatial overlap between CDL use layers

Column crop makes up x% of 1st row crop	Cattle Eartag	Christmas Tree	Corn	Cotton	Cull Piles	Developed	Golf Courses	Managed Forest	Nurseries	Open Space Developed	Orchards and Vineyards	Other Crops	Other Grains	Other RowCrops	Pasture	Pineseed Orchards	Rice	Right of Way	Soybeans	Vegetables and Ground Fruit	Wheat
Cattle Eartag		63	15	9	24	2	16	35	17	2	24	23	15	12	74	4	5	18	14	12	15
Christmas Tree	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corn	4	14		28	8	1	1	1	8	3	8	17	28	47	8	0	16	4	80	36	36
Cotton	0	0	4		3	0	0	0	1	1	3	5	10	22	1	1	4	1	4	5	7
Cull Piles	0	5	0	1		0	1	0	2	0	95	2	1	1	1	1	1	0	0	3	1
Developed	0	1	0	0	1		11	0	43	0	1	1	0	0	0	0	0	42	0	1	0
Golf Courses	0	0	0	0	0	0		0	0	2	0	0	0	0	0	0	0	0	0	0	0
Managed Forest	10	13	1	1	9	1	3		3	2	9	2	1	1	4	100	0	6	1	1	1
Nurseries	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0
Open Space Developed	0	2	1	3	3	0	65	1	18		3	1	1	1	1	1	1	21	1	1	1
Orchards and Vineyards	0	5	0	1	98	0	1	0	2	0		2	1	1	1	1	1	0	0	4	1
Other Crops	3	13	7	16	19	1	3	1	5	2	20		34	14	6	2	32	2	6	21	32
Other Grains	1	3	8	21	5	0	1	0	1	1	6	23		18	3	0	7	1	6	21	27
Other RowCrops	0	0	4	14	1	0	0	0	0	0	1	3	5		1	1	1	0	3	13	7
Pasture	63	88	25	18	48	6	30	11	24	11	49	41	35	24		22	8	19	21	29	30
Pineseed Orchards	0	0	0	0	1	0	0	4	0	0	1	0	0	0	0		0	0	0	0	0
Rice	0	0	1	1	0	0	0	0	0	0	0	3	1	0	0	0		0	3	0	0
Right of Way	3	8	2	3	5	100	15	3	53	37	5	3	2	2	4	3	2		2	2	2
Soybeans	4	4	73	26	3	1	1	1	7	3	3	12	21	35	6	0	69	4		25	35
Vegetables and Ground Fruit	0	4	4	4	8	0	0	0	2	0	8	5	8	16	1	0	1	0	3		9
Wheat	3	4	24	36	8	1	1	0	3	3	9	52	65	60	7	0	8	3	26	59	

E. APPENDIX: RISK HYPOTHESES FOR CRITICAL HABITAT

All Salmonids

- Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater spawning sites.
- Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in freshwater rearing sites.
- Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality, natural cover, and/or reductions in prey in freshwater migratory corridors.
- Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in estuarine areas.
- Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality and/or reductions in prey in nearshore marine areas.

Atlantic salmon

For Atlantic salmon, NMFS jurisdiction is limited to the marine environment only. However, specific areas of designated critical habitat were not identified within the marine environment (71 FR 69054). Therefore, NMFS did not assess impacts to designated critical habitat of Atlantic salmon in this Opinion; these impacts are addressed by FWS.

Sturgeon – Gulf

- Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality.
- Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey.

Sturgeon – Green

- Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater habitats.
- Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in freshwater habitats.
- Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in estuarine habitats.
- Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in estuarine habitats.
- Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in coastal habitats.
- Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in coastal habitats.

Eulachon

- Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in freshwater and estuarine habitats.
- Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in freshwater and estuarine habitats.
- Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality in nearshore and offshore habitats.
- Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in nearshore and offshore habitats.

Rockfish

- Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality.
- Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey.

Sawfish

- Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey in shallow euryhaline habitats.

Steller Sea Lion

- Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey.

Hawaiian Monk Seal

- Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey within 0-200 meters of depth.

Killer Whale

- Direct exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey.
- Exposure to the stressors of the action outside of designated critical habitat is sufficient to in-directly reduce the conservation value via reductions in prey availability (Chinook salmon).
- Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality.

Black Abalone

- Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality.
- Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey.

Elkhorn Coral & Staghorn Coral

PBFs identifies are not anticipated to be effected by the action.

Johnson's Seagrass

- Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality

Green Sea Turtle & Hawksbill Sea Turtle

- Exposure to the stressors of the action is sufficient to reduce conservation value via degradation of water quality

Leatherback Sea Turtle

- Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey (jelly fish).

Loggerhead Sea Turtle

- Exposure to the stressors of the action is sufficient to reduce conservation value via reductions in prey (sargassm, copopods).

F. APPENDIX: R-PLOT GENERATION

To provide an aid in the Risk Characterization section, NMFS developed a plot (referred to as an 'R-plot') displaying the various sources of data (i.e. exposure, response, and use) available in EPA's Biological Evaluation (BE). The R-plots are generated using the R programming language:

R Core Team (2017). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

This Appendix consists of several sections with information on the R-plot process:

- **R-plot Process Overview:** An overview of the R-plot process
- **Example R-Plot:** An example of an R-plot
- **Directory and Files:** A list of the directories and file needed by the R-plot process
- **R code lines to modify:** A description of inputs to change in the R code
- **Toxicity Data File:** An example of a toxicity data file used by the R code
- **HUC-12 List File:** An example of a HUC-12 list that may be used by the R code
- **Main R Code:** The primary R code file used to generate R-plots
- **Import R Code:** R code used to import data prior to running the main R code
- **Functions R Code:** R code defining several functions used by the other R code

R-plot Process Overview
The following is a brief overview of the R-plot process. The overview assumes an understanding of the data within the BE and Biological Opinion and some knowledge of the R programming environment.

The data displayed on the R-plots comes from three sources. For the R-plot process, these sources appear as various files that the R code relies on for generating the plots. A list of the files is provided in the **Directory and Files** section. A summary of the sources is detailed here:

1) Toxicity information for a species gathered from the available literature and presented in the BE. For sublethal endpoints, such as growth, this is typically a range of LOECs across the available studies. For endpoints such as mortality, this is can be a range of percent mortalities using an LC50 and slope chosen based on a species sensitivity distribution. For the R-plot process this information is provided by a tab-delimited text file generated by the user (an example is provided in **Toxicity Data File**).
2) Data on the species range and critical habitat (e.g. a list of HUC-12s), the uses of the pesticide (e.g. Vegetable and Ground Fruit), and their overlap (by HUC-12). This information is from the GIS analysis presented in the BE. For the R-plot

process, this information is provided by various files distributed by EPA with the BE and the MagTool. Files such as species_huc12.csv (in the bin directory of the MagTool) provide a list of HUC-12s by species. The various CDL files (e.g. CDL_L48_2010.csv in the bin directory) provide a list of uses and their overlaps for each of the HUC-12s.

3) Exposure estimates generated by EPA using the Pesticide Water Calculator (PWC). For each crop and use category (e.g. lettuce crop within the Vegetable and Ground Fruit use category) EPA generated thirty years of EECs for each HUC-2 and aquatic bin. The resulting data is provided with the BE and the MagTool. For the R-plot process, the thirty annual peak EECs for four different averaging periods are provided by files distributed with the MagTool (e.g. chlorpyrifos_eec.csv in the EECs directory).

The process of generating an R-plot typically starts with selecting a chemical and species. The selection of species determines which HUc-12s are extracted from the data files. The selection of chemical determines the relevant EECs and uses for the list of HUC-12s. The list of HUC-12s determines which HUC-2s are needed from the EEC data.

The plot only displays a single EEC range for a specific crop and use category (e.g. lettuce as a Vegetable and Ground Fruit use). If the list of HUC-12s spans multiple HUC-2s an adjustment can be made that computes a weighted average of the multiple HUC-2 EECs available. This adjustment is based on the proportion of the total area represented by each HUC-2. The more area of HUC-12s that belong to a HUC-2, the more that the EECs for that HUC-2 will contribute to the EECs displayed on the plot.

The R code compiles these sources of information into a single plot. An example of an R-plot is shown in **Example R-Plot**. The plot consists of five parts.

1) The upper portion displays the information present in the selected toxicity data file. This consists of multiple rows of endpoints each with a set of labeled markers. The meaning of each marker is up to the user (e.g. a LOEC, percent morality, etc.). The markers are positioned along the concentration axis below.
2) The center of the plot displays all the EEC data associated with the selected chemical, HUCs and relevant PWC scenarios. Each point represents the median peak annual EEC for one averaging period for a specific PWC scenario. For each crop (e.g. lettuce) of a use category (e.g. Vegetables and Ground Fruit) there will be a point for each averaging period and each aquatic bin. Error bars around the point indicate the 5% and 95%tile of the distribution of thirty years of data. The EEC data is positioned using the same concentration axis as the toxicity data to allow direct comparison of exposure and effects.
3) The left side of the plot (i.e. the left Y-axis labels) list the use categories associated with the species range (or list of HUC12s) in order of their area (largest area at the top). The area of each use category is denoted in the parentheses. Mosquito Control and Wide Area Use will be at the top due to their allowed use anywhere. The bin 3 and 4 estimates for the entire range (a 'watershed') account for the contribution of each use-specific EEC to the watershed based on the

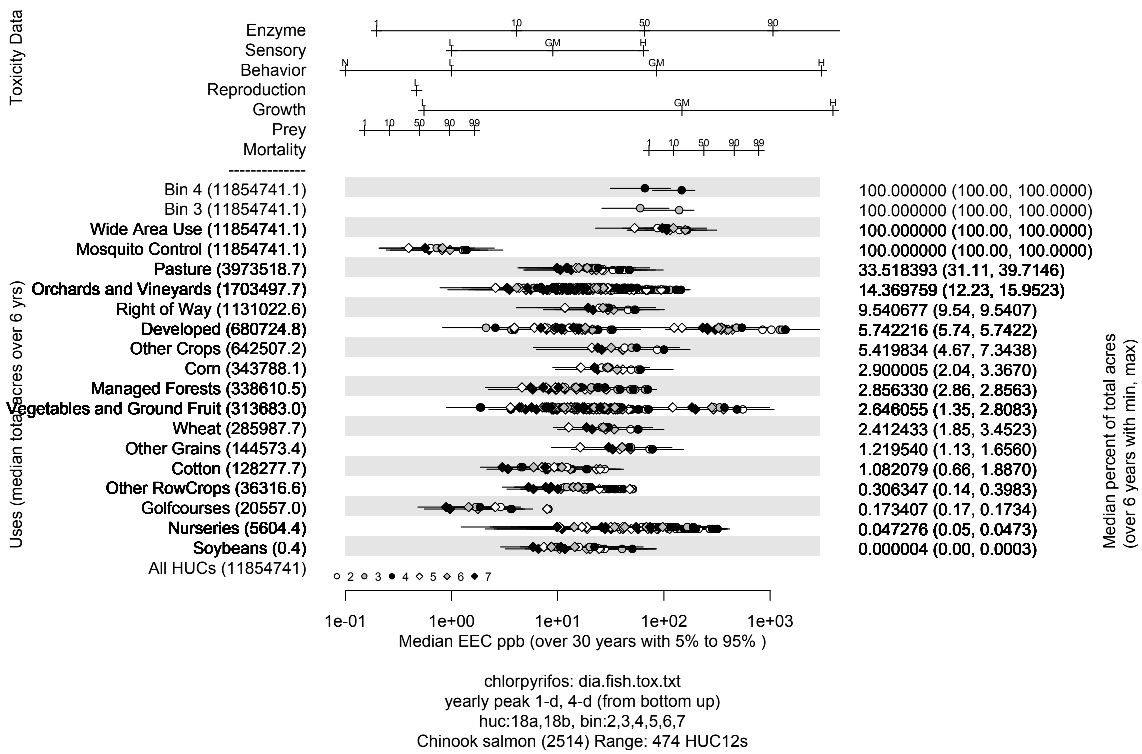
proportion of the range represented by the use.

4) The right side of the plot (i.e. the right Y-axis labels) shows the percent of the range represented by each use. For each use, six years of overlap data were provided and the median, minimum, and maximum percent overlaps are shown.
5) The bottom of the plot has four lines of text that identify the specific information presented in the R-plot. The first line shows the chemical and toxicity data file. The second line shows which averaging periods were plotted. The third line lists the HUC-2s and bins from which the EECs were selected. The fourth line shows some species and range info (e.g. number of HUC-12s).

Running the R code requires a collection of files and folders (see **Directory and Files**). In brief, the R-plot process begins with converting several files (see **Directory and Files**) into R objects using one of the R files (*AqEECsImportMagToolDataC.R).* This needs to be done once each time the source data changes. Generating an R-plot then involves editing several lines within the main R file (*AqEECsSummariesWithOverlapY.R*) to select the desired information (e.g. the chemical and species) and then running ('Source') the code. Details on these lines in the R code is provided in **R code lines to modify**. The resulting plot can then be saved as needed by the user. Generating a different R-plot entails editing a few lines as needed and repeating the process.

Example R-Plot

Example of a plot generated by the R code.



Directory and Files

List of files and directories associated with running the R-code. They all need to be in the same directory. There are three R files (identified in italics below), the code of which is provided later in this document.

File/folder	Comments
AqEECsSummariesWithOverlapY.R	Main R-code run to generate plot
AqEECsFunctionsB.R	Functions loaded by main file
AqEECsImportMagToolDataC.R	R-code run to import data Creates R objects used by main R file Needs to be run at least once
Species Summary sheet updates_01-04-17.xlsx	Info from EPA used to create species_info.txt Export columns A-E as tab-delimited
dia.fish.tox.txt	Example of toxicity data file (provided below) Tab-delimited text file used by main R code
nurseryHUC12.txt	Example of HUC12 list (provided below) Tab-delimited text file
Data Tables	Folder used to store any tables created
MagTool Data	Folder of files needed by
CDL_L48_2010.csv	*AqEECsImportMagToolDataC.R*
CDL_L48_2011.csv	All data provided with EPA's MagTool
CDL_L48_2012.csv	
CDL_L48_2013.csv	
CDL_L48_2014.csv	
CDL_L48_2015.csv	MagTool files from bin directory
Critical_habitat_huc12.csv	
huc12_acres.csv	
huc_convert.csv	
input.csv	
species_huc12.csv	
chlorpyrifos_eec.csv	
diazinon_eec.csv	MagTool files from EECs directory
malathion_eec.csv	
species_info.txt	Tab-delimited file created from Species Summary sheet updates_01-04-17.xlsx Export columns A-E as tab-delimited
R Objects	Folder of R objects used by main R file
EECs.df	Files created by *AqEECsImportMagToolDataC.R*
cdl.names	
huc_acres.df	
huc_convert.df	
overlaps.ar	
speciesHUC.df	
species_info.df	

R code lines to modify

Several specific lines of the R code define the information plotted. The values for the variables specified in these lines determine the resulting R-plot (e.g. the species and chemical). These lines are located at the beginning of the R code just after the following comment.

```
# select data to summarize ***********  USER selection section of inputs
```

Changing these values prior to running the R code is how different R-plots are generated.

An element from each of these lists is chosen in lines below.

```
chemlist<-c("chlorpyrifos","diazinon","malathion")
readoptions<-c("Species range","Read from file","Choose HUC2s")
```

Changing the index of chemlist determines which chemical is summarized (e.g. which EEC data is used).

```
chemtext<-chemlist[1] # *************** select chemical from chemlist above e.g. 1 for cpy, 2 for dia, 3 for mal
```

The value of toxfilename specifies the file containing the toxicity data used to generate the toxicity display at the top of the R-plot. The file needs to exist in the same directory as the R code file. An example of a file is below.

```
toxfilename<-"dia.fish.tox.txt" # file with info for toxicity data section of the plot
```

The index of readoptions determines which HUCs are used to generate the uses and overlaps shown on the R-plot. Species range uses the HUC12s associated with the species. Read from file uses a list of HUC12s specified in a file the user is asked to select. Choose HUC2s uses the HUC2s specified in a variable below.

```
readhucs<-readoptions[1] # ****************** how to get HUC12 and HUC2 lists, from readoptions list e.g. 1 for "Species range"
```

The value of speciesID determines which species is summarized (e.g. which HUC12s are used).

```
speciesID<-2514 # ************* Select species Entity ID
```

The value of plotHabitat determines whether the plot is based on HUCs in the species range (True) or the designated critical habitat (False).

```
plotHabitat<-FALSE # set to true to plot critical habitat rather than species range
```

Use to force the plot to be based on selected HUC2s (False) rather than HUC12s (True).

```
useHUC12s<-True # ****************** use HUC12 info otherwise rely on HUC2 and don't plot overlap
```

Lines used to determine which aquatic bins are summarized in the plot. Changing useSpeciesBins to False will plot only the bins specified by bintext and not all the bins associated with a species. The bin 3 and 4 EECs associated with individual uses can be omitted by changing the lines to True. The aggregated bin 3 and bin 4 EECs across the collection of HUC12s (the 'watershed') are plotted separately.

```
useSpeciesBins<-True # **************** plot all the bins
assigned to a species or specific bins
OmitBin3<-False  # **************** don't plot bin 3 values for
individual uses
OmitBin4<-False  # **************** don't plot bin 4 values for
individual uses
bintext<-c("2","6","7") # *************** bins to plot if not
based on species
```

The HUC-2s specified in huctext are used to determine the EEC data summarized if the HUC-2s aren't specified by the species data.

```
huctext<-c("18a") # *************** list of HUC2s for EEC data if
not specified by the species HUC12 list
```

The values in avgper determine which EEC averaging periods are plotted. Any combination of 1, 2, 3, and 4 can be specified.

```
avgper<-c(1,2) # ************** EEC averaging periods to plot, 1-
4 correspond to 1-d, 4-d, 21-d, 60-d
```

The value of multiHUC2adj determines how to adjust for multiple HUC2 regions in the species range. Set to False will average the HUC-2 EECs without respect to area, while True will account for the proportion of the total range represented by each HUC-2 as described above. This will involve more computation time.

```
multiHUC2adj<-TRUE # if multiple HUC2s adjust EECs based on
proportion of total area
```

Toxicity Data File

Example of toxicity data file used to generate toxicity data at the top of the plot. Needs to be a tab-delimited file with two columns for each endpoint. Endpoints are plotted in reverse order (i.e. first column pair appears at the bottom of the toxicity data). The first row has the name of the endpoint in the first column that will be used on the plot with the second column being ignored. The remaining rows contain data that will be plotted. The first column has the concentration and the second column has the label for the point.

Mortality	M.labels	Prey	P.labels	Growth	G.labels	Reproduction	R.labels	Behavior	B.labels	Sensory	S.labels	Enzyme	E.labels
72.3	1	0.15	1	0.55	L	0.47	L	0.1	N	1	L	0.196	1
123.5	10	0.26	10	148	GM			1	L	9	GM	4.086	10
237.9	50	0.50	50	3915	H			85	GM	64	H	65.95	50
458.3	90	0.96	90					3043	H			1064.43	90
782.3	99	1.64	99									22148.04	99

HUC12 List File

Example of a HUC12 list. Needs to be a tab-delimited file. The first row has the name of the region. This is used by the R code to present a list from which the user selects the desired HUC12s to plot. The remaining rows are the HUC12s to use to generate the plot.

Charlotte Harbor	Everglades	Nursery
31001010907	30902041000	31001010907
31001010906	30902040800	31001010906
31001011106	30902040700	31001011106
31001011107	30902041100	31001011107
31001020506	30902021300	31001020506
31001011108	30902021400	31001011108
31001030202	30902061609	31001030202
31001030101	30902061608	31001030101
31001030201	30902030200	31001030201
31002010303	30902030100	31002010303
30902050502	30902030300	30902050502
31001030102		31001030102
30902050602		30902050602
31001030103		31001030103
30902050601		30902050601
30902050408		30902050408
31001030300		31001030300
30902050603		30902050603
31001030104		31001030104
30902050607		30902050607
30902050605		30902050605
30902050606		30902050606
31001030105		31001030105
30902040102		30902040102
30902040103		30902040103
30902040107		30902040107
30902040105		30902040105
30902040106		30902040106
30902040208		30902040208
		30902041000
		30902040800
		30902040700
		30902041100
		30902021300
		30902021400
		30902061609
		30902061608
		30902030200
		30902030100
		30902030300

Main R Code

The primary R code file. Any changes to the code should be made (e.g. modify the USER selection lines), the code should then be saved, and then the code should be "Sourced". This allows the first line of the code to determine the folder the code is in and therefore how to find the support folders needed.

AqEECsSummariesWithOverlapY.R

```
# establish dirs
wd<-dirname(sys.frame(1)$ofile) # get dir of sourced R script and other
dir
rdir<-"R Objects" # dir name for R objects within dir of R script
sdir<-"Data Tables" # dir name to store data tables within dir of R script

# load functions and data if needed
if (!exists("getHUC")) source(file.path(wd,"AqEECsFunctionsB.R")) # load
functions
if (!exists("getHabitatHUC")) source(file.path(wd,"AqEECsFunctionsB.R")) #
load functions
if (!exists("EECs.df")) load(file.path(wd,rdir,"EECs.df")) # load data
if (!exists("overlaps.ar")) load(file.path(wd,rdir,"overlaps.ar")) # load
data
if (!exists("cdl.names")) load(file.path(wd,rdir,"cdl.names")) # load data
if (!exists("huc_convert.df")) load(file.path(wd,rdir,"huc_convert.df")) #
load data
if (!exists("huc_acres.df")) load(file.path(wd,rdir,"huc_acres.df")) #
load data
if (!exists("speciesHUC.df")) load(file.path(wd,rdir,"speciesHUC.df")) #
load data
if (!exists("habitatHUC.df")) load(file.path(wd,rdir,"habitatHUC.df")) #
load data
if (!exists("species_info.df")) load(file.path(wd,rdir,"species_info.df"))
# load data

chemlist<-c("chlorpyrifos","diazinon","malathion")
huclist<-
c("1","2","3","4","5","6","7","8","9","10a","10b","11a","11b","12a","12b",
"13","14","15a","15b","16a","16b","17a","17b","18a","18b","19a","19b","20a
","20b","21")
binlist<-c("2","3","4","5","6","7")
readoptions<-c("Species range","Read from file","Choose HUC2s")

# select data to summarize ***********  USER selection section of inputs
usedialog<-FALSE # ******************** use dialog boxes to enter data,
leave FALSE for now
chemtext<-chemlist[1] # *************** select chemical from chemlist
above e.g. 1 for cyp, 2 for dia, 3 for ma
toxfilename<-"dia.fish.tox.txt" # file with info for toxicity data section
of the plot
readhucs<-readoptions[1] # ****************** how to get HUC12 and HUC2
lists, from readoptions list e.g. 1 for "Species range"
speciesID<-2514 # ************* Select species Entity ID
```

```
plotHabitat<-FALSE # set to true to plot critical habitat rather than
sepcies range
useHUC12s<-T # ******************* use HUC12 info otherwise rely on HUC2
and don't plot overlap
useSpeciesBins<-T # **************** plot all the bins assigned to a
species or specific bins
OmitBin3<-F  # **************** don't plot bin 3 values for individual
uses
OmitBin4<-F  # **************** don't plot bin 4 values for individual
uses
bintext<-c("2","6","7") # *************** bins to plot if not based on
species
huctext<-c("18a") # *************** list of HUC2s for EEC data if not
specified by the species HUC12 list
avgper<-c(1,2) # ************** EEC averaging periods to plot, 1-4
correspond to 1-d, 4-d, 21-d, 60-d
multiHUC2adj<-TRUE # if multiple HUC2s adjust EECs based on proportion of
total area
# ************************************

toxdatafile<-file.path(wd,toxfilename)

if (usedialog) {
	chemtext<-select.list(chemlist,preselect=chemtext,title="Select
pesticide")
	toxdatafile<-file.choose()
	bintext<-select.list(binlist,preselect=bintext,title="Select desired
bins",multiple=TRUE)
	readhucs<-select.list(readoptions,preselect=readhucs,title="Select
HUCs")
	toxfilename<-basename(toxdatafile)
}
if (readhucs=="Read from file") {
	foo<-read.delim(file.choose()) # use file.choose() for windows
tk_choose.files() for Mac
	listname<-select.list(names(foo))
	speciesID<-paste0(listname," (List)")
	HUCs<-sort(na.omit(foo[,grep(listname,names(foo))])) # make sure
list is sorted in HUC12 order
	huc2list<-subset(huc_convert.df, HUC12 %in% HUCs)
	huc2list<-huc2list[order(huc2list$HUC12),]
	huctext<-unique(as.character(huc2list$HUC02))
	useHUC12s<-TRUE
	if (length(HUCs)==0) {
		stop("No HUC12s in list")
	}
}
if (readhucs=="Species range") {
	if (useSpeciesBins) {
		bintext<-
as.character(unique(species_info.df[species_info.df$EntityID==speciesID,]$
Bin))
	}
	if (plotHabitat==FALSE) {
```

```
		HUCs<-sort(getHUC(speciesID)) # species entityID to get list 
of HUCs in order
		HUCtype<-"Range"
	} else {
		HUCs<-sort(getHabitatHUC(speciesID)) # species entityID to get 
list of HUCs in order
		HUCtype<-"Habitat"
	}
	speciesID<-
paste0(species_info.df[species_info.df$EntityID==speciesID,][1,5]," 
(",speciesID,") ",HUCtype)
	huc2list<-subset(huc_convert.df, HUC12 %in% HUCs)
	huc2list<-huc2list[order(huc2list$HUC12),]
	huctext<-unique(as.character(huc2list$HUC02))
	useHUC12s<-TRUE
	if (length(HUCs)==0) {
		stop("No HUC12s in list")
	}
}
if (readhucs=="Choose HUC2s") {
	if (usedialog) {
		huctext<-select.list(huclist,preselect=huctext,title="Select 
desired HUC2s",multiple=TRUE)
	}
	if (useSpeciesBins) {
		bintext<-
as.character(unique(species_info.df[species_info.df$EntityID==speciesID,]$
Bin))
	}
	speciesID<-paste0(huctext,collapse="_")
	useHUC12s<-FALSE
}

toxdata.df<-read.delim(toxdatafile) # read tox data from tab-delimited 
file, columns in pairs with conc col and label col
numToxRows<-dim(toxdata.df)[2]/2

# ************************************
# get use overlap data based on HUC12s or set to dummy fill data
GroupedHUCdata<-data.frame(cdl.names[3:27])
if (useHUC12s) {
	tempHUCs<-subset(huc_acres.df, HUC12 %in% HUCs) # get list of HUC12s 
with acres
	tempHUCs<-tempHUCs[order(tempHUCs$HUC12),] # order list by HUC12 to 
make sure and match order of HUC12s in other data objects
	HUCsTotalAcres<-tempHUCs[,2]
	HUCsRows<-as.numeric(row.names(tempHUCs))
	HUCsPercents<-overlaps.ar[,HUCsRows,3:27] # overlaps omit HUC12 and 
acres

	GroupedUseAcres<-array(0,dim=c(6,25)) # array to collect acres for 
each HUC12 based on use for each of 6 years
	if (length(HUCsRows)==1) {
```

```
            GroupedUseAcres<-HUCsPercents*HUCsTotalAcres/100 # acres foe
each of 6 years for each use
      } else {
            for (i in 1:length(HUCsRows)) {
                  GroupedUseAcres<-GroupedUseAcres +
HUCsPercents[,i,]*HUCsTotalAcres[i]/100 # add acres for each of 6 years by
use for the ith HUC in the list
            }
      }

      GroupedUsePercents<-100*GroupedUseAcres/sum(HUCsTotalAcres)
      GroupedHUCdata<-
cbind(GroupedHUCdata,apply(GroupedUsePercents,2,median),apply(GroupedUsePe
rcents,2,min),apply(GroupedUsePercents,2,max))
} else {
      GroupedHUCdata<-cbind(GroupedHUCdata,array(-1,dim=25),array(-
1,dim=25),array(-1,dim=25)) # dummy data to fill object
      HUCsRows<-0
      HUCsTotalAcres<-0
}
names(GroupedHUCdata)<-c("scenario","PercentUse","min","max")

# **********************************
# get EEC info
pks.df<-EECs.df[EECs.df$Pesticide==chemtext,-1]
scentext<- levels(pks.df$Scenario)
croptext<- levels(pks.df$Crop)

temp.df<-subset(pks.df,HUC2 %in% huctext & Bin %in% bintext)
if (dim(temp.df[temp.df$Scenario=="Other Rowcrops",])[1]>0) {
      temp.df[temp.df$Scenario=="Other Rowcrops",]$Scenario<-"Other
RowCrops" # make Scenario names consistent
}
rm(pks.df)

temp.df<-temp.df[temp.df$X1.day>0,] # omit rows with 0 EEC

# check for multiple huc2 EECs
# if desired pad EECs from each HUC2 to reflect contribution to overall
distribution proportional to area
if (multiHUC2adj & length(huctext)>1 & useHUC12s) {
      hucsWithAcres<-merge(huc2list,tempHUCs)
      huc2Acres<-
aggregate(hucsWithAcres[,3],by=list(hucsWithAcres$HUC02),FUN="sum")
      huc2Acres<-cbind(huc2Acres,round(100*huc2Acres$x/sum(huc2Acres$x)))
      names(huc2Acres)<-c("HUC2","Acres","Percent")
      for (i in 1:dim(huc2Acres)[1]) {
            t.df<-
temp.df[as.character(temp.df$HUC2)==as.character(huc2Acres$HUC2[i]),]
            for (j in 1:(huc2Acres$Percent[i]-1)) {
                  temp.df<-rbind(temp.df,t.df)
            }
      }
}
```

```
temp_medians<-
aggregate(temp.df[,8:11],by=list(temp.df$Bin,temp.df$Scenario,temp.df$Crop
),FUN="median")
temp_quants<-
aggregate(temp.df[,8:11],by=list(temp.df$Bin,temp.df$Scenario,temp.df$Crop
),FUN="quant95")

# *********************************
# combined plot of use and EECs
temp_y<-array(-1,dim=length(temp_medians$Group.2)) # vector for the median
percent use data over 6 years
temp_min<-array(-1,dim=length(temp_medians$Group.2)) # vector for the min
percent use data over 6 years
temp_max<-array(-1,dim=length(temp_medians$Group.2)) # vector for the max
percent use data over 6 years
if (useHUC12s) {
      for (i in 1:length(temp_y)) {
            temp_y[i]<-
sum(na.omit(GroupedHUCdata[GroupedHUCdata$scenario==as.character(temp_medi
ans$Group.2[i]),])[,2])
            temp_min[i]<-
sum(na.omit(GroupedHUCdata[GroupedHUCdata$scenario==as.character(temp_medi
ans$Group.2[i]),])[,3])
            temp_max[i]<-
sum(na.omit(GroupedHUCdata[GroupedHUCdata$scenario==as.character(temp_medi
ans$Group.2[i]),])[,4])
      }
}

temp_data<-cbind(temp_medians,temp_quants[4:7]) # combine median and range
EECs
temp_data<-cbind(temp_data,temp_y,temp_min,temp_max) # combine percent
areas

if (useHUC12s & max(temp_y)>0) {
      temp_data<-temp_data[temp_data$temp_y>0,] # remove uses with zero
percent area
      temp_order<-as.numeric(factor(temp_data$temp_y)) # establish order
based on percent area
} else {
      temp_order<-as.numeric(factor(temp_data$Group.2)) # establish order
based on Scenario
}
temp_data<-cbind(temp_data,temp_order) # add order for y plotting of EEC
data

maxed_uses<-
unique(temp_data[temp_data$temp_order==max(temp_data$temp_order),]$Group.2
) # identify max uses (multiple could be at 100%)
for (i in 1:length(maxed_uses)) {
      temp_data[temp_data$Group.2==maxed_uses[i],]$temp_order<-
temp_data[temp_data$Group.2==maxed_uses[i],]$temp_order + (i-1) #
increment order to separate uses
```

```
}

par(mar=c(8,17,4,15),cex.axis=1, bty="n")

miny<-min(temp_data$temp_y)
min1<-min(temp_data[,8:11]) # min of quant data
max1<-max(temp_data[,8:11]) # max of quant data
min1<-0.1 # overide auto scale if desired

if (useHUC12s & max(temp_y)>0) {
      # omit bin 3 data except for 100% Uses unless no data remains
afterward
      if (OmitBin3 & dim(temp_data[!(temp_data$Group.1==3 &
temp_data$temp_y<99),])[1]>0) {
            temp_data<-temp_data[!(temp_data$Group.1==3 &
temp_data$temp_y<99),]
      }
      # omit bin 4 data except for 100% Uses unless no data remains
afterward
      if (OmitBin4 & dim(temp_data[!(temp_data$Group.1==4 &
temp_data$temp_y<99),])[1]>0) {
            temp_data<-temp_data[!(temp_data$Group.1==4 &
temp_data$temp_y<99),]
      }
}

# ******************************************************
# plot data with uniform spacing along Y axis
# plot median, 5%, 95% on continuous Y axis
maxy<-max(temp_data$temp_order) # number of uses to plot need to add more
for bins 3 and 4 and tox data (2 plus 1 gap plus numToxRows)
plot(temp_data$X1.day, temp_data$temp_order, type="n", ylim = c(0,
maxy+3+numToxRows), xlim = c(min1,max1), log = "x", xlab ="", yaxt="n",
ylab="")

for (i in seq(1,maxy+2,by=2)) {
#     abline(h=i-0.35,lty="dotted")
      rect(min1,i-0.35,max1,1+i-0.35,border="transparent",col="grey90")
}

binmark<-c(21,21,21,23,23,23) # list of symbols for bins 2-7
bincol<-c("white","grey","black","white","grey","black") # list of colors
for bin 2-7 symbols

avgperlabels<-c("1-d","4-d","21-d","60-d")
avgperinfo<-paste0("yearly peak ", paste0(avgperlabels[avgper],collapse=",
"), " (from bottom up)")
if (useHUC12s) {
      HUClabel<-paste0(speciesID,": ",length(HUCsRows), " HUC12s")
} else {
      HUClabel<-"HUC2 info only"
}
```

```
titletext<-
c(chemtext,avgperinfo,paste0("huc:",paste0(huctext,collapse=","),",
bin:",paste0(bintext,collapse=",")),HUClabel)

# add averaging periods 4:7 for 1, 4, 21, 60 d
for (i in avgper+3) {
	arrows(unlist(temp_data[,i+4])[,1], temp_data$temp_order + (i-4)/10,
unlist(temp_data[,i+4])[,2], temp_data$temp_order + (i-4)/10, length = 0,
angle = 90, code = 3)
	for (j in 2:7) {
		points(temp_data[temp_data$Group.1==j,i],
temp_data[temp_data$Group.1==j,]$temp_order + (i-4)/10, pch=binmark[j-1],
bg=bincol[j-1])
	}
}

# add levels "Bin 3" and "Bin 4" to temp_data columns 2 and 3
levels(temp_data[,2])<-c(levels(temp_data[,2]),"Bin 3","Bin 4")
levels(temp_data[,3])<-c(levels(temp_data[,3]),"Bin 3","Bin 4")

# add aggregate data for bins 3 and 4 if in bintext and overlap info is
available
if (useHUC12s & max(temp_y)>0) {
	t.bins<-as.numeric(bintext[bintext %in% c("3","4")]) # list bins 3
and/or 4 if in bintext
	if (length(t.bins>0)) {
		for (t.b in t.bins) {
			t.df<-
aggregate(temp_medians[temp_medians$Group.1==t.b,4:7],by=list(temp_medians
[temp_medians$Group.1==t.b,]$Group.2),FUN="max") # maximum run for each
use and bin 3
			names(t.df)[1]<-"scenario"

			t.df<-merge(t.df,GroupedHUCdata)
			t.df<-t.df[t.df$PercentUse<99,]

			# get row names of temp_medians that contain the data in
t.df
			t.rows<-
as.numeric(row.names(temp_medians[temp_medians$Group.1==t.b &
temp_medians$X60.day==t.df$X60.day[1] &
temp_medians$Group.2==t.df$scenario[1],]))[1] # start with first row of
t.df (pick only one row if dup X60day eecs)
			for (i in 2:dim(t.df)[1]) {
				t.rows<-
c(t.rows,as.numeric(row.names(temp_medians[temp_medians$Group.1==t.b &
temp_medians$X60.day==t.df$X60.day[i] &
temp_medians$Group.2==t.df$scenario[i],]))[1]) # pick only one row if dup
60-d eecs
			}

			tq.df<-temp_quants[t.rows,] # get quantile data from same
runs
			t.df<-cbind(t.df,tq.df[,4:7])
```

```
                  temp_data<-rbind(temp_data,temp_data[1,]) # append row to
temp_data
                  newrow<-dim(temp_data)[1] # row number of row added
                  # update new row in temp_data for bin 3 or 4 info
                  temp_data[newrow,1]<-t.b
                  temp_data[newrow,2:3]<-paste0("Bin ",t.b)
                  temp_data[newrow,12:14]<-100
                  temp_data[newrow,15]<-maxy + t.b - 2

                  # calculate bin 3 and 4 averaging periods 4:7 for 1, 4,
21, 60 d
                  for (i in avgper+3) {
                        t.median<-sum(t.df[,i-2]*t.df[,6]/100)
                        t.max<-sum(unlist(t.df[,5+i])[,2]*t.df[,6]/100)
                        t.min<-sum(unlist(t.df[,5+i])[,1]*t.df[,6]/100)

                        # update new row in temp_data
                        temp_data[newrow,i]<-t.median
                        temp_data[newrow,i+4][1]<-t.min
                        temp_data[newrow,i+4][2]<-t.max

                        # plot handling off scale points with < or >
                        if (t.max<min1) {
                              points(min1,maxy + t.b - 2 + (i-4)/10,pch=60)
                        } else {
                              if (t.min>max1) {
                                    points(max1,maxy + t.b - 2 + (i-
4)/10,pch=62)
                              } else {
                                    arrows(t.min, maxy + t.b - 2 + (i-
4)/10, t.max, maxy + t.b - 2 + (i-4)/10, length = 0, angle = 90, code = 3)
                                    points(t.median, maxy + t.b - 2 + (i-
4)/10, pch=binmark[t.b-1], bg=bincol[t.b-1])
                              }
                        }
                  }
            }
      }
}

# add various labels
axis(2,at=c(0,temp_data$temp_order,maxy+seq(1:(3+numToxRows))),labels=c(pa
ste0("All HUCs
(",format(sum(HUCsTotalAcres),digits=1,nsmall=0,trim=TRUE,scientific=FALSE
),")"),as.character(paste0(temp_data$Group.2,"
(",format(sum(HUCsTotalAcres)*temp_data$temp_y/100,digits=1,nsmall=0,trim=
TRUE,scientific=FALSE),")")),"","","--------------
",names(toxdata.df[seq(1,numToxRows*2-1,by=2)])),las=1,padj=0.4,lwd=0) #
addition of Bin 3 and 4 and tox data

if (useHUC12s & max(temp_y)>0) {
      axis(4,at=temp_data$temp_order,labels=paste0(format(temp_data$temp_y
,digits=1,scientific=FALSE,trim=TRUE),"
```

```
(",format(temp_data$temp_min,digits=1,scientific=FALSE,trim=TRUE),",
",format(temp_data$temp_max,digits=1,scientific=FALSE,trim=TRUE),")"),las=
1,lwd=0) # percent area on right Y-axis
      mtext("Median percent of total acres", side = 4, line=13, adj=0,
at=1)
      mtext("(over 6 years with min, max)", side = 4, line=14, adj=0,
at=1)
}

mtext("Uses (median total acres over 6 yrs)", side = 2, line=15, adj=0,
at=1)
mtext("Toxicity Data", side = 2, line=15, adj=1)

mtext("Median EEC ppb (over 30 years with 5% to 95% )", side=1, line=2)
mtext(paste0(titletext[1],": ",toxfilename),side=1, line=4)
mtext(titletext[2],side=1, line=5)
mtext(titletext[3],side=1, line=6)
mtext(titletext[4],side=1, line=7)

# add additional data to show magnitude of effect info
for (i in seq(1,numToxRows*2-1,by=2)) {
      if (!is.na(toxdata.df[1,i])) {
            if (max(na.omit(toxdata.df[,i]))<min1) {
                  points(min1,maxy+3+(i+1)/2,pch=60)
            } else {
                  if (min(na.omit(toxdata.df[,i]))>max1) {
                        points(max1,maxy+3+(i+1)/2,pch=62)
                  } else {

      points(toxdata.df[,i],rep(maxy+3+(i+1)/2,length(toxdata.df[,i])),pch
=3)

      arrows(min(na.omit(toxdata.df[,i])),maxy+3+(i+1)/2,max(na.omit(toxda
ta.df[,i])),maxy+3+(i+1)/2,length=0,angle=90,code=3)
                        text(toxdata.df[,i],
rep(maxy+3+(i+1)/2+0.4,length(toxdata.df[,i])), toxdata.df[,i+1], cex=0.6)
                  }
            }
      }
}

# add legend
legend(x="bottomleft",pch=binmark,pt.bg=bincol,bty="n",horiz=TRUE,legend=a
s.character(seq(2,7)),cex=0.7)

# save table of EECs to file if desired
if (menu(c("Yes","No"),graphics=TRUE,title="Save Table?")==1) {
      tableName<-file.path(wd,sdir,paste0(speciesID,"_",chemtext,".csv"))
      write.csv(temp_data,file=tableName)
}
```

Import R Code

R code to import various data files and generate R objects for use in *AqEECsSummariesWithOverlapY.R.* Needs to be run at least once to generate R objects. Also, needs to be run anytime that the data used to generate plots has been updated (e.g. EPA releases new data). Needs to be saved and then 'sourced' in order for the first line to determine where the file is located and find the folder to save the R objects.

AqEECsImportMagToolDataC.R

```
# establish directories
wd<-dirname(sys.frame(1)$ofile) # get dir of sourced R script and other
dir
mdir<-"MagTool Data" # dir name with MagTool data within dir with script
rdir<-"R Objects" # dir name for R objects within dir of R script

# _____________ EECs.df
# import EEC files into a single dataframe
# set file names for EEC files
c.file<-"chlorpyrifos_eec.csv"
d.file<-"diazinon_eec.csv"
m.file<-"malathion_eec.csv"
p.files<-c(c.file,d.file,m.file)
p.names<-c("chlorpyrifos","diazinon","malathion")

# get dir name for EEC files assuming they are in the same dir
eec.dir<-file.path(wd,mdir) # or use dirname(file.choose())

for (i in 1:length(p.files)) {
  temp<-read.csv(file.path(eec.dir,p.files[i])) # read EEC csv
  temp<-cbind(p.names[i],temp) # prepend column with pesticide name
  names(temp)[1]<-"Pesticide" # rename first column that was created
  if (i == 1) EECs.df<-temp
  else EECs.df<-rbind(EECs.df,temp)
}
names(EECs.df)[6]<-"Crop"

# _________________ overlaps.ar, cdl.names
# import CDL data into a 3D array of overlaps (year,huc12,use with HUC12
and acres first)
# list of CDL files
cdl.files<-
c("CDL_L48_2010.csv","CDL_L48_2011.csv","CDL_L48_2012.csv","CDL_L48_2013.c
sv","CDL_L48_2014.csv","CDL_L48_2015.csv")
# get dir name for CDL files assuming they are in the same dir
cdl.dir<-file.path(wd,mdir) # or use dirname(file.choose())

for (i in 1:length(cdl.files)) {
  temp<-read.csv(file.path(cdl.dir,cdl.files[i])) # read CDL csv
  temp<-temp[order(temp$HUC12),] # make sure to order overlap data by
HUC12
  if (i == 1) overlaps.ar<-array(-1,dim=c(6,dim(as.matrix(temp)))) #
create initial array
```

```
  overlaps.ar[i,,]<-as.matrix(temp)
}

cdl.names<-gsub("\\."," ",names(temp)) # list of use names with spaces

# _________________ huc_acres.df huc_convert.df
# create dataframe with huc12, acres, huc2

huc_convert.df<-read.csv(file.path(cdl.dir,"huc_convert.csv")) # get huc12
to huc2 conversion
huc_acres.df<-data.frame(overlaps.ar[1,,1:2])
names(huc_acres.df)<-c("HUC12","Acres")

# _________________ speciesHUC.df
# create dataframe with species id and comma-separated range huc12 list
speciesHUC.df<-read.csv(file.path(cdl.dir,"species_huc12.csv"),as.is=TRUE)

# _________________ habitatHUC.df
# create dataframe with species id and comma-separated critical habitat
huc12 list
habitatHUC.df<-
read.csv(file.path(cdl.dir,"critical_habitat_huc12.csv"),as.is=TRUE)

# _________________ species_info.df
# create dataframe from Species Summary with HUC, Bin, EntityID and
Species
species_info.df<-
read.delim(file.path(cdl.dir,"species_info.txt"),as.is=TRUE)

# _________________ save data objects to same dir
save(EECs.df,file=file.path(wd,rdir,"EECs.df"))
save(overlaps.ar,file=file.path(wd,rdir,"overlaps.ar"))
save(cdl.names,file=file.path(wd,rdir,"cdl.names"))
save(huc_convert.df,file=file.path(wd,rdir,"huc_convert.df"))
save(huc_acres.df,file=file.path(wd,rdir,"huc_acres.df"))
save(speciesHUC.df,file=file.path(wd,rdir,"speciesHUC.df"))
save(habitatHUC.df,file=file.path(wd,rdir,"habitatHUC.df"))
save(species_info.df,file=file.path(wd,rdir,"species_info.df"))
```

Functions R Code

R code with various functions used the other R files. Needs to be loaded into R before other files are run. Not all functions are used by *AqEECsSummariesWithOverlapY.R.*

AqEECsFunctionsB.R

```
# *************************
# set of functions used in other places
parsename <- function(fn) {
  fn<-basename(fn)
  t1<-unlist(strsplit(fn,"_"))
  esaindex<-grep("ESA",t1)
  t2<-unlist(strsplit(t1[esaindex],"ESA"))
  tmp<-paste(t1[1:(esaindex-2)],collapse="_")
  output<-list(huc=t2[2],scenario=t2[1],bin=t1[esaindex-1],run=tmp)
  return(output)
}

meanci <- function(X1, conf = 95) {
  lenX1 <- length(X1)
  X195 <- qt(1 - (100 - conf)/200, df = lenX1 - 1) *
sqrt(var(X1))/sqrt(lenX1)
  output <- c(lower.ci = mean(X1) - X195, upper.ci = mean(X1) +X195)
  return(output)
}

dist95 <- function(X1) {
  lower05 <- qnorm(0.05,mean = mean(X1), sd = sd(X1))
  upper95 <- qnorm(0.95,mean = mean(X1), sd = sd(X1))
  output <- c(lower05, upper95)
  return(output)
}

quant95 <- function(X1) {
  output<-quantile(X1,c(0.05,0.95))
  return(output)
}

f1in15 <- function(X1) {
  output <- qnorm(14/15,mean = mean(X1), sd = sd(X1))
  return(output)
}

# extract daily eecs from the *daily.csv file into a 3D array
dayeecs <- function(fn) {
      foo<-read.csv(fn,header=FALSE,skip=5) # read SWCC daily
      foo<-foo[,2:4]*10^6 # get peaks and convert to ppb
      foo<-foo[-seq(from=1155, length=7, by=1461),] # omit leap days
      output<-array(dim=c(365,30,3)) # create 3D array for daily eecs
(day, year, value)
      for (i in 1:3){
```

```
            output[,,i]<-array(foo[,i], dim=c(365,30)) # build array from
daily values (avg aqueous, avg benthic, peak aqueous)
      }
      return(output)
}

# extract yearly summaries from a *15_Parent.text
yreecs <- function(fn) {
      tmp<-scan(fn,skip=19) # read yearly summary data from *15_Parent.txt
summary file
      tmparr<-array(tmp, dim=c(9,30))
      output<-t(tmparr) # 2D array (30,9) of year on rows and different
summaries in columns
}

# extract overall summaries from a *15_Parent.txt file
runeecs <- function(fn) {
      tmpfile<-readLines(fn,18) # get overall summary lines
      tmpfile<-tmpfile[6:15] # overall summary with each line having the
summary value

      # extract data from each summary line
      measlist <- vector("list",length(tmpfile))
      for (i in 1:length(tmpfile)) {
            l1<-unlist(strsplit(tmpfile[i],"="))
            names(measlist)[i]<-paste0("x",gsub("[ ,-
]",".",trimws(l1[1]))) # measurement description w/o spaces, hyphens
            measlist[[i]]<-as.numeric(unlist(strsplit(l1[2]," ppb"))[1]) #
measurement value
      }
      output<-measlist
}

# get array of HUC12s from comma delimited list of range
getHUC <- function(id) {
      tempHUC<-speciesHUC.df[speciesHUC.df$EntityID==id,2]
      output<-as.numeric(gsub("\\D","",unlist(strsplit(tempHUC,","))))
      return(output)
}

# get array of HUC12s from comma delimited list of critical habitat
getHabitatHUC <- function(id) {
      tempHUC<-habitatHUC.df[habitatHUC.df$EntityID==id,2]
      output<-as.numeric(gsub("\\D","",unlist(strsplit(tempHUC,","))))
      return(output)
}
```