Draft Step-Down Plan
Bison and Elk Management:
A Review

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Executive Summary

In 2007 the National Elk Refuge (NER) and Grand Teton National Park (GRTE, collectively the Refuge and Park) published their Bison and Elk Management Plan (BEMP) and Environmental Impact Statement (EIS), providing operational guidance for the management of these species in the southern Greater Yellowstone Area (GYA) on Interior lands. That plan recognized that feeding wildlife (specifically elk) placed that resource at great risk of disease amplification and was antithesis to sound ecological management. As had been known for years before the BEMP (e.g. see Dunkley and Cattet, 2003), feeding wildlife has "significant [adverse] ecological effects …at the individual, population, and community levels". The BEMP therefore included a goal of reducing and eventually eliminating reliance of wildlife on supplemental feed. However the Plan lacked methods, metrics, milestones, deadlines or criteria to assess progress or measure eventual success at reducing supplemental feeding. Now, nearly 13 years after BEMP implementation, the Refuge and Park have produced this Draft Step Down Plan (SDP) and associated Environmental Assessment (EA) from the BEMP as their vision of how reliance on supplemental feed might be reduced. While the ultimate goal of managing wildlife under a feed-free paradigm is ecologically sound, the SDP is too little, too late, with a poor chance of success. The SDP also runs the risk of providing an opportunity for further delay in addressing the significant issues facing bison and elk management in the southern GYA. Specifically:

- **The SDP is significantly constrained by the BEMP.** The authors note that several management alternatives that may significantly help reduce reliance of elk and bison on supplemental feed are not addressed in the SDP because of constraints imposed by the 2007 BEMP and EIS, or because those options from 2007 were not supported by cooperating agencies.
- **The SDP is likely to fail.** The SDP has a phase 1 goal of reducing the population of elk in the NER to 5000, but specifically states "it is no longer possible to winter 5000 elk on the NER and maintain 11,000 elk in the overall Jackson herd." Yet elk numbers are not addressed and are considered outside the purview of the SDP. The extremely limited management options due to constraints mentioned above are also likely to contribute to failure.
- **The SDP is too late.** The SDP comes almost 13 years after implementation of the 2007 BEMP, as a component of that 2007 management plan. The BEMP

was designed as a 15 year management guidance document and is scheduled for review in 2022. Even the most optimistic scenario upon which the SDP can be assessed for success is realistically more than a decade, with the Refuge and Park noting that initial assessment of progress toward the goal will not be possible until 5 or more years.

- **The SDP is not objective.** The SDP has 1 clearly defined quantitative trigger that initiates the single measureable management action (later onset of feeding), with 1 quantitative assessment criterion (elk and bison feeding days (EFD and BFD)) and 2 acceptance criteria for success (Phase 1. reducing elk on NER to 5000 over some unspecified timeframe, and Phase 2. at least a 50% reduction in EFD and BFD over baseline for 5 years using a running 3 year average as the metric). Despite using considerable language consistent with adaptive management, the SDP then enumerates the multiple subjective parameters that will actually be used to determine the onset of supplemental feeding. The number and range of subjective variables, without specifics, that will be considered in determining feeding onset severely undermine the objective trigger, making it essentially useless and nearly impossible to apply in the field except under the most unusual conditions where feeding might not be traditionally implemented (e.g. conditions in 2018).
- **The SDP fails to address its primary goal.** The stated primary goal of reducing reliance on supplemental feed is to mitigate the risk of catastrophic disease outbreaks (SDP, page vii) by decreasing disease prevalence and transmission risk (SDP, page 8). But disease management is considered outside the scope of the SDP, which does not include a single disease prevalence or transmission risk criterion for assessing success. Even if successful at achieving Phase 1 objective, almost half of the Jackson herd would remain on feed for nearly 2 months, leaving a substantial disease amplification risk. Phase 2 objective (elk and bison substantially on native winter range) also includes a significant amount of feeding and its overall effect on density is unknown.
- **The SDP is at odds with itself.** The SDP clearly states elk and bison redistribution will be the primary consequence of delayed feeding but that elk distribution is outside the purview of the SDP. The link between Phase 1 elk number objective and Phase 2 EFD reduction is not explicitly stated. But implied is that decreasing EFD will decrease density through redistribution off NER consequently resulting in 5000 elk wintering on NER. Though some elk distribution changes may occur onto GRTE, most are likely to be onto private and other lands not under Refuge and Park authority. Acceptability of this elk redistribution is beyond the scope of the Refuge and Park authorities, and beyond the scope of the SDP.

Recommendation

While it is laudable that the NER would finally attempt to start towards its goal of reducing, and perhaps eliminating, reliance of wildlife on supplemental winter feeding, the constraints imposed upon the SDP by a BEMP nearing the end of its

lifespan are insurmountable. Evidence of the obstructions and limitations posed by the 2007 BEMP provided in the SDP, combined with broad statements regarding the need to address these obstacles, argues that the best approach would be to incorporate findings of the SDP into a review and revision of the BEMP now instead of 2022. It is nonsensical to implement an SDP almost 13 years into a 15 year management plan, especially when that subcomponent of the overarching management plan will take a decade or more to assess success. Formal adoption of the SDP could also prove an impediment to a comprehensive review of the BEMP if it is argued that the SDP has not had sufficient time to assess its effectiveness. Specifically, I recommend:

- **Suspend formal adoption of the SDP (or address other BEMP goals and objectives to decrease elk numbers and increase distributions) and initiate review and revision of the BEMP in 2020 incorporating findings in the SDP, and involving cooperating agencies such as Wyoming Game and Fish Department and Bridger Teton National Forest at the onset.**
- **Develop and implement clear objective, quantitative methodology to reduce reliance on feeding that extend well beyond the single tool (delayed onset of feeding) objectively addressed in the SDP.**
- **Incorporate quantitative disease prevalence and transmission risk indices as measureable endpoints for success in the revised BEMP and any associated SDP to reduce reliance on feed.**
- **Use flexibility provided in the original BEMP, its EIS and the EA developed with the SDP, to use subjective/objective criteria in reducing reliance on winter feeding in the interim without adopting a formal SDP. Along with delaying the onset of winter feeding, use subjective criteria of "what is possible" to consider actions for early feeding cessation, redistribution of elk and bison to delay arrival at NER, interference with migration paths to NER, promotion of winter range use (both access to existing native winter range and development of new opportunities for wintering), and where possible collaboration with other management agencies as identified in the SDP to affect elk and bison numbers and distribution through hunting and other means.**
- **The number of elk continuing to winter on NER during the last decade is a clear indication of the BEMP failure to address the core issue of feeding wildlife to maintain too many ungulates on too small a winter landscape. The competing variables – 1. feeding to maintain distribution, and delayed feeding to cause redistribution, and 2. an elk herd objective that appears incompatible with wintering an ecologically sound wintering population on NER – need cooperative resolution with other agencies up front. Barring resolution, and as unpalatable as it sounds, the Refuge and Park should unilaterally undertake a program to decrease and eliminate feeding wildlife in the foreseeable future, providing assistance to other agencies where possible on the likely adverse effects of redistribution and mortality, but resolutely striving to no-feed management.**

Plan Review

Introduction

The Draft Step-Down Plan: Bison and Elk Management (SDP) is an outcome of the original Bison and Elk Management Plan (BEMP) developed and published in 2007 after years of effort to come to grips with disease and ecological problems posed by high density feeding of elk on the National Elk Refuge (NER). I was part of that effort in the late 1990s and early 2000s as the Program Manager for Department of Interior's Brucellosis Research Program (through USGS) and later as the Chief for Wildlife Health, Region 6, US Fish and Wildlife Service. Free-ranging wildlife in the southern Greater Yellowstone Area (GYA) occupy a variety of jurisdictions, often with competing goals and objectives, requiring cooperation among the agencies involved in wildlife management. Combined with the diversity of stakeholders and public opinions, the controversy and debate over feeding wildlife in the southern GYA have been high profile, and are well known, well documented and summarized in the SDP and elsewhere. Despite the validity of competing values, jurisdictions and management prerogatives, one factor stands out: Wyoming Game and Fish Department (WGFD) has the primary authority and responsibility for elk numbers and distribution off the Refuge and Park while the NER has borne the ecological costs of supplemental feeding of elk and bison at numbers well beyond the natural carrying capacity of USFWS wintering habitat. As identified in the SDP, part of this unnatural high-density aggregation is a consequence of learned behavior, another part is excessive numbers restricted in winter distribution without access to native winter range.

Reducing Bison and Elk Reliance on Winter Feeding

The SDP authors note that 'actions to adaptively decrease the need for supplemental feed' was a key element of the BEMP. The adverse effects of feeding wildlife are acknowledged in the SDP (e.g. habitat destruction, disease outbreaks and loss of biodiversity, though the ecological effects of segregating elk and bison, and the impact on other species are ignored). Even the "unusually low mortality" has had effects on predators and other species, and requires an "intensive hunting program". Accordingly one would expect that the SDP would broadly examine the management options that would assist in achieving the ultimate goal of eliminating feeding. In fact, the Refuge and Park seem to have purposely placed obstacles to considering potentially effective management actions to limit reliance of elk and bison on winter feeding. The BEMP incorporates 4 major goals:

1. Habitat Conservation
2. Sustainable populations
3. Elk and bison numbers and distribution

4. Disease Management

The Refuge and Park chose to limit the SDP to goal number 2, Sustainable Populations, and the 4 objectives under that goal, returning current management back 13 years to 2007. Despite inclusion of a paragraph on developments since the 2007 BEMP, the SPD acknowledges continuation of anachronistic and ineffective management actions such as vaccination, documented ineffective in research (Roffe et al 2004) and field studies (Maichak et al 2017). As such, elk numbers and distribution (goal 3), and disease management (goal 4, the primary purpose for reducing reliance on supplemental feed) were considered outside the purview of, and are not addressed, in the SDP. The SDP asserted that, because the BEMP had undergone National Environmental Policy Act (NEPA) review and a Record of Decision in 2007, limiting the SDP to one goal and associated objectives meant considering management alternatives outside Goal 2 (Sustainable Populations) would require additional NEPA analysis, which the Refuge and Park chose not to do. Management attempts to reduce reliance on feeding are severely limited by this approach. Such a limited scope and constraint imposed upon SDP that removes significant management options that would enhance success from consideration, is an argument that the SDP should be considered in totality of a BEMP review and not as a separate action almost 13 years into a 15 year plan. Instead, the findings of the SDP should be incorporated into a comprehensive review of the BEMP in 2020.

The SDP articulates 3 current reasons for winter elk feeding: 1. Reduced access to significant portions of winter range and loss of historic migration patterns. 2. Behavioral conditioning to elk winter feeding, and 3. Desire to maintain a population objective established in the context of winter feeding. The SDP solely addresses the second reason elk are fed – the behavioral component – and neglects the other two because of constraints discussed above. Failure to address access to native winter range (beyond comments that private landowner incentives will be explored, without specifics on what, where, when and how) and population size and distribution are critical failures of the SDP. In fact, the authors recognize these limitations virtually assure the SDP is sabotaged. The objective of Phase 1 implementation of reduced reliance on feeding is to decrease the number of elk on the NER to 5000. But, from the SDP:

> "it is no longer possible to winter 5000 elk on the NER and maintain 11,000 elk in the overall Jackson herd[1]." (SDP, Page 10)

This statement would seem to clearly indicate the Refuge and Park are aware that a herd objective, which was set in the context of winter feeding, and 5000 elk on NER

[1] The SDP interchangeably refers Phase 1 objective to be 1. numbers wintering on NER, 2. numbers on feed on NER, or 3. with regard to bison, 500 in the Jackson Hole area. While virtually all elk and bison may be fed when feeding occurs on NER, the objective should be clarified. Are the phase 1 goals the number of elk and bison fed on NER, or the total number of elk and bison wintering on NER? Specifics have ramifications regarding elk and bison density and spatial redistribution.

are incompatible with reducing winter feeding. In fact, data from the last decade show that achieving Phase 1 objective hasn't been possible with the current level of feeding, though the SDP plans to test the hypothesis that the incompatibility is purely a learned behavior. The inability to winter 5000 elk on NER with an 11,000 herd size also suggests the Refuge and Park are aware that increased distribution over native winter range is a requirement for success if the herd size is not reduced. However, changing elk distributions, while on one hand being the focus of SDP management (through behavioral modification), is outside consideration of the SDP. The SDP makes no effort to address access to or availability of native winter range habitat. Phase 2, further reducing EFD, would seem even less likely to be successful. Overall the plan to "adaptively manage elk and bison in a manner that contributes to State herd objectives and allows for biotic integrity and environmental health of the resources" (SDP, Page 8) is predominantly focused on maintaining, the herd objective over other biological considerations.

Another large obstacle to achieving the desired objective of reduced feeding is that feeding is not solely for nutritional purposes, especially early and late in the season. As noted in the SDP, the trigger to start feeding is generally to keep elk on the NER and prevent them from searching for forage (SDP, Page 11). In fact, feed initiation as currently used, is primarily to control elk distribution and the result has been the status quo of excess elk on NER. The primary, and realistically only, management option considered by the SDP and placed in a quantitative "adaptive management" framework is delayed onset of feeding. The SDP would be attempting to address the behavioral reason elk (and bison) attend the NER in winter, and the authors believe delaying the onset is the best mechanism to modify behavior. They defend this single action for behavioral modification because they believe, without evidence, delaying the onset of feeding will

> "decrease the probability that elk….will discover NER feeding grounds" (SDP page 17)

and will learn to stay on native winter range or state feedgrounds (ironically, though feedgrounds are designed to manage elk distribution and prevent unwanted movement, the SDP identifies movement from State feedgrounds to the NER as one factor contributing to a higher proportion of the Jackson herd currently wintering on the NER than historically). Not only does this not solve the problem because at least some elk would simply move to State feedgrounds, but current NER management often utilizes early and late season feeding to manage elk distribution in a desirable configuration. SDP implementation, then, assures conflict. Though these adverse responses to management are expected, the SDP does not identify likely locations, times, mitigations (other than broad statements about what might be done on private lands), or contingencies agreed with other cooperating agencies for response. The SDP does not identify what constitutes an unacceptable redistribution or who makes that decision. The authors also expect delayed onset of feeding to encourage elk and bison to use native winter range, "<u>especially</u> [emphasis mine] those individuals that have not previously received a food reward on the

Refuge" (SDP, page viii). Presumably this learning modification occurs after elk that previously fed at NER learn not to go to the NER, and in subsequent years trailing calf/immature elk never visit the NER. Because young elk will still be exposed to feed for years, this scenario seems overly optimistic.

The SDP design is mostly subjective. The SDP identifies an objective trigger (2 weeks after forage availability reduces to 300lbs/acre) for the onset of winter feeding, but negates that objectivity by listing throughout the document the numerous variables (private land conflicts, herd size, elk and bison spatial distribution, population dynamics, hunting guidelines, winter weather conditions, mortality (both total and calf), and other factors) that will be subjectively involved in the decision of when to initiate feeding. The authors justify the subjectivity and "vagueness" apparent throughout the document by stating this has never been tried before and they really don't know what's going to happen. Avoidance of objectivity is not adaptive management and the vagueness and subjectivity essentially translate into a plan that flies by the seat of the pants with the decision to initiate feeding left to a variety of undefined conditions. Further, many of the possible negative factors that could affect feeding onset are predictable, acknowledged in the SDP, yet not a single set of contingencies that could potentially be activated are included in the SDP. This failure to develop contingencies – a critical aspect of wildlife and disease management – is a marked limitation of the SDP. In fact, the authors seem to expect only positive effects from delaying feeding onset even though they know the likely conflicts:

> "as bison and elk behavioral responses are better understood and targeted mitigation on private lands is achieved feeding delays will be extended" (SDP page 16)

But what happens if the "better understanding of behavioral responses" and/or "mitigations on private lands" are unacceptable? What and who define acceptable and unacceptable responses? What is the contingency if responses and mitigations are not acceptable? Further, no contingencies are prepared if the SDP fails to succeed in achieving overarching BEMP management goals. SDP success can be declared while not significantly addressing adverse disease or ecological conditions. Further, while a criterion for declaring success is clearly identified, failure is not defined or parameterized. How long does "attempting" to delay feeding without achieving the acceptance criterion for success at reducing EFD and BFD go on before the program is considered a failure?

The authors also avoid the clarity and scientific underpinning of Adaptive Management by stating that while the SDP is intended to be adaptive it:

> "is not intended to include all the adaptive management elements" (SDP page 7)

found in their own national guidance (DOI Adaptive Management Technical Guide 2007). In summary, the SDP comes up with one idea that might help decrease reliance on supplemental feed (delay feeding onset), and hopes, maybe, it might be implemented….but maybe not. And if not, management options are not articulated.

The lack of adequate objective criteria of true adaptive management, and acknowledgement that the management action of "delayed feeding onset" will be so cautiously implemented that no results are expected for at least 5 years (SDP, page 30 the authors use "many years", elsewhere initial implementation will be just "days" (SDP, Page viii)), means results are not expected until well after the BEMP is due for re-evaluation. The more realistic timeline is that the acceptance criterion for success at reducing elk and bison feeding is unlikely to be reached within a decade. The consequence for the managing agencies is that the SDP can become a delaying factor for comprehensive and biologically meaningful reassessment and revision of the BEMP, currently scheduled for 2022, if it is argued the SDP has had insufficient time to know if it will succeed.

How mortality, particularly calf mortality, will be incorporated (adapted) into management is poorly discussed. How many years of what level of mortality is acceptable while testing the SDP preferred management action to reduce EFD and BFD? While delayed feeding is expected to increase mortality, the SDP "seeks to avoid….elk winter mortality levels significantly higher than baseline" (SDP, page 30), or "without causing increased elk mortality" (SDP page 38), and plans that overall mortality will be $\leq$ 3% (SDP, table 4, page 22). It's unclear, but appears the SDP sets an acceptable all-age mortality in any one season at 5% as the upper limit. But the SDP provides no contingencies should the mortality limit be met or exceeded or any specifics as to what, when, or how soon changes in management would be instituted. Further, is all-age mortality of 3% on average a reasonable level of mortality to be expected, especially in an over-abundant herd on feed being transitioned to no feeding? In natural hunted populations, annual female survival ranges from .64 to .88 (Conard et al 2012, Kunkel and Pletscher 1999). The average across western US for 12 elk populations is 0.87 (Raithal et al 2007). In a predator rich un-hunted environment, Glacier NP, survival was 0.83 with young and old most susceptible (Kunkle and Pletscher 1999). The Jackson herd is hunted yet experiences a similar survival at 0.83 for adult cows (Cole and Foley, 2015). This suggests that natural mortality in the Jackson elk population, even in a predator rich environment is minimal, and could sustain a higher level of winter mortality perhaps while modifying hunting. Also, while the Jackson herd is intensively managed and hunted, the BEMP accepts a summer gender distribution of 35 bulls:100 cows based on GRTE estimate of this ratio being the most natural in absence of human impact (SDP, page 21). Other herds in North America are managed at considerably lower bull:cow ratios. It would appear the Jackson herd is being managed under a variety of conflicting criteria acceptable to different management agencies, some that either favor natural processes, others that favor criteria designed to maintain a population above accessible wintering habitat.

Currently calf mortality on the NER is generally less than 10%, though is variable enough that the winter of 2017 calf mortality exceeded 19%. In other populations, such as Yellowstone, calf mortality is 28% (Singer et al 1997). Smith and Anderson (1998) found calf mortality of 29% in unfed populations versus 11% on feed. The data suggest total mortality and calf mortality in the Jackson herd are artificially low. The acceptable calf mortality rate, total mortality rate, and population size of the Jackson elk herd are all artificial parameters derived in the context of feeding. If the SDP wants to achieve the stated goal of reducing reliance on feed (with eventual goal of no feeding), then increased calf mortality, total mortality, and/or population size will need re-evaluation and acceptable parameters may need to be more in alignment with other, non-fed populations. Having artificially low over-all and calf mortality set in the context of feeding, then striving for reduced feeding without changing the acceptable mortality level or population size is illogical. Even in the presence of assured increased winter habitat, natural mortality in unfed elk populations is higher than that experienced in fed populations.

Reducing Reliance on Winter Feeding - Actions Considered but Dismissed

Delaying the onset of feeding to affect elk behavior is one way to achieve the desired result of lower EFD and BFD. The SDP also briefly entertains early stoppage of feeding, and some subjective target parameters are discussed. Currently feeding is ended when biologists believe there is sufficient forage to end feeding. The SDP includes plans to develop measurable criteria by which this might be objectively determined, and hopes to end feeding about a week earlier than usual. But without objective criteria to evaluate, this is only a hoped-for outcome that cannot be reviewed or analyzed. These criteria should have been developed prior to publication of the SDP, and instead should now be incorporated into a revised BEMP.

The third option, decrease daily ration, is dismissed out of hand. Authors believe modifying daily ration will result in unacceptable calf mortality. This, in fact, may be true but warrants further objective investigation and trials. As an intensively manipulated population, the NER should accept a broader and more normal annual calf mortality and total mortality. In fact, with an excess of elk relative to winter range in the Jackson herd, an even higher mortality than typically seen in non-fed populations may be acceptable. Modifying daily ration, possibly coupled with mild hazing, has real potential for altering behavior as the attraction of NER has some behavioral cost. Reducing daily ration and/or mild hazing may encourage more effective elk dispersal as the cost/benefit of daily relocation enters into the energetics equation. Elk might delay return to feedlines and learn quicker. All of this is speculation since the SDP dismisses the option without analysis.

Disease Management

The SDP contains measureable objective acceptance criteria for success. EFD and BFD are easily defined, as is success at achieving a significant reduction (≥50% decrease in baseline EFD and BFD for 5 years using a 3 year running average). A phase 1 objective of 5000 is clear, though measurement frequencies may need to be increased. But their relevance to disease management, the stated overall goal of reduced feeding, is unknown and not assessed by the SDP (and the BEMP focuses only on brucellosis seroprevalence). As written, the primary goal of reducing feeding by the SDP is reduction in disease prevalence and transmission risk (SDP, Page 8 and Table 1). But neither variable is part of the adaptive management framework of the SDP despite the Refuge and Park presenting a hypothesis "that the SDP will cause seroprevalence to decline" (SDP page 29). In fact disease management is outside the purview of the SDP and even the BEMP presents no criteria for what constitutes acceptable, significant or expected decline in the single monitored disease - brucellosis seroprevalence. The acceptance criterion of reduction in EFD and BFD is an interim step and likely adopted because it's easy to measure, but bears an unknown relationship to overarching BEMP goals.

The SDP simply assumes all disease is density dependent and any reduction in feeding reduces density thereby reducing disease prevalence and transmission risk (the authors' assumed equation is decreased feeding = decreased density = decreased disease transmission and risk). However, this simplistic assumption is unlikely valid. Virtually every density-dependent infectious contagious disease has a threshold response, a range of host densities where transmission is not significantly affected. Put another way, host density must reach a certain lower threshold before transmission is significantly interrupted. Further, the duration that density reduction must be maintained to affect disease transmission is unknown. Each disease is unique in these characteristics. For example, directly transmitted diseases like pasteurellosis and psoroptic mange require relatively high densities at close proximity for effective transmission. Other diseases, such as brucellosis, have an environmental component (shed infectious abortants) that allow effective transmission at lower densities and greater distances. Still others, like CWD, which is transmitted both directly and through environmental contamination with a decades-long persistent infectious agent, have an even different density threshold, considerably lower than the other example diseases. If the SDP reaches the Phase 1 objective of 5000 elk wintering on NER, and reaches its success criterion for reducing EFD by 50% after a decade or more of effort, that still leaves nearly half of the Jackson herd (5000 elk) on feed for over 50 days (baseline EFD = 505,680; 50% reduction = 252,840 EFD; divided by 5000 = 50.6 days of feeding)[2]. The level and

[2] The situation may actually be worse if only Phase 1 is reached. The SDP is inconsistent in treatment of Phase 1 and 2 objectives. The success of Phase 1 will be based on using an average feeding duration from 1995 through 2007 of 64 days. Multiply by 5000, and the SDP plans to look for a "benchmark" of success as 320,000 EFD (SDP, page 14). However, the baseline for EFD, 505,680, is based on data from

duration of dense crowding on feed under successful SDP implementation still leaves a substantial risk of catastrophic disease propagation.

Density is just one factor in disease transmission, though certainly the one most easily addressed in the BEMP and SDP. Other factors, such as environmental persistence, spatial heterogeneity (which is a big issue in CWD surveillance design), type of agent, infectious dose, host susceptibility, environmental conditions, route of entry, social behavior, etc all affect disease expression.

Disease management and monitoring in the SDP focuses exclusively on brucellosis and CWD. While technically Disease Management, as a BEMP goal, is outside the purview of the SDP, reduction in disease prevalence and transmission risk is the overarching purpose for reducing supplemental feeding. Brucellosis has been monitored for decades on the NER. While protocols rely primarily on hunter-killed samples and therefore may not be truly reflective of the entire population, these historical data on seroprevalence provide a reasonable basis for assessing success of SDP actions. However, relying on brucella seroprevalence alone ignores transmission risk factors for this disease that should be part of the SDP (e.g. timing and spatial distribution of abortions, duration of persistence of infectivity, etc). For example, feeding an average of 50 to 66 days will still occur during peak time for brucellosis abortion so how disease prevalence is likely to be affected is unknown (though brucellosis seroprevalence will be measured under the BEMP). But even if brucellosis seroprevalence declines, what level will be considered successful? And what is successful for other, more persistent or easily transmitted, diseases?

CWD has recently been detected on GRTE in a mule deer. Problematic with this disease is its decades long epidemic curve and the tendency of managers to therefore ignore the issue as it quietly smolders without much yearly change. Data from Rocky Mountain National Park indicate population-significant CWD prevalence (13%) in a considerably lower density elk population (Monello, 2014). Current NER densities are 5 to 1100x greater than Rocky Mountain National Park (77-16,850/km2 (NER data) compared to 15/km2, respectively (Montello, 2014)) and delaying the onset of feeding alone is unlikely to reduce density enough to interfere with CWD transmission. Fewer elk, distributed over a much greater landscape is required. The Refuge and Park seem to recognize this noting that precautionary measures, such as reducing densities and numbers of elk, would reduce the chance of major adverse impacts if the disease became established.

2008 to 2017 (SDP, pages vii and 28) and success at reducing EFD would be 252,840 (50% of baseline, though this number is not actually stated in the SDP). Further, actual average feeding days under current management, 1995 through 2017 (onset 28 January, cessation 3 April) is 66 days (SDF, Page 11). Why the different datasets and differing measures of success using the same criterion (EFD) is not explained in the SDP. But if only Phase 1 is reached, feeding apparently may continue for 64 days while success is declared.

Currently management's response to CWD is entirely surveillance and reactionary. Prevention, through significant density reduction and redistribution, should be the first priority of the SDP. Aside from attempting to reduce EFD, the SDP makes no effort to reduce elk densities. Testing the efficacy of preventive measures is extremely difficult, and not possible on the NER alone. However, a well matched paired design on smaller feedgrounds with close approximation to CWD may be a good way to test the effectiveness of eliminating feeding and markedly decreasing density by distributing elk over larger landscapes at mitigating CWD. This would require unusual cooperation from WGFD.

CWD surveillance on NER (and likely throughout the Jackson elk herd distribution) is designed to detect 1% prevalence with 95% confidence. This low prevalence with such high confidence of detection requires an exceptionally large sampling effort, and the SDP notes the requirement of trained sample collectors. The SDP intentionally doesn't address the sample design, as disease management is not sufficiently considered. However, the spatially heterogeneous clumped distribution on the landscape for infectious prion and CWD-infected cervids, along with the large sample size required, makes the assumption of a 95% confidence at detection 1% sampling intensity questionable at best. Even if CWD developed in a more randomly distributed fashion within the Jackson population, and hunter killed samples represented a random sample, a 1% prevalence upon a first detection, statistically means a high likelihood of CWD in over 100 elk.

Wyoming and other states' data make clear CWD is expanding inexorably on the landscape, and eventually will arrive in the Jackson herd. The question for land and wildlife managers is whether biological conditions should be set up before its introduction in a "best practices" way to limit the impact and spread of the disease (i.e. prevention), or should management be solely reactionary or perhaps none at all. The NER is currently revising its Disease Contingency Plan. That plan is not available for review, but is reactionary. According to the SDP (page 16) a key element of the CWD plan is "response <u>if</u> CWD is detected on or adjacent to" feedgrounds, not preventive mitigation. It presumably will focus on surveillance, carcass removal, removal of clinically consistent with CWD animals, restrictions on hunter carcass movement, and other factors contained in Wyoming CWD Response Plan. Little thought seems to be going to a-priori preventative steps other than herd objectives would be "reconsidered" in light of CWDs appearance in a fed herd[3].

[3] Recently much has been made of a model that suggests fed elk populations may survive and persist in the presence of CWD because of differential genotype survival (genotypes with a leucine allele at codon 132 of the PrPc gene survived longer in a CWD-rich environment than homozygous methionine under confined conditions (Williams et al 2014)). Other models (e.g. Galloway, et al. 2017) and the Williams et al model suggest significant impact to the Jackson herd once CWD is introduced without differential genotype survival. Problematic is the assumption in the Williams et al model that no other genotype fitness differentials exist aside that

Nothing is provided in the SDP with regard to how management implemented by the SDP would change if CWD is detected in the Jackson elk herd.

Despite concerns expressed in the modeling data (Williams et al 2014 , Galloway, et al 2017) and from the presence of CWD in mule deer at GRTE, the Refuge and Park do not address key elements in their CWD surveillance, perhaps because they view this as outside the purview of the SDP. However, as noted above, the primary reason for reducing reliance on supplemental feed is reduction in disease amplification. Mule deer sympatric with and nearby to Jackson elk will be a key in assessing CWD distribution and risk. Presumably this is ongoing. Further, though, PrPc codon 132 genotype fitness might be grossly assessed by genotyping natural adult and calf mortality and comparing genotype frequencies in the adult hunted population as a stand-in for random population sampling. Such data might give an idea if genotype-specific fitness differences unrelated to CWD exist and might play a role in the Jackson herd response to CWD incursion.

Other diseases are simply ignored by the SDP, likely in deference to the limitations imposed upon the SDP by the 2007 BEMP and associated EIS. Pasteurellosis, psoroptic mange, infectious pododermatitis, oral necrobacillosis, pneumonia, are known to occur on the NER in elk (and potentially bison). These, and other potential newly-introduced diseases such as tuberculosis and foreign animal diseases, are all exacerbated by feeding (e.g. see Samuel et al 1991, Smith 1991, Roffe and Smith 1992, Smith and Roffe 1994). Some diseases, such as infectious pododermatitis, are caused by crowded conditions directly related to feeding and can greatly amplify calf mortality. Environmental health (e.g. contamination of Flat Creek by coliforms associated with high densities of elk and bison) is not addressed. Some of these diseases, or surrogate biomarkers for disease or environmental contamination, could be used by the SDP in criteria for assessing success of simply reducing reliance on supplemental feed at reducing disease prevalence and transmission risk.

SDP Limitations

Hunting: Earlier and more intensive NER hunting may be a tool to decrease elk and bison reliance on NER feeding by delaying elk and bison arrival while not significantly affecting populations. As noted in the SDP, hunting on NER later in the

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attributed to CWD resistance. But MM and ML polymorphisms characterize over 97% of the Jackson population based on Williams et al. The rarity of LL genotypes, and low prevalence of ML genotypes suggest the assumption that methionine alleles at this location have no fitness value may not be valid. Models are useful but direct predictive application to field conditions rarely accurate. No other cervid population is known to have experienced selection for genotypes thought to be more resistant to CWD infection despite adverse effects in those populations. Regardless, the demographic effects on the modeled elk population under selective pressures of CWD in Williams et al were not discussed.

season may be quite helpful in changing elk distribution. The SDP also notes that later cessation of hunting on the Bridger Teton National Forest (BTNF) would aid in changing elk distributions and delaying feeding but this management option could only be considered if the December 1 closure date of BTNF is changed. Cole and Foley (2015) point out that an increase of elk summering adjacent to the NER contributes to high winter elk numbers on NER. None of these options are seriously addressed in the SDP despite their potential utility, and while the SDP plans to "consider expanded hunting opportunities" with WGFD and BTNF nothing has been accomplished prior to publishing the SDP. In addition, the SDP states

> "few options for manipulating elk hunting are currently available because the Jackson elk herd is at or near 11,000 WGFD objective" (SDP page viii)

apparently precluding any serious discussion for impactful hunting modifications after the SDP is adopted. While the text (SDP page 18) suggests the elk hunting season on the NER may be shifted one week later, a summarization of management actions under the SDP (Table 4) indicates "no change" to hunting onset and ending dates. Hunting modification may be so important to success of the SDP that the Refuge and Park note that later elk arrivals might make later hunting a <u>necessity</u> to achieve herd objectives.

Part of the problem is highlighted by data presented in the SDP. During the last decade the Jackson herd size was reduced from over 13,000 to the herd objective of 11,000. At the same time proportion of the Jackson elk herd wintering on NER has increased. These data would suggest that hunting, as currently implemented, is not adequately addressing the cohort tending to NER or assisting management actions to decrease reliance on winter feeding.

The above issues are relevant to hunting within the parameters of an 11,000 herd objective. But the SDP points out that the increased winter use of the NER by Jackson elk is correlated with decreased use of native winter range. The SDP doesn't address winter range, as discussed above. But the authors take the position that if winter range use cannot be increased, the Refuge and Park will

> "collaborate with the WGFD in the public process of reviewing and adjusting the future Jackson elk herd population objective".. [which]… "will provide a level of harvest flexibility more commensurate with addressing changes in herd distribution". (SDP page 18)

Despite decades of discussion with the state over herd objective, with literally no change, the SDP authors are optimistic this can be accomplished without any supportive evidence. Hunting parameters and herd objectives will need modification to better address the segment of the Jackson herd that migrates to, and winters on, the NER. Collectively, the lack of pre-publication collaboration and agreement with other agencies on hunting alternatives is another critical failure of the SDP.

Private Lands: This is an area where the Refuge and Park could have made significant progress to increase the chance of success of the SDP before publication. Having specific private landowners acknowledge greater acceptance of elk on private land, providing specifics on acceptable incentives, and having addressed some of the well known and expected landowner conflicts and mitigations in time, place, and degree would have greatly enhanced the objectiveness and practical implementation of the SDP. The Refuge and Park will determine winter distribution and movement through data provided by 50 collared elk. Amazingly, their stated hypothesis is that more elk will move onto private land yet the SDP has no concrete specifics for how this will be addressed. Instead, the Private Lands section lists a variety of actions that might be considered on private land but leaves the reader to speculate where, when, how, by what funding, and which landowners might find acceptability in some of these alternatives.

Habitat Restoration: Adequate discussion is provided about GRTE restoration efforts on the Kelly hayfields. The project is ongoing irrespective of the SDP but is the only place in the SPD where increasing availability of native winter habitat is discussed. The SDP fails to address how increased access to existing native winter habitat (aside from comments about private land) might be addressed or how other increases in the base of winter habitat might be obtained. These are 2 critical elements for the success of the SDP at reducing reliance on winter feeding.

Adaptive Management Monitoring: A critical component of adaptive management that sets it apart from subjective changes in management is collecting data specific for assessing management success and feeding those results back for adjusting (adapting) management. The SDP outlines many monitoring actions that will be appropriate and useful for various aspects of the BEMP, though acceptance criteria for success are lacking. Methods for assessing available forage, making them more robust and objective, while retaining historical sites for comparative purposes, are anticipated but clearly not completed therefore not defined in the SDP. Forage production will be enhanced, but no detail provided for review. More significantly, there are no metrics for assessing how forage production will affect animal density. Because habitat enhancement projects are spatially limited, their effect on animal disease and environmental health will likely be minimal. Without a measureable link between the outcome of these enhancement projects and disease or environmental health, their utility at addressing these objectives of the BEMP will remain unknown.

Animal abundance and distribution are adequately addressed through standardized procedures established over the decades. Using collared elk to estimate winter distribution is an enhancement though sample size may be inadequate. More frequent counts of animals on feed is not specifically discussed in the SDP but historically NER staff providing feed made routine counts of animals on feed. How accurate these assessments is not discussed. More robust population distribution assessments during migration time to the NER may permit development of options

to interfere with migration onto NER and encourage migration onto native winter range. Management actions to address migration could help in changing the behavioral component of migration to the NER.

Winter mortality estimation, quantifying EFD and BFD, and measuring brucellosis seroprevalence and CWD surveillance are continuation of ongoing activities. As outlined above some of these could be augmented, and some may be inadequate. The SDP specifically discusses using collared samples (n=10 per year for 2019 and 2020) with regard to disease sampling but that sample size is insufficient. Presumably these monitoring efforts include large samples from hunter killed animals and are adequately addressed (certainly brucellosis seroprevalence, possibly CWD surveillance, but other diseases likely not) but outside the purview of the SDP. But as outlined above, the fact that disease prevalence and presence is not used as assessment criteria for the success of reducing reliance on supplemental feeding is a major deficit of the SDP.

Public Outreach: This section does little more than enumerate the various means and general topics the Refuge and Park might use in contact and education of the public regarding the issues. No specific education is outlined, nor are specific issues identified that need to highlighted to the public and stakeholders.

Final Note

I have personally worked on this issue with all involved agencies for decades before retirement. While my background is as a research ecologist and veterinarian, the entire field of wildlife management is guided primarily by values, not, as is commonly misunderstood, science. What we, as a society, want to see on the landscape shapes management. Science can only help delineate methods to achieve the outcomes of desired and articulated values, and can help predict likely outcomes of alternative management strategies. We have the variety of wildlife management agencies, with different purposes on different landscapes, expressly so the diversity of values of the public have a place on the landscape. This makes for difficulty, compromise, and conflict when common wildlife resources range over multiple jurisdictions. From the SDP (page 33):

> "The practice of feeding elk evokes passionate responses from those that oppose and those that support this practice. The general public and key stakeholder groups must understand the biological need for and strategies of the SDP in order to gain general consent to modify long-standing elk and bison herd management methods".

I would very much agree with SDP authors on this point. But what is the education about the biological need the authors seek to convey? What, specifically, are the biological needs to which they refer? Are these values of the National Wildlife Refuge System (NWRS) and the US Fish and Wildlife Service (USFWS)? There will

always be objections to any wildlife management plan. In fact, some would do away with public lands and some would do away with wildlife management agencies as expressions of their values. But the values of the general public outside local and state are essential guidance for federal land management agencies. Wildlife on National Wildlife Refuges and National Park lands in the US is a public trust managed for the benefit of all citizens, not just a few, and not just the state of Wyoming. Further, the federal agencies must manage in accordance with their enabling and governing legislation. The USFWS has an obligation under the BEMP and its EIS, as well as the Refuge Improvement Act, to manage for healthy populations, ecological functioning and biological integrity on the NER and other lands under its jurisdiction to provide THAT specific value for the American public. We eliminated feeding on other refuges, even those involved with endangered species recovery, as we recognized the ecological ramifications. Though the Refuge and Park are quite aware of the issues, perhaps this may be the education needed in public outreach (Dunkley and Cattet 2003):

> "Significant ecological effects of providing feed to wildlife have been documented through observation and experimentation at the individual, population, and community levels…. [of which disease is a major concern, but]
>
> ….even if spread of disease is prevented, other significant ecological concerns exist. Disruption of animal movement patterns and spatial distribution, alteration of community structure with reduced diversity and abundance, the introduction and invasion of exotic plant species, and general degradation of habitat are all major negative effects that have been documented at different locations throughout North America. Although information gaps exist, current information appears sufficient to conclude that the potential for negative ecological effects as a result of providing food to wildlife through artificial feeding or baiting is high."

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