Susan Markley, PhD; April 2016, Comments re:
FWS Docket ID: FWS-R6-ES-2016-0042: **Removing the Greater Yellowstone Ecosystem Population of Grizzly Bears from the Federal List of Endangered and Threatened Wildlife;**

GENERAL COMMENTS

It is encouraging that management practices implemented under recovery plans have led to an increase in numbers of grizzly bears in the Greater Yellowstone Ecosystem (GYE), particularly in areas of suitable habitat beyond the boundaries of the National Parks. However, as stated throughout the published Proposed Rule Document (PRD) and supporting reports, grizzly bears remain "*a "conservation-reliant" species because of their low resiliency to excessive human-caused mortality*", and therefore continuation of such management practices are required to assure the potential for a self-sustaining population that remains recovered by any definition.

It is also encouraging that improved scientific modeling strategies have provided better understanding of grizzly population demographic patterns and trends. Again, as acknowledged repeatedly in the PRD and supporting reports, for long-lived mammals with low reproductive rates and which are difficult to observe directly in remote and rugged terrain*, "extensive data collected over decades are needed to understand"* or even identify trends with confidence, particularly the factors driving observed or modeled changes.

Therefore, though bear numbers have increased and may have reached carrying capacity in the core recovery area, I oppose delisting of GYE grizzly bears under management conditions as described in the currently posted FWS PRD and Conservation Strategy. Uncertainties about bear demographics and driving forces that affect their vitality, climate change, and understanding of carrying capacity, as well as increasing human activity (including "discretionary" hunting mortality) and practical tools available to manage threats, collectively demand a more conservative approach than outlined in the Proposed Rule. As a minimum condition of delisting, within the Primary Conservation Area (PCA) and allied "secure habitat" beyond the National Park boundaries, previously established recovery strategies and criteria should be retained or even strengthened, with continuing effort to reduce human activity that either damages habitat or invites the greatest risk of human-bear conflict which leads to bear mortality. There should be no "discretionary" bear mortality within the PCA. Relaxation or suspension of the very protections intended to reduce human-caused bear mortality and assure secure habitat throughout the GYE is premature, and the risk of jeopardizing the progress made is not justified. Recovery of the GYE bears is something to be celebrated, a treasured investment not to be placed at risk.

Additionally, because the majority of bear deaths in the GYC are human-caused, and this remains the principal threat to bears, I strongly support ongoing efforts to reduce human-bear conflicts through education and outreach for recreationists and people who live or work in the region, purchase or trade of grazing allotments bear habitat, support for bear-proof trash containers, compensation for livestock depredation, and other methods used to help residents protect livestock and property. These strategies are a "win" for people and for bears.

I offer this opinion based upon review of the PRD and some supporting reports, my experience as a Montana property owner, my own frequent and regular recreation in the GYE, and a >30 year career in natural resource management (including service on a listed species Recovery Team).

DETAILED COMMENTS

Recommend a Priority Management Approach for PCA and Secure Habitat

The Proposed Rule and supporting documents make clear the importance of "secure habitat" and limitation of human-caused mortality National Forests bordering the national parks in the increased and possibly stable population of grizzlies. National Forest lands account for more than 58% of the defined primary conservation area (PCA), and presumably even more of the suitable habitat area. Various lines of evidence demonstrate that bear populations in these areas have grown and/or stabilized (when in the past before protection afforded by listed status and the recovery planning process, these may have been "sinks").

The Proposed Rule document states that "*Rapidly accelerating growth of human populations in some areas outside of the PCA continues to define the limits of grizzly bear range, and will likely limit the expansion of the GYE grizzly bear population onto private lands in some areas outside the PCA. Urban and rural sprawl (low-density housing and associated businesses) has resulted in increasing numbers of grizzly bear-human conflicts with subsequent increases in grizzly bear mortality rates. Private lands account for a disproportionate number of bear deaths and conflicts*." Thus, the GYE grizzly population remains constrained by human factors, particularly beyond the PCA, and this part of the habitat has now become the "sink". The posted reports contain modeled estimates of grizzly population and demographics, and conclude that grizzlies have reached "carrying capacity" within the PCA or perhaps demographic modeling area (hard to determine that from the text), and that bear-density-dependent factors may be limiting population within that area. However, there is acknowledged uncertainty associated with the model output and the difficulty of distinguishing various density-dependent and density-independent drivers of bear numbers and vigor. In any system, such drivers and therefore potential carrying capacity are variable and often unpredictable. The drivers affecting bear survival and vigor may be confounding, synergistic, or cumulative and difficult or impossible to recognize in a given year, or even several year period. Although it is also clear from numerous reports that bears are opportunistic and adaptive with respect to food sources, the core population's continuing resiliency is likely limited by growing human populations, increased visitor/recreational activity in Parks and National Forests, and interests in extractive uses or grazing which are often otherwise allowed on public and private lands outside of National Park boundaries.

Although the PRD and the Draft Conservation Strategy suggest that habitat management practices in National Forests will be maintained as they have in the recent past, with continuation of Habitat Based Recovery Criteria, it is not clear that this will be practicable, given that listed status provides tools and incentives that may not otherwise be available. Of even greater concern, the Forest Service does not have authority to directly manage wildlife take, apparently even within the PCA. Without actually having Forest Service and state regulations in place and available for review concurrent with delisting, it is not possible to assure that critical management strategies and regulatory framework upon which recovery is dependent will be maintained.

A higher priority should be afforded within the delisting process to continued protection of bears and habitat within public lands, particularly those within the PCA and designated wilderness areas. For example, new research shows that hundreds of bears aggregate in high, rugged terrain to feed upon army cutworm moths, a high value food source. No hunting or other encouragement of human activity (except as necessary to protect human life/safety) should be allowed in areas that provide such feeding opportunities. Within PCA and allied "secure habitat", previously established recovery strategies and criteria should be retained or even strengthened, with continuing effort to reduce human activity that

either damages habitat or invites the greatest risk of human-bear conflict which leads to bear mortality. There should be no "discretionary" bear mortality within the PCA. Regulations assuring this should be in place before delisting.

Improving Monitoring, Models, and Demographic Recovery Criteria

The PRD and supporting reports stress that due to bears' long life span, relatively low reproductive rate, relatively low density, and occurrence in remote and difficult to observe terrain, long-term monitoring is required to understand population trends and patterns: "*However, to obtain a biologically meaningful estimate of average annual population growth rate for a long-lived species like the grizzly bear that reproduces only once every 3 years and does not start reproducing until at least 4 years old, we must examine lambda over a longer period of time to see what the average trend is over that specified time. This is not an easy task; for grizzly bears, it takes at least 6 years of monitoring as many as 30 females with radio-collars to accurately estimate average annual population growth (Harris et al. 2011, p. 29)*." And, some population statistics used for the status analyses are based on many years-to-decadal time periods: *"The 5- to 10-year time interval was selected based on life-history characteristics of bears and methodologies in order to obtain estimates with acceptable levels of uncertainty and statistical rigor (Harris et al. 2011, p. 29).*" In Yellowstone Science 23(2): Pages 17-25, Van Dranen et al. state that the change in population growth rate (presumably the "leveling off" or approach to carrying capacity) was recognized only a decade after it began. They state: *"Detecting changes in a grizzly bear population simply takes time."* This appropriately leads to the recommendation that Conservation Strategies and monitoring will continue beyond the 5-year period required by the ESA, an important tool, but which does not address the challenge of management strategies dependent on determining an instantaneous "annual" estimate.

In efforts to derive such annual Demographic Criteria, particularly those applied to determining acceptable annual levels of mortality, the long-term perspective is compromised. Although FWS and other managers are trying to do the right thing by establishing adaptive management strategies that can be adjusted based upon assessment of new data, uncertainties associated with the underlying monitoring and modeling create a vulnerability in this approach: a risk that a negative trend in population or various components of bear population vigor could be occurring, perhaps as a result of or aggravated by human-related and/or natural causes such as climate change, and it will not be recognized with statistical rigor until adverse impacts have occurred. Also, the calculation of a specific number of male and female bear deaths that is acceptable annually (and specific number available for hunting, a calculation that is necessary for actually implementing managed hunts), without an accompanying description of uncertainty (such as confidence intervals) creates a perception of scientific precision and confidence that does not actually exist, given challenges of bear monitoring and the ever-changing nature and variability of the GYE.

Experts agree that the Chao2 estimator, which is based upon annual observations of females with cubs-of-the-year, adjusted for unobserved females/cubs, is the best available tool for population assessment. Although reports state that this advance allows estimates of total population, as well as each age and sex class, to be calculated instead of minimums, uncertainties in any mathematical modeling approach remain. The Chao2 estimator produces estimated total population metrics, with uncertainty expressed as lower and upper bounds, or confidence intervals (CI), which presumably encompass the actual, but unmeasurable, population. Demographic Criteria consider the uncertainty described by the CI's to create a "sliding scale" of % allowable total and discretionary mortality (or various triggers for reassessment) by comparing the annual model-averaged Chao2 total population estimate to lower bound, long term (2002-2014) average, and upper bounds. It is not clear how or if the uncertainty of

each annual model-averaged Chao2 population estimate will be considered. This additional layer of uncertainty should be reported and compared to long-term uncertainty bounds and to determine what % mortality level is applied. A more careful and less risky approach would be to calculate CI's for each annual estimate, and compare lower and upper bounds to the long term CI, as well as comparing annual average to long-term average. Increasing uncertainty in an annual calculation, or possibly lower population, leading to a lower bound of the CI could suggest that the actual unmeasurable population might be less than the metrics defined by longer-term modeling as a trigger for action. For example, if the lower bound of the CI in an annual estimate is less than the lower bound of the long-term lower bound, then reductions in allowable % mortality (and thus calculated number of bears available for hunting) or triggers for reassessment should occur. It is also recommended that an additional "trend" criterion be added: if a pattern of three or more years of consecutive declining model-averaged total population or lower CI bounds occurs (even if the decreasing metrics are not as low as those proposed for single-year triggers), then discretionary mortality should decrease/end and assessment protocols should begin. This conservative approach would provide some buffer for the challenge of identifying longer-term trends.

Assuming that bear population within the Demographic Monitoring Area (DMA) has reached carrying capacity (and that *k* is not changing much over short time periods) and population is leveling somewhere around 700 bears, the general implication is that are not very many "extra" bears, especially females, within the DMA whose deaths would not have consequence. If there were, bear abundance, distribution, vigor would still increase, though incremental increase as well as negative consequences or feedback, would be difficult or impossible to recognize on an annualized or even a multi-year basis. Such risk is lessened if Demographic Criteria are all calculated/assessed using the lower bounds of CIs.

Additionally, the Demographic Criteria for determining acceptable total mortality compare annual observations to an estimate of "average background mortality", apparently based upon a recent four year period: "*If the average background mortality was higher than the 2012-2015 average of 37, there may not be any discretionary mortality in a given year. Concurrently, if the average background mortality declined, there may be additional discretionary mortality available*." The period over which a moving average is calculated should be defined, particularly if the annual figure used to determine allowed mortality each year is also a based upon a moving average. The calculated average background mortality must also carry a degree of uncertainty (because it varies from year to year). The allowable annual total mortality, calculated as a percentage of the Chao2 estimates, should also be expressed as a range with lower and upper bounds taking into account the uncertainty (CI) of the long-term Chao2 estimate. These elements of variability in mortality should be defined and considered in determining whether or not there are "extra" bears that could be available for hunting. In an example given in the PRD for an annual estimate that is the same as the long term average, only a small number of female bears would be available for hunting: "*In this example, with an average background mortality of 37 (15 females and 22 males), if the DMA population in a given year was at 674 bears as calculated by the modeled-averaged Chao 2 method, using table 3 there would be 3 female bears and 13 male bears available for discretionary hunting mortality."* Also, according to the PRD, when Chao2 estimated annual population is lower than the targeted population and a lower percentage (though the actual % mortality level that would be used is not clearly defined, just stated as "<7.6%)" mortality is tolerated, then the number of available bears would be even smaller, and likely within a range of uncertainty where no additional mortality is acceptable. In summary, a more conservative and lower risk approach is to determine uncertainty, and use triggers and sliding scales that compare lower bounds to lower bounds, as well as averages to averages. Allowable total mortality and determination of discretionary mortality calculations should be performed using lower bounds of CI's.

Given that the number of "extra" bear deaths that could be sustained will often be small, it is possible that the mortality targets could be exceeded in a given year before a correction in management of hunting strategy can occur. "Removing" those excess mortalities from the next year's figure is a reactive approach, a sort of after-the-fact "mitigation", and carries risk. There is a long-term data base of observed mortality (http://nrmsc.usgs.gov/science/igbst/mort). Therefore, it should not be difficult to construct a month-by-month or seasonal analysis of cumulative annual mortality, with corresponding uncertainty related to variability from year-to-year. A simple cumulative %-total-mortality vs month (or other appropriate time interval) could help alert managers in advance if annual mortality is progressing in a "normal" pattern, or is exceeding known trend of mortality. Then, an additional criterion could be established, which would trigger adjustment of management strategies for the current year, if bear deaths appear to be outpacing the limit due to unexpected natural or human-related causes. For example, if there are 20% (or some other appropriately established threshold) greater numbers of bear deaths in mid-year than the long term pattern predicts, then discretionary mortality may be suspended/deferred for that year.

The suite of Chao2 estimator metrics, with enhancements as suggested, are useful tools. However, they are arcane, complicated, and can be difficult to explain or understand (even for scientists who are not experts in mathematical modeling methods). Criteria based directly upon observational data, such as the components of Criterion 1 and 2 that assess number and distribution of identified females with cubs-of-the-year, are easier to describe and show graphically. FWS and the interagency committee should consider the potential for an annual criterion or descriptive indicator, such as an annual index, that relates number of observed females with cubs to total observed mortality for that year. Presumably, an average and CI could be calculated for this type of metric by examining such an index over the period of record. Such a metric might help to clarify if an unusual ratio or mortality is emerging (for example, to address a potential question if a higher number of deaths can be explained by a higher number of living bears), providing clues that may not be revealed in models for many years/decades.

Recommendations Concerning Implementation of Managed Hunts

Even if the strategy for setting numerical limits proposed in the PRD is implemented, meeting these limits through a strictly managed hunt by multiple management authorities is likely to raise practical issues of allocation among states and tribes, feasibility of enforcement, prevention of exceedance of limits (including gender limits), and subsequent implementation of mitigation (reduced discretionary mortality) in a following year. It is important for States or Tribe wildlife authorities that will make rules and implement them to address these kinds of issues up front as part of this delisting proposal. Without doing so, it is simply not possible to conclude that an acceptable regulatory framework (as required by the ESA for delisting) exists to assure Conservation Strategy is implemented.

If a concession for hunting is a goal, a structured approach that maintains protection of the PCA and other secure habitat is required. Several more careful potential alternatives include:

1) Allow limited hunting only outside of the DMA, away from "secure habitat". Such a concept would be supported by this conclusion in the PRD: "*Grizzly bears in these peripheral areas are not biologically necessary to the GYE grizzly bear population and a lack of occupancy outside the DMA boundaries in peripheral areas will not impact whether the GYE population is likely to become endangered or threatened in the foreseeable future throughout all or a significant portion of its range. The core population inside the DMA is resilient, and its distribution provides the necessary redundancy to offset loss of individual bears in peripheral areas.*"

2) Allow strictly managed hunting only in the outer fringes DMA and beyond it, but NOT within the Primary Conservation Area, Wilderness areas, or in any area where bears aggregate to feed on army cutworm moths. Such discretionary mortality would utilize an enhanced and more conservative suite of demographic criteria to determine a limit or how many tags/licenses will be issued.
3) If it is logistically difficult to identify the boundaries of the PCA or other "secure habitat" in the context of managed hunting, allow strictly managed hunting only in identified areas or readily definable zones distant from the PCA or Wilderness, in the outer fringes of the DMA or beyond it. Discretionary mortality would be regulated in such designated areas utilizing an enhanced and more conservative suite of demographic criteria to determine a limit or how many tags/licenses will be issued.

Issues Related to Food Resources and Climate

Additional analysis of availability of various food resources (particularly white pine nuts) and possible consequences for bear abundance and distribution are helpful in underscoring bears' adaptability and apparent resilience. However, there are a large, possibly bewildering, number of driving forces affecting bear vitality and various kinds of food availability (including unknown effects of climate change and extreme weather or fires). These factors together confound prediction of effects of a particular food on a population level. Bears may have been able to adapt within the core recovery area, given the level of protection currently in place, giving reason for optimism. However, cumulative or synergistic effects of changing food availability combined with climate change are likely to occur on a multi-decadal time scale, beyond the scope of existing complete datasets or any mathematical modeling. Also, with extent of secure habitat ultimately limited by existing (and increasing) human uses and various natural features of the landscape, uncertainty about the cumulative or synergistic effects of multiple declining food sources and climate should not be dismissed. It is simply premature, given the estimated number of bears, sustainable estimates of mortality, and long term analysis required to recognize trends, to conclude that bears will continue to adapt without limit to more declines or limited availability of food sources.

Though data did not show direct relationships between white pine occurrence and various measures of bear population health or ranging, there was a relationship between lower availability of pine nuts and higher use of "secure habitat" by bears, which leads to less human-conflict and mortality (https://www.nps.gov/yell/learn/how-important-is-whitebark-pine-to-grizzly-bears.htm, https://www.nps.gov/yell/learn/response-of-grizzly-bears-to-changing-resources.htm). This pattern of white pine habitat preference seemed to decrease, only in the last few years of the study, likely far too short a time to recognize any population-level feedback in modeled estimates. Similarly, some components of the bear population inside of YNP show resilience to decline of cutthroat trout in fairly recent time frame, though it is not clear how adaptive food uses may continue in the long term. Abundance of elk and bison (young and winterkill) and competition with other predators and scavengers for carcasses are changing and subject to numerous population drivers and management strategies distinct from bear management.

New understanding of the significance of army cutworm moths is of great importance, and deserves further emphasis in emerging bear Conservation Strategy and the PRD: *"…the number of moth sites used by bears and the number of bears observed on sites has increased considerably (Bjornlie and Haroldson 2014). During a flight over all moth sites in 2014, 220 unique grizzly bears were observed feeding on sites, including 14 different females with cubs."*(Bjornlie and Haroldson, 2015, *Yellowstone Science* 23(2): 2015, pages 49-61). These feeding aggregations occur within and beyond the boundaries

of the National Parks. They deserve extraordinary level of protection, not currently defined in the PRD, across agency and political boundaries. Though these are remote, rugged areas not easily accessed by typical human activities, it should not be assumed that they will remain undisturbed. Discretionary mortality (hunting) and increased human uses or habitat impacts in areas where bears aggregate to feed on moths should be specifically prohibited (except as necessary to directly protect human life and safety) in the PRD or other rules in place before delisting. Because these areas are so remote and difficult for people to access, the happy corollary to such a regulatory protection is that it is unlikely to place an undue burden on any current human interest.

The PRD and other supporting documents note that bears cross agency jurisdiction and various management boundaries that have been described in the past. Gunther et al. (*Yellowstone Science* 23(2): 2015, pages 7-11. https://www.nps.gov/yell/learn/grizzly-bears-ultimate-omnivores.htm) state: "*Because occupied grizzly bear habitat in the GYE is managed by many different state and federal agencies, bears often cross jurisdictional boundaries to forage different food resources. Consequently, interagency cooperation is critical for successful, long-term conservation of grizzly bears and may be particularly important in the face of uncertainties such as climate change and expanding human occupation of the area*." This is the best argument for establishing through the PRD and allied regulatory framework a consistent higher tier of continuing protection for bears and habitat within the PCA and Wilderness areas, regardless of whether the area is within the boundaries of a National Park, National Forest, or other designated public land.

Public Education, Awareness, and Living Responsibly with Bears

As emphasized in the PRD and many supporting documents, reducing conflicts with people is the key to grizzly conservation, since the main threat to bears and habitat continues to be human conflict. When people who live, work or recreate in bear country are injured or killed by bears, or when bears damage property or kill/injure livestock, bears lose. However, the perception still held by many that there is an absolute choice between people vs. bears on the landscape is a false dichotomy. Teaching people how better to coexist with bears and reduce potential for conflict is extremely important. All strategies to educate residents and visitors, realign and provide equivalent areas for grazing or other traditional human activity outside of bear habitat, assist landowners and businesses in protecting their property, etc., deserve high priority in each agency, community, and interest group. Employing best practices for safety in bear country is a "win-win" strategy, protecting people, and the welfare of animals.

Clarity and Organization of the Proposed Rule Document (PRD)

As stated in the PRD, for comments to be most effective, they should be detailed and informed. However, the listing/delisting process is complex and difficult for the general public to understand. The published PRD, particularly the sections relating to modeling and development of Demographic Recovery Criteria, is too arcane. Cited references are too difficult to obtain. Figure 1, a conceptual illustration of carrying capacity, does not demonstrate anything about GYE grizzlies in particular. A much more helpful graph would have shown the Chao2 modeled estimates that suggest a leveling off of population. Figure 2, a tiny map, in black and white, portraying various components and acronyms used to describe bear habitat is difficult to read and the gray shades are not easily distinguished. It is necessary to search for other documents to even find a chart or table showing estimated population of females with cubs-of-the-year, estimated total population, or mortality patterns over time. To do this, one must copy-paste a link (not even a live link!) to a complicated list of other documents, which in turn must be searched. The lengthy narrative is numbing, and could have been improved by simple graphics (such as pie charts, graphs, clear maps, or tables with observed data). There are various places in the PRD narrative (and also in the Conservation Strategy) where the upper bound of the population

confidence interval is listed as 757, and elsewhere 747. I believe, but am not sure, that 747 is the correct upper bound. I could not find a link to any FWS report or web page that showed model-estimated total population or various subcomponents of total population over time. Without such information, it is difficult for a commenter to prepare a substantive recommendation, without having been intimately involved in the process. Furthermore, a more transparent and non-technical presentation is much more likely to reduce skepticism and inspire trust.