May 14, 2019

Natural Resources Committee
Subcommittee on Water, Oceans, and Wildlife
United States House of Representatives
1324 Longworth House Office Building
Washington, DC 20515

Chairman Grijalva, Subcommittee Chairman Neguse, Ranking Member McClintock, Honorable Members:

Thank you for the opportunity to provide a written statement in support of the "Tribal Heritage and Grizzly Bear Protection Act" (H.R. 2532). Please accept these comments for the official record.

My Background and Expertise

For the record, my name is David J. Mattson, a scientist and recently retired wildlife management professional with extensive experience in grizzly bear research and conservation spanning four decades. My educational attainments include a B.S. in Forest Resource Management, an M.S. in Plant Ecology, and a Ph.D. in Wildlife Resource Management. My professional positions prior to retirement from the U.S. Geological Survey (USGS) in 2013 included: Research Wildlife Biologist, Leader of the Colorado Plateau Research Station, and Acting Center Director for the Southwest Biological Science Center, all with the USGS; Western Field Director of the Massachusetts Institute of Technology-USGS Science Impact Collaborative; Visiting Scholar at the Massachusetts Institute of Technology; and Lecturer and Visiting Senior Scientist at the Yale School of Forestry & Environmental Studies.

My dissertation focused on the ecology of grizzly bears in the Greater Yellowstone Ecosystem (GYE) during 1977-1996 (Mattson 2000). I intensively studied grizzly bears in the GYE during 1979-1993 as part of the Interagency Grizzly Bear Study Team (IGBST) and was charged with designing and supervising field investigations during 1985-1993. My field research focused on human-grizzly bear relations; grizzly bear foraging, habitat selection, diet, and energetics; and availability and ecology of grizzly bear foods. I have continued to closely observe grizzly bears and their habitats in the GYE since the end of my intensive field investigations in 1993.

Although my field studies in the GYE ended in 1993, my involvement in grizzly bear-related research, management, and education, both regionally and internationally, has continued through the present. Throughout my career I have been consulted by brown/grizzly bear managers and researchers worldwide, including from Russia, Japan, France, Spain, Greece, Italy, and, most notably, Canada. I have also given numerous public presentations on grizzly bear ecology and conservation, including talks, nationally, at the Smithsonian (Washington, D.C.) and American Museum of Natural History (New York, NY), and, regionally, at the Denver Museum of Natural History (Denver, CO), the Museum of Wildlife Art (Jackson, WY), and the Museum of the Rockies (Bozeman, MT).

My Expert Opinion in Brief

H.R. 2532 "Tribal Heritage and Grizzly Bear Protection Act" will provide much-needed protections for grizzly bears in the contiguous United States, along with long-overdue representation for Native Americans in decisions affecting a species of widespread spiritual and cultural value.

Without the protections and acknowledgments of native cultural values provided in H.R. 2532, inevitable divestiture of federal management to the states of Wyoming, Montana, and Idaho will almost certainly cause irreparable harm to grizzly bears and native peoples who value this species. All three states have made clear that high priority will be placed on instituting a grizzly bear trophy hunt as well as other lethal management designed to reduce bear numbers and effectively perpetuate isolation of currently disjunct populations.

Irreparable harm will occur not only immediately upon implementation of such a management regime, but also longer-term by entrained effects that will magnify long-standing and newly emergent threats. These threats include deleterious environmental changes and resulting dietary shifts manifest in burgeoning lethal conflicts with humans; populations that are isolated and too small to insure viability; uncertain and misleading monitoring methods that debar timely remediation by managers; and punishing management regimes that entail not only purposeful population reductions, but also inadequate conflict prevention and facilitation of population connectivity.

In what follows I explicate this thesis to clarify how implementation of foreseeable changes under auspices of state management will be the figurative straw that broke the camel's back, in this case embodied by elements of a natural and manmade system that have synergistically brought our grizzly bear populations to crisis. Given the domain of my expertise, I focus on Greater Yellowstone's grizzly bear population, but with implications for grizzly bears throughout the Northern Rockies.

Grizzly Bears in the Contiguous United States Are Unique

Grizzly bears in the contiguous United States are globally unique. Our bears share a singular evolutionary history. They have also borne the brunt of extirpations caused by European settlers in North America. Greater Yellowstone grizzly bears are, moreover, ecologically unlike grizzly or brown bears anywhere else in the Northern Hemisphere.

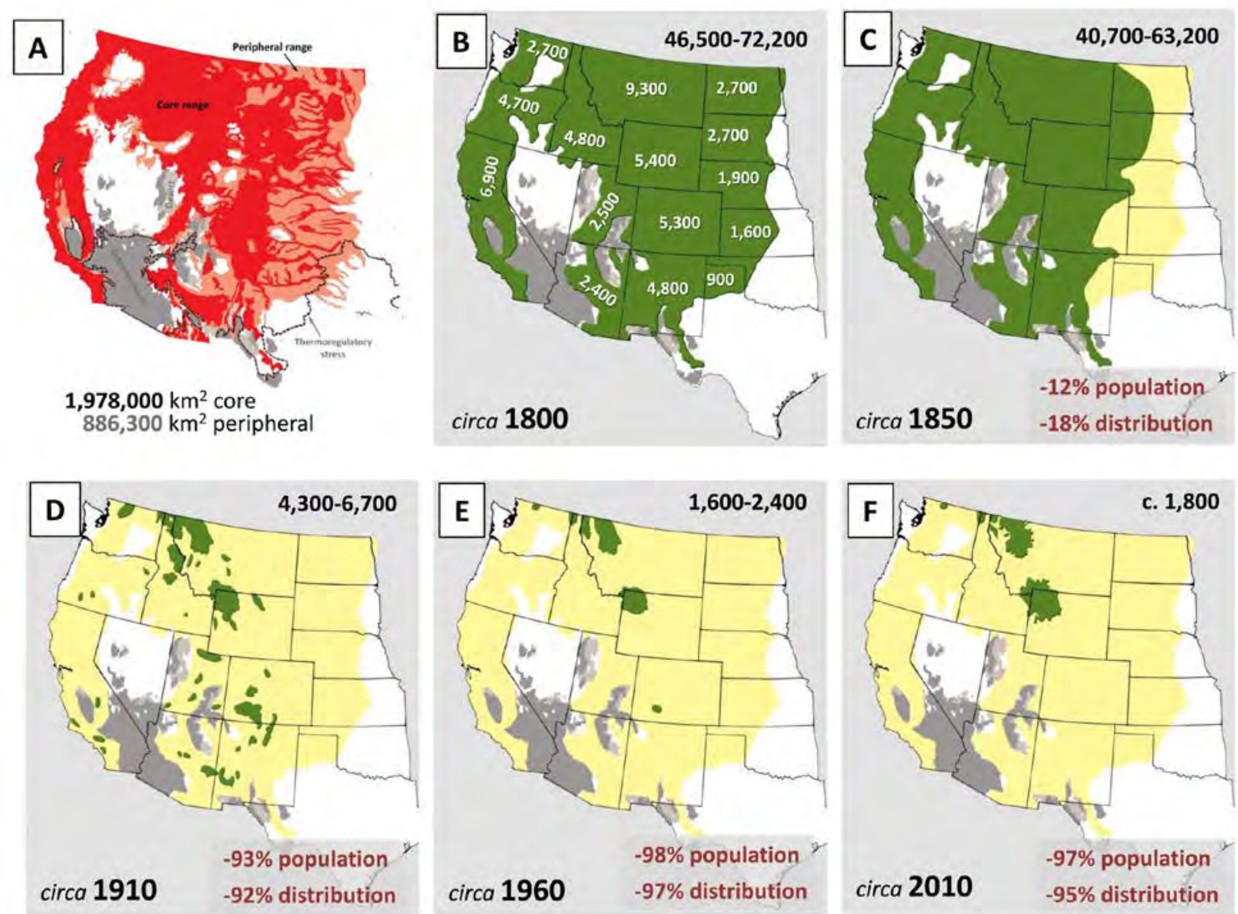


Figure 1. Losses of grizzly bear numbers and distributions in the western contiguous United States between 1800 and 1960 (Panels B, C, D, and E) along with the extent of gains since roughly 1970 (Panel F), largely under ESA protection. The extent of grizzly bear distributions at each time step are shown in green and the extent of losses in yellow. Estimated total populations are shown in the upper right corner of each figure and estimated cumulative losses of populations and distributions in red in the lower right-hand corner. Panel (A) shows estimated core and peripheral historical range relative to the extent of extreme desert and hot climates that would have imposed thermoregulatory limits on the distributions of grizzly bears.

Our current grizzly bear populations are the southernmost remnant of this species in North America, and a mere 3% of what we once had (Fig. 1). Extirpations perpetrated by Europeans between 1850 and 1960 were sudden, catastrophic, and synchronous with the alienation of native peoples from ancestral homelands. For that reason alone, our surviving grizzly bears are important. As context, losses would almost certainly have been much greater without Endangered Species Act (ESA) protections (Mattson and Merrill 2002), although gains since listing have been sufficient to recoup only 1-2% of the totality lost during the 1800s and early 1900s.

Grizzly bears in the contiguous United States are also important from an evolutionary standpoint. They consist of a currently rare genetic lineage (Clade 4[1]) of brown bears that was one of three clades and subclades first emigrating from Eurasia to North America during the Pleistocene. These bears spread from Beringia south to middle latitudes of North America sometime before 30,000 years ago, prior to when continental ice sheets of the Last Glacial Maximum isolated grizzly bears to the south from conspecifics to the north. Since then, most bears of the Clade 4 lineage have been extirpated, and now consist only of a small relic in Hokkaido, Japan, and grizzly bears residing south of central Alberta and southeast British Columbia (Waits et al. 1998, Miller et al. 2006, Davison et al. 2011). These Clade 4 bears once occupied all of the western contiguous United States, south into Mexico, and bore the brunt of European-caused extirpations that resulted in the loss of roughly 95% of all bears belonging to this genetic lineage in North America, if not the world (Mattson, 2017, *What's in a grizzly name*, https://www.grizzlytimes.org/single-post/2016/11/11/Whats-in-a-Grizzly-Name). Conservation and recovery of Greater Yellowstone's grizzly bears are all the more important given that they are part of this rare and much diminished genetic lineage.

Finally, of ecological relevance, Greater Yellowstone's bears continue to exhibit behaviors and diets that were once widespread in mid-latitudes of North America, but now largely vanished due to historical extirpations. The Greater Yellowstone ecosystem is thus a museum, and the grizzly bears within a truly rare relic of much that has been lost behaviorally. Overall, Greater Yellowstone's grizzly bears exhibit foraging behaviors, diets, and habitat relations that are unique in North America, and possibly the world.

More specifically, nowhere else in the world do grizzly bears depend, as they do in Greater Yellowstone, largely on energy and nutrients from army cutworm moths (*Euxoa auxliaris*), whitebark pine seeds (*Pinus albicaulis*), elk

[1] Clades and subclades are roughly equivalent to subspecies and the nomenclature currently preferred by taxonomists and phylogenetisists for referencing noteworthy genetic lineages within species.

(*Cervus elaphus*), bison (*Bison bison*), and, prior to 2000, spawning cutthroat trout (*Oncorhynchus clarki*; Mattson et al. 2004). Although some have claimed that grizzly bears along the Rocky Mountain East Front in Montana have similar diets, bears in this more northern region obtain most of their meat from livestock and deer rather than elk and bison (Aune and Kasworm 1989), very few seeds anymore from whitebark pine (Smith et al. 2008, Retzlaff et al. 2016), and unknown but probably only regionally minor amounts of army cutworm moths (White et al. 1998).

Of lesser energetic importance—but emblematic of behaviors lost to historical extirpations in the western U.S. —grizzly bears in the GYE are also the only, worldwide, to currently eat substantial amounts of mushrooms, biscuitroots (*Lomatium cous*), yampah (*Perideridia gairdneri*), and pocket gopher (*Thomomys talpoides*) root caches, plus non-trivial amounts of wasps, bees, earthworms, and roots of sweet-cicely (*Osmorhiza* sp.) and pondweed (*Potamogeton* sp.) (Mattson 1997, 2000, 2002, 2004; Mattson et al. 2002a, 2002b, 2004, 2005).

Grizzly bears in the Contiguous United States are truly unique evolutionarily and historically and, among them, Greater Yellowstone's bears are unlike any others ecologically.

Grizzly Bears Are Vulnerable Because Of Their Life History

Grizzly bears are acutely vulnerable to any human-caused mortality simply because their birth rates are so low. In fact, grizzly bears are among the least fecund terrestrial mammals in the world, and certainly in North America. Figure 2 contextualizes this seminal point by locating grizzly bears relative to other terrestrial placental mammals in terms of three signifiers of fecundity: (1) annual reproductive rate; (2) age at which females reach sexual maturity; and (3) age at which a reproductive female replaces herself in the population. Grizzly bears, along with polar bears, have the lowest reproductive rate and longest generation length of any terrestrial mammal in North America. Globally, only elephants and some primates are less fecund. By contrast, black bears in North America produce ten to twenty- times as many cubs per unit area and exist at ten-times the densities of sympatric grizzly bears (Mattson et al. 2005).

As a consequence, grizzly bear populations are unable to accommodate appreciable human-caused mortality without declining, and even small rates of decline, if sustained, can result in catastrophic losses. Of relevance, even though annual rates of decline in grizzly bear populations in the western contiguous U.S. averaged only -3 to -4% between 1850 and 1910, cumulative losses totaled 90% (Mattson and Merrill 2002; Fig 2). This sensitivity of grizzly bear populations to even small, added increments of mortality leaves managers with little margin of error.

Consistent with this thesis, Weaver et al. (1996: 964, 972) succinctly note in their overview of carnivore conservation in the northern U.S. Rocky Mountains: “Grizzly bears…possess much less resiliency [than other carnivores] because of their need for quality forage in spring and fall, their low triennial productivity, and the strong philopatry[2] of female offspring to maternal home ranges.”

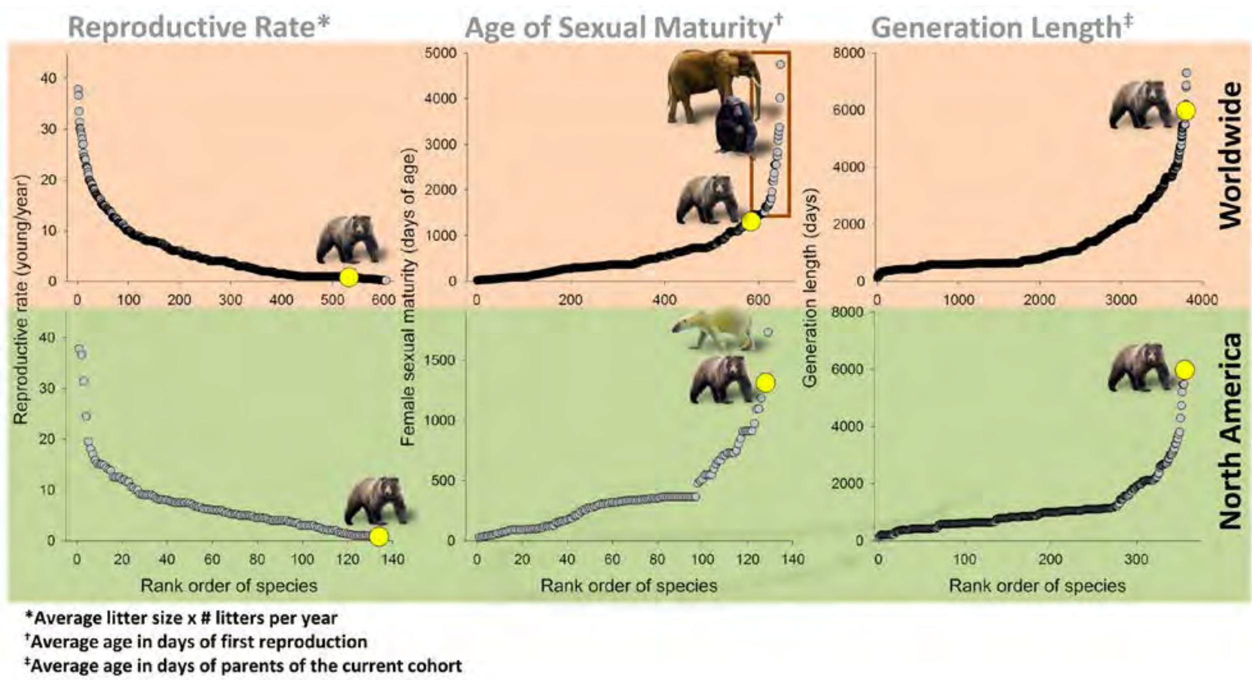


Figure 2. Signifiers of population productivity for grizzly bears (large yellow dots) relative to all other terrestrial mammals, worldwide (top) and in North America (bottom). Sources: Ernest, S. K. (2003). Life history characteristics of placental nonvolant mammals. Ecology, 84(12), 3402-3402. https://doi.org/10.6084/m9.figshare.c.3297992.v1; Pacifici, M., Santini, L., Di Marco, M., Baisero, D., Francucci, L., Marasini, G. G., ... & Rondinini, C. (2013). Generation length for mammals. Nature Conservation, 5, 87-94. http://datadryad.org/resource/doi:10.5061/dryad.gd0m3; Tacutu, R., Craig, T., Budovsky, A., Wuttke, D., Lehmann, G., Taranukha, D., Costa, J., Fraifeld, V. E., de Magalhaes, J. P. (2013). Human Ageing Genomic Resources: Integrated databases and tools for the biology and genetics of ageing. Nucleic Acids Research, 41(D1), D1027-D1033. http://genomics.senescence.info/species/query.php

The need for high-quality spring and fall forage leads to a conclusion seemingly at odds with the fact that grizzly bears are omnivores. Grizzlies do, in fact, require high-quality forage, optimally with high concentrations of fat (Erlenbach et al. 2014), typically provided by only a few foods in environments that are otherwise paradoxically over-run with alternate but low-quality foods. Such is the case with Greater Yellowstone grizzly bears that have depended on just

[2] Philopatry refers to the extent to which offspring share space and other resources with their mothers subsequent to attaining independence.

four main foods for most energy and nutrients. In contrast to the many other foods available to Greater Yellowstone bears, the euphemistic “Big Four” provide much higher concentrations of net digested energy (Fig. 3; Mattson et al. 2004). As a consequence, grizzly bears such as those in Greater Yellowstone —as well as elsewhere in the world (Hilderbrand et al. 1999; McLellan 2011, 2015; Nielsen et al. 2017; Hertel et al. 2018) — can be affected in potentially major ways by losses of a high-quality mainstay food, despite compensatory subsistence for periods of time on low-quality alternate foods.

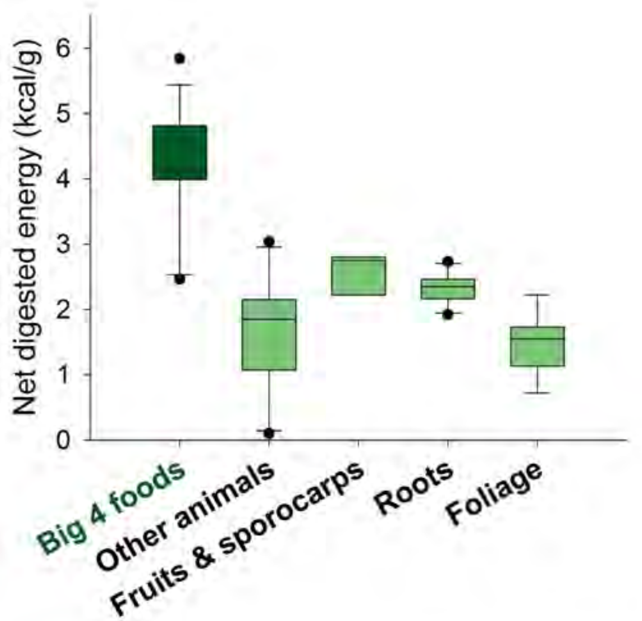


Figure 3. Median net digested energy available from the “Big 4” bears foods (whitebark pine seeds, army cutworm moths, meat from bison and elk, and cutthroat trout) versus all other known, alternate, foods in the GYE.

Our Grizzly Bears Are Vulnerable Because Of Isolation

The effects of human-caused mortality on grizzly bear populations are aggravated not only by low fecundity, but also by isolation and small sizes. Grizzly bear populations in the Selkirk, Cabinet-Yaak, and Greater Yellowstone Ecosystems are all more-or-less isolated. The GYE population has probably been isolated for roughly a century (Miller and Waits 2003; Haroldson et al. 2010). This isolation is intrinsically problematic, first, because the genetic diversity of Greater Yellowstone grizzly bears is lower than that of any other mainland North American grizzly bear population (Miller and Waits 2003); and second, because the current population of roughly 700 bears is far fewer than the thousands currently deemed necessary to ensure long-term viability (e.g., 99% probability of persistence for 40 generations; Lande 1995; Brook et al. 2006; Traill et al. 2007, 2010; Frankham et al. 2014). More to the point, Reed et al. (2003) estimated that, for species such as grizzly bears, minimum viable populations need to be near 9,000 when managed for little or no increase, as is the case for the GYE and Northern Continental Divide (NCDE) populations.

These viability considerations create a mandate for connectivity (e.g., Craighead and Vyse 1996; Servheen et al. 2001; Carroll et al. 2001, 2003, 2004;

Proctor et al. 2005) that poses yet more problems given the limited ability of grizzly bears to colonize even nominally nearby areas. Averaged across relevant studies (Blanchard and Knight 1991, McLellan and Hovey 2001, Proctor et al. 2004, Støen et al. 2006, Zedrosser et al. 2007, Norman and Spong 2015), female brown/grizzly bears disperse only around seven miles from their natal ranges, in contrast to twenty-six miles for male bears. Assuming that annual survival rates in current protected areas apply to bears colonizing connective habitat, it would take female grizzlies roughly 80 years, and male grizzly bears roughly 50 years, to colonize areas 100 miles distant (note that the pace of colonization is slower than might be expected for males, given that their advance is pegged to the advance of reproductive females, barring the next to last generational step). Meaningful recovery and long-term viability is thus rendered nearly impossible if grizzly bears are subject to higher levels of mortality on the population periphery, as would likely be introduced by sport hunting and purposeful population reductions.

Our Grizzly Bears Are Threatened by Environmental Change

All of these foundational considerations of relevance to human-caused mortality are being manifest in an environment typified by major losses of important grizzly bear foods. Since the 1970s climate warming and non-native invasive species have caused substantial deleterious and long lasting changes in the demography and diets of grizzly bears in both the GYE and NCDE. As I describe above, grizzly bears in the GYE once obtained most of their energy and nutrients from just four foods, or food-groups: (1) army cutworm moths; (2) elk and bison; (3) cutthroat trout; and (4) whitebark pine seeds. But predation by non-native lake trout, coupled with unfavorable climate-driven changes in the hydrology of spawning streams, had functionally extirpated cutthroat trout as a grizzly bear food by around 15 years ago (Kaeding 2010, Gunther et al. 2011; Fig. 4e). Soon after, between 2000 and 2010, 40 to 70% of all mature whitebark pine in the Greater Yellowstone Ecosystem were killed by an outbreak of mountain pine beetles (*Dendroctonus ponderosae*) driven by climate warming (Macfarlane et al. 2010, Van Manen et al. 2016), reprising 70-90% losses of whitebark pine to a non-native fungal pathogen (white pine blister rust, *Cronartium ribicola*) in the NCDE that began during the 1970s. On top of these losses, almost all Greater Yellowstone Ecosystem elk populations declined between 1995 and 2010 (Fig. 4a) as a result of predation, deteriorating summer forage conditions, and sport hunting (Vucetich et al. 2005, Evans et al. 2006, Griffin et al. 2011, Brodie et al. 2013, Proffitt et al. 2014). As I elaborate below, the losses of cutthroat trout and whitebark pine likely catalyzed dietary changes that resulted in increasing grizzly bear mortality and stalling population growth.

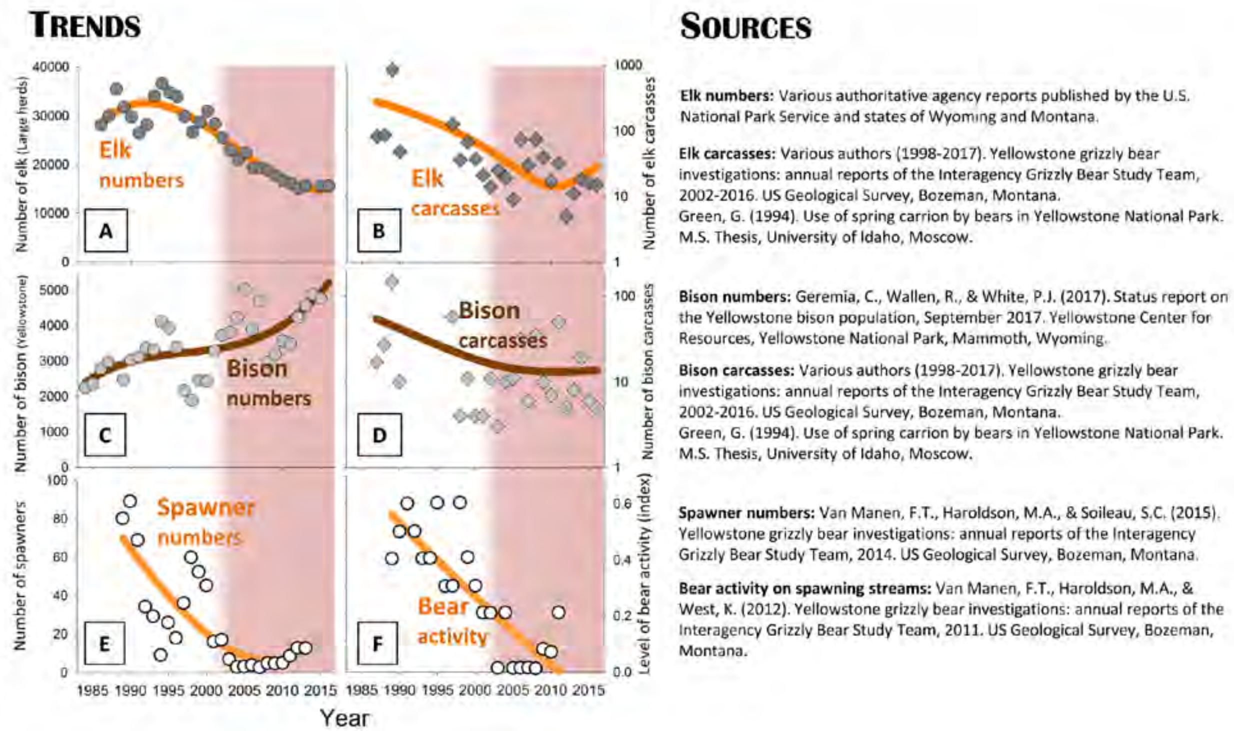


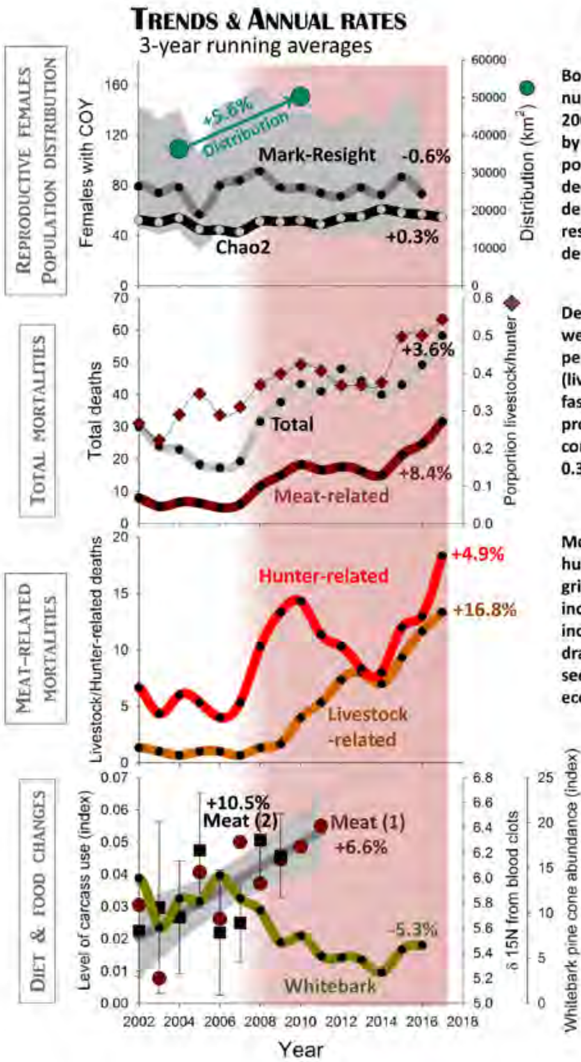
Figure 4. Summary of trends in availability of three important Greater Yellowstone Ecosystem grizzly bear foods, including: (A) size of the Northern Yellowstone and Jackson elk herds; (B) numbers of elk carcasses counted along fixed transects in Yellowstone National Park; (C) size of the Northern and Central bison herds; (D) numbers of bison carcasses counted along transects in Yellowstone Park; (E) numbers of spawning cutthroat trout counted in front-country streams around Yellowstone Lake; and (F) levels of indexed bear activity (scats and tracks) along these same streams. Sources for time series data are given to the right of each pair of graphs.

I summarize key transitions in environments, diets, and demography of Yellowstone grizzly bears in Figures 4 and 5. Consumption of meat from large herbivores began to steadily climb around 2002 (Fig. 5d), soon after major declines in numbers of spawning cutthroat trout (Figs. 4e, 4f), and coincident with the onset of major losses of whitebark pine trees to bark beetles (Macfarlane et al. 2013). Meat consumption continued to increase after the mid-2000s when, of relevance to grizzly bears subsisting on pine seeds, losses of mature whitebark pine trees to beetles were no longer offset by what had been a fortuitous series of large cone crops (Fig 5d).

Several researchers, including Middleton et al. (2013), Schwartz et al. (2013), and Ebinger et al. (2016), hypothesized that increased consumption of meat from large herbivores by Greater Yellowstone grizzlies was in compensation for losses of cutthroat trout and whitebark pine seeds. The weight of available evidence certainly makes this the most plausible of any candidate explanation. If so, this begs the question of where grizzly bears obtained additional meat given that elk populations had declined substantially (Fig. 4a), and that spring availability of ungulate carcasses on ungulate winter ranges either declined or remained static (Figs. 4b, 4d) despite increases in bison populations (Fig. 4c). Given these trends, grizzly bears plausibly obtained more meat from early-summer predation on elk calves, evident in a tripling of grizzly bear-specific calf mortality rates between the mid-1980s and mid-2000s (Middleton et al. 2013). Otherwise, grizzly bears likely obtained more meat during summer from livestock and, during fall, from remains of elk killed by big game hunters.

These latter two sources of meat are implicated in the exponential increases of grizzly bears dying because of conflicts over livestock depredation and encounters with big game hunters (Fig. 5c), coincident with the terminal decline in ecosystem-wide availability of whitebark pine seeds in the GYE beginning in 2007 (Fig. 5d). These dramatic increases in hunter- and livestock-related grizzly bear deaths —signifying greater reliance by bears on meat — substantially contributed to sustained increases in total grizzly bear mortality in the GYE beginning, again, around 2007 (Fig. 5b). Death rates of cubs and yearlings also increased substantially during this same period (Van Manen et al. 2016), consistent with greater reliance on meat by reproductive females. Not surprisingly, the steady increase in grizzly bear deaths during the last eleven to twelve years correlates with a static number of reproductive females in the ecosystem (Fig. 5a). Van Manen et al. (2016) claim that this drop in population growth rate was caused by increasing grizzly bear densities and related increases in bears killing bears. These authors point to increasing rates of cub and yearling deaths as evidence of their thesis.

However, their thesis fails for several reasons. First, at the same time that numbers of reproductive females remained static, the distribution of the population increased by over 40% (Fig. 5a). Axiomatically, population-wide densities dropped rather than increased, given that essentially the same number of bears was spread over a much larger area. Second, the expansion of a static population over a larger area is consistent with a decline in carrying capacity, which is consistent, in turn, with losses of key foods that occurred during the last fifteen to twenty years. Third, the modeling reported by Van Manen et al. (2016) is at odds with straight forward data showing a 3.6% per annum increase in grizzly bear deaths in the Greater Yellowstone Ecosystem at the same time that population size remained more-or-less constant — hence, basic math dictates that death rates (numbers of bears dying divided by numbers of live bears) likely increased (Fig. 5b). Finally, increased rates of cub and yearling deaths are plausibly attributed to a shift by reproductive females towards eating more meat, which, even with constant bear densities, predictably exposes dependent young more often, not only to predatory grizzly bears (Mattson et al. 1992b, Mattson 2000), but also to predatory wolves (Gunther & Smith 2004).



IMPLICATIONS

Both the Mark-resight and Chao2 methods show that numbers of reproductive females remained static during 2002-2017. Even so, population distribution increased by 38% between 2004 and 2010. Axiomatically, population-wide density of reproductive females declined, which debars an effect of increasing bear densities on birth or death rates. Dietary changes and resulting effects on death rates are the logical drivers of demographic changes during the last 15 years.

Despite the fact that numbers of reproductive females were static, total recorded mortality increased by 3.6% per annum during 2002-2017. Meat-related mortalities (livestock- and hunter-related) increased at an even faster 8.4% annual rate. As a consequence, the proportion of total grizzly bear mortality resulting from conflicts with humans over meat increased from roughly 0.35 to 0.55.

Mortalities resulting from meat-related conflicts with humans sky-rocketed as a presumed consequence of grizzly bears eating more meat. Hunter-caused deaths increased by 4.9% per annum. Livestock-related deaths increased by an astounding 16.8% annual rate. These dramatic increases probably arose, in part, from bears seeking human-associated meat as compensation for ecosystem-wide declines in elk populations.

Aerial extent of mature whitebark pine began to decline around 2002, but total availability of whitebark pine cones (the green trend line at left) didn't begin to appreciably decline until around 2007 primarily because losses of mature trees were offset by a series of large cone crops during 2002-2006. Whitebark pine seeds have remained relative scarce at an ecosystem level since 2007, as denoted by the pink background shading. Substantial increases in consumption of meat between 2002 and 2011 presumably occurred as compensation for losses of whitebark pine.

SOURCES

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2002-2016 mortalities: Various authors (2003-2017). Yellowstone grizzly bear investigations: annual reports of the Interagency Grizzly Bear Study Team, 2002-2016. US Geological Survey, Bozeman, Montana.

2017 mortalities: Haroldson, M. A. (2017-2018). 2017 Known and probable grizzly bear mortalities in the Greater Yellowstone Ecosystem. Interagency Grizzly Bear Study Team, US Geological Survey, Bozeman, Montana. https://www.usgs.gov/data-tools/2017-known-and-probable-grizzly-bear-mortalities-greater-yellowstone-ecosystem

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Meat (1): Ebinger, M. R., Haroldson, M. A., Manen, F. T., Costello, C. M., Bjornlie, D. D., Thompson, D. J., ... & White, P. J. (2016). Detecting grizzly bear use of ungulate carcasses using global positioning system telemetry and activity data. Oecologia, 181(3), 695-708.

Meat (2): Schwartz, C. C., Fortin, J. K., Teisberg, J. E., Haroldson, M. A., Servheen, C., Robbins, C. T., & Van Manen, F. T. (2014). Body and diet composition of sympatric black and grizzly bears in the Greater Yellowstone Ecosystem. The Journal of wildlife management, 78(1), 68-78.

Whitebark pine cone crops: Various authors (2003-2017). Yellowstone grizzly bear investigations: annual report s of the Interagency Grizzly Bear Study Team, 2002-2016. US Geological Survey, Bozeman, Montana.

Whitebark pine aerial extent: Van Manen, F. T., Haroldson, M. A., Bjornlie, D. D., Ebinger, M. R., Thompson, D. J., Costello, C. M., & White, G. C. (2016). Density dependence, whitebark pine, and vital rates of grizzly bears. The Journal of Wildlife Management, 80(2), 300-313.

Figure 5. Synopsis of population, mortality, and dietary trends of Greater Yellowstone Ecosystem grizzly bears relevant to dynamics unfolding from 2002 to 2017. Sources for each data time series are provided farthest right, with a brief discussion of implications provided in the middle column. The pink-shaded background spanning all time series denotes the onset and subsequent persistence of whitebark pine losses caused by mountain pine beetles.

This collective evidence renders implausible central claims made by the the US Fish & Wildlife Service (FWS) about GYE grizzly bears and their habitat, largely based on complicated, flawed models (see my comments submitted to the FWS dated 5 May (FWS_Pub_CMT_004008) and 7 October, 2016 (FWS_Pub_CMT_001630)). FWS argues that the population has grown, reached a static, invariate carrying capacity, and has thus spread-out commensurate to increases in population size, fully compensating for losses of key foods by eating other largely unspecified foods—without any explicit demographic consequences.

By contrast, the weight of evidence more defensibly suggests that losses of cutthroat trout and whitebark pine precipitated shifts to more hazardous diets comprised increasingly of human-associated meat, resulting in more dead grizzly bears, stalled growth in numbers of reproductive females, and burgeoning conflicts between people and grizzly bears on an ever-expanding population periphery (e.g., Van Manen et al. 2012, 2013). Moreover, theoretical (Doak 1995) and empirical (McLellan 2015) evidence of lagged responses by grizzly bear populations to deteriorating environmental conditions suggests that negative demographic trends will continue, especially given declines in future recruitment caused by the recent increases in mortality rates of young bears (Van Manen et al. 2016).

The picture painted by a clear-eyed comprehensive look at all of the available evidence is of a population in trouble, largely as a consequence of low reproductive rates, isolation and small population size, deleterious habitat changes – including the loss of important food sources – caused directly or indirectly by humans, compounded by lethal human responses to emerging arenas of conflict. The plight of such a population will be unambiguously worsened by the additional burden of deaths caused by trophy hunting.

Connectivity is Necessary and Possible

Given the magnitude of historical losses (98 percent), comparatively small subsequent gains (approximately 1-2 percent), and current environmental deterioration, management of grizzly bears in the contiguous U.S. would logically seek to accelerate rather than curtail expansion of populations into adjacent as-yet-unoccupied suitable habitat. Yet state management plans promise to do the opposite and, given the problematic context that I describe above, this is likely to result in irreversible negative consequences.

With connectivity and colonization of suitable adjacent habitat, bears in the GYE and elsewhere would have access to more foods in more areas to compensate for unfolding losses; long-term genetic health would be assured; populations would be more resilient to future environmental changes simply because of larger size; colonization of currently unoccupied potential habitat in the Selway-Bitterroot

Recovery Area of central Idaho would be facilitated; and colonization of other suitable areas farther south, in expanses depopulated during the heyday of human lethality, would be more likely.

Achieving such goals is obviously contingent on whether suitable habitat and connective corridors are located contiguous to or nearby occupied grizzly bear habitat. Figure 6 summarizes the results of research conducted by numerous researchers designed to identify potential corridors and other habitat suitable for long-term occupancy by grizzly bears in the U.S. Rocky Mountains, including areas farther south. There is clearly ample contiguous habitat with potential to sustain resident grizzly bears to the west of the GYE into central Idaho, thence north through the Selway-Bitterroot Recovery Area, and, further north yet, connecting with the Cabinet-Yaak Recovery Area. Substantial potential habitat also extends south in Wyoming into the Wind River, Wyoming, and Salt River Ranges.

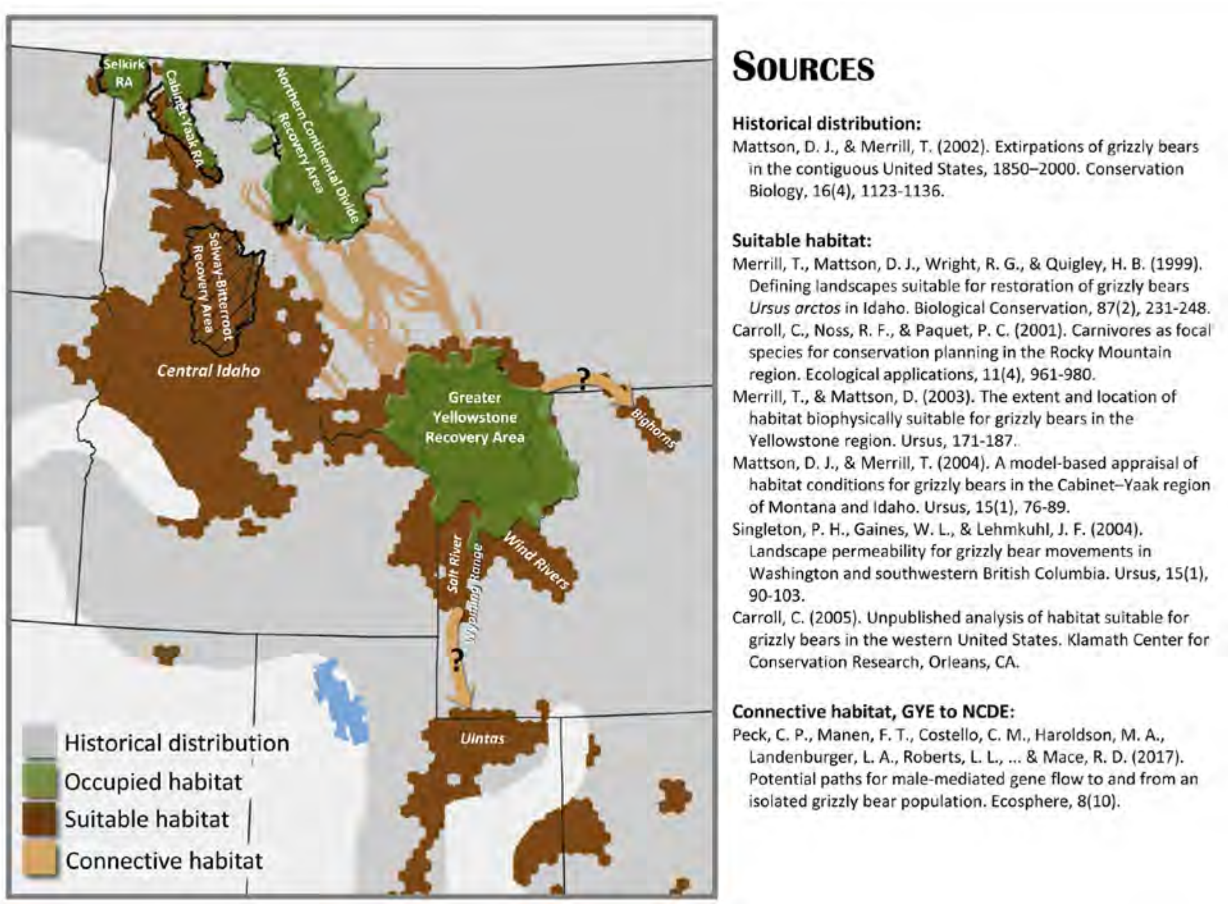

Figure 6. Currently occupied grizzly bear habitat in the northern U.S. Rocky Mountains (green) in relation to suitable, but unoccupied, habitat (dark brown) and potential dispersal routes between the Greater Yellowstone and Northern Continental Divide ecosystems (tan). Probable dispersal routes to the Bighorn Mountains and Uinta Mountains are also identified.

Additional but disjunct potential habitat occurs in the Uinta and Bighorn Mountains to the south and east of habitat contiguous with current grizzly bear distribution in the GYE. As research by Peck et al. (2017) and others have shown, corridors sufficient to host transient grizzly bears—independent of capacity to sustain permanent residents—also exist between the GYE and NCDE, suggestive of additional corridors south and east of the GYE able to support colonizing dispersers.

However, all of this research makes a critical assumption: that human lethality is constant, and that the only features varying from one location to another are habitat productivity and remoteness from humans. Lethality can be understood as the probability that, given an encounter with a human, the involved bear will end up dead (Mattson et al. 1996a, 1996b). In other words, lethality can vary independent of habitat productivity and remoteness from humans, with landscapes becoming more or less deadly for grizzly bears depending on how lethality is managed — most notably, whether killing of grizzly bears is licensed or otherwise encouraged by those with authority over grizzly bear management. If management regimes become more lethal, as would be the case with trophy hunting, even the most remote and productive wilderness can become inhospitable for grizzly bears, debarring colonization.

State Management Will be Highly Lethal and Not Subject to Remedy

Of specific relevance to GYE grizzly bears, the Memorandum of Agreement (MOA) drafted by the states of Montana, Wyoming, Idaho to govern management after removal of Endangered Species Act (ESA) protections virtually guarantees that conditions will become more lethal for bears, and that trophy hunting will be an ingredient. Even though each state's Commission expressly reserved the right to deviate from the MOA, this agreement nonetheless specified what management would look like until at least the end of a FWS five-year oversight period.

Of particular relevance, the MOA's protocols were expressly designed to prevent growth of the grizzly bear population within the Demographic Monitoring Area (DMA; as estimated by the Chao2 population estimation method; Fig. 5a) above levels observed from 2002 to 2014. If, as during 2017 and 2018, estimated population size exceeded the 2002-2014 average, prescribed mortality rates would be increased to reduce bear numbers, with prospectively much of the differential between so-called "discretionary" and "non-discretionary" mortality allocated to trophy hunting.

The since-overturned FWS Final Rule to remove ESA protections for GYE grizzly bears describes provisions putatively designed to guard against post-delisting population declines, including statements averring that state managers would adaptively decrease mortality rates as population estimates dropped below triggering thresholds, and disallow trophy hunting if estimated bear numbers dropped below 600. However, neither provision was binding on the states — both were discretionary. The only substantive population-related trigger for authoritative FWS intervention would have occurred when estimated bear numbers dropped below 500.

However, all these provisions, discretionary or otherwise, were compromised by uncertainties, lags, and deficient assumptions built into the MOA's methods. These methods assumed that males could be killed at roughly twice the rate as females (e.g., 15% versus 7.6% annually at a population of 674), even though males and females are born in roughly equal numbers (Schwartz et al. 2006; Van Manen et al. 2016). This alone guaranteed declines in numbers and average ages of males, especially in non-Park areas that would have exclusively borne the burden of trophy hunting. Yet numbers of males are not directly monitored. Adolescent and adult males are numerically added to total population estimates proportional to retrospective estimates of their fractions in the population, based, in turn, on assumption-ridden model-contingent estimates of comparative mortality rates using data collected during the previous five to ten years. In other words, even if estimates of comparative mortality rates were unbiased, male population dynamics would be viewed through a rearview mirror, with relevant estimates lagging well behind unfolding real-time conditions.

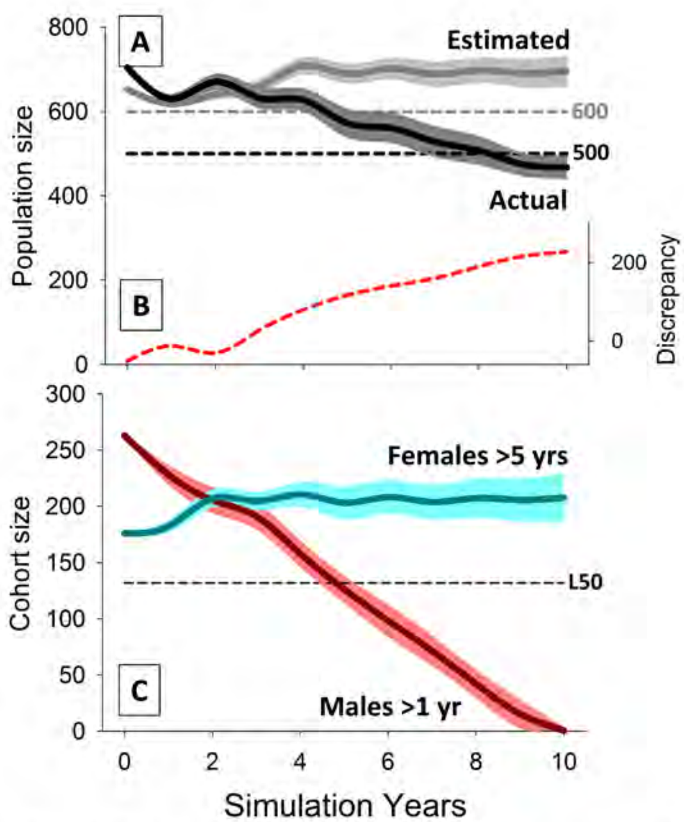

Figure 7. 10-year population projections simulating implementation of MOA protocols for management of grizzly bears inside the Yellowstone DMA. Estimated population size increasingly exceeds real population size over time (A), with over-estimates reaching near 200 bears by 10 years out (B), largely because the male segment >1-year-old crashes outside of National Park jurisdictions. Roughly 50% of adult males are killed within 5 years, corresponding to L50.

Figure 7 visually summarizes projections simulating the implementation of protocols specified by the Tri-State MOA. These projections took the protocols at face value and, in the absence of any enforceable specifics, did not credit assertions by wildlife managers that untoward trends would somehow be detected and corrected. Succinctly, if fully implemented, the MOA protocols—including the sport hunting—would have likely led to an undetected crash in the DMA's male population segment outside National Park jurisdictions (Fig. 7c), at the same time that estimated population size would have increasingly exceeded true population size (Fig. 7a). By ten-years out, the population would have been over-estimated by >200 animals (Fig. 7b). As a consequence, managers would not have detected a population decline below 600, and then 500 (Fig. 7a), the putative trigger for a formal status review by FWS. Instead, state managers would have erroneously applying mortality rates designed to further depress a population assumed to be near 700, but actually nearer 500.

As an upshot, the near- and long-term effects of male-biased mortality, as planned by the states of Wyoming, Montana, and Idaho, would have likely remained undetected and thereby debarred timely correctives on the part of GYE grizzly bear managers—at the same time that these managers were purposefully instituting a hunt designed to reduce the bear population.

The Spatial Configuration of Planned Trophy Hunting Would be Harmful

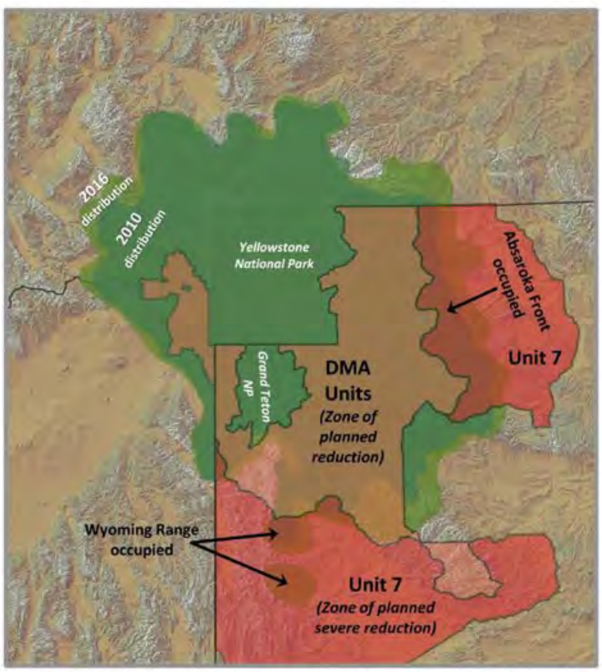

Figure 8. Map showing the estimated 2010 and 2016 distributions of the Greater Yellowstone grizzly bear population overlain by Wyoming and Idaho hunting units within which grizzlies will be sport hunted beginning September 1, 2018. Hunting units within the Demographic Monitoring Area (DMA) are differentiated by Wyoming's Hunting Unit 7 outside. Stated objectives are to reduce the size of the grizzly bear population within the DMA and sharply reduce bear numbers outside, in Unit 7, largely through sport hunting.

The spatial configuration and extent of trophy hunting that was planned by the states of Wyoming and Idaho to begin in 2018 warrants emphasis, and is particularly relevant to understanding the extent to which hunting-caused mortality would have harmed the GYE grizzly bear population both near- and long-term.

The map in Figure 8 shows the location and extent of zones within which planned trophy hunting of grizzly bears would have occurred in the GYE relative to the current distribution of the population. Several key patterns and related implications are evident. For one, trophy hunting would affect GYE grizzlies in the majority of their current distribution. In other words, hunting would directly and indirectly affect most bears in this population. For another, the portion of the DMA within which the states of Wyoming and Idaho intended to reduce grizzly bears numbers, in part through hunting, likewise entails the majority of current distribution. As problematic, areas outside the DMA where Wyoming planned to sharply reduce bear numbers—notably the Wyoming Range and the eastern front of the Absaroka Mountains—are non-trivial in extent and coincident with habitat that is sufficiently productive and remote from humans to support resident grizzly bears (Fig. 6).

It is clear from this that the spatial configuration of trophy hunting planned by Wyoming and Idaho would harm the majority of the GYE grizzly bear population, with harm disproportionately concentrated in areas outside National Parks. Moreover, this harm would be especially severe in peripheral areas supporting the bears most likely to colonize adjacent and nearby suitable habitat.

State Plans Would Essentially Eliminate Grizzly Bears Outside the DMA

State plans for managing grizzly bears outside the DMA compound the deficiencies in protocols for managing grizzly bear mortalities within DMA boundaries. These plans matter because FWS explicitly stated in the over-turned Final Rule for removing GYE ESA protections that: "Mortalities outside the DMA are the responsibility of each State and do not count against total mortality limits," 82 Fed. Reg. 30,502, 30,531 (table 3) (June 30, 2017), which functionally gave state managers *carte blanche*. Of relevance here, the three involved states either intended to limit or even prevent occupancy of areas outside the DMA by grizzly bears — as in the case of Wyoming — or, at best, allow for expansion in highly ambiguous and qualified terms — as in the case of Montana.

To quote the Wyoming Grizzly Bear Management Plan: "Habitats that are biologically and socially suitable for grizzly bear occupancy are the portions of northwestern Wyoming within the DMA that contain large tracts of undisturbed habitat, minimal road densities, and minimal human presence;" and: "Although grizzly bears will not be actively discouraged from occupying all areas outside the DMA, management decisions will focus on minimizing conflicts and may proactively limit occupancy where potential for conflicts or public safety issues are very high." (emphasis added).

As direct evidence of its intent, the State of Wyoming planned to hunt as many as twelve grizzly bears in areas outside the DMA during its fall 2018 hunting season. Two of these bears would have prospectively been adult females. Given that there are almost certainly no more than 90-100 bears outside the DMA, the sport hunt alone would have killed 12-13% of all extra-limital grizzly bears in Wyoming, and this on top of other mortality that will likely be of equal magnitude (see Point 20.1 in my May 5, 2016, comments on Proposed Rule

(FWS_Pub_CMT_004076). No research has ever shown that an annual mortality rate near 25% can be sustained by any interior North American grizzly bear population. More commonly, as posited by the MOA, sustainable mortality rates are less than half such a rate, nearer 7-10% at maximum.

With reference to key linkages in Montana, the Final Rule merely stated: "To increase the likelihood of occasional genetic interchange between the [Greater Yellowstone Ecosystem] grizzly bear population and the [Northern Continental Divide Ecosystem] grizzly bear population, the State of Montana has indicated they will manage discretionary mortality in this area in order to retain the opportunity for natural movements of bears between ecosystems." (emphasis added). The Grizzly Bear Management Plan for Southwestern Montana (Montana Fish, Wildlife & Parks, 2013) states throughout that "non-conflict" grizzlies will be accommodated in potential linkage zones, but then specifies measures for dealing with "conflict" grizzly bears, all of which history has shown lead to a high likelihood of death for the involved bear. As a consequence, and as the Plan itself acknowledges, connectivity between the Greater Yellowstone Ecosystem and other grizzly bear populations will depend on widespread effective efforts to prevent conflict and curb detrimental private land development—sufficient in part to mitigate, if possible, the effects of a hunt—all of which require ample funding.

State Management of Conflicts is Deficient, More So in the Future

Despite laudable language in various planning documents, FWS and the States of Wyoming, Montana, and Idaho are demonstrably ill-equipped to prevent or non-lethally mitigate escalating human-grizzly bear conflicts concentrated on the periphery of both the GYE and NCDE in ways that might mitigate harm from a sport hunt or other lethal management. As I note above, grizzly bear deaths have been increasingly linked since the mid-2000s in the GYE to human-associated meat — notably livestock and the remains of hunter-killed big game, which together account for near 55% of known and probable grizzly bear fatalities. The fact that meat-associated grizzly bear deaths have been increasing at rates of 5% (hunter-related) and 17% (livestock-related) per annum (Fig. 5a) during a period of stalled population growth is a self-evident verdict on the deficiency of measures taken by managers to non-lethally address these burgeoning causes of human-grizzly bear conflict—a circumstance that will only be aggravated by trophy hunting.

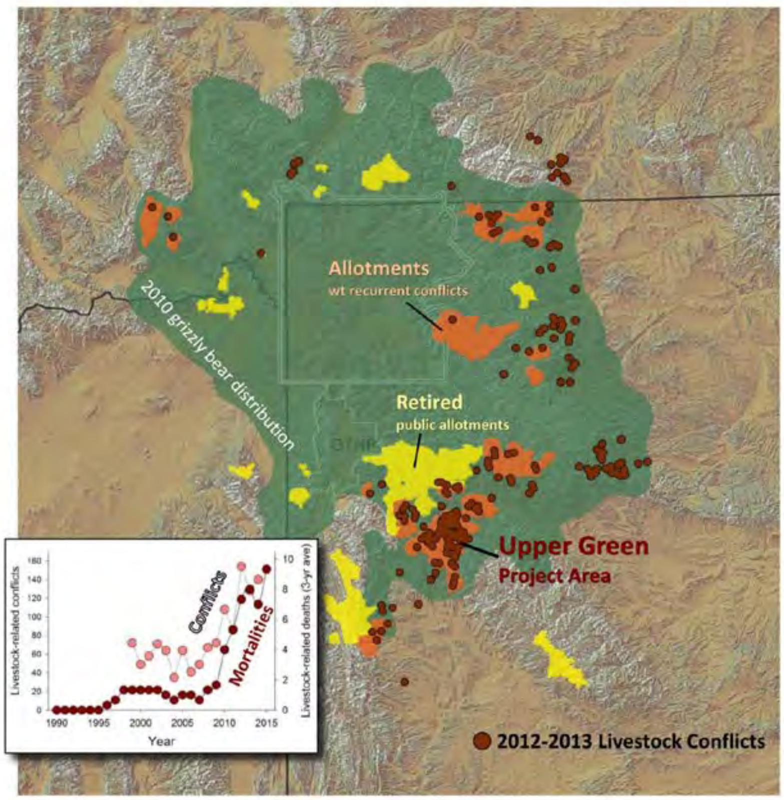

Figure 9. Distribution of grizzly bear depredation on livestock and related conflicts in the GYE during 2012-2013 (dark red dots) along with *circa* 2010 grizzly bear distribution (green), recently retired public land grazing allotments (yellow) and active allotments identified as having chronic conflicts. The inset graph shows trends in grizzly bear-livestock conflicts (pink) and related grizzly bear mortalities (dark red).

The 2016 GYE Conservation Strategy (FWS_LIT_016978) along with state grizzly bear management plans, furthermore explicitly call for maintenance of the status quo, which will likely institutionalize an inadequate conflict prevention regime. A pointed example can be found in the Upper Green River Area Rangeland Project Final Environmental Impact Statement completed by the Bridger-Teton National Forest in October 2017. This project area contains the highest concentrations of grizzly bear depredations on livestock — mostly cattle — in the entire GYE.

Figure 9 shows the Upper Green River grazing allotments along with the ecosystem-wide locations of grizzly bear depredations in the GYE during two emblematic years (2012 and 2013; mapped locations for more recent years are not publicly available). Despite the fact that these allotments continue to account for much of the livestock-related conflict in the GYE, the Final Environmental Impact Statement essentially enshrined the status quo. There was no provision for substantive changes in husbandry practices, stocking rates, or allotment delineations and infrastructure. Unmitigated conflict and resulting bear deaths will likely continue here and elsewhere, with localized trophy hunting adding to the toll.

This prognosis is rendered even more plausible by the fact that state grizzly bear conflict specialists were under-resourced during 2018, with this trend continuing in the near future. Appendix F of the 2016 GYE Conservation Strategy summarizes the prospective annual costs of implementing mandated human/grizzly bear conflict management, estimated to be $650,000 for the U.S. Forest Service; $735,000 for the State of Wyoming; and $246,000 for the State of Montana. On top of this, the Montana state plan also asserts the importance of "[s]ecuring important linkage habitats through purchase or easement…." Few of the requisite operating funds are currently available, much less funds for purchasing easements or fee simple titles. Out-year budgets for the Forest Service and state wildlife management bureaus suggest a worsening rather than improving fiscal situation.

Funding deficiencies are fully acknowledged in state grizzly bear management plans. For example, the 2013 Montana plan states "a funding mechanism to support Montana's responsibilities for Yellowstone grizzly bear management is necessary." Since then, the agency's wildlife-related budget has been essentially static after accounting for inflation, with no increased allocations to support grizzly bear conflict prevention. Likewise, the 2016 Wyoming Grizzly Bear Management Plan states that "costs associated with data collection and conflict management will vastly exceed any revenue generated by the grizzly bear program." The Wyoming Game and Fish Department's budget has concurrently declined by a net $6 million since 2016 (Wyoming Game & Fish Department 2017). There is little prospect that shortfalls will be covered by grants from the federal government, given that proposed 2018-2019 budgets for the FWS and Forest Service call for major cuts in programs supporting recovery of endangered and threatened species.

Mortality During 2018 Was Excessive

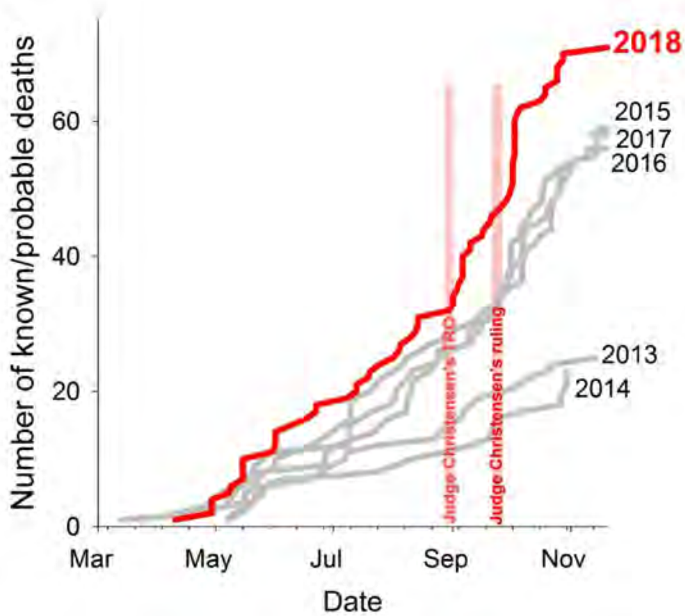

Figure 10. Annual accumulation curves for known and probable grizzly bear deaths in the GYE during 2013-2018. Deaths are attributable to all causes both inside and out of the DMA.

Record-breaking grizzly bear mortalities in both the NCDE and GYE during 2018 high-light the hazards facing bears in these ecosystems, even with ESA protections. Seventy-one bears are known to have or likely died in the GYE, 10 more than the next-highest total during 2015. In the NCDE 52 bears died, 18 more than the next-highest total during 2004.

Figure 10 illustrates the pace at which known and probable grizzly bear mortalities accrued each year in the GYE during 2013-2018. Year-end totals broke records during 2015-2017, representing a dramatic jump from totals during 2013-2014, but with the total for 2018 breaking all previous records. As suggested by population trends in Figure 5a, this increase cannot be explained by either the non-existent increase in population size or modest increase in population distribution since 2014. And, of import here, the pace at which grizzly bears died in the Greater Yellowstone Ecosystem during 2018 represents a period during which state wildlife managers were *de facto* in charge of conflict management. At a minimum, data from 2018 (see https://www.usgs.gov/data-tools/2018-known-and-probable-grizzly-bear-mortalities-greater-yellowstone-ecosystem) demonstrate that exceedingly high levels of mortality this year were, in part, a continuation of trends in livestock-related deaths that drove high levels of mortality during 2015-2017. These trends are a tacit verdict on the inadequacy of conflict prevention measures in the ecosystem and the lethality of state-administered management of grizzly bears. Moreover, the trend that unfolded during 2018 was alarming, even prior to the trophy hunts planned for Wyoming and Idaho during September-October 2018.

Hunting Would Add Mortalities, Not Compensate for Conflict Mortalities

Hunting will irrefutably harm grizzly bears in the GYE and NCDE by, at a minimum, adding to, magnifying, and compounding dynamics heretofore described that already sorely compromise future prospects of these populations. But, even more problematic, this harm is likely to be irreparable, not only for the directly affected bears, but also for surviving bears, through a cascade of subsequent indirect effects.

Most obviously the grizzly bears killed by trophy hunters will be irreparably harmed. These bears' lives will be irreversibly ended in ways definitively linked to hunting. They will, moreover, be unambiguously removed from the pool of potential reproductive individuals.

Beyond the obvious, there is the question of whether bears that would be killed by hunters would have likely died for other reasons during the subsequent year. If yes, then these hunting-related mortalities would have "compensated" for other causes of death. If no, then hunting-related mortalities would be in addition to any that would have otherwise occurred. This is the distinction in technical ecological literature between "compensatory" and "additive" mortality. If hunting-related mortality is fully compensatory, then at a population level there are no direct numeric effects incurred during a seasonal cycle. However, if mortality is additive, then population numbers will axiomatically be reduced below levels that would have otherwise been sustained. This is a key consideration because it sets the stage for determining whether, aside from irrefutable harm to individual bears, hunting would likely cause irreparable longer-term harm to populations—compounded by any hunting that might occur during subsequent years.

In fact, there is little doubt that most hunting-caused mortality would be additive, not compensatory. Deductively, sport hunters who deliberately seek out bears to kill them will be far more lethal than humans under virtually any other circumstances. Absent hunting, a certain number of independent-aged grizzly bears in the GYE and NCDE would survive even the existing relatively lethal environments. At present, their exposure to such environments occurs largely because of choices *they* make, for example, by seeking out gut piles that bring them into close contact with elk hunters or by seeking out and either killing or scavenging livestock on private lands or public lands grazing allotments.

But, even more, these endemic scenarios do not translate into the near-certain death of the involved bears upon encountering the involved humans — which would be the case with a grizzly bear trophy hunt. The point here is that tropy hunting by its very nature is, deductively, *per capita* much more lethal to grizzly bears. By first principles, many deaths from trophy hunting would be additive — that is, would not have otherwise occurred.

The weight of empirical evidence supports this conclusion. Without being exhaustive, research by Bishof et al. (2009) and Frank et al. (2017) has definitively shown additive effects of hunting in *Ursus arctos* populations, and is consistent with the additive effects shown for wolves by Creel & Rottella (2010), for American black bears by Obbard & Howe (2008), and for cougars by Weilgus et al. (2013), Robbinson et al. (2014), and Wolfe et al. (2015). By contrast, no credible investigation of any species of large carnivore has shown that hunting-related mortality wholly, or even largely, merely compensates for other causes of mortality; i.e., there is no credible evidence that hunting-related mortality is *not* additive.

Harm Caused By Hunting Would Be Compounded By Indirect Effects

The toll of trophy hunting would not be limited to direct numeric effects on the GYE and NCDE grizzly bear populations. Other indirect effects — manifested in decreased production, survival, and recruitment of cubs — would likely transpire during subsequent months.

Some mammalian populations have been shown to increase reproduction and recruitment in the aftermath of elevated human-caused mortality. These responses have the potential to indirectly compensate for mortality caused by trophy hunting. However, in other instances, human-caused mortality depresses reproduction during subsequent months, which amplifies and exacerbates direct numeric effects—a phenomenon termed ‘depensatory’. These sorts of depensatory effects have been most consistently shown for carnivore species in which males kill offspring of reproductive females to enhance their own reproductive opportunities — a phenomenon known as sexually-selected infanticide, or SSI (Ebensperger, 1998, Milner et al. 2007).

A priori, SSI is likely to be common in brown and grizzly bear populations, given the large average difference in size of male and female bears (i.e., sexual dimorphism) and the fact that females, as in the Northern Rockies, have three-year reproductive cycles (Schwartz et al. 2006). Synthetic analyses by researchers such as Harano & Kutsukake (2018) have shown the SSI correlates with the same intense competition among males that leads to selection for increasingly large comparative size. Moreover, rough parity between numbers of adult males and females slaved to a three-year reproductive cycle, as in GYE and NCDE (Schwartz et al. 2006), means that there are approximately three reproductive males for every breeding female. Such a skew by itself predictably leads to intense competition among males; a substantial portion of cubs unrelated to the males battling to reproduce; and significant incentive for males to kill cubs as a means of inducing premature estrus in the targeted female (Bunnell & Tait 1981). Even a lesser ratio of reproductive males to breeding females predictably generates such a dynamic.

Amplification of SSI by trophy hunting that disproportionately targets adult males would entrain several deleterious consequences. Cub and yearling death rates would likely increase with an influx of non-sire males triggered by the disruption of a social structure otherwise maintained by mature resident males. Longer-term, reproductive females would likely abandon productive habitats to seek refuge in more spartan environs (for example; Mattson et al. (1987, 1992); Ben-David et al. (2004); Gardner et al. (2014)), with resulting depression of fecundity. All of this could exacerbate, longer-term, the direct and additive numeric effects arising from hunter-caused deaths.

In addition to a strong deductive case, there is overwhelming empirical support for the existence of SSI and related dynamics among grizzly bears, and for the amplification of these phenomena by human persecution. Without being exhaustive, there are more than twenty publications reporting evidence from investigations of brown and grizzly bears that: SSI is amplified by sport hunting (Bellemain et al. 2006; Gosselin et al. 2015, 2017; Bischof et al. 2018), including depensatory effects on birth and death rates (Stringham 1980, Swenson et al. 1997, Wielgus et al. 2013, Gosselin et al. 2015, Frank et al. 2017, Bishof et al. 2018); that deleterious social restructuring occurs, including an influx of potentially infanticidal males (Swenson et al. 1997; Wielgus et al. 2001; Ordiz et al. 2011, 2012; Gosselin et al. 2017; Leclerc et al. 2017; Bishof et al. 2018; Frank et al. 2018); and that foraging efficiencies of adult females decrease (Wielgus & Bunnell 2000; Ordiz et al. 2011, 2012; Hertel et al. 2016; Bishof et al. 2018) in tandem with increased physiological stress (Bourbonnais et al. 2013, Støen et al. 2015).

These results specific to *Ursus arctos* are in context of compendious research showing the same spectrum of results for large carnivores more broadly (e.g.; Milner et al. 2007, Packer et al. 2009, Harano & Kutsukake 2018), as well as more specifically for American black bears (Czetwertynski et al. 2007, Stillfried et al. 2015, Treves et al. 2010), mountain lions (Robinson et al. 2008, Peebles et al. 2013, Wielgus et al. 2013, Maletzke et al. 2014, Keehner et al. 2015, Teichman et al. 2016), and wolves (e.g.; Murray et al. 2010, Wielgus et al. 2014).

By contrast, research specific to *Ursus arctos* that calls into question the potential amplification of SSI and other depensatory effects by hunting amounts to essentially two publications (Miller et al. 2003, McLellan 2005). Even so, Miller et al. do not cover conditions of particular relevance to GYE and NCDE grizzly bear populations, where, unlike what they considered, hunting would perturb social dynamics of a population hard up against a declining carrying capacity; and McLellan premises a regime where "some" adult males might be killed, which would not concur under the regime being promoted by Wyoming and Idaho entailing the hunting of numerous males in addition to others of the same sex that will have died from other human causes. Moreover, this paucity of findings casting doubt on the aggravating effects of trophy hunting is consistent with a continent-wide deficit pertaining to other large carnivores. Only a handful of authors, notably Czetwertynski et al. (2007) and Murray et al. (2010), call into question depensatory effects of sport hunting on black bears and wolves, respectively, and, even so, with significant qualifications.

Deductive logic and the available evidence leaves little doubt that male-biased trophy hunting will entrain longer-term depensatory effects that amplify the more immediate negative effects of elevated mortality among grizzly bears occupying hunting units managed by the states of Wyoming, Montana, and Idaho.

As Currently Planned, State Management Will Cause Irreparable Harm

The post-ESA regime planned for managing grizzly bear populations in the GYE and NCDE is designed to prevent numeric increases within the heart of the ecosystem (i.e., the DMA); discourage, if not prevent, dispersal to and colonization of most of the adjacent or farther distant suitable habitat; and promulgate inadequate conflict prevention programs. Moreover, this insufficient if not punitive management would be implemented using methods that not only engender considerable uncertainty, but also stand a good chance of leading to unintended undetected population declines.

This inauspicious regime is being promoted at a time when long-term conservation goals and on-the-ground conditions create an imperative to encourage

— not discourage — occupancy of all adjacent suitable habitat; connectivity among all ecosystems; and colonization of novel, yet suitable, habitats to the south and east by grizzly bears in the GYE.

Compounding these manifold stressors and problems, the states of Idaho and Wyoming have demonstrated their intentions by moving aggressively forward with planning post-ESA trophy hunts designed to kill the maximum number of bears allotted for this purpose. And these hunting-caused deaths would almost certainly be additive to the toll taken by humans for other reasons, and likely compounded by longer-term indirect, but depensatory, effects on female reproduction and recruitment.

Taken altogether, these problematic environmental dynamics coupled with uncertain monitoring methods and purposefully lethal post-delisting management promise irreparable harm to grizzly bears throughout the Northern U.S. Rocky Mountains. As a consequence, prospects for meaningful recovery and restoration would be potentially fatally compromised, which is of all the greater consequence given that grizzly bears in this region represent a globally unique genetic and behavioral lineage, as well as an imperiled remnant of bears that once occupied most of the western contiguous United States.

I am not alone in this conclusion. Seventy-two other scientists raised similar concerns in a 2017 letter to Governor Matt Mead of Wyoming (see Attachment 1).

David J. Mattson, Ph.D.

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Attachment 1. Letter to Matt Mead, Governor of Wyoming, dated April 25, 2018, signed by 73 scientists.

April 25, 2018

The Honorable Matt Mead
Governor for the State of Wyoming
Governor's Office
Capitol Building Room 124
200 West 24th Street
Cheyenne WY 82002-0010

Re: Stay Wyoming's unscientific, drastic grizzly bear hunt for an outside peer-review process

Dear Governor Mead:

We, the seventy-three (73) undersigned biologists and scholars, appreciate the opportunity to provide scientific input on Wyoming's planned grizzly bear sport hunt, which is necessarily addressed in context of Wyoming's broader plans for managing grizzly bear mortality in the Greater Yellowstone Ecosystem (GYE). As preamble, we also appreciate Wyoming's efforts during the last 40 plus years to help bring Yellowstone's grizzly bear population back from the brink of extirpation. However, Wyoming's current plans for managing mortality of GYE grizzly bears suffer from numerous deficiencies, both scientifically and in service of precautionary conservation, we therefore ask you to stay the hunt until Wyoming's proposed sport hunt of grizzly bears receives external peer review and subsequent adjudication by independent scientists.

In brief, Wyoming is purposefully planning to reduce bear numbers within the core Demographic Monitoring Area (DMA), as well as functionally extirpate grizzly bears ranging outside that invisible boundary. These objectives are not prudent given rapidly changing environmental conditions within the GYE and foreseeable amplification of these dynamics during future decades. On top of these threats, Wyoming and Idaho have both signaled their readiness to permit dangerously high levels of trophy hunting even in the face of overwhelming public opposition. Reducing and geographically truncating the GYE grizzly bear population would foreclose opportunities for bears in this ecosystem to occupy ample suitable habitat that is contiguous with or nearby the DMA and, with that, debar achievement of population viability and related resilience to rapid environmental change.

The particulars of our concerns are as follow:

- The methods currently used by Wyoming, Montana and Idaho to calculate total and discretionary allowable mortality, which encompass deaths allocated to sport-hunting, are explicitly premised on the goal of reducing grizzly bear numbers within the DMA. This is not prudent or ecologically justified for reasons that we articulate below.

- Plans to severely reduce grizzly bears outside the DMA are egregiously indefensible. Given a likely population of 80-100 bears outside the DMA, but within Wyoming, a sport hunt of 12 bears—in addition to other foreseeable mortality—is likely to be 500-1000% of sustainable levels. This is tantamount to planned extirpation.

- Even without planned reductions, the current GYE population of roughly 700 grizzly bears is far too small to be viable in the face of foreseeable environmental changes and genetic losses. Recent research suggests that viable populations of animals such as grizzly bears need to be 2,000-10,000 animals. Wyoming's current plans would limit connectivity with other grizzly bear populations and colonization of suitable habitats, thereby preventing the achievement of meaningful viability and, in fact, perversely drive population numbers in the opposite direction.

- Several researchers have independently documented ample suitably remote and productive habitat contiguous with or within colonizing distance of current grizzly bear distribution. Wyoming's plan to reduce grizzly bear numbers inside the DMA and essentially extirpate bears outside prevents expansion into suitable habitat and genetic exchange with other populations by targeting vital dispersers, thereby degrading population viability, especially of the currently isolated GYE population.

- Although there is disagreement over whether recent environmental changes (e.g., loss of historically important whitebark pine and cutthroat trout and loss of snow depth for denning cover) have harmed GYE grizzly bears, no disagreement exists that this change has been dramatic and will continue, if not amplify, during coming decades. Under such conditions, it is not defensible to eliminate bears that would otherwise contribute to enhanced population resilience and viability.

- Deliberate perpetration of human-caused mortality is not needed to control the GYE grizzly bear population. Recent research from the GYE, and indeed worldwide, suggests that grizzly bears and other large-bodied carnivores are self-regulating, with self-regulating dynamics strengthening nearer carrying capacity. If so, the grizzly bear population will naturally oscillate around carrying capacity, even as this capacity changes, and without the need for overt human intervention, particularly in the form of sport hunting.

- The methods used by Wyoming to calculate allowable mortality—including the toll allocated to sport hunting—assume that males can be sustainably killed at twice the rate as females even though males and females are born in equal numbers. This assumption is patently illogical and leads to unsustainable killing of males. Further skewing the sex ratio will drive the effective population size (N_e) lower than the census population, which makes genetic isolation and potential future inbreeding depression more of a problem for the GYE population. The consequences of this logical failure are exacerbated by the fact that the male population segment is not annually monitored and is instead accounted for by complex and assumption-ridden estimates of male survival rates using 6-10 years-worth of retrospective data. This methodology is tantamount to relying on an out-of-focus rearview mirror to manage future male mortality.

- Finally, Wyoming has not accounted for the indirect and almost wholly negative effects that will amplify direct numeric consequences of sport hunting and other human-caused mortality. A large body of research has shown that hunting—along with other mortality biased against adult male bears—leads to increased rates of infanticide and, with that, unanticipated damping of population growth rates. Moreover, adult-biased, human-caused mortality is evolutionarily novel for grizzly bears, and will select for traits that propel the GYE population in unpredictable and probably maladaptive directions.

- To trophy hunt such a vulnerable population is ethically irresponsible, unwarranted, and not in the public's interest. National and state surveys have consistently shown that the majority of respondents do not support trophy hunting. Moreover, wildlife viewers have outnumbered hunters by 6-7-fold for at least the last 15 years, as evidenced by the millions of tourists who come to view GYE grizzly bears and wolves. According to the National Park Service, in 2016, Grand Teton and Yellowstone National Parks generated $1.5 billion in revenues that benefited local economies, including supporting almost 18,000 jobs related to park visitation. None of these economic benefits derive from providing a handful of hunters the opportunity to kill grizzly bears—an activity guaranteed to be economically inconsequential.

Again, we appreciate this opportunity to provide input on Wyoming's plans for managing the GYE grizzly bear population, including its recent plans for sport hunting. Please contact Dr. David Mattson if you have any questions or would like additional input.

Sincerely,

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