Efficacies & Effects of Sport Hunting Grizzly Bears

An Evaluation of Prospective Demographic & Social Effects of Sport Hunting Grizzly Bears in the Contiguous U.S.

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The Grizzly Bear Recovery Project

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Introduction to a Controversy

Wildlife managers in the states of Wyoming, Montana, and Idaho are actively promoting—and even planning for—reinitiation of a grizzly bear (*Ursus arctos*) trophy hunt after a multi-decade hiatus in state authority over grizzly bear management. Grizzly bear trophy hunting ended during 1975 in Wyoming shortly after grizzly bears in the contiguous United States received federal Endangered Species Act (ESA) protections. For rather peculiar reasons, a trophy hunt continued in the Northern Continental Divide Ecosystem (NCDE) of Montana—despite ESA protections—until it was ended in 1991 by a federal court order.

Grizzly bears in the Greater Yellowstone Ecosystem (GYE) lost federal ESA protections for a brief period during 2017-2018 (that is, the population was "delisted"), although ESA protections were restored shortly after by a federal court order prompted by litigation. During the lead-up to and immediate aftermath of delisting, the three states encompassing the GYE put together a Memorandum of Agreement (MOA) in which they outlined a protocol for post-delisting management of grizzly bear mortality in the core of the ecosystem—within what is called the Demographic Monitoring Area (DMA). The tacit if not expliciit goal was to prevent further growth of the bear population within the DMA, although state plans outside this zone allowed for potentially no limits on grizzly bear mortality (see Sections B.4 and B.5 below).

Of particular relevance here, the states of Wyoming and Idaho moved ahead with implementing a grizzly bear trophy hunt in the GYE as soon as delisting occurred—and with the intent of using these hunts to kill the maximum number of bears allowed under terms of the MOA (see Section B.4). A patently unsustainable hunt was planned for outside the DMA (see Section B.5). These plans were likewise ended by a federal court order. Meanwhile, in Montana, state wildlife managers were actively setting the stage for a grizzly bear trophy hunt in the NCDE in anticipation of this population being delisted as well. Promotion of a sport hunt has been partly accomplished through control of information being provided to a citizen's group called the Grizzly Bear Advisory Council that was convened by the Governor of Montana during 2019-2020 to develop recommendations for management of grizzly bears in Montana.

Conflict Fueled by Indentity and Worldview

Although state managers have used the euphamisms of "sport hunt" and "harvest" throughout these planning and promotion processes, there is good reason to think that a primary (although not sole) motivation for hunters involved in these hunts would be to obtain trophies. There is ample research supporting this reasoning, not just for large carnivores, but also for hunters motivated to participate in a guided out-of-state hunt for larger herbivores (for example, see Kalof & Fitzgerald 2003, Brower 2005, Radder 2005, Eliason 2008, Johnson et al. 2010, Palazy et al. 2012, Simon 2013, Darimont & Child 2014, Braczkowski et al. 2015, Child & Darimont 2015, Mattson 2016b, Ebeling-Schuld & Darimont 2017, Mihalik et al. 2019).

The point here is not so much to establish some fundamental truth about motives, but rather to observe that obtaining a grizzly bear trophy is almost certainly a common motive starkly evident in trophy shots easily accessed by a simple Google search (for example, Darimont & Child 2014, Child & Darimont 2015). These public displays are relevant simply because most adults in the United States—somewhere between 65 and 70%—do not support trophy hunting or even object to trophy hunting on ethical grounds (Kellert 1980, Heberlein & Willebrand 1998, Remington Research Group 2016, The Economist/YouGov 2018). Interestingly, these results hold regardless of political affiliation, age, and gender. Disapproval such as this sets the stage for conflict between those who promote a grizzly bear trophy hunt and much of the general public.

But perhaps even more important, potential for conflict is predictably amplified by relatively profound differences in the identities and demographic profiles between those who engage in trophy hunting and those who most actively denounce it—which allows, in turn, for the ready demonizaton of opponents. More specifically, trophy hunters are overwhelmingly white and male—with an apparent interest in masculine prowess—whereas opponents of trophy hunting are disproportionately urban-dwelling women with an interest in animal welfare (Kalof & Fitzgerald 2003; Brower 2005; Eliason 2008; Mattson & Clark 2010b; Mattson 2014, 2016).

Politicization of Science

These sorts of latent or realized conflicts predictably lead to the politicization of science relevant to judging the efficacies and effects of trophy hunting, with the potential, for example, of contaminating deliberations over development of hunt-based wildlife management plans or judgements regarding the merits of removing ESA protections for grizzly bears. Evidence can be found in the often shakey scientific foundations of management plans (Artelle et al. 2014, 2018; Artelle 2019), the exploitation of uncertain scientific information and under-specified policy to advance special interests (Mattson & Craighead 1994), the related rhetorical and discursive dynamics of “political populations” (Darimont et al. 2018), and vagarious judgments of wildlife scientists and managers that align more with affiliations than with evidence (Heeren et al. 2017).

This politicization spills over into scientific disputes over methods used to monitor grizzly bear mortality and populations, with implications for judging the sustainability of grizzly bear hunts. Those aligned with management agencies implementing (or planning) a hunt almost invariably defend the agency’s methods and sustainability claims (for example, Van Manen et al. 2014, McLellan et al. 2016), whereas those who are unaligned almost invariably contest the veracity of both (for example, Mattson 1997a, Doak & Cutler 2014a, 2014b; Artelle et al. 2013).

The problematic upshot of all this is that science and scientific evidence often become weapons used to serve preordained political ends. This weaponization is predictably achieved through selective use and promotion of scientific information; a related selective disregard of inconvenient information; subjective claims presented as “science” but without a credible scientific basis; control over questions addressed by researchers; related control over the framing and representation of completed research; and, where possible, control over information made available for public deliberations.

Goals, Framing, and Approach

Current conflict over grizzly bear trophy hunting is almost certainly driven largely by worldviews and identities, with science and scientific information often relegated to serving partisan ends. This likely holds for both proponents and opponents of hunting. Nonetheless, scientific evidence arguably remains the best basis for judging the efficacies and effects of human policies and practices. This premise is the inspiration for putting together the analysis of logic and review of available scientific information that follows. The point of reference throughout is current deliberations over the advisability of instituting a grizzly bear sport hunt in the U.S. Northern Rockies.

My goal here is to provide information that will help stakeholders reach well-substantiated conclusions regarding the potential effects of a sport hunt on both grizzly bears and people. I bounded this review by focusing on a handful of key questions that have emerged during recent debates: What are the likely effects on grizzly bear populations? (Section B); What are the likely effects on human-bear conflict? (Section C); What are the likely effects on human safety? (Section D); and What are the likely effects on social acceptance of grizzly bears? (Section E). Where relevant I also examined alternative approaches that would be more likely to achieve stated or implicit goals (for example, reduce conflict and increase human safety).

It is virtually impossible to encompass all of what has been published in the scientific literature on a topic as multi-dimensional and interconnected as this one, which means that I strove to be comprehensive, but not tedious, with more complete reference to the available literature in instances where the issue was demonstrably more contentious or directly relevant.

In policy-relevant applications such as this the standards for reaching conclusions differ from those usually employed by scientists. Conventional scientific practice prioritizes the avoidance of so-called Type I errors (erroneously concluding that an effect exists when it actually doesn't). By contrast, here I prioritize weight of evidence as well as the precautionary principle. In other words, I prioritize describing a tentative model of how the world might work that is better supported by the available evidence than any of the alternatives. With a frame such as this, contradictory evidence might exist, but would not prevail if outweighed by the preponderance of other available evidence.

The precautionary approach introduces an additional consideration. Given that grizzly bear populations in the contiguous United States are widely considered to be at risk—regardless of whether formally protected by the ESA or not—the burden should be to show beyond a reasonable doubt that no harm to grizzly bears, or even people, will be caused by a sport hunt. This burden of proof comports with compelling arguments made by scholars such as Kristin Shrader-Frechette in instance where risks are not symmetrical (Shrader-Frechette & McCoy 1993, Shrader-Frechette 1994). In other words, where weight-of-evidence or logical arguments are inconclusive, I emphasize conclusions that are precautionary rather than risk-embracing.

A. Context

The effects and efficacies of sport hunting grizzly bears (*Ursus arctos*) can only be understood in context of past, present, and foreseeable environmental conditions; the threats or opportunities engendered by those conditions; and methods for monitoring populations and managing mortalities. All of these factors configure risks as well as costs and benefits of sport hunting grizzly bears.

With these considerations in mind, what follows is a necessarily brief overview of factors affecting the intrinsic vulnerabily of grizzly bears to increments of mortality added by a sport hunt; emerging and foreseeable threats to grizzly bears in the Northern Rockies primarily embedded in changing environmental conditions and human populations; and key aspects of current protocols and plans for managing grizzly bear mortality in the Greater Yellowstone (GYE) and Northern Continental Divide (NCDE) Ecosystems. The emphasis throughout this section is on clarifying risks and the corresponding extent to which management has been and will likely be precautionary when dealing with mortality caused by a sport hunt.

A.1. The Intrinsic Vulnerability of Grizzly Bears

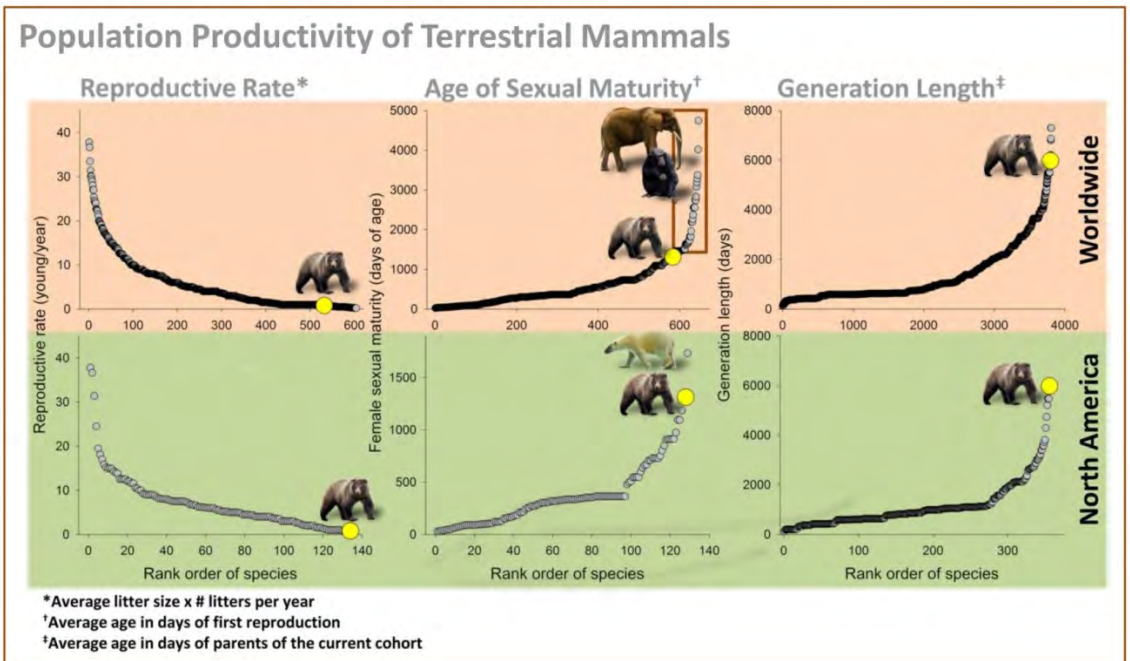

Figure A.1. Indices of population productivity for grizzly bears (large yellow dots) relative to all other terrestrial mammals, worldwide (top) and in North America (bottom). Sources: Ernest, S. K. (2003). Life history characteristics of placental nonvolant mammals. Ecology, 84(12), 3402-3402. https://doi.org/10.6084/m9.figshare.c.3297992.v1; 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

Grizzly bears are intrinsically vulnerable to human persecution in part because they have the lowest reproductive rate of any terrestrial mammal in the world, certainly in North America. Figure A.1, immediately above, contextualizes this seminal point by locating grizzly bears relative to other terrestrial placental mammals in terms of three indices of population productivity: annual reproductive rate, age at which females reach sexual maturity, and age at which a reproductive female replaces herself. Grizzly bears, along with polar bears, have the lowest reproductive rate and longest generation lengths of any terrestrial mammal in North America; only elephants and some primates are less productive globally. On average, black bears in North America (*Ursus americanus*) produce 10-20-times as many cubs per unit area and exist at 10-times the densities of sympatric grizzly bears (Mattson et al. 2005).

As a consequence, grizzly bear populations are unable to accommodate much 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 averaged only -3-4% during 1850-1910 in the western contiguous U.S., cumulative losses during this period were 90% (Mattson and Merrill 2002). This sensitivity of grizzly bear populations to even small added increments of mortality leaves managers with little margin of error.

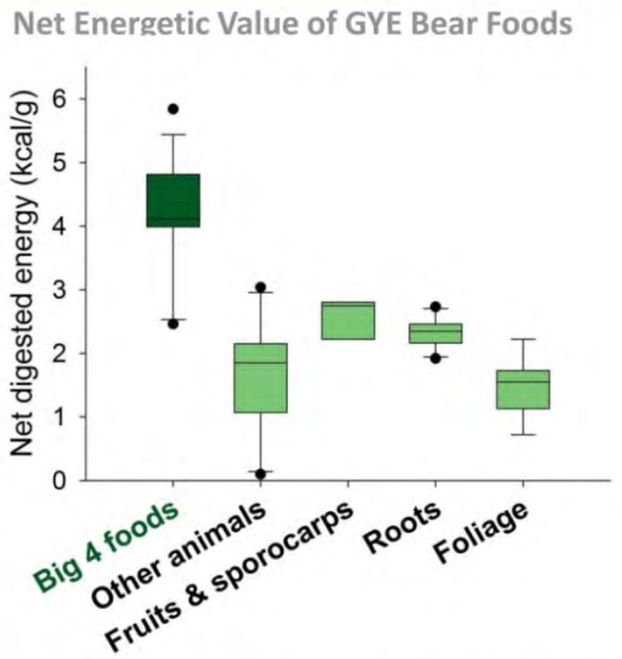

Figure A.2. Median net digested energy available from the "Big 4" bears foods (whitebark pine seeds, army cutworm moths [Euxoa auxiliaris], meat from bison and elk, and cutthroat trout) versus all other known alternate foods in the GYE (data from Mattson et al. 2004). Energetic values are summarized as box and whisker plots, with the median shown by a horizontal line inside a box delimiting the 25th and 75th precentile range of values, and the dots at the vertical extremes denoting outlier values.

Consistent with this thesis, Weaver et al. (1996) 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 of female offspring to maternal home ranges." 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 over-run with alternate but low-quality foods.

Such is the case for Yellowstone grizzly bears that have depended on just four main foods for most energy and nutrients. In contrast to the many other foods available to Yellowstone bears, the euphemistic "Big Four" provide much higher concentrations of

net digested energy (Figure A.2; Mattson et al. 2004). As a consequence, grizzly bears such as those in Yellowstone—as well as elsewhere in the world—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 (Hilderbrand et al. 1999; McLellan 2011, 2015; Nielsen et al. 2017; Hertel et al. 2018).

A.2. The Issue of Viability and Problem of Isolation

Isolation compounds the problems created by low productivity and small size for grizzly bear populations. The Yellowstone population in particular has probably been isolated for nearly a century (Miller & Waits 2003, Haroldson et al. 2010) and, although not as isolated, free movement of grizzly bears into and out of the NCDE is impeded by major barriers to the north and west (Proctor et al. 2005, 2012) and very low grizzly bear population densities in adjacent portions of Alberta (Proctor et al. 2018). Within the NCDE an additional impedement is posed to movement of bears out of a source population centered on Glacier National Park to demographically less robust populations to the south by the Burlington Northern-Santa Fe/Highway 2 transportation corridor along the south boundary of the Park (Mattson 2019a).

This isolation and fragmentation is intrinsically problematic, first, because genetic diversity of Yellowstone grizzly bears is lower than that of any other mainland North American grizzly bear population (Miller & Waits 2003) and, second, because the populations of roughly 700-1000 bears currently in the GYE and NCDE are far fewer than the several thousand, each, currently deemed necessary to insure long-term viability (e.g., 99% probability of persistence for 40 generations; Lande 1995; Allendorf et al. 2001; Brook et al. 2006; Traill et al. 2007, 2010). More to the point, Reed et al. (2003) estimated that minimum viable populations need to be near 9000 for species such as grizzly bears especially if the focal population is managed for little or no increase (see A.4 below).

These viability considerations create a mandate for connectivity (for example, see Craighead & 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 & Knight 1991, McLellan & Hovey 2001, Proctor et al. 2004, Støen et al. 2006, Zedrosser et al. 2007, Norman & Spong 2015), female brown/grizzly bears disperse only around 7 miles from their natal ranges, in contrast to 26 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 bears roughly 50 years to colonize areas 100 miles distant. (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 is thus rendered nearly impossible if grizzly bears are subject to higher levels of mortality on the population periphery (see point A.5 below).

A.3. The Exacerbating Effects of Environmental Trends

The comparatively small and isolated grizzly bear populations in the contiguous United States are subject to a number of on-going and foreseeable threats. For one, key food resources have been lost

or destabilized by rapidly changing environments and climates. Whitebark pine (*Pinus albicaulus*) was functionally extirpated as a bear food throughout the NCDE and in most of the GYE, with much of the losses in the GYE happening during 2000-2010 due to an unprecedented outbreak of mountain pine beetles unleashed by a warming climate (https://www.mostlynaturalgrizzlies.org/recent-trends; Mattson 2019a, page 15). Cutthroat trout (*Oncorhynchus clarkii*) that had been consumed while spawning in streams tributary to Yellowstone Lake were functionally extirpated as a bear food between 1995 and 2005 by a non-native piscivorous predator and by deteriorating hydrologic conditions (https://www.mostlynaturalgrizzlies.org/trends). Elk (*Cervus canadensis*) populations in the GYE declined during this same period, along with two of three bison (*Bison bison*) populations (https://www.mostlynaturalgrizzlies.org/trends-1)—as did the mule deer (*Odocoileus hemionus*) population along the Rocky Mountain Front in the NCDE (Mattson 2019a, Page 16). Meanwhile, a dramatic increase in wildfires since 1985 produced rapid increases in transient unproductive habitats in wildlands of the NCDE (Mattson 2019a, page 15).

All of these dynamics have driven demonstrable changes in grizzly bear diets and distributions that have, in turn, led to problematic increases in conflicts with humans. In the GYE grizzly bears have conpensated by eating more meat (https://www.mostlynaturalgrizzlies.org/trends-1; Mattson 2017), with most of that meat coming from scavenging or predating on livestock, or exploiting the remains of elk shot by big game hunters (Mattson 2017). Under both circumstances bears come into conflict with people who are often armed and intolerant—resulting in escalating conflicts and bear deaths (Figure A.3). In the NCDE, grizzly bears have rapidly spread into agricultural landscapes (Mattson 2019a, pages 33-34), likely in compensation for diminished food resources in wildland areas (Mattson 2019a, pages 15-16 & 35). Here, as in the GYE, conflicts with livestock producers and farmers have dramatically increased (Mattson 2019a, page 16)—along with resulting bear deaths (Figure A.3.e-f).

Grizzly bears spreading out into human-impacted areas on the west side of the NCDE have come up against increasing urban and suburban sprawl (Mattson 2019a, pages 37-38), as well as other more remote residential developments, all of which are populated with human-associated attractants that likewise bring bears into conflict with people—and result in yet more dead bears (Figure A.3.f). Compounding all of this, steadily increasing traffic in transportation corridors of the NCDE has resulted in an accelerating toll of grizzly bears killed by vehicle (Mattson 2019a, pages 43-44) and train (Mattson 2019b) strikes.

Without exhausting all of the current identifiable threats, grizzly bears remain threatened by malicious killing, often by people driving backcountry road networks. These roads are nowhere more problematic than on Forest Service jurisdictions where management prioritizes industrial-scale extraction of timber over all other values—and nowhere more so than in the Selkirk and Cabinet-Yaak Ecosystems (Mattson 2019d, pages 11-12) as well as in western portions of the NCDE on the Flathead and Lolo National Forests (Mattson 2019a, page 37).

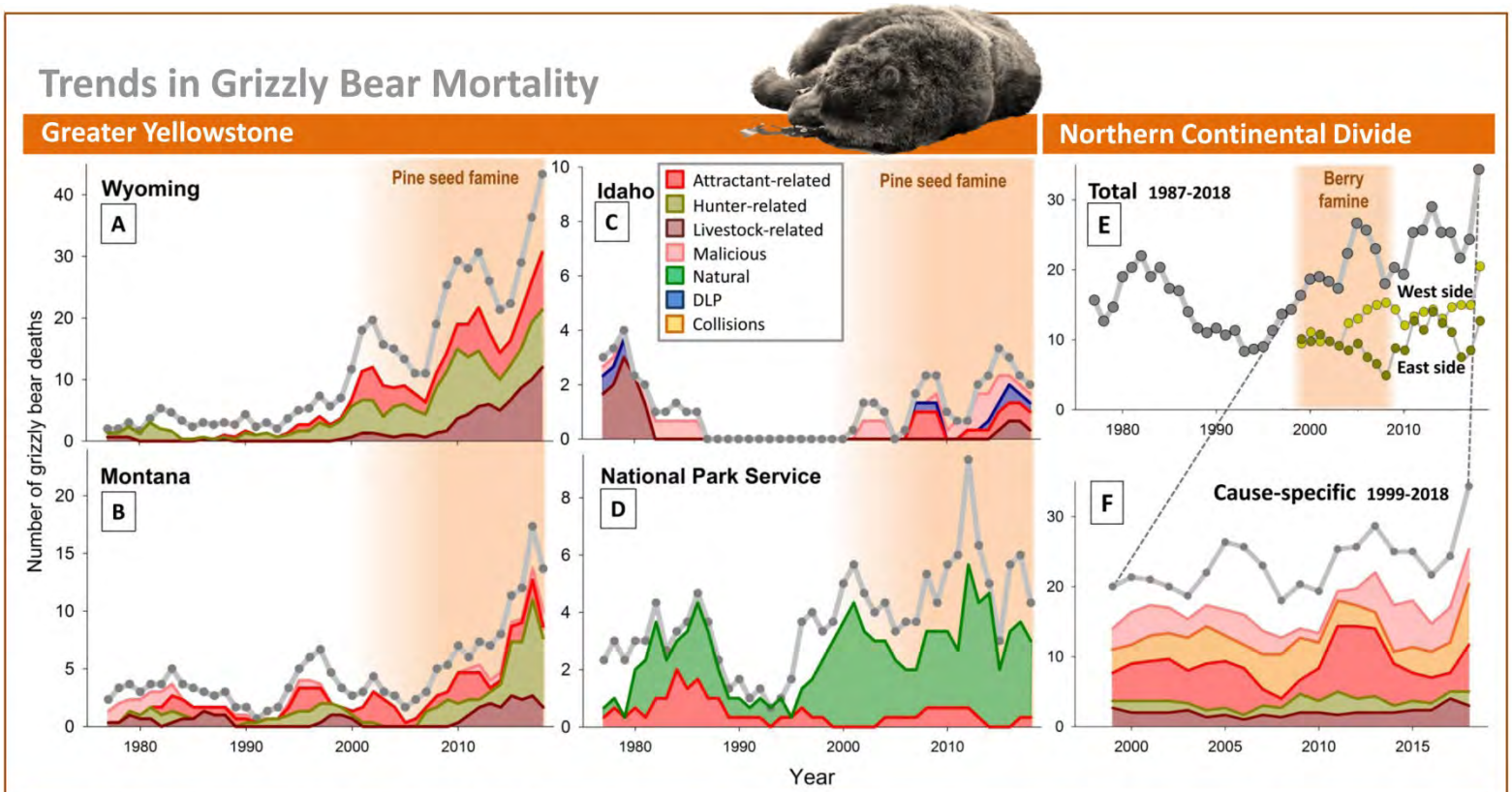

Figure A.3. Trends in total numbers of known and probable grizzly bear mortalities, broken down by major causes, for the Greater Yellowstone (GYE) and Northern Continental Divide (NCDE) Ecosystems : in the GYE for (A) for Wyoming, (B) Montana, (C) Idaho, and (D) National Park Service jurisdictions; in the NCDE (D) for the entire ecosystem, 1978-2018, and differentiating deaths on the west and east sides, 1999-2018, and (E) by major causes for 1999-2018. Gray lines and darker gray dots denote total mortality whereas each major cause is shown by different colored bands. Periods of major food shortages are shown by vertical bands of orange-colored shading, including the terminal decline in availability of whitebark pine (*Pinus albicaulis*) seeds in the GYE and a period of widespread berry shortages ("berry famine") in the NCDE. Note the substantial increase in bear mortalities in Wyoming and Montana portions of the GYE coincident with loss of whitebark pine seeds , driven largely by conflicts with humans over meat, and the spike in bear mortalities coincident with the berry famine, but driven largely by increases on the west side of the NCDE. Berries are a more important food source on the west compared to east sides of the NCDE (Mattson 2019). Data are from datasets obtained under Open Documents and Freedom-of-Information Act requests for 1959-2014 in the GYE and for 1999-2018 in the NCDE. Other data on mortalities come from Interagency Grizzly Bear Study Team Annual Reports for 2015-2018 and from Dood et al. (2006). Data for estimating abundance of whitebark pine seeds come from Macfarlane et al. (2013), Van Manen et al. (2016), and Interagency Grizzly Bear Study Team Annual Reports for 1979-2018. Data for estimating berry abundance come from McLellan (2015) and Kasworm et al. (2018).

Looking to the future, few of the threats rooted in environmental change and human population growth are likely to abate. Regional human populations will almost certainly continue to grow, as will residential developments built to accommodate unrelenting demand (Mattson 2019a, page 48). Increasing humanpopulations will predictably fuel more traffic on high-speed highways as well as ever-more hikers, runners, and mountain bikers on backcountry trails (see Mattson [2019d] for threats posed by these activities). Bear foods in wildlands will also, in the net, almost certainly continue to be lost. Climate warming promises to eliminate the last crucial native food for grizzly bears in the GYE within the next 100 years—army cutworm moths (*Euxoa auxiliaris*) concentrated in alpine areas to feed on wildflowers in alpine tundra (https://www.mostlynaturalgrizzlies.org/the-future). Fruit, the main staple of grizzly bears west of the Continental Divide, will also be less abundant as climate change eliminates much of the habitat currently suitable for serviceberry (*Amelanchier alnifolia*), chokecherry (*Prunus virginiana*), and buffaloberry (*Sheperdia canadensis*)—with huckleberry (*Vaccinium membranacuem*) also at risk (https://www.mostlynaturalgrizzlies.org/future-prospects-1; Mattson 2019a, page 47; Prevéy et al. 2020). On top of this, increasingly frequent and widespread wildfires will drive volatile dynamics and the propagation of habitat conditions that will likely be less rather than more favorable to grizzly bears (https://www.mostlynaturalgrizzlies.org/future-prospects; Mattson 2019a, page 47).

Given that there are almost certain lags between when environmental change occurs and when these changes are manifest in grizzly bear population size and vital rates (for example, Doak 1995), and that the NCDE Conservation Strategy does not provide for any monitoring of environmental conditions other than geospatial reckonings of human infrastructure within the Demographic Monitoring Area (DMA; NCDE Subcommittee, Interagecy Grizzly Bear Committee 2018), past and likely future environmental change will predictably leave bear managers inattentive too and offering lagged responses to deliterious changes in habitat.

A.4. Protocols for Managing Within DMAs

Having identified emerging and likely future threats embedded in environmental change, it throws into relief the issue of whether current protoc ols for managing grizzly bear populations in the contiguous U.S. are precautionary, attentive to underlying and often cryptic threats, and designed to create a buffer registered in both bear numbers and distributions.

Looking first at the GYE, management of this grizzly bear population within its Demographic Monitoring Area (DMA) is currently governed by a Memorandum of Agreement (MOA) adopted by Wildlife Commissions in Wyoming, Montana, and Idaho (Montana Fish, Wildlife & Parks, Wyoming Game & Fish Department, Idaho Fish & Game Department 2015). The U.S. Fish & Wildlife Service (FWS) gave the MOA authoritative weight under the ESA by codifying its objectives, protocols, and guidelines in a rule for removing ESA protections that was finalized during 2017, including explicit provision for implementation of a sport hunt by all three involved states (U.S. Fish & Wildlife Service 2017). Even though each state's Commission expressly reserved the right to deviate from the MOA, and that the 2017 Rule was over-turned in court, this agreement nonetheless is positioned to govern—if not dictate—grizzly bear management for the near future.

Of particular relevance here, the MOA's protocols are expressly designed to prevent growth of the grizzly bear population within the GYE DMA above levels observed during 2002-2014. If, as during 2017-2019, estimated population size exceeds the 2002-2014 average, prescribed mortality rates will be increased to reduce bear numbers (in other words, "adjustable mortality rates"). As described in the FWS's 2017 Final Rule, the MOA's "…adjustable mortality rates were calculated as those necessary to manage the population to the…population estimate of 674 bears..." and "…total mortality is limited…when the population is at or below 674, with higher mortality limits when the population is higher than 674." I emphasize "to" in the quote above because this single word is critical. In essence, it encapsulates the central post-delisting objective of managing to prevent growth of the GYE grizzly bear population within the DMA above 674 animals, which is particularly relevant given that current estimated population size is around 700.

The 2017 Final Rule describes provisions putatively designed to guard against post-delisting population declines within the Yellowstone DMA, including statements averring that state managers will adaptively decrease mortality rates as population estimates drop below triggering thresholds, and disallow sport hunting if estimated bear numbers drop below 600. However, neither provision is binding on the States; both are discretionary. The only substantive population-related trigger for authoritative FWS intervention occurs when estimated bear numbers drop below 500. As stated in the Final Rule, "The Service will initiate a formal status review and could emergency re-list the GYE grizzly bear population…If the population falls below 500 in any year..."

However, all these provisions, discretionary or otherwise, are compromised by uncertainties, lags, and deficient assumptions built into the MOA's methods. These methods assume that males can 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; Costello et al. 2016; Van Manen et al. 2016). This alone guarantees declines in numbers of males, even if females are being managed sustainably. Yet numbers of males are not directly monitored in either the GYE or NCDE. In the GYE, 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 the assumptions hidden in model-contingent estimates of comparative mortality rates using data collected during the previous 5-10 years. In other words, even if estimates of comparative mortality rates are unbiased, male population dynamics will be viewed through a rearview mirror, with relevant estimates lagging well behind unfolding real-time conditions.

These problems are even more pronounced for the NCDE given that (1) there is no real-time monitoring of any population segment (Costello et al. 2016), (2) estimates of population growth rate are based solely on estimates of birth and death rates (Costello et al. 2016), and (3) the data to used to produce these estimates are on average 10 years old (Mattson 2019a, page 24). If anything, management of grizzly bears in the NCDE will be even more affected by lags in data and corresponding lags in management responses than in the GYE. Moreover, as in the GYE, the goal of Montana Department of Fish, Wildlife & Parks (FWP) is one of managing relative to the floor: to prevent the population from dropping below 800 animals (Costello et al. 2016; NCDE Subcommittee, Interagency Grizzly Bear Committee 2018). Given that the population is currently estimated to be around 1000

bears, this goal gives ample room for managers to reduce population size. Moreover, the methods used to assess whether the population is likely to be above 800 animals under-estimate risks at numerous junctures (Mattson 2019a, pages 23-31).

A.5. Protocols for Managing Outside DMAs

State plans for managing grizzly bears outside the DMAs compound the deficiencies in protocols for managing grizzly bears within. These plans matter because the FWS has explicitly stated that "Mortalities outside the DMA are the responsibility of each State and do not count against total mortality limits," which functionally gives state managers carte blanche. Of relevance here, the three involved states either intend 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."

As direct evidence of its intent, the state of Wyoming had planned to sport hunt as many as 12 grizzly bears in areas outside the DMA during a fall 2018 hunting season that was prevented by a federal court order that same year. Two of these bears would have been adult females. Given that there were almost certainly no more than 90-100 bears outside the GYE DMA during 2018, the sport hunt alone would have prospectively killed 12-13% of all extralimital grizzly bears in Wyoming—on top of other mortality of prospectively equal magnitude. No research has ever shown that an annual mortality rate near 25% can be sustained by any interior North American grizzly bear population (Bunnell & Tait 1980, Harris et al. 2006, McLellan et al. 2016, Miller et al. 2017). More commonly, as posited by the MOA, sustainable mortality rates are less than half such a rate, nearer 5-10%.

With reference to key linkages in Montana (see point A.2, above), the FWS's 2017 Final Rule for delisting GYE grizzly bears merely stated: "To increase the likelihood of <u>occasional</u> genetic interchange between the GYE grizzly bear population and the NCDE grizzly bear population, the State of Montana has <u>indicated</u> they will manage discretionary mortality in this area in order to <u>retain the opportunity</u> 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 GYE and other grizzly bear populations will depend on widespread effective efforts to prevent conflict and curb detrimental private land development, all of which require ample funding.

A.6. Inadequate Resources and Commitment

Despite laudable language in various planning documents, the U.S. Forest Service and 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 the GYE and NCDE. Grizzly bear deaths in the GYE have been increasingly linked since the mid-2000s to human-associated meat, notably livestock and the remains of hunter-killed big game, together accounting for near 55% of known and probable bear fatalities (Figure A.3.A & A.3.B). The fact that meat-associated grizzly bear deaths have been increasing at rates of 5% (hunter-related) and 17% (livestock-related) per annum (Figure A.3.A & A.3.B) during a period of stalled population growth (Van Manen et al. 2019) 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. In the NCDE, escalating grizzly bear deaths have been increasingly associated with conflicts on private agricultural lands and collisions with vehicles on heavily-trafficked highways (Figure A.3.E & A.3.F; Mattson 2019a). Here, again, and despite some heroic efforts, neither cause has yet to be effectively addressed.

Of relevance to all grizzly bear Recovery Areas, the current NCDE and GYE Conservation Strategies along with state grizzly bear management plans furthermore explicitly call for maintenance of the status quo, emebdded in baseline reference points for the human footprint during 1998 (GYE) and 2011 (NCDE), which will likely institutionalize an inadequate conflict prevention regime (Yellowstone Ecosystem Subcommittee 2016, NCDE Subcommittee 2019). Two pointed examples can be found in the Upper Green River Area Rangeland Project Final EIS completed by the Bridger-Teton National Forest during October 2017 (Bridger-Teon National Forest 2017) and the Black Ram Project Final EIS completed by the Kootenai National Forest during December 2019 (Kootenai National Forest 2019).

This prognosis is rendered even more plausible by the fact that state grizzly bear conflict specialists will likely be further under-resourced in the near future. Appendix F of the penultimate GYE Conservation Strategy summarizes the prospective annual costs of implementing mandated human/grizzly bear conflict management, estimated to be $650,000 for the US Forest Service, $735,000 for the state of Wyoming, and $246,000 for the state of Montana in this ecosystem alone. On top of this, the Montana state plan also asserts the importance of "Securing important linkage habitats through purchase or easement…" However, 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. 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 plan states "…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 short-falls will be covered by grants from the federal government given that proposed future budgets for the FWS and Forest Service call for major cuts in programs supporting recovery of endangered and threatened species.

A.7. Conclusions

This context provides the basis for reaching several conclusions of relevance to judging the direct, indirect, and social effects of sport hunting grizzly bears in the U.S. Northern Rocky Mountains:

- Grizzly bear populations are intrinsically vulnerable to mortality exceeding 5-10% per annum, and are likely to decline at rates higher than these especially if mortality rates of adult females exceed 3-5%.

- Grizzly bear populations need to number in the 1000s—perhaps as many as 9000—to ensure long-term viability. None of the grizzly bear populations in the U.S. Northern Rocky Mountains number much more than 1000 and even the largest in the GYE and NCDE are likely smaller than this.

- Grizzly bear populations in the contiguous U.S. are rendered even more vulnerable to environmental change and episodic catastrophes by complete or partial isolation, further aggravated by within-population fragmentation.

- Environmental changes in the GYE and NCDE during the last 30 years have precipiated changes in habitat conditions and food availability that have, in turn, caused changes in diets and local distributions of grizzly bears. These changes have very likely been driving increased levels of contact and conflict between humans and grizzly bears.

- Foreseeable environmental changes will probably not only exacerbate conflicts between humans and grizzly bears, but also cause declines in carrying capacity.

- Because of lags between when environmental change happens and when such changes manifest in the demography of bear poplations, an absence of habitat monitoring in the NCDE guarantees that management responses will in turn lag far behind any deteriorations in habitat conditions.

- Protocols for managing grizzly bear mortality in both the GYE and NCDE are either overtly or tacitly designed to prevent growth of populations within the Demographic Monitoring Areas (DMAs).

- The reliance of management on historically back-weighted data, especially in the NCDE, guarantees that population management will be done looking in the rear-view mirror, which will compound the problem of lagged responses by vital rates to environmental change. Population declines will likely not be detected until well after they have started.

- Population goals, together with management methods, create a risk-laden regime that will not guard against nor readily detect unintended population declines within DMAs.

- There is minimal evident commitment on the part of Montana, Wyoming, or Idaho to facilitate connectivity between current grizzly bear populations, exacerbated by current management protocols that encourage unsustainable mortality rates outside of DMAs.

- A lack of resources virtually guarantees that programs to foster coexistence between grizzly bears and people will be insufficient, especially in connective habitat outside of DMAs.

- Inadequate coxexistence programs together with prospectively punitive management regimes outside of DMAs will impede connectivity among grizzly bear populations and perpetuate the problems of isolation.

- Continuing isolation together with demographically regressive management regimes informed by retrospective data will render grizzly bear populations in the contiguous U.S. acutely vulnerable to any unintended undetected effects caused by a sport hunt.

B. What Are the Effects of Hunting on Grizzly Bears?

The factors described in Section A governing risks for grizzly bears in the U.S. Northern Rocky Mountains set the stage for examining the likely effects of a prospective grizzly bear sport hunt—which are necessarily assessed in reference to the environment of bears in this region as well the evolutionary history of *Ursus arctos*.

As a premise, it is important to recognize that prior to the arrival of numerous well-armed Europeans, grizzly bears were probably only rarely the prey of other species—at least for the last 10-13 millenia. During the Pleistocene it is conceivable that grizzly bears were occasionally killed outright by large carnviores such as short-faced bears (*Arctodus simus*), saber-toothed tigers (*Smilodon fatalis*), and scimitar-toothed cats (*Homotherium latidens*), but not after the advent of the Holocene (https://www.allgrizzly.org/early-prehistory).

The implications are that, up until the last several centuries, grizzly bear populations in North America were largely regulated by factors such as competition for food and mates, predation by conspecifics, and environmental carrying capacity (Bunnell & Tait 1981, Stirling & Derocher 1990, Steyaert et al. 2012). In other words, like other large carnviores—but unlike large herbivores such as elk (*Cervus canadensis*), deer (*Odocoileus* sp.), and moose (*Alces alces*)(Leslie et al. 1999)—grizzly bears did not evolve life strategies that engendered resilience to high levels of predation. Survival and reproductive success were almost certainly governed more by adipose reserves, dietary resilience, and aggressive defense of space (see Secion C) than by the ability to escape predators or adaptively increase

reproduction and recruitment (https://www.allgrizzly.org/bio; Ferguson & Larivière 2002). Put another way, predation in the form of hunting by humans is a novel evolutionary force to which grizzly bears are almost certainly not well-adapted (Bischof et al. 2018).

This evolutionary perspective is a necessary basis for reviewing and, more importantly, explaining contemporary evidence regarding the direct and indirect effects of male-biased sport hunting.

B.1. Likely Direct Effects of Hunting on Grizzly Bears

Most obviously—perhaps tautologically—the grizzly bears killed by sport hunters will be removed from the pool of potential reproductive individuals. And these bears' lives will be ended in ways definitively linked to hunting.

But beyond the obvious, there is the question of whether bears that will 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 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 could cause attrition in bear populations, with prospective harm to long-term prospects.

There is little doubt that most hunting-caused mortality would be additive, not compensatory. Deductively, heavily-armed humans that deliberately seek out bears to kill them (i.e., sport hunters) will, as a modality, be far more lethal than humans under virtually any other circumstances (the lethality factor: Mattson et al. 1996a, 1996b; https://www.allgrizzly.org/the-lethality-factor). Absent hunting, a certain number of independent-aged grizzly bears would survive the existing relatively lethal environments that they are exposed to 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.

But 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 sport hunt. The point here is that sport hunting, by its very nature is per capita much more lethal to grizzly bears. By first principles, many deaths from sport hunting will 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, consistent with additive effects shown for wolves (*Canis lupus*)by Creel & Rottella (2010), for American black bears (*Ursus americanus*) by Obbard & Howe (2008), and for cougars (*Puma concolor*) by Weilgus et al. (2013), Robinson 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 compensates for other causes of mortality.

Importantly, under current State plans and agreements (most importantly the Memorandum of Agreement [MOA] between Montana, Wyoming, and Idaho; see Section A.4), tallies of grizzly bear mortalities pre-dating a fall sport hunt will not account for the additive effects introduced by hunting-related deaths. Nor, under current management protocols, will the additive effects manifest during the 12 months following a hunt be accounted for in calculations of mortalities allowed for the following year.

B.2. Likely Indirect Effects of Sport Hunting

But the toll of sport hunting will likely not be limited to direct numeric effects on GYE and NCDE grizzly bear populations. Other indirect effects, manifest in decreased production, survival, and recruitment of cubs, have a good chance of transpiring 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 sport hunting. However, in other instances, human-caused mortality depresses reproduction during subsequent months, which amplifies and exacerbates direct numeric effects. 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).

By first principles, 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 have 3-year reproductive cycles. Synthetic analyses by researchers such as Harano & Kutsukake (2018) have shown the SSI correlates with the 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 3-year reproductive cycle—as with GYE and NCDE grizzly bears (Schwartz et al. 2006, Costello et al. 2016)—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 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 sport 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 caused by hunter-caused deaths.

But, 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 20 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 (for example; 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), cougars (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 (for example; 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 three publications (Miller et al. 2003, McLellan 2005, Brockman et al. 2020). Even so, Miller et al. did not cover conditions of particular relevance to the Greater Yellowstone (GYE) and Northern Continental Divide (NCDE) grizzly bear populations, where, unlike what they considered, hunting would perturb social dynamics of a population near a dynamic carrying capacity, and McLellan posited a regime where “some” adult males might be killed, which does not concur with the regime that was being considered by Wyoming and Idaho during 2018 that would have hunted 21 males in addition to congeners that would have died from other human causes. Finally, Brockman et al. (2020) considered an extreme at the other end of the spectrum where males were subject to exceptionally heavy harvest in an area where immigration of males from elsewhere was unlikely because punitive harvest regimes were widespread outside the boundaries of their study area.

This paucity of findings specific to grizzly bears 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 strongly suggest that male-biased sport hunting will entrain longer-term depensatory effects that amplify the more immediate negative effects of elevated mortality among grizzly bears.

B.3. The Effects of Historical Sport Hunts by Montana and Wyoming

Montana and Wyoming both had limited entry grizzly bear sport hunts that predated by several decades the implementation of ESA protections during 1975. Although this history does not necessarily foreshadow how both states might manage future grizzly bear hunts, it is nonetheless relevant. Wyoming contended that hunting during the 1960s and early 1970s was sustainable (Craighead et al. 1995), as did Montana up until termination of its hunt in the NCDE during 1991 (Dood & Pac 1993)—claims that are being made by both states regarding their current plans or aspirations for a sport hunt if and when ESA protections for grizzly bears are removed (see Section A.4). For this reason alone it is instructive to look at evidence of how historical grizzly bear hunts might have affected pre-1975 grizzly bear populations.

Unfortunately, the evidence upon which to base any retrospective assessment is scant, especially for Wyoming; and virtually all of what's available is cirumstantial at best. With those provisos in mind, there are some hard data on how many bears were being killed by hunters, and proportionately what fraction of the total known and probable human-caused deaths were attributable to this cause.

In the GYE, known deaths in state jurisdictions accounted for the majority (54%) of mortality for the entre ecosystem, 1959-1970 (Craighead et al. 1995). Of the deaths overseen by state managers, a full 84% were attributable to sport hunting. Of these kills, 59% were adults—33% adult males and 26% adult females. Craighead et al. (1995) concluded from this that adult bears bore a disproportional part of the mortality burden meted out by sport hunting.

Aside from these numbers, a demographic crisis was evidenced simply by the small size of the grizzly bear population *circa* 1970. This small size, together with the crisis created by mortalities in the wake of garbage dump closures by Yellowstone National Park, was primary justification for implementing ESA protections in 1975 (Craighead et al. 1995). At that time there were probably no more than 350 bears in the entire ecosystem (Cole 1973, McCullough 1981, Knight et al. 1980), in contrast to the current 700+ bears estimated within the GYE Demographic Monitoring Area during 2018 (Van Manen et al. 2019).

The most defensible conclusion to be reached from this evidence is that the states of Wyoming and Montana were administering a sport hunt in the GYE that was unsustainable and that management of the GYE grizzly bear population during the 1960s and early 1970s was not precautionary nor particularly prudent.

Turning to the NCDE, roughly 55% of all known and probable human-caused deaths during 1967-1985 were caused by sport hunting, of which roughly 40% were females (Dood et al. 1985). A crude estimate of unreported mortalities during that period (a doubling of human-caused deaths not attributable to hunting) suggests that roughly 30-40 grizzly bears were dying each year on state

jurisdictions, which is roughly 10% of the estimated population of grizzly bears outside of Glacier National Park (Dood et al. 1985). Although not patently unsustainable, this fraction is on the high end of what is widely considered to be sustainable (Bunnell & Tait 1980, Harris et al. 2006, McLellan et al. 2016, Miller et al. 2017).

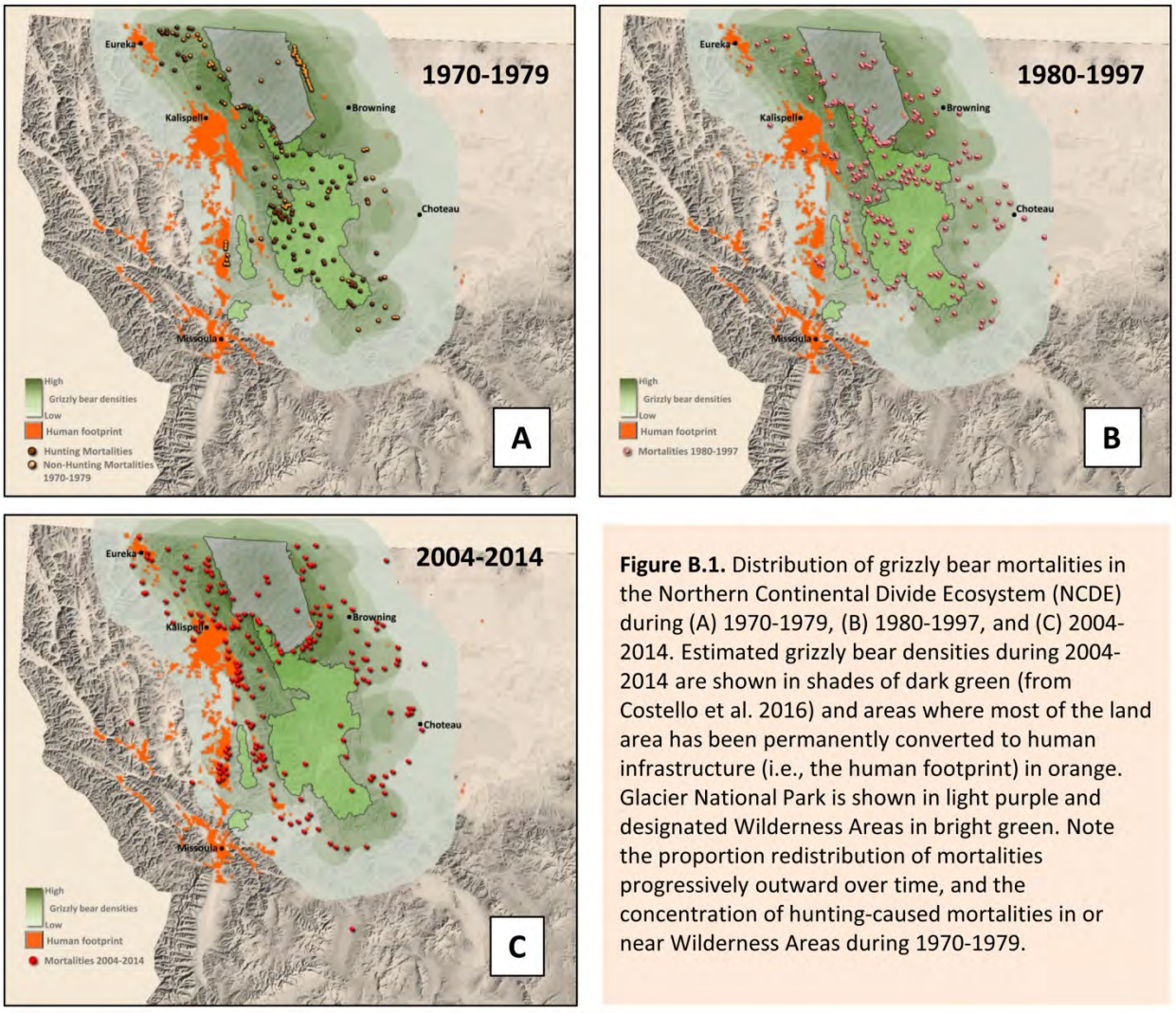

Figure B.1. Distribution of grizzly bear mortalities in the Northern Continental Divide Ecosystem (NCDE) during (A) 1970-1979, (B) 1980-1997, and (C) 2004-2014. Estimated grizzly bear densities during 2004-2014 are shown in shades of dark green (from Costello et al. 2016) and areas where most of the land area has been permanently converted to human infrastructure (i.e., the human footprint) in orange. Glacier National Park is shown in light purple and designated Wilderness Areas in bright green. Note the proportion redistribution of mortalities progressively outward over time, and the concentration of hunting-caused mortalities in or near Wilderness Areas during 1970-1979.

Additional insight into the impacts of hunting on NCDE grizzly bears can be gained by looking at distributions of mortalities during different periods of time (Figure B.1; data from: Dood et al. 1985, Dood & Pac 1993; Costello et al. 2016). The distributions of grizzly bear mortalities changed dramatically between 1970-1997 and 2004-2014. More specifically, mortalities during the earlier period were concentrated in the southern interior of the ecosystem, in the Bob Marshall Wilderness (Figures B.1.A and B.1.B), especially in contrast to more recent years when mortalities were concentrated on the periphery in areas with embedded drivers of human-bear conflict (Figure B.1.C; Mattson 2019a). The earlier concentration of mortalities in remote wilderness was a direct function of a focus by grizzly bear trophy hunters on these areas (Figure B.1.A).

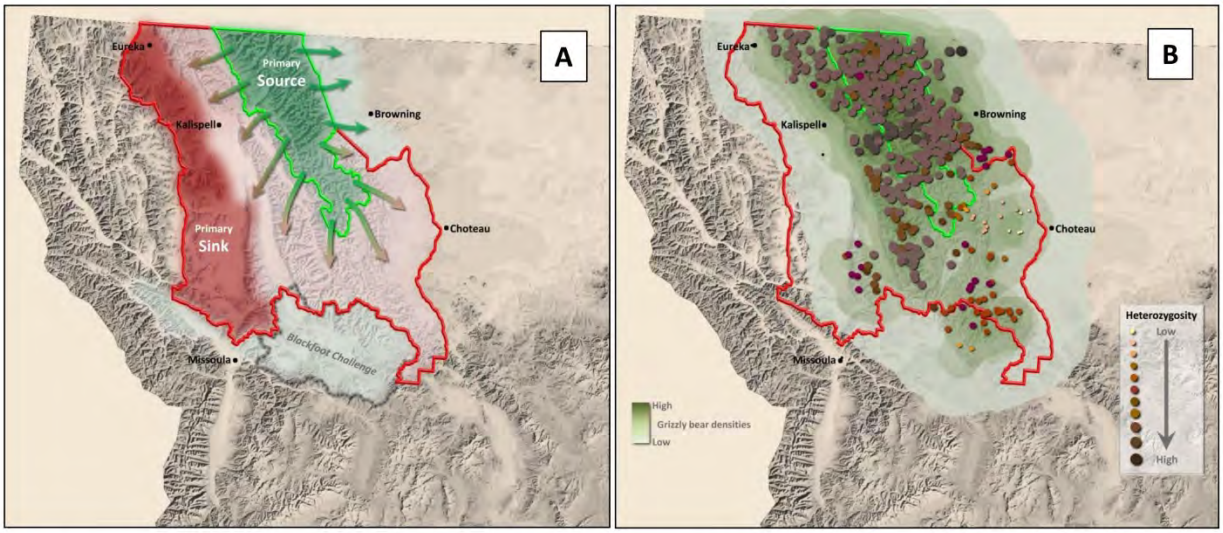

Figure B.2. (A) Current source-sink structure of the Northern Continental Divide Ecosystem (NCDE) population. This approximate structure is based on the ratio of estimated per annum bear mortalities bear and estimated bear densities stratified by NCDE subunits (data from Costello et al. 2016). More pronounced sink areas are shown as darker shades of green and more pronounced source areas as darker shades of green. Subunit boundaries are used to delineate source and sink areas. The area encompassed by the Blackfoot Challenge is also shown by a dashed gray line. (B) Results of genetic analyses presented in Mikle et al. (2016) showing levels of genetic heterozygosity for bears sampled during 2004. Each dot denotes the location of a sample, with higher levels of heterozygosity represented by larger darker points. Note the association of higher levels of heterozygosity with primary source areas.

The consequences of concentrating lethal humans in remote portions of the southern NCDE during 1970-1990 (Figure B.1.A) almost certainly included driving down bear numbers in this area and establishing what was probably a strong source-sink population structure that has persisted up until the present, with Glacier National Park throughout this time being the most vigorous source area (Figure B.2.A). Despite the termination of sport hunting, data on bear densities and mortalities broken down by NCDE management subunits in Costello et al. (2016) show that a source-sink structure still likely exists, with darker red denoting more extreme sink areas in Figure B.2.A.

A long-duration source-sink structure is consistent with results of genetic analyses presented by Mikle et al. (2016) showing severely diminished genetic heterozygosity as late as 2004 among bears residing in sink areas (Figure B.2.B), presumably as a consequence of a long preceding period of time during which a mere handful of male bears were responsible for most reproduction. Since then, Mikle et al. (2016) suggest that there has been an infusion of reproductive adults into southern portions of the NCDE between 2004 and 2012 that has increased genetic heterozygosity and contributed to recovery of this portion of the population.

In the NCDE, as in the GYE, the weight of available evidence suggests that sport hunting took an unsustainable toll on the grizzly bear population and that management was not prudent nor precautionary—despite claims to the contrary.

B.4. Conclusions

- These results suggest that the additive mortality caused by sport hunting could be effective in achieving certain goals for grizzly bear populations, especially if hunting targeted females as well as

males. More specifically, if managers wanted to use sustained high levels of sport hunting to reduce the size and distributions of grizzly bear populations, they could probably do so, as has been done in Alaska (Brockman et al. 2020).

- Direct numeric effects of sport hunting are likely to be amplified by a cascade of subsequent indirect and depensatory behavioral and demographic dynamics, potentially leading to unintended population-level impacts.

- Regimes for managing grizzly bear populations in the GYE and the NCDE after removal of ESA protections are being expressly designed to prevent numeric increases within the heart of each ecosystem (i.e., the DMA) and discourage, if not prevent, dispersal to and colonization of most of the adjacent or farther distant suitable habitat—partly through the use of sport hunting (see Sections A.4 and A.5).

- Past sport hunts of grizzly bears in Wyoming and Montana were probably unsustainable and more certainly not precautionary. This history calls into question the veracity of claims that current plans for sport hunting grizzly bears in the U.S. Northern Rocky Mountains will be sustainable.

- The goal of decreasing numbers and distributions of grizzly bears in the Northern Rockies through sport hunting is not desirable given a mandate for long term viability (Section A.2), the number of threats faced by bears in this region (Section A.3), the likelihood that unintended population declines would not be detected in a timely manner (Section A.4), and the unpredictable ways that indirect effects of sport hunting might manifest.

C. Will Hunting Grizzly Bears Reduce Conflicts?

There is a common belief that hunting grizzly bears (*Ursus arctos*), or bears of any sort, will reduce conflicts between bears and humans. This belief is seemingly linked to the belief that hunting bears will make them more fearful of humans, which will then cause bears to avoid us and the foods that would otherwise attract to the places we live and recreate (see Section D). There is also an ancillary although sometimes unstated anticipation—that hunting would substantially reduce numbers of bears and, simply because of this, result in fewer conflicts. So there are two prospective mechanisms that might link sport hunting to a reduction in bear-human conflicts: (1) a change in bear behaviors and (2) a reduction in bear numbers.

Based on the statements of state wildlife managers, it is often unclear which of these two mechanisms is being invoked when claims are made that hunting grizzly bears will reduce conflicts with humans, although both mechanisms are in fact coupled. Even if reducing bear numbers is a management objective, the questions still remains: are human and bear behaviors the dominant drivers of conflicts?; or are bear numbers the primary determinant? If the former is the answer, then bear numbers would probably need to be reduced substantially, perhaps even to local extirpation, before many benefits would be accrued in the realm of conflicts.

These issues frame what follows. I start with some bear basics, then go to some observations regarding documented drivers of human-grizzly bear conflicts, and then examine the scant evidence directly relevant to judging whether sport hunting can reduce levels of human-bear conflict. I also consider evidence for the efficacy of targeting specific individuals for lethal removal that were known to be involved in conflicts—whether by managers or hunters—as an alternative to more broadly levied

sport hunting, all of which is necessarily examined in context of evidence for the efficacies of non-lethal methods for mitigating or preventing conflicts.

C.1. Some Grizzly Bear Basics

Grizzly bears are intelligent ominvores (https://www.allgrizzly.org/intelligence). They are, moreover, highly motivated to feed during most parts of their active season, with that motivation considerably amplified during the late-summer and fall hyperphagic period (for example, Roth 1980, Mattson et al. 1991). This amplification is a consequence of basic life history. Grizzly bears need to subsist largely on adipose reserves for the 4-6 months they are in a den (see Haroldson et al. 2002) as well as for the 1-3 subsequent months when high-quality foods are typically not abundant (see Mattson et al. 1991). By default, grizzlies need to accumulate most of the energy and nutrients they will need during a year largely during a brief 3-½ months, coincident with when high-quality bear foods are typically most abundant.

The urgent need to consume large quanities of (preferably) high-quality food, when combined with intelligence, a retentive memory, and acute olfactory senses (see https://www.allgrizzly.org/senses), results in the widely observed ability of grizzly bears to both seek out rich food sources and remember where those sources were located from one season or year to the next (that is, engage in geo- and temporal-referencing; for more on a this see, for example, Herrero [2002]).

These basics have several implications for human-grizzly bear conflicts. Because grizzly bears are omnivores, humans and grizzlies have almost complete overlap of potential foods. Because garbage, domesticated grains, tissue from livestock, and honey from beehives are rich in energy and nutrients, in potentially optimal combinations (Mattson et al. 2004, Coogan & Raubenheimer 2016), these foods are intrinsically attractive to bears. Moreover, once these foods are found, the involved bears almost certainly will not forget the location and timing of the source. Bears are probably highly motivated to exploit unsecured human foods wherever and whenever those foods can be found.

C.2. Known Drivers of Conflict

Before getting into the scant and ambiguous evidence regarding effects of sport hunting on levels of human-bear conflicts, it is worth examining the ample and unambiguous evidence regarding geospatial and temporal determinants of conflict patterns.

Geospatially, conflicts concentrate around availability of unsecured anthropogenic attractants near vegetation cover—often near where people live (Elfström et al. 2014). This is not surprising. Conflicts are often over food, and grizzly bears tend to favor forest edges (for example, see Graham [1978], Mattson [1997b],Fernandez et al. [2012]).

Perhaps the best evidence for this can be found in agricultural landscapes. Wilson et al. (2005, 2006) found that most bear-human conflicts east of the Rocky Mountain Front in Montana were concentrated in or near riparian areas, associated with sheep and calving pastures, unsecured beehives, and areas used by ranchers to dispose of dead livestock (known as boneyards). The same

patterns occurred in the Blackfoot River watershed south and west of the Rocky Mountain Front (Wilson et al. 2014; Mattson 2019a, page 35). Similarly, in more forested mountainous areas, depredations of livestock tend to be concentrated near vegetal and topographic cover and in areas with more abundant natural foods (Horstman & Gunson 1982, Bjorge 1983, Gastineau et al. 2019, Wells et al. 2019).

Temporally, conflicts tend to be negatively correlated with annual abundance of natural foods and positively correlated with onset of hyperhagia and colonization of new areas by bears, especially when these areas do not have established coexistence programs and are occupied by people unused to living with bears. The inverse relationship of conflicts (or just simply degree of contact between people and bears) with natural food availability is perhaps best documented for whitebark pine (*PInus albicaulis*) seed crops in the GYE. Sightings of bears increase as do conflicts and resulting bear mortalities when seed crops are small (Mattson et al. 1992, Mattson 1998, Pease & Mattson 1999, Schwartz et al. 2006, Hermansson 2010, Haroldson & Gunther 2013). Similar relationships have been documented between conflicts involving black bears (*Ursus americanus*) and abundance of berries or hard mast (Howe et al. 2010, Baruch-Mordo et al. 2014, Obbard et al. 2014, Hamr et al. 2015).

On a seasonal basis, conflicts spike during hyperphagia (Gunther et al. 2004). And, longer-term, increases in conflict have been associated not only with colonization of new areas on the plains of Montana and Alberta (Morehouse & Boyce 2017), but also with a switch to relying more heavily on meat from livestock after widespread declines in natural foods such as mule deer (Mattson 2019a, page 16) and whitebark pine (Mattson 2018, page 14).

There is a final pattern of particular importance. When attractive habitats defined by free availability of high-quality foods attract animals into situations where they are likely to die, the phenomenon is know as an ecological trap (Battin 2004). Such “traps” have been documented for grizzly or brown bears in association with natural foods (Falcucci et al. 2009), but also, more importantly, in association with human foods. Northrup et al. (2012) documented such a phenomenon on agricultural lands in Alberta; Lamb et al. (2017) found the dynamic organized around domesticated fruit trees in British Columbia.

Such “traps” guarantee that bears will continually be fed into conflict situations regardless of how many are killed on location simply because of recruitment from surrounding wildlands. A similar situation probably arose for grizzly bears in the western U.S. during the 1800s with the coincident declines of native foods and flooding of nearby environs with livestock (Storer & Tevis 1996, Brown 1996). Importantly, the population sinks that organize around such traps can impact bears over a large area simply because grizzly bear home ranges are so large (Knight et al. 1988).

All of this is perhaps self-evident, and none is surprising. With the basics of bear life history in mind, conflicts are driven primarily by spatial and temporal availability of anthropogenic foods, and secondarily by losses of native foods or the arrival of bears in novel landscapes without a coexistence infrastructure. More importantly, extremely problematic situations arise for grizzly bears when

encountering ecological traps; that is, areas where bears are attracted into lethal environments by the free availability of anthropogenic foods.

C.3. What About the Direct Evidence?

This section is necessarily brief simply because very little research has directly addressed the relationship between human-bear conflicts and levels of sport harvest. Moreover, essentially all of this research has focused on black bears in the eastern U.S. or Canada. Of the five relevant publications, three showed that levels of sport hunting had no effect on conflicts, especially in contrast to annual variations in abundance of natural foods (Howe et al. 2010, Treves et al. 2010, Obbard et al. 2014); one showed increases in conflict with both the termination of spring bear hunting as well as shortages of natural foods (Hamr et al. 2015); and one putatively showed a decline in conflicts following years of heavy harvest coupled with high levels of other lethal removals (Raithel et al. 2017).

Importantly, this last research did not consider availability of natural foods and furthermore noted that harvests were biased towards the removal of female bears. Neither of these provisos recommends leaning too heavily on the results of Raithel et al. (2017) as a guide for judging the potential efficacy of using sport hunting to reduce numbers of grizzly bear-human conflicts in the U.S. Northern Rockies.

On a related note, the amount of research focused on relationships between levels of culling (including by sport harvest) and levels of conflict is also limited for other large carnivores in North America. Nonetheless, the consistent documented pattern for cougars (*Puma concolor*) is one of increased rather than reduced conflict, partly attributable to the influx of adolescent males in the wake of removing dominant males, which are typically the target of a sport hunt (Peebles et al. 2013, Teichman et al. 2016), which is also consistent with evidence aggregated to a very coarse grain showing no difference in depredations between California and other other western states in the U.S. despite the absence of a sport hunt in California (Laundré & Papouchis 2019).

In the case of wolves, Bradley et al. (2015) showed no effect of sport harvest on levels of depredation on livestock, whereas an inconclusive scientific tit-for-tat over a controversial study suggesting that levels of conflict actually increased with levels of culling did not lead to any apparent consensus (Wielgus & Peebles, 2014, Poudyal et al. 2016, Kompaniyets & Evans 2017).

In a nutshell, the weight of evidence available from a limited amount of topic-specific research suggests that sport hunting is of prospectively limited use for reducing levels of human-grizzly bear conflict—perhaps barring situations where hunting locally extirpates bears. Put another way, this evidence is consistent with what one might expect from the evidence presented in Section C.2. Levels of conflict probably will be driven primarily by whether anthropogenic foods are freely available and secondarily by proximal landscape features coupled with both annual and longer-term variation in abundance of natural foods—not by sport hunting—consistent with Jon Swenson's speculations nearly 20 years ago (Swenson 1999).

C.4. What About the Efficacy of Alternative Approaches?

Lethal management can also take the form of removing individual animals or, the the case of wolves, packs with a known history of conflicts. The short-term efficacy of a targeted lethal response to conflict situations has been shown for several carnviore species (Swan et al. 2017), including grizzly bears and wolves in the U.S. Northern Rocky Mountains (Anderson et al. 2002, DeCesare et al. 2018). Nonetheless, this efficacy depends on specific circumstances, and is almost certain to be ineffective in situations where an ecological trap fuels a constant influx of animals from surrounding areas into conflict situations with humans. In the Northern Rockies, there is no better example of this than the dynamics surrounding depredation on cattle by grizzly bears in the Upper Green River area of Wyoming (Mattson 2020). Under such circumstances, lethal management of any sort is highly inefficient and exacts unnecessary sustained attrition on both animals and people.

In contrast to lethal methods, there is much stronger evidence for the short- and long-term efficacy of non-lethal strategies focused on removing, guarding or otherwise securing the attractants that fuel most bear-human conflicts (for example, in recent reviews such as Treves et al. [2016], Miller et al. [2016], Lennox et al. [2018], Moreina-Arce et al. [2018], and van Eeden et al. [2018]), which is consistent with the expert judgement of wildlife management professionals worldwide (Lute et al. 2018).

Moreover, whereas targeted removal of animals with a conflict history tends to have only short-term benefits, comprehensive programs that target vulnerabililty of livestock or availability of attractants usually have lasting effects. Perhaps some of the best examples specific to grizzly bears can be found in the U.S. Northern Rockies. In Yellowstone Park, increased sanitation along with management of people and bears along roadways resulted in a substantial drop in conflicts and related human injuries over a 50 year period—despite increased visitation (Gunther 2015; Gunther et al. 2015, 2018). In the Blackfoot River drainage of Montana, a program that emphasized securing garbage, removing livestock carcasses, and deploying electric fence around beehives and vulnerable livestock also resulted in a dramatic decline in conflicts that had been escalating after colonization of the watershed by grizzly bears (Wilson & Clark 2007, Wilson et al. 2014).

C.5. Conclusions

- Grizzly bears will predictably seek out and consume anthropogenic foods such as beehives, garabage, vulnerable livestock, remains of hunter-killed animals, and even agricultural crops—whenever and wherever they are easily accessible.

- Most human-bear conflicts are a result of bears exploiting accessible anthropogenic foods, with the resulting imperative for some sort of remedial action.

- Given the centrality of anthropogenic foods, conflicts spatially concentrate near where such foods are available, but partially contingent on access to nearby cover. Temporal patterns of conflict often

track annual variation in availability of high-quality natural foods, presumably because bears seek out anthropogenic alternatives when natural foods are scarce.

- Although there is very little research of direct relevance to the issue, weight of available evidence suggests that sport hunting does not lead to reduced human-bear conflict, potentially barring instances where bears are driven to local near-extirpation.

- Targeted removal of individual animals chroncially involved in conflicts holds more promise, but with only short-term likely benefits, especially if drivers of conflict such as availability of anthropogenic foods are not addressed.

- Strategies centered on non-lethal methods hold the best promise of leading to sustained reductions in conflict and related long-term benefits for both people and animals.

D. Will Hunting Grizzly Bears Make People Safer?

The notion of using sport hunting to make grizzly bears (*Ursus arctos*) more fearful of people has gotten increased attention during recent years in part because it is one of several justifications for removing endangered species act (ESA) protections for grizzlies in the U.S. Northern Rockies—thereby allowing for implementation of a sport hunt under state authority—and also because there have been several bear-caused human fatalities in this region during recent years. The idea is to have sport hunters kill grizzlies to teach other bears to fear people. As a presumed result, there will be fewer bear attacks and people will be safer. To borrow a phrase from Valerius Geist, a proponent of hunting bears, people will have "freedom of the woods."

What follows is a review of the logic and relevant evidence for these propositions. But first:

D.1. Some Grizzly Bear Fundamentals

The first point to be made of relevance to human safety is that grizzly bears exist at a baseline characterized by a greater tendency to respond aggressively to perceived threats compared to other bear species. Steve Herrero, a Canadian behavioral ecologist, was the first to speculate that this aggressiveness was rooted in the evolutionary history of grizzlies (Herrero 1972). Grizzlies (and brown bears—all of the same species, *Ursus arctos*) evolved in open environments where safety depended on an animal standing its ground and intimidating or beating back any threat. (You can find more on

the formative evolutionary environments of grizzly bears here: https://www.allgrizzly.org/evolutionary-biogeography; https://www.allgrizzly.org/early-prehistory).

Even so, grizzlies can exhibit a high degree of tolerance for humans and other bears that might otherwise be viewed as threats (Herrero 2002, Herrero et al. 2005, Smith et al. 2005). This can be seen in coastal environments where bears have become highly socialized and tolerant of each other because of frequent interactions with conspecifics concentrated around salmon spawning streams. Or this phenomenon can be found among bears that have interacted enough with benign humans to internalize a less fear-based response—a process known as "habituation" (Herrero 2002).

This leads to a couple of key points: First, grizzlies seem to be hard-wired genetically to deal with perceived threats aggressively. Second, and perhaps more importantly, grizzlies can become less reactive to people, not as a result of heightened fear, but rather as a result of the opposite. These fundamentals alone call into question the logic of using hunting to increase human safety. Killing grizzlies (notably, a lot of this has been done even with ESA protections) is unlikely to rewire the genetic underpinnings of their behavior; and less fear rather than more is probably going to make people safer, especially if the number of circumstances is reduced (e.g., garbage around human residences or hunters near freshly-killed elk) that allow people to do things that trigger aggressive responses at close range from even the most tolerant bears (see D.6, below).

D.2. Risks of Being Attacked and Injured

Assuming that the focus of concerns is on human safety around grizzly bears, the odds of encountering a grizzly at close quarters, eliciting an aggressive response, being attacked, and being injured as a consequence are central to judging risks that would presumably need to be addressed by one means or another. With that assumption as a premise:

Attacks by bears on people on foot are quite rare, whether near or far from residences. Estimates of attacks per close encounter with a grizzly bear range from 3 to 6 per 1,000—or 0.3 to 0.6% of encounters (Nadeau 1987; Mattson 2019c, page 14). Close encounters are judged to be any that occur at distances of 50-120 yards. These are low odds. A person stands a greater chance of being injured when encountering a strange dog (Overall 1997, Weiss et al. 1998, Langley 2009). And this only accounts for encounters with bears where the involved people were aware of it happening.

This still doesn't address the odds that a bear will act aggressively in any obvious way during a close encounter—usually evidenced by a bluff charge or threatening approach, which happens during roughly 4-6% of encounters (Mattson 2019c, pages 12-13). Focusing only on only these types of aggressive reactions, what are the resulting odds of injury? Estimates come in at around 6-18% or 6-18 of 100 encounters where aggression of any sort occurred (Kendall 1983, Nadeau 1987, Mattson 2019c).

These low odds are premised on the bear acting aggressively in the first place—as opposed to being passive, curious, or fleeing. Under circumstances where grizzly bears could be observed, they fled from humans during 72% of close encounters. During 22-24% of encounters the involved bear acted curious and eventually left, or didn't overtly react in any way (Mattson 2019c, page 6).

The circumstances of known attacks are probably the most helpful of all for judging risk. Most people seem to be attacked by grizzly bears (and black bears, *Ursus americanus*) for a limited suite of reasons, including: females with cubs defending themselves and their offspring; bears defending a food source that they've laid claim to, whether that food be natural or of human origin; close or other problematic encounters with bears attracted to human food sources; and chance surprise encounters. Only very rarely are attacks of a predatory nature. For grizzly bears, most documented instances of predation on a human were at night involving people in tents (for example, Herrero & Fleck 1990; Herrero & Higgins 1999, 2003; Herrero 2002; Smith & Herrero 2018; Scharhag 2019; https://en.wikipedia.org/wiki/List_of_fatal_bear_attacks_in_North_America).

D.3. Conclusions I

- Grizzly bears do not pose much of a threat to people, especially compared to other risks for people in the backcountry or pursuing normal day-to-day activities.

- There is no obvious connection between a plausible effect of sport hunting on grizzly bears and the types of circumstances that result in documented injuries.

- Instead, there is a more obvious connection of risk to how people behave when they are out among bears (Penteriani et al. 2016), the proximal configurations of terrain and habitat, whether a bear is defending a food source or its dependent young, and whether people have food or other attractants available to bears around the places they live, work, or camp. Sport hunting does not address any of these risk factors.

D.4. Evidence for a Connection Between Sport Hunting and Human Safety?

There is very little scientific evidence that directly addresses whether sport hunting of grizzly bears leads bears to become generally more fearful of people. The scant available evidence shows increased diel avoidance of people by hunted bears (Ordiz et al. 2012), which could lower odds of an encounter, but without any obvious connection to whether bears might be less aggressive during an encounter should it happen.

But, perhaps more importantly, basic knowledge of animal behavior strongly suggests that a fearful animal such as a dog or cat will be more dangerous than one that is not during a close encounter (McFarland 1981, Borchelt 1983, Serpell & Jargoe 1995). This likely holds for bears as well (Stringham & Rogers 2017).

Tolerant (i.e., less fearful) bears are, by definition, not particularly reactive to people. As a consequence, tolerant bears tend to be less aggressive during most close encounters, which can make such encounters safer for the involved people (Herrero et al. 2005, Stringham & Rogers 2017). On the other hand, bears that are tolerant of people will typically let people get closer than would otherwise be the case, which increases the odds that someone will do something to elicit an aggressive response at close range. Nonetheless, there is no clear connection between sport hunting and the prevalence of tolerance or habituation—which typically develops when bears are seeking a food resource near people out of drive that will predictably over-ride fear even among fearful bears (Swenson 1999, Herrero 2002).

Of parenthetical relevance to this issue, grizzly bears have been functionally "hunted" by people in the Northern Rockies even under protections offered by the ESA (Figure A.3, Section A). Much of the human-caused mortality in defense of life and property plausibly mimics hunting—complete with gunshots, blood, gory remains, and lots of associated human scent and sign. Despite this, there is no evidence that bears have generally become more fearful. In fact, many people have argued that bears have become less fearful.

An additional consideration is that, essentially by definition, sport hunting will not occur in National Parks where a significant portion of bear attacks on people have happened (Herrero 2002). Even if sport hunting changed bear behavior it would not affect dynamics unfolding within Parks, other than, perhaps, along Park boundaries.

All of these qualifications, uncertainties, and equivocations regarding the efficacy of sport hunting are evident in judgements by wildlife management professionals regarding the comparative effectiveness of various strategies for reducing human-bear conflicts and increasing human safety. On average, the 505 professionals queried by Lute et al. (2018) judged a sport hunt to be the least effective of all options they considered, most of which were non-lethal.

D.5. Conclusions II

- Despite intensive research on bear behavior in Europe and North America, and a *de facto* situation that functionally entails the hunting of grizzly bears in the Northern Rockies, there is no evidence that hunted bears are more fearful of people, other than perhaps through a tendency to be more night- rather than day-active.

- Even if hunted grizzlies were to become more fearful of people, there is no reason to conclude that people would be safer; in fact, the opposite may be the case.

D.6. A Better Way

In contrast to the speculative and at best doubtful effectiveness of a sport hunt, there are strategies and tactics available to managers and private citizens that have a proven track-record for improving

human safety. More specifically, human injuries and human-bear conflicts—which are often linked—have been demonstrably reduced by decreasing the numbers of unsecured anthropogenic foods that would otherwise attract bears to areas where people, live, work, and recreate; modifying livestock husbandry practices; and encouraging prudent behaviors among backcountry users of all sorts.

Wildlife and wildland managers have long recognized the self-evident effectiveness of such measures in authoritative recommendations and mandates going back to the 1986 Interagency Grizzly Bear Guidelines (Interagency Grizzly Bear Committee 1986), more recently affirmed in the Bear Management Guidelines for Glacier National Park (U.S. National Park Serivce, Glacier National Park 2010) and Conservation Strategies for both the Greater Yellowstone (GYE) and Northern Continental Divide (NCDE) Ecosystems (Yellowstone Ecosystem Subcommittee, Interagency Grizzly Bear Committee (2007, 2016); NCDE Subcommittee, Interagency Grizzly Bear Committee 2018). Similar affirmation of strategies organized around prudent sanitation, husbandry, and backcountry behaviors can be found in recommendations that emerged from several analyses of factors driving human-bear conflicts and associated human injuries in the GYE (Toman, 1991; Servheen et al. 2004, 2009).

There are, moreover, several unimpeachable examples of how non-lethal management focused on peoples' behaviors has led to dramatic reductions in bear-related injuries and human-bear conflict. In Yellowstone and Grand Teton National Parks conflicts and injuries dropped dramatically from 1969 through the present primarily because of improved sanitation, education, and management of human exposure to habituated bears—and all of this despite substantial increases in visitation (for example, see Gunther [2015] and Gunther et al. [2015, 2018]). Similar reductions in human-bear conflict were achieved in agricultural landscapes of the Blackfoot River watershed of Montana through (among other measures) improved sanitation, deployment of electric fencing around beehives and calving areas, and removal of livestock carcasses (Wilson & Clark 2007, Wilson et al. 2014).

D.7. Conclusions III

- Non-lethal strategies and tactics focused on improved sanitation, protective husbandry, and prudent backcountry behavior can demonstrably reduce human-grizzly bear conflicts and related human injuries.

- The effectivenss of such strategies and tactics has long been recognized in authoritative grizzly bear management guidelines, plans, and strategies formulated by state and federal wildlife managers.

- Non-lethal strategies and tactics stand a far better chance of improving human safety compared to sport hunting grizzly bears (see Lute et al. [2018]).

E. Will Sport Hunting Grizzly Bears Build Social Acceptance?

Numerous organizations that promote hunting, including Montana Fish Wildlife & Parks (FWP), have claimed that instituting a sport hunt on grizzly bears (*Ursus arctos*) will foster widespread tolerance or social acceptance of bears—in other words, that people will become more accepting of having grizzlies around, although how this might relate to specific numbers or distributions is rarely specified. This contention by FWP is in keeping with similar claims made by other state wildlife management agencies as justification for hunting large carnivores in states such as Florida, Maine, Minnesota, and elsewhere (Mattson 2019e).

The task of critically examining the merits of such claims is quite difficult simply because there is considerable ambiguity regarding the over-arching goal being served, the particular populations of "people" being referenced, the up-front likelihood of any connection between sport hunting and the people of interest, and the scientific evidence for such a connection.

There are also ethical issues that arise, especially when sport hunting is being promoted in part to serve the special interests of a minority. Given a mandate to serve the public trust, should the special interests of one particular group or subpopulation be favored over those of another? Should the preferences or opinions of a large percentage of the public be disregarded? Similarly, is it appropriate to effectively deprive certain segments of the national and state public of standing in policy deliberations, especially regarding an iconic species of national interest such as the grizzly bear? At

what point do the diffuse interests of the many preempt the more intensely-held interests of the few, similar to considerations behind the invocation of Eminent Domain?

What follows is my attempt to address these issues, starting with elucidation of the tacit goal being served and a necessary parsing of "people" and "public" into more meaningful subgroupings.

E.1. What Higher-Order Goals?

Building social acceptance or tolerance for grizzly bears, by whatever means, is presumably in service of some higher order goal. It is not an end in itself. Without being exhaustive, the tacit goal of fostering acceptance seems to be at least two-fold. (1) For one, it is presumably political: to increase support for grizzly bear conservation through participation of the public in political processes. (2) For another, it is presumably about behaviors and behavioral intentions: to increase tolerance among those sharing space with grizzlies and, through that, decrease the likelihood of illegal or malicious killing of bears (i.e., poaching). Again, this list is not exhaustive, but seemingly the most plausible and justifiable.

Assuming these goals are valid, the task here then becomes one of examining the logic and ethical merits of as well as evidence for a connection between instituting a grizzly bear sport hunt and (1) building political support for (presumably) more grizzly bears in more places; and (2) decreasing the likelihood of poaching.

E.2. What Goal for Bear Distributions and Numbers?

Having invoked these goals and related tasks, though, the question still remains: is building social acceptance in service of (i) allowing more bears to live in more places; (ii) sustaining the current number of bears living within the current distribution; or (iii) tolerating fewer bears within a reduced distribution? Presumably the desired outcome is either (i) or (ii), although (iii) is plausible given statements that have been made suggesting that, in the case of Montana, FWP's goal is to cap numbers of grizzlies within the Demographic Monitoring Areas (DMAs) for both the Yellowstone (GYE) and Northern Continental Divide (NCDE) populations, and in the NCDE push the distribution of grizzlies east of the Rocky Mountain Front back to historical limits nearer the mountains. Needless to say, the numeric and distributional goal being served is relevant to addressing the question of whether social acceptance needs to be increased and, if so, amongst which population(s) of people. If (iii) is indeed the goal for bear numbers and distributions, then the logical question is: Why work to increase social acceptance?

E.3. Social Acceptance by Whom?

An obvious and immediate consideration arises from the fact that sport/trophy hunting is viewed and valued in widely varied ways by different people. In broad terms, the perspectives of hunters will differ from those of non-hunters and certainly from members of the public who consider sport hunting to be unacceptable or trophy hunting morally repugnant. There will also be differences in perspective between a hunter who has not paid any personal price for living with a grizzly, and hopes

to have the pleasure of killing one, versus an agricultural producer who has lost livestock to grizzly bear depredation, but is not likely to sport hunt a bear.

Even on the face of it, offering trophy hunting opportunities to a necessarily limited number of people would be a tool for recruiting acceptance among only specific—if not limited—sectors of the public. At a minimum, it is important to different (i) self-identified hunters from (ii) rural residences sharing space with grizzlies, from (iii) urban dwellers, from (iv) those who do not support sport hunting, and certainly, from (v) those who consider trophy hunting to be morally unacceptable.

Without pursuing the matter any further, it is self-evidently the case that instituting a trophy hunt for grizzlies will not increase acceptance of grizzlies among people in categories (iv) and (v), but rather more likely lead to further alienation among these groups from the institution of wildlife management, writ large (see Section E.11 below). It is also debatable whether there would be any net effect among (iii) urban dwellers, as such (researchers have repeatedly shown that urban residents tend to hold strikingly different views of wildlife compared to rural residents).

Moreover, the response of (ii) rural residents living near grizzlies may be different from (i) trophy hunters. It is perhaps fair to say that a number of farmers and ranchers in areas recently occupied by grizzlies support eliminating these newly-arrived bears, regardless of the means used, and without particular reference to trophy hunting. By contrast, those who want to kill a grizzly as a trophy, and hope to obtain a license to do so, will probably have less definite ideas about where grizzlies live—and be the most invested of all in whether or not there are hunting opportunities, as such. Other hunters yet, who are less motivated to hunt a grizzly, may want to see fewer grizzlies in most areas—achieved by whatever means possible—simply because they see them as a threat to human safety and a competitor for opportunities to kill elk, moose, and perhaps deer.

None of these perspectives could be construed as naturally producing increased acceptance of grizzlies through institution of a sport hunt. Even taking the special case of trophy hunters, it is probably safe to say that they have an antecedent interest in killing grizzlies for sport, independent of whether a hunting opportunity actually exists. If so, under a hunting regime they would support having grizzlies around largely as means of realizing a pre-existing desire, not as a result of any changes in intrinsic acceptance or valuation of these animals.

E.4. Conflating Social Acceptance with a Desire for Fewer Bears in Fewer Places?

This deconstruction of “people” and “the public” into plausible subpopulations holding markedly different perspectives about grizzly bears and hunting raises an important issue. It is very likely the case that many people—as well as most managers—conflate support for sport hunting of grizzly bears with an underlying and perhaps often unarticulated desire simply for there to be fewer bears in fewer places. In other words, a substantial number of people who say they support a grizzly bear hunt may be offering that support, not out of a place that is likely to produce increased acceptance, but rather out of a desire to achieve the antecedent goal of reducing grizzly bear numbers and distributions. This is something fundamentally different from increased “acceptance” or certainly “tolerance,” other than

perhaps as expressed in abstract support for the existence of grizzlies somewhere, but not in a person's literal or figurative back yard—which is what would be needed to achieve goals (i) and (ii) under point 2, above.

E.5. What About the Evidence?

Does the implementation sport hunting on large carnivores lead to either increased acceptance of the hunted species or, on a related note, decreased poaching? If so, among which sub-populations of people? Unfortunately, there has been very little scientific inquiry into these questions, and essentially all of what's been reported has focused on wolves (*Canis lupus*). And, with that proviso, it is unclear the extent to which the available research is relevant to grizzly bears, primarily because of the different ways that wolves and grizzlies are symbolically constructed by most people (Kellert et al. 1996). That having been said:

In the United States, Treves et al. (2013), Hogberg et al. (2015), and Browne-Nuñez et al. (2015) found little change in attitudes towards wolves among residents of Wisconsin regardless of whether hunting was allowed or lethal control more aggressive. In fact, among certain people they found less tolerance and a greater proclivity to poach wolves, especially among hunters and male rural residents. Similarly, Chapron & Treves (2016) found indications that levels of poaching in Wisconsin and Michigan had actually increased after the institution of programs to cull wolves, presumably in response to tacit signals from authorities that encouraged private vendettas. Such phenomena are also likely playing out in the Northern Rockies given that roughly 22% of all the radio-marked wolves that have died were illegally killed (Smith et al. 2010), which is probably a minimum estimate given that much poaching can be quite cryptic (Liberg et al. 2012).

In Scandinavia and Finland, where hunting of wolves is legal, Suutarinen & Kojola (2018) and Liberg et al. (2020) found that areas with a legal hunt tended to experience less poaching, but that the effect was relatively small. Poaching in all areas was quite high. Adding a layer of complexity, Kaltenborn & Brainerd et al. (2016) found that poaching (not hunting, as such) might have increased local tolerance for wolves by affirming rural community values, although a large majority of people in the region still disapproved of poaching—with resulting social dissonance. All of this played out against the unsurprising backdrop of greater acceptance of poaching in rural areas with strong hunting traditions (Gangass et al. 2013).

These results are clearly ambiguous and even contradictory regarding the key question of whether institution of a hunt leads to less poaching and increased acceptance of, in this case, wolves. Even so, there is certainly no basis in the relevant science for claiming that a grizzly bear sport hunt would recruit more tolerance among those sharing space with grizzlies—consistent with earlier assessments by researchers such as Adrian Treves (Treves 2009).

E.6. Montana's Own Unplanned Experiment

Montana's own experience with grizzly bear hunting is also instructive. Sport hunting of grizzly bears in the Greater Yellowstone Ecosystem (GYE) ended shortly after grizzlies were given ESA protections

during 1975. For rather peculiar reasons, sport hunting continued in the NCDE until ended by a court order during 1991. One would expect that if the existence of a trophy hunt significantly affected public support for grizzly bears there would have been some sort of a reaction. Given that there are no surveys of public sentiment from that period that would provide insight into how people responded, the best proxy for a backlash would be evidence of increased poaching. To my knowledge, there is no evidence of such an increase.

E.7. Worldviews, Beliefs, and Fear

These equivocal results are not surprising given that an overwhelming amount of research has shown that people's perspectives and behaviors regarding the environment are profoundly shaped by beliefs, worldviews, social identity, and community norms, all potentially entangled with levels of fear—all of which is resistant to change (for example, see: Kellert 1996, Clayton & Myers 2009, Koger & Du Nann Winter 2010).

More specifically, Kaltenborn et al. (1998), Bjerke & Kaltenborn (1999), Kaltenborn & Bjerke (2002), and Mattson & Ruther (2012) found strong ties between people's attitudes towards large carnivores and their more generalized views of proper relations between people and the natural world. Not surprisingly, baseline attitudes were additionally affected by the extent to which people feared or were otherwise emotionally engaged with large carnivores (Johansson & Karlsson 2011, Johansson et al. 2012, Slagle et al. 2012), perceived costs attached to their presence (Naughton-Treves et al. 2003, Zajac et al. 2012, Kaltenborn et al. 2013, Schroeder et al. 2018), and distrust of government authorities (Højberg et al. 2017). All of these proclivities were consolidated and sustained by shared narratives, often among those with shared identities (Byrd 2002, Mattson et al. 2006, Lute & Gore 2014, Lute et al. 2014), amplified by community norms and resentments (Lüchtrath & Schraml 2015, Von Essen et al. 2018, Peterson et al. 2019).

E.8. Conclusion I

A few conclusions can be reached at this point:

- Based on deductive considerations, the available evidence, and what we know about the basics of human social-psychology, there is little likelihood that instituting a grizzly bear sport hunt will increase acceptance of grizzlies among most back-country users, hunters, or rural residents.

- More likely, a sport hunt would merely satisfy a pre-existing demand held by a small number of people interested in killing grizzly bears as trophies, and be understood by rural residents and backcountry users who resent the presence of grizzly bears as a tacit or even explicit commitment by FWP to reduce numbers and distributions of bears.

- A hunt might also be seen by many hunters as fulfillment of FWP's obligations to them under the current business model and cultural norms of state wildlife management (see E.11 below). None of these outcomes amount to increased tolerance or acceptance.

E.9. A Better Way

Stepping away from the unhelpful frame of arguing for or against the recruitment of social acceptance through the institution of grizzly bear sport hunts, it is worth considering a worthier, more robust, and more justifiable goal: lessening polarization and resentment among stakeholders while building trust for state wildlife managers, with the derivative potential through these means of increasing accommodation for grizzly bears.

In fact, there is good reason to argue that this goal should be paramount for state wildlife managers—including Montana's Governor and those in FWP. Much of the anger, conflict, and distrust surrounding management of wildlife—including grizzly bears—likely arises from people on all sides feeling victimized by current power and decision-making arrangements; in other words, from people feeling treated unjustly and then acting out of a place of resentment even to the extent of poaching animals that are identified with the perceived injustice (for examples see Lüchtrath & Schraml [2015], Jacobsen & Linnell [2016], Højberg et al. [2017], Pohja-Mykrä [2017], and Von Essen et al. [2018]). As Steve Primm so eloquently noted (Primm 1996), much this resentment arising from unequitable power arrangements gets displaced onto the involved animals (for example, grizzly bears) and people (those holding different values and seeking different outcomes) through symbolic processes such as demonization.

Unlike research focused on how sport hunting carnivores might affect human attitudes—which, although scant, uniformly calls in question any direct beneficial effect—there has been a large body of research focused on how conflict might be reduced and trust increased among stakeholders with different perspectives about proper wildlife management. This research uniformly shows or otherwise supports the idea that greater trust and increased accord can come from allowing stakeholders of all perspectives to authoritatively participate in decision-making processes. Moreover, this is more likely to happen if stakeholders are meaningfully engaged on an on-going basis rather than as part of a one-off process such as Montana's 2019-2020 Governor's Grizzly Bear Advisory Council (for example, see Primm & Wilson [2004], McLaughlin et al. [2005], Treves et al. [2006], Wilson & Clark [2007], Pellikka & Sandström [2011], Redpath et al. [2017], Wilson et al. [2017], and various chapters in Clark & Rutherford [2014]).

But with this idea as a premise, there is additional research showing that attempts at engagement can backfire and actually spawn increased conflict and distrust if considerable attention is not given to creating a fair, well-facilitated process that does not unduly favor one set of stakeholder interests over another (for example, Richie et al. 2012, López-Bao et al. 2017)—either in who is designated to participate, how the process is conducted, or voices that are or are not heard. In other words, processes end up being counter-productive if they are seen by a significant number of stakeholders as being stacked to represent certain interests, controlled by people with an obvious interest in achieving preordained outcomes, and facilitated by people who are also obviously serving the special interests of power-brokers who convened the process.

E.10. Conclusion II

- The upshot of all this is that it would be far more productive for wildlife managers such as those in FWP to focus on creating well-constituted high-quality collaborative decision-making processes that provide stakeholders of all sorts with sustained and meaningful opportunities to participate—rather than focusing on divisive issues such as instituting a grizzly bear sport hunt and removing federal Endangered Species Act protections for grizzly bears.

E.11. Finally, Who's In and Who's Out?

Having introduced the idea of empowering stakeholders through authoritative collaborative processes, some big questions remain. Who is considered to be a legitimate stakeholder by those authorized to convene processes and establish boundaries for participation (for a statement of the problem see Mattson [2014], Serfass et al. [2008], and Wilson [2015])? Moreover, what is the basis for making such a determination?

With these questions in mind, it is worth critically examining the current nature of wildlife management in the western United States, including Montana. In a technical sense, wildlife management here is despotic (Mattson 2016a). In other words, the special interests of a small minority of people are given preference over the valid interests of the remainder. As a simple matter of fact, FWP, like most other state wildlife management agencies, almost exclusively serves the interests of resident hunters and fishers—and also those of rural landowners—because of cultural preferences and direct or indirect financial and political dependencies (Decker et al. 1996; Hagood 1997; Beck 1998; Pacelle 1998; Rutberg 2001; Gill 1996, 2001; Nie 2004a, 2004b; Clark & Rutherford 2005; Jacobson & Decker 2006; Mattson & Clark 2010a; Mattson 2014; Peterson & Nelson 2017). The model employed by most state wildlife management agencies more closely resembles that of a for-profit business serving a specific set of customers than it does that of a government bureau focused on serving the public trust (Jacobson & Decker 2008, Mattson 2014, Serfass et al. 2018).

The business model employed by state wildlife managers is justified by the North American Model of Wildlife Management, which is ardently promoted by hunters and state wildlife managers. Paradoxically, the North American Model features the public trust, but then is often interpreted as suggesting that hunting should be the primary management tool and that the only valid stakeholders are hunters and fishers residing within a given state served by a particular wildlife management agency (Geist et al. 2001, Organ et al. 2012). In some statements of the Model, stakeholders who ascribe intrinsic value to wildlife are viewed as a threat (Mahoney et al. 2008). These sorts of exclusions are problematic because they contravene what the Public Trust actually requires—which is giving due regard to the valid interests of all citizens (for example; Clark & Milloy 2014, Hare & Blossey 2014, Treves et al. 2015).

Moreover, there is the question of whether the national public with an interest in management of regional wildlife should be explicitly included or excluded (Mattson 2016a). This is an especially relevant question for management of an iconic species such as the grizzly bear, which in the United

States survives only in Montana, Wyoming, and Idaho, yet is of interest to numerous people nationwide. It is commonly argued that those with the greatest material stakes, such as livestock producers living among grizzlies, should be able to dictate the terms of management—despite being comparatively few in number, and despite there being many more people both regionally and nationally with a less tangible stake in how grizzlies are treated.

Although there is some merit in this contention, in reality a democracy is always negotiating the balance between the localized interests of the few and the more diffuse interests of the many (for example, see Dahl [1982]). A related issue is the scale at which we give citizens standing in decision-making processes. Municipal? County? State? National? Some issues entail consequences of such magnitude for so many people that decision-making necessarily occurs at a national scale. National defense is a classic example. Regardless of the scale, some issues and outcomes are of such importance collectively that they trump the localized special interests of the few—partly codified in the well-established notion of Eminent Domain. At some point, enough people have a sufficient stake over a wide enough geographic extent to legitimize the elevation of political deliberations from the state to the national level. At some point the aggregate interests of the many outweigh the localized interests of the few. Such is likely to be the case with grizzly bears in the U.S. Northern Rocky Mountains.

These sorts of considerations are important if for no other reason than the decline in numbers of hunters as a proportion of adults and the large percentages of the general public that disapprove of sport hunting—trophy hunting in particular. For example, the percent of people over the age of 15 who participated in hunting dropped in Montana from 12-16% during 1996-2005 to 10% during 2011 (U.S. Fish & Wildlife Service & U.S. Census Bureau, 1997, 2002, 2007, 2014). And, insofar as trophy or sport hunting is concerned, surveys have consistently shown that 63 to 71% of adults in the United States disapprove of such activities or even find them morally unacceptable (for example, Kellert 1978, Heberlein & Willebrand 1998, The Economist/YouGov 2018), consistent with the 68% of those surveyed during 2016 who opposed trophy hunting grizzly bears (Remington Research Group 2016). Such figures are ignored by wildlife managers and others at their peril, especially when promoting a grizzly bear trophy hunt for reasons that could be construed as largely political.

E.12. Conclusion III

- State wildlife managers, including those in FWP, need to have an on-going way of actively incorporating into grizzly bear management the valid interests of those who don't hunt or even fish, ideally through well-constituted processes that empower a legitimate cross-section of the public both at the state and local levels (Jacobson & Decker 2006, 2008; Jacobson et al. 2010; Clark & Milloy 2014; Decker et al. 2016). FWP itself has already fielded this idea in the form of a recommendation included in its 2006 state grizzly bear plan (Dood et al. 2006, page 29).

- There are good reasons to offer the broader American public on-going authoritative opportunities to participate in management of grizzly bears in Montana, Wyoming, and Idaho, regardless of whether bears here are listed under the Endangered Species Act or not.

F. Conclusions: The Likely Effects of a Sport Hunt

- **Grizzly bear populations in the contingent United States are too small and isolated to insure long-term viability. Vulnerability of these populations has been and will continue to be amplified by recent and foreseeable deterioration of environmental conditions.**

- **State plans for managing grizzly bear populations are not precautionary and exacerbate rather than ameliorate risks, partly through ideological commitments to the initiation of grizzly bear sport hunts as soon as federal Endangered Species Act protections are removed.**

- **Sport hunting will likely have additive rather than compensatory effects on grizzly bear mortality, compounded by unplanned-for indirect effects arising from depensatory demographic responses. Taken together, these effects will likely result in unanticipated and even undetected population declines.**

- **Sport hunting will likely *not* reduce levels of human-grizzly bear conflict barring hunts that drive local bear populations near to extirpation.**

- **Targeted removal of bears chronically involved in conflicts will likely locally reduce conflicts over the short-term. However implementation of strategies that focus on reducing availability of anthropogenic attractants are more likely to result in long-term benefits for both bears and people.**

- **Sport hunting will likely *not* improve human safety, with beneficial effects more likely arising from the promotion of prudent human behaviors—including sanitation of human facilities, improvements in livestock husbandry, and changes in practices of big game hunters.**

- **Sport hunting will almost certainly *not* increase acceptance of grizzly bears, even among those sharing space with grizzlies, but rather satisfy preexisting demands held by a small minority for hunting opportunities and the tacit if not explicit expectations of a comparably small minority that numbers and distributions of grizzly bears will be reduced by a sport hunt.**

- **The issues of a grizzly bear sport hunt and removal of ESA protections for grizzly bears have more to do with the institutional premises and the business model of state wildlife management than with fulfillment of public trust responsibilities by state wildlife managers.**

- **Acceptance of grizzly bears is more likely to be encouraged by involvement of a broad cross-section of the public in grizzly bear management—with an emphasis on equity and meaningful representation on a sustained basis—than by implementation of a sport hunt.**

- **Sport hunting grizzly bears will almost certainly *not* achieve any of the goals stated by those who promote it, but rather simply fulfill a cultural predisposition, with the potential of further alienating the large majority of people who do not support trophy hunting or even morally object to it.**

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Report GBRP-2020-1
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