

# PUBLIC SUBMISSION

<b>As of:</b> May 18, 2016
<b>Received:</b> May 10, 2016
<b>Status:</b> Posted
<b>Posted:</b> May 10, 2016
<b>Tracking No.</b> 1k0-8pjy-p9uh
<b>Comments Due:</b> May 10, 2016
<b>Submission Type:</b> Web

**Docket:** FWS-R6-ES-2016-0042

Endangered and Threatened Wildlife and Plants; Removing the Greater Yellowstone Ecosystem Population of Grizzly Bears From the Federal List of Endangered and Threatened Wildlife

**Comment On:** FWS-R6-ES-2016-0042-0001

Endangered and Threatened Wildlife and Plants: Removing the Greater Yellowstone Ecosystem Population of Grizzly Bears from the Federal List of Endangered and Threatened Wildlife

**Document:** FWS-R6-ES-2016-0042-5446

Submitted Electronically via eRulemaking Portal

---

## Submitter Information

**Name:** Joshua Osher

**Address:**

P.O. Box 1135  
Hamilton, MT, 59840

**Email:** josh@westernwatersheds.org

**Phone:** 406-830-3099

---

## General Comment

Western Watersheds Comments on the Proposed Rule to remove Endangered Species Act protections from Yellowstone Grizzly Bears are attached. In short, WWP opposes delisting due to the numerous threats to this population that still remain and are to some extent increasing. WWP also opposes the hunting of Yellowstone grizzlies and management by the states as a game animal.

---

## Attachments

USFS\_Grizzly\_area\_allotments

WWP GYE Griz Delisting Comments

Mattson Attachments

WY14F0040\_Cover Letter and BO\_2014 Supplement Livestock Grazing\_Northern Portions of Pinedale RD

Mattson\_critique-2016-delisting-rule\_5-5-2016\_corrected

BLM\_Grizzly\_Area\_Allotments





**Josh Osher**  
**Montana Director**  
**P.O. Box 1135, Hamilton, MT 59840**  
**Tel: (406) 830-3099 Fax: (208) 475-4702**  
**Email: [josh@westernwatersheds.org](mailto:josh@westernwatersheds.org)**  
**Web site: [www.westernwatersheds.org](http://www.westernwatersheds.org)**

*Working to protect and restore Western Watersheds*

---

May 10, 2016

Public Comments Processing  
*Attn:* Docket No. FWS–R6–ES–2016–0042  
U.S. Fish & Wildlife Service, MS: BPHC  
5275 Leesburg Pike  
Falls Church, VA 22041–3803

*Submitted via certified mail and electronically via <http://www.regulations.gov>.*

RE: Public Comments on the Proposed Rule to Remove the Greater Yellowstone Ecosystem Population of Grizzly Bears from the Federal List of Endangered and Threatened Wildlife,  
Docket No. FWS–R6–ES–2016–0042

Dear Director Ashe and Acting Recovery Coordinator Kasworm,

Thank you for the opportunity to comment on the U.S. Fish & Wildlife Service’s (“Service”) proposed rule to remove the Greater Yellowstone Ecosystem (“GYE”) population of grizzly bears from the federal list of endangered and threatened species.<sup>1</sup>

Western Watersheds Project is a non-profit organization with over 1,400 members that works to influence and improve public lands management throughout the West with a primary focus on the impacts of livestock grazing on 250,000,000 acres of western public lands, including impacts to ecological, biological, cultural, historic, archaeological, wilderness and scenic resources. Western Watersheds Project works through education, scientific study, public policy initiatives, and litigation. Western Watersheds Project has an organizational interest in the proper and lawful management of grizzly bear in the United States. Western Watersheds Project and its staff and members have significant recreational, scientific, spiritual, educational, and other interests in the conservation and recovery of grizzly bears across the entirety of their former range in the Western United States. We appreciate your consideration of the following comments on the Service’s proposed rule to remove federal protections under the Endangered Species Act (“ESA” or “Act”), 16 U.S.C. § 1531, et seq., from the GYE population of grizzly bears.

### **Organization of Comments**

---

<sup>1</sup> United States Dep’t of the Interior, Fish & Wildlife Service, Endangered and Threatened Wildlife and Plants; Removing the Greater Yellowstone Ecosystem Population of Grizzly Bears From the Federal List of Endangered and Threatened Wildlife, 81 Fed. Reg. 13174 (Mar. 11, 2016) [hereinafter “Proposed Rule”] available at <https://www.gpo.gov/fdsys/pkg/FR-2016-03-11/pdf/2016-05167.pdf>.

The following comments are organized as follows: Section 1 deals with the Service's decision to create an Distinct Population Segment (“DPS”) for grizzly bears in the GYE and then subsequently delist that DPS. Section 2 discusses the Services definition of “suitable habitat” in the context of livestock grazing allotments and additionally, the impact of the continued presence of domestic livestock in the various designated zones of grizzly occupancy or migration. Section 3 discusses various threats to the continued recovery and conservation of GYE grizzlies. Section 4 describes WWP's position on the hunting of grizzly bears and the inherent problems with state management of Yellowstone grizzly bears.

Our comments will often reference the comments submitted by Dr. David Mattson for Wyoming Wildlife Advocates which are also included in their entirety as an attachment.

## **Section 1**

On July 28, 1975, the U.S. Fish and Wildlife Service (“USFWS”) published a rule designating the grizzly bear, *Ursus arctos horribilis*, as threatened in the conterminous (lower 48) United States. 40 FR 31734. On Friday, March 11, 2016 the USFWS proposed to designate those bears found in a portion of the range in the conterminous United States - the Greater Yellowstone Ecosystem Population of Grizzly Bears - as a DPS and remove that DPS from the federal endangered species list. 81 FR 13174.

Western Watersheds Project opposes this simultaneous listing and delisting of the GYE grizzly bears on multiple grounds.

Under the 1996 DPS Policy (61 FR 4722), three elements are considered in a decision regarding the status of a possible DPS as endangered or threatened under the Act. “These are applied similarly for addition to the lists of endangered and threatened wildlife and plants, reclassification, and removal from the lists”:

1. Discreteness of the population segment in relation to the remainder of the species to which it belongs;
2. The significance of the population segment to the species to which it belongs; and
3. The population segment’s conservation status in relation to the Act’s standards for listing (i.e., is the population segment, when treated as if it were a species, endangered or threatened?).

For its own convenience, in the proposed delisting notice the USFWS restates this policy as being based on the first two elements only – “Under this policy, the Service considers two factors to determine whether the population segment is a valid DPS: (1) Discreteness of the population segment in relation to the remainder of the taxon to which it belongs; and (2) the significance of the population segment to the taxon to which it belongs.” 81 FR 13190.

The USFWS deliberately omits the third element of the policy that “The population segment’s conservation status in relation to the Act’s standards for listing (i.e., is the population segment, when treated as if it were a species, endangered or threatened?). Yet the Courts have clearly ruled on the key importance of this element. “The FWS may not designate a new DPS to remove protections from the covered vertebrates because a DPS, as an entity, has no legal significance if the covered vertebrates are not entitled to protection under the ESA.” *HSUS v Jewell*<sup>2</sup>. Indeed, it makes no sense for the USFWS

---

<sup>2</sup> *Humane Soc’y of the United States v. Jewell*, 76 F.Supp.3d 69, 117 (D.C.C. 2014).



to propose delisting grizzly bears in the one area within the vast historic range of the species where the population has increased solely due to the existence of Yellowstone National Park and the species being listed under the ESA.

The USFWS is deliberately seeking the simultaneous designation and delisting of the Greater Yellowstone Ecosystem Population of Grizzly Bears DPS in the same rulemaking. But if the USFWS believes that grizzly bears in the Yellowstone area are not threatened, then it also knows that the third prong of the policy, “The population segment’s conservation status in relation to the Act’s standards for listing (i.e., is the population segment, when treated as if it were a species, endangered or threatened?)” does not apply. The proposed rulemaking is clearly contrary to the ESA and invalid.

Furthermore, the USFWS has failed to demonstrate that the population segment in the proposed DPS meets the discreteness and significance prongs of the DPS policy.

The discreteness of the population segment in relation to the remainder of the species to which it belongs is defined in the policy so:

**Discreteness:** A population segment of a vertebrate species may be considered discrete if it satisfies either one of the following conditions:

1. It is markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, or behavioral factors. Quantitative measures of genetic or morphological discontinuity may provide evidence of this separation.
2. It is delimited by international governmental boundaries within which differences in control of exploitation, management of habitat, conservation status, or regulatory mechanisms exist that are significant in light of section 4(a)(1)(D) of the Act.

For the GYE grizzly bears, the Service has defined the boundaries of the proposed DPS based on roads: "the proposed GYE grizzly bear DPS consists of: That portion of Idaho that is east of Interstate Highway 15 and north of U.S. Highway 30; that portion of Montana that is east of Interstate Highway 15 and south of Interstate Highway 90; and that portion of Wyoming that is south of Interstate Highway 90, west of Interstate Highway 25, west of Wyoming State Highway 220, and west of U.S. Highway 287 south of Three Forks (at the 220 and 287 intersection, and north of Interstate Highway 80 and U.S. Highway 30) (see DPS boundary in figure 2, above). Due to the use of highways as easily described boundaries, large areas of unsuitable habitat are included in the proposed DPS boundaries."

But these roads are completely permeable to grizzly bears. In fact, the stretch of I-15 used as the western boundary determination is known as the least traveled stretch of interstate in the country. It is certainly not a barrier to bear movement. It is also by this route that grizzly bears are most likely to reach the Bitterroot Selway mountains and the Northern Continental Divide Ecosystem.

Because of this choice of boundaries, the proposed DPS includes swathes of unsuitable habitat that are crossed by bears. Under the Recovery Plan, the species throughout the lower 48 States can be delisted when the populations in all established recovery zones have been delisted. In establishing this proposed DPS boundary far outside the boundaries of the PCA/Yellowstone Recovery Zone and the Demographic Monitoring Area, the Service seems to be trying to circumvent the Recovery Plan

delisting criterion by including occupied habitat and those few bears that are outside the established recovery zone within the DPS. But it is those very bears that are moving out from the Recovery Zones that are most contributing to the recovery of the species.

Moreover, the USFWS also argues that genetic data support the conclusion that grizzly bears from the GYE are separated from other grizzly bears. “Genetic studies estimating heterozygosity (which provides a measure of genetic diversity) show 60 percent heterozygosity in the GYE grizzly bears compared to 67 percent in the NCDE grizzly bears (Haroldson *et al.* 2010, p. 7).” 81 FR 13191. But the slightly lower diversity among the GYE bears supports the need to protect any bears in linkage habitat to encourage interpopulation movement and increased heterozygosity.

In sum, the USFWS has not established that the DPS it has defined meets the primary criterion of discreteness. Without this, there is no basis for assessing the significance of the population segment to the species.

## **Section 2**

The Proposed Rule designates an number of different management boundaries including the Primary Conservation Area (“PCA”), the Demographic Monitoring Area (“DMA”) and the DPS. Within these classifications, the Service has designated “suitable grizzly bear habitat” also defined as “biologically suitable habitat”.<sup>3</sup> The Proposed Rule then goes on to define this so-called suitable habitat claiming that grizzly bear reproduction and survival is a function of both the biological needs of grizzly bears and remoteness from human activities, which minimizes mortality risk for grizzly bears.”<sup>4</sup>

Livestock grazing and the proximity of grizzly bears to domestic livestock and particularly domestic sheep is well known as a factor that contributes to grizzly bear mortality. The Proposed Rule therefore excludes sheep allotments from its definition of suitable habitat even when those areas occur in otherwise biologically suitable habitat with little or no other human related activity. The Proposed Rule then goes on to describe additional areas excluded from suitable habitat due to so-called “edge effects”. Mattson on p. 32 and 55 describes this briefly in terms of the incongruity with other arguments made by the Service in the proposed rule.

*Interestingly, the Service tacitly refutes its own definition of secure habitat in its argument on page 13185 of the Rule for excluding fragments of habitat adjoining sheep allotments in the Wind River Range from “suitable” habitat. The Service’s argument rests on an ill-defined invocation of “edge effects”; i.e., that edges of an unspecified dimension are somehow unsecure enough to warrant exclusion from “suitable” habitat. Without being privy to the exact dimensions of these “edges,” they are almost certainly larger, each, than the 4 ha (plus 500 m buffer) threshold that the Service argues elsewhere is sufficient to ensure “security.” The Service thus presents us with a prospective logical contradiction that needs to be reconciled.<sup>5</sup>*

---

<sup>3</sup> Proposed Rule at 13184

<sup>4</sup> Ibid

<sup>5</sup> Mattson, David J., *Comments on the US Fish & Wildlife Service proposal to remove grizzly bears in the Yellowstone ecosystem from the list of endangered and threatened wildlife protected under the US Endangered Species Act (ESA); Federal Register 81(48): 13174-13227, May 5, 2016. p.55*

The presence of domestic sheep allotments within the DMA and the DPS and the exclusion of these areas as suitable habitat also has a direct effect on the ability of grizzly bears to occupy other areas of suitable habitat as these allotments act as barriers to grizzly bear movements.

The Proposed Rule also summarily dismisses the importance of domestic cattle allotments in grizzly bear conflicts and restrictions of access to otherwise suitable habitat.<sup>6</sup> In fact, the vast majority of conflicts with domestic livestock in the Upper Green Allotment on National Forest Service lands at the north end of the Wind River range involve domestic cattle, particularly calves.<sup>7</sup> So clearly, it is not just sheep allotments that cause “population sinks” as described on p. 13185 of the Proposed Rule, but also cow/calf allotments. The failure of the Service to acknowledge the importance of cattle allotments as a barrier to grizzly bear access to otherwise suitable habitat must be reconciled. Taking cattle allotments into account clearly demonstrates that the habitat within the DMA and DPS is highly fragmented and poses as a significant threat to the future conservation of grizzly bears in the GYE.

The maps below depict the location of livestock grazing allotments on public lands within the various habitat boundaries.<sup>8</sup> It is clear that not only is the DMA fragmented by livestock grazing allotments, but that the entire area is hemmed in by grazing allotments that essentially surround the DMA and act as a significant barrier to grizzly bear occupancy of otherwise suitable habitat. Furthermore, these allotments are the primary barrier to grizzly bear migrations that would lead to connectivity with other populations or establishment of populations in other areas that are otherwise suitable for bears. Rather than using roads to delineate the DPS boundaries, it would have been more appropriate for the service to use the much more impermeable bounds of livestock grazing allotments as this is the true factor limiting expansion of the bear population and connectivity.<sup>9</sup>

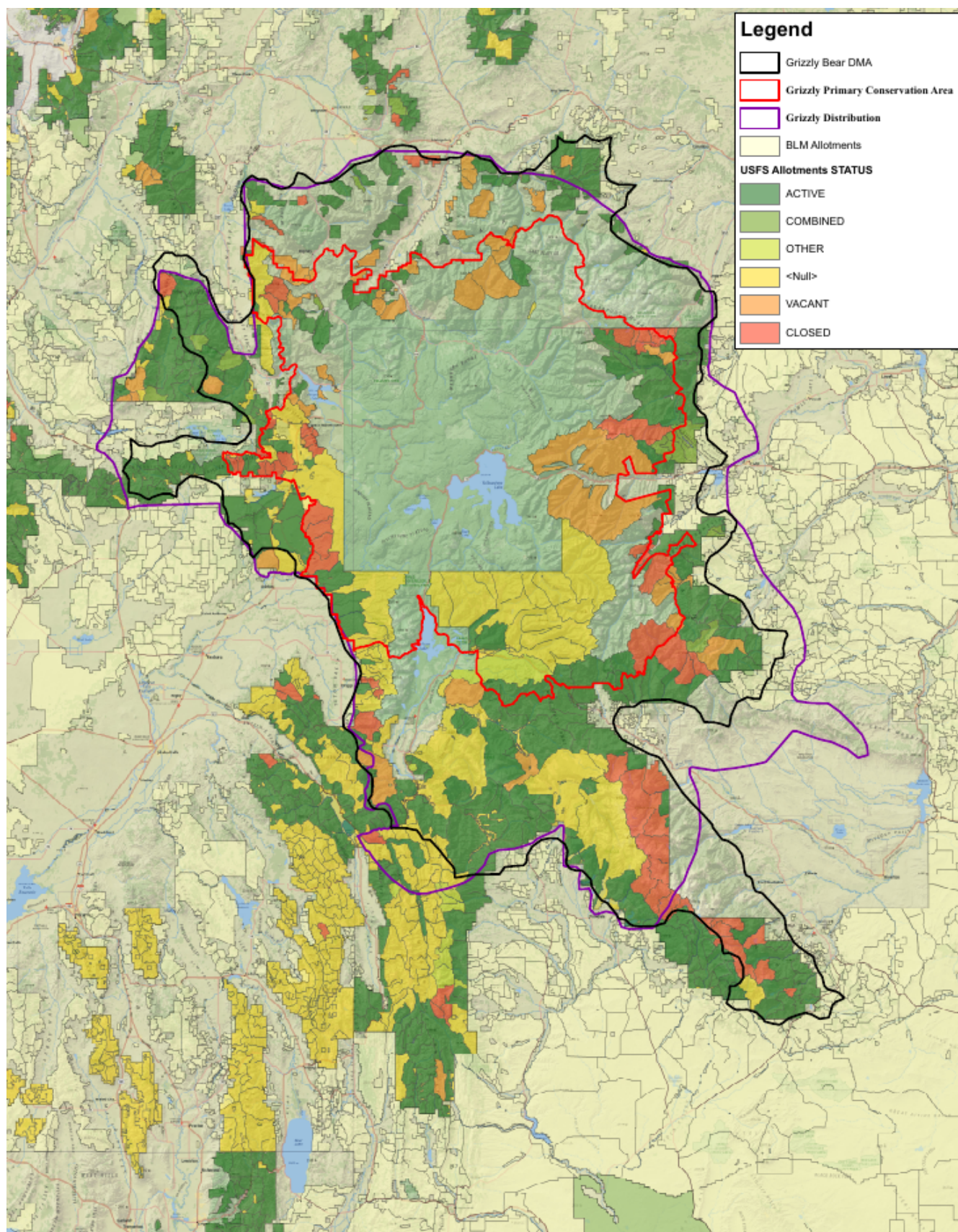
---

<sup>6</sup> Proposed Rule at 13185

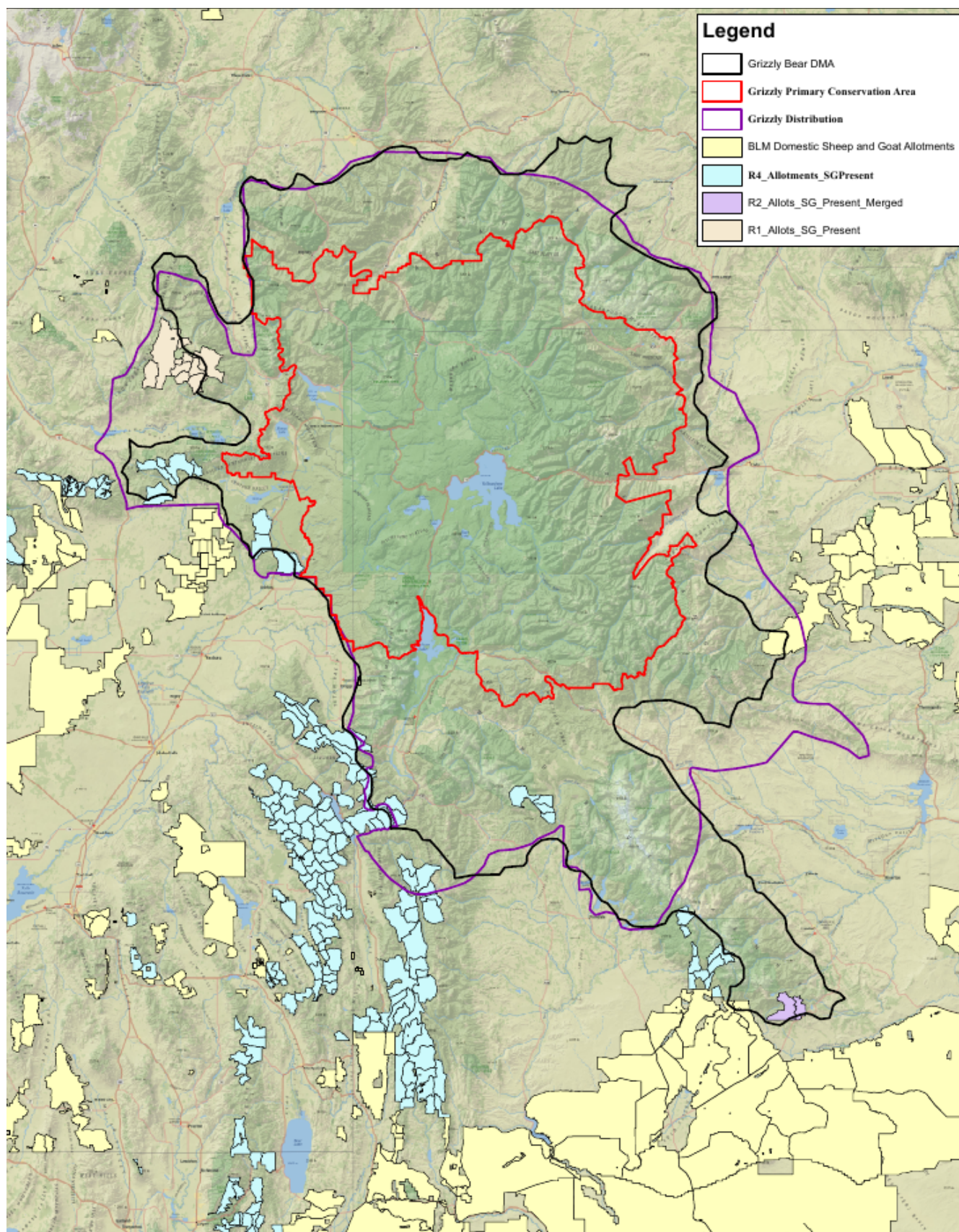
<sup>7</sup> See the Biological Opinion for the 2014 supplement to the 2013 supplement and 2010 amendment to the 1999 Biological Assessment for Livestock Grazing on the Northern Portions of the Pinedale Ranger District which demonstrates the impact on secure habitat of domestic livestock grazing allotment. Included as an attachment.

<sup>8</sup> Maps created by Ken Cole using data obtained from USFWS, BLM and USFS sources.

<sup>9</sup> Also see the attached spreadsheets that document the extent of grazing allotments in the GYE.

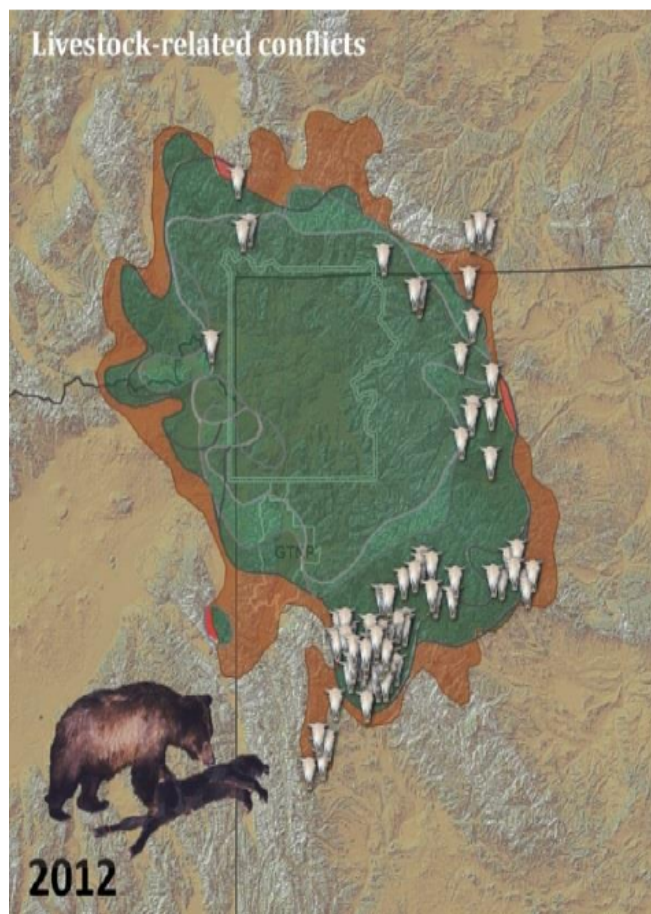








To illustrate the point even more clearly, Mattson provides an example using 2012 data of the locations of grizzly bear and livestock conflicts. Note in particular wall to migration that occurs in the northern Wind River range and blocks access to otherwise suitable habitat to the south.<sup>10</sup>



**Figure 9.1.** *This map shows the current distribution of Yellowstone’s grizzly bear population in relation to livestock-related conflicts that occurred during 2012 (each represented by a cattle skull) and the distribution of moth sites (encompassed by yellow-green blobs). Grizzly bear distribution is differentiated by the area occupied by bears prior to circa 2000 in green and areas occupied since then in orange.*

### **Section 3**

The discussion of livestock grazing allotments in the GYE leads to a discussion of the threats to the continued and recovery and conservation of grizzly bears. The primary threat facing bears today stems from the loss of key food sources and the transition to greater dependency on terrestrial meat. In

---

<sup>10</sup> Mattson, p. 25

short, more meat eating leads to more conflicts with livestock and hunters as well as increased risk of predation both inter and intra species. The following brief description of threats relating to changing availability of high quality foods will rely primarily on Mattson's comments which are attached in their entirety.

Essentially, GYE grizzly bears have relied heavily on 4 primary food sources: Whitebark pine seeds, Yellowstone Cutthroat trout, ungulate meat, and army cutworm moths. The claims by the Service that the loss of these foods is relatively unimportant to grizzly bear birth and death rates because bears are “extremely omnivorous” and eat over “260 species of foods...representing 4 of the 5 kingdoms of life.” is unsubstantiated by the evidence and a clear misrepresentation of the importance of losing the highest quality of foods available in the GYE. As Mattson explains on page 19,

*Put another way, give the overwhelming reliance by Yellowstone's grizzly bear on essentially four foods (lumping elk and bison together as ungulates), major losses of any one are almost certainly to have major impacts. The Service confesses to major losses of cutthroat trout and whitebark pine. Moreover, ... elk populations have declined substantially since the mid-1990's, with prospects of army cutworm moths being hit hard by climate warming. This begs the question of whether plausible alternative foods are (and would be) of sufficient quality, simply from a nutritional perspective, to compensate for the loss of the euphemistic “big 4” that we've seen.*

Mattson goes on to establish the clear energetic superiority of the big 4 food over any foods that might be used in compensation and relates this to the extent to which food sources impact population densities as a reflection of habitat productivity. The upshot is that the loss of the important food sources does impact the demography of Yellowstone's grizzly bears and, “there is ample evidence for detrimental effects arising from losses of whitebark pine, cutthroat trout, and elk, including major increases in mortality arising from greater reliance of bears on meat – which has included consumption of livestock.”<sup>11</sup>

In discussing the particular loss of whitebark pine seeds as food source, Mattson thoroughly points out the fatal flaw in the Service's analysis but then goes on to make this important point:

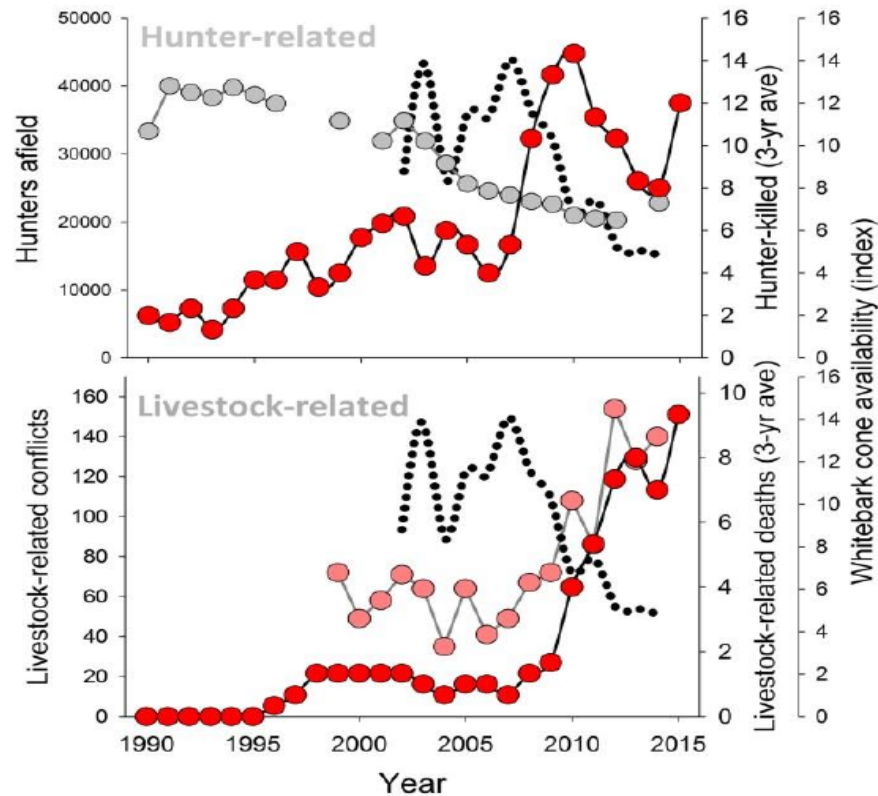
*Perhaps more important, the Service does not acknowledge nor present the compelling body of evidence showing major deleterious changes in grizzly bear behavior and demography coincident with terminal losses of whitebark pine – and cutthroat trout – in the Yellowstone ecosystem. These changes include increasing consumption of meat from terrestrial sources and, along with this, a dramatic increase in meat-related conflicts with people, leading to increases in numbers of human-caused deaths. Moreover, the decline in cub and yearling survival rates the Service attributes to “density dependent effects” (citing IGBST [2012] and Van Manen et al. [2016]) is more plausibly attributable to the consequences or reproductive females eating more meat in the wake of trout and whitebark pine losses. All of these change have ultimately manifested in a dramatic rise in known and probably grizzly bears deaths that correlates perfectly with terminal losses of whitebark pine, and which amounts to a substantial increase in grizzly bear death rates at a time when the population has reached stasis or even begun to decline.<sup>12</sup>*

---

<sup>11</sup> Mattson p. 20

<sup>12</sup> Mattson p. 24

Mattson provides the following charts that document the correlation between declines in whitebark cone availability and stark increases in meat-related conflicts and deaths. He notes also that meat eating, while once largely a characteristic activity of male bears is now equally common among females and not potentially accounts for the majority of energy and nutrients for both sexes.<sup>13</sup>



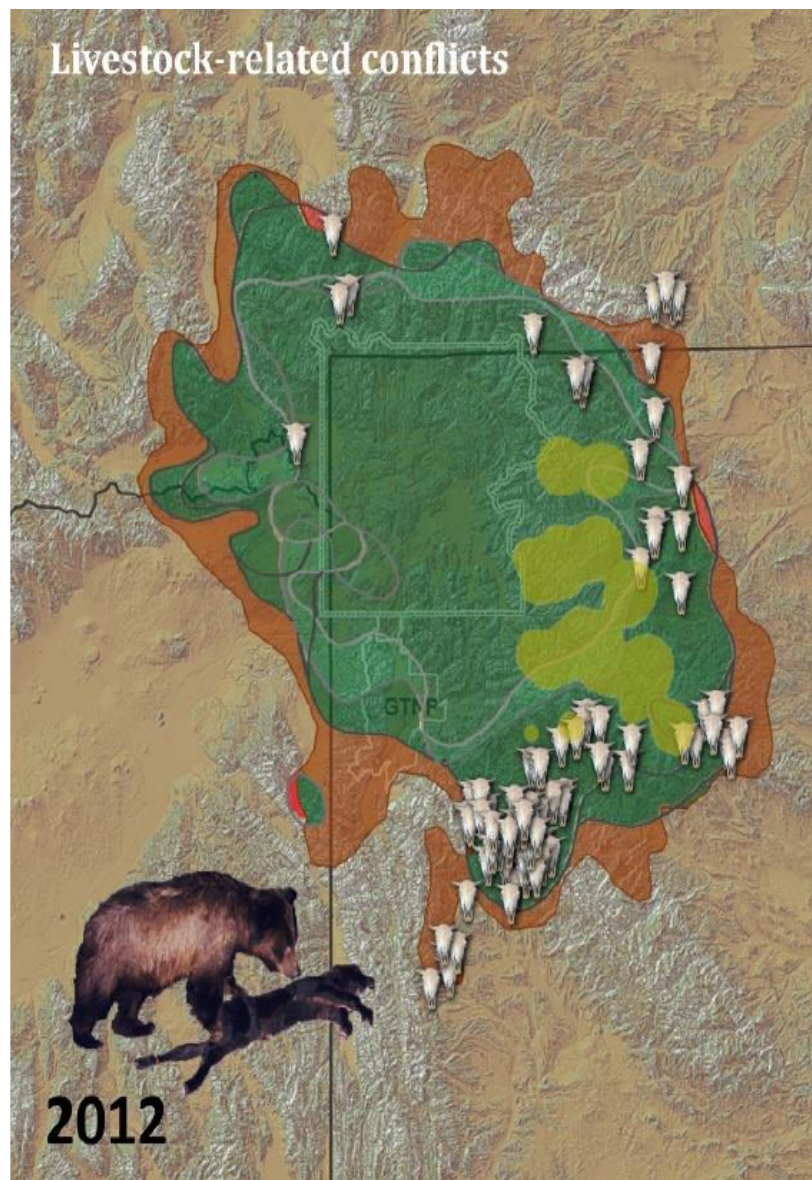
**Figure 9.2. Trends in numbers of grizzly bears killed (top) because of conflicts with big game hunters (red dots) and (bottom) conflicts over livestock (red dots as well). Gray dots in the top graph show numbers of hunters afield and pink dots in the bottom graph, total numbers of livestock-related conflicts. The black dotted lines show trends in whitebark pine cone availability since onset of losses to bark beetles.**

In addition to whitebark pine losses, an increasing threat to grizzly bears relates to the correlation between an increased reliance on meat eating and the geographic location of army cutworm moth sites. Mattson summarizes this by explaining that, “all of the moth sites are on the east side and towards the periphery of the ecosystem, in areas where we have seen expansion of the grizzly bear population, and a burgeoning of livestock-related conflicts and resulting grizzly bear deaths.”<sup>14</sup> The following graphic shows conflicts with livestock that are figuratively downhill from moth sites.

<sup>13</sup> Mattson, p. 25

<sup>14</sup> Mattson, p. 35





**Figure 11.1.2.** *All of known sites where grizzly bears feed on moths in the Yellowstone ecosystem are shown here encompassed by the yellowish-green blobs. The cattle skulls each represent a location of a grizzly bear-livestock conflict during the emblematic year of 2012. The greenish shaded area represents the distribution of grizzly bears as of circa 2000 and, the orange, areas newly colonized by grizzlies during the last decade or so.*

Mattson continues the analysis of food source losses and the impact on Yellowstone grizzly bears addressing declines in Yellowstone elk populations, declines in the central bison herd, the decline

in Yellowstone cutthroat trout and the potential decline in army cutworm moths due to climate change and other factors. In essence, it is clear the Service has failed to incorporate the best available science and adequately address the threat to the primary food sources used by Yellowstone grizzlies and the subsequent impact on the birth and death rate of bears.<sup>15</sup>

In summary, the threats facing Yellowstone grizzly bears due to declining primary food sources and the increased reliance on meat is leading bears into greater conflicts with humans via fatal interactions with hunters and livestock grazing on public lands. In regard to livestock, these conflicts will only increase as bears are forced to expand the area in which they search for food and secure habitat. Simply put, at every corner, bears will encounter livestock and will increasingly fall victim to the intolerance of public lands ranchers and the states of Idaho, Wyoming and Montana.

#### **Section 4**

As a simple matter of course, Western Watersheds Project adamantly opposes hunting of grizzly bears under any circumstances. Grizzly bears are apex predators. There is no moral, ecological, or otherwise necessary reason to hunt grizzly bears. The only purpose hunting serves is to provide trophies and to shield from the public the need for reforms in public land management, particularly as it relates to domestic livestock grazing in the GYE.

Furthermore, based on the experience with wolf management in Idaho, Montana, and Wyoming, we have serious concerns about the states' perspective on the ecological role of predators and the importance of maintaining their presence in the healthy ecosystems. In fact, we believe that given even the slightest opportunity, the states would move to substantially reduce grizzly bear numbers and severely restrict their migrations out of the GYE. It is a simple fact that the states of Wyoming, Montana and Idaho manage predators with two primary purposes in mind. First and foremost is the protection of domestic livestock. Second is the promotion of inflated populations of big game animals to support the outfitting industry. There is no reason to believe that state management of grizzly bears will be any different. The latest draft proposals for how Montana and Wyoming plan to manage bears does nothing to assuage our concerns.

#### **Conclusion**

Based on the aforementioned inadequacies of the Proposed Rule and the ongoing and increasing threats to Yellowstone grizzlies, Western Watersheds Project respectfully requests the Service reconsider its conclusion that removing ESA protections from GYE grizzly bears is appropriate. In fact, it is only through the maintenance of ESA protections and additional measures to address the threats currently facing GYE grizzlies, including the permanent closure of domestic livestock grazing allotments, that recovery of bears will continue and conservation will be truly achieved.

---

<sup>15</sup> See Mattson, p. 36-52

Respectfully submitted,



Josh Osher  
Montana Director  
WESTERN WATERSHEDS PROJECT  
P.O. Box 1135  
Hamilton, MT 59840  
(406) 830-3099  
<josh@westernwatersheds.org>

Attachments:

USFS Grazing Allotments in the GYE  
BLM Grazing Allotments in the GYE  
Biological Opinion for the 2014 supplement to the 2013 supplement and 2010 amendment to the 1999  
Biological Assessment for Livestock Grazing on the Northern Portions of the Pinedale Ranger District  
Dr. David Mattson Comments and Attachments



## **Attachments**

**David J. Mattson, Ph.D.**

### **Wyoming Wildlife Advocates**

**Comments on the**

**US Fish & Wildlife Service proposal to remove grizzly bears in the Yellowstone ecosystem from the list of endangered and threatened wildlife protected under the US Endangered Species Act (ESA); Federal Register 81(48): 13174-13227**

**And Related Materials**

May 5, 2016

# Attachment 1. Literature Cited

*to accompany*

**David J. Mattson, Ph.D., Wyoming Wildlife Advocates, Comments on the US Fish & Wildlife Service proposal to remove grizzly bears in the Yellowstone ecosystem from the list of endangered and threatened wildlife protected under the US Endangered Species Act (ESA); Federal Register 81(48): 13174-13227; And Related Materials**

Al-Chokhachy, R., Alder, J., Hostetler, S., Gresswell, R., & Shepard, B. (2013). Thermal controls of Yellowstone cutthroat trout and invasive fishes under climate change. *Global change biology*, 19(10), 3069-3081.

Armstrong, J. S. (1997). Peer review for journals: Evidence on quality control, fairness, and innovation. *Science and engineering ethics*, 3(1), 63-84.

Bacchetti, P. (2002). Peer review of statistics in medical research: the other problem. *British Medical Journal*, 324(7348), 1271.

Ballard, W.B., L.N. Carbyn, & D.W. Smith. 2003. Wolf interactions with non-prey. Pages 259-271 in Mech, L.S. & L. Boitani (eds.) *Wolves: ecology, behavior, and conservation*. The University of Chicago Press.

Ballenberghe, V. V., & Ballard, W. B. (1994). Limitation and regulation of moose populations: the role of predation. *Canadian Journal of Zoology*, 72(12), 2071-2077.

Barber-Meyer, S. M., Mech, L. D., & White, P. J. (2008). Elk calf survival and mortality following wolf restoration to Yellowstone National Park. *Wildlife Monographs*, 169(1), 1-30.

Barbero, R., Abatzoglou, J. T., Larkin, N. K., Kolden, C. A., & Stocks, B. (2015). Climate change presents increased potential for very large fires in the contiguous United States. *International Journal of Wildland Fire*, 24(7), 892-899.

Bartlein, P.J., Whitlock, C., & Shafer, S.L. (1997). Future climate in the Yellowstone National Park region and its potential impact on vegetation. *Conservation Biology*, 11(3), 782-792.

Bear, E. A., McMahon, T. E., & Zale, A. V. (2007). Comparative thermal requirements of westslope cutthroat trout and rainbow trout: implications for species interactions and development of thermal protection standards. *Transactions of the American Fisheries Society*, 136(4), 1113-1121.

Bell, D.M., Bradford, J.B., Lauenroth, W.K. (2013). Early indicators of change: divergent climate envelopes between tree life stages imply range shifts in the western United States. *Glob. Ecol. Biogeogr.* 23, 168–180.

Bell, D.M., Bradford, J.B., Lauenroth, W.K. (2014). Mountain landscapes offer few opportunities for high-elevation tree species migration. *Glob. Change Biol.* 20, 1441–1451.

- Bellemain, E., Swenson, J. E., & Taberlet, P. (2006). Mating Strategies in Relation to Sexually Selected Infanticide in a Non-Social Carnivore: the Brown Bear. *Ethology*, 112(3), 238-246.
- Benos, D. J., Bashari, E., Chaves, J. M., Gaggar, A., Kapoor, N., LaFrance, M., ... & Qadri, Y. (2007). The ups and downs of peer review. *Advances in physiology education*, 31(2), 145-152.
- Biagioli, M. (2002). From book censorship to academic peer review. *Emergences: Journal for the Study of Media & Composite Cultures*, 12(1), 11-45.
- Billings, W.D. & H.A. Mooney (1968). The ecology of arctic and alpine plants. *Biol. Rev.*, 43, 481-529.
- Bininda-Emonds, O. R., Gittleman, J. L., & Purvis, A. (1999). Building large trees by combining phylogenetic information: a complete phylogeny of the extant Carnivora (Mammalia). *Biological Reviews of the Cambridge Philosophical Society*, 74(2), 143-175.
- Bischof, R., Swenson, J. E., Yoccoz, N. G., Mysterud, A., & Gimenez, O. (2009). The magnitude and selectivity of natural and multiple anthropogenic mortality causes in hunted brown bears. *Journal of Animal Ecology*, 78(3), 656-665.
- Bjornlie, D. D., Thompson, D. J., Haroldson, M. A., Schwartz, C. C., Gunther, K. A., Cain, S. L., ... & Aber, B. C. (2013). Methods to estimate distribution and range extent of grizzly bears in the Greater Yellowstone Ecosystem. *Wildlife Society Bulletin*, 38(1), 182-187.
- Bjornlie, D. D., Van Manen, F. T., Ebinger, M. R., Haroldson, M. A., Thompson, D. J., & Costello, C. M. (2014). Whitebark pine, population density, and home-range size of grizzly bears in the Greater Yellowstone Ecosystem. *PloS one*, 9(2), e88160.
- Brodie, J., Johnson, H., Mitchell, M., Zager, P., Proffitt, K., Hebblewhite, M., ... & Gude, J. (2013). Relative influence of human harvest, carnivores, and weather on adult female elk survival across western North America. *Journal of Applied Ecology*, 50(2), 295-305.
- Bruggeman, J. E., White, P. J., Garrott, R. A., & Watson, F. G. (2009). Partial migration in central Yellowstone bison. Pages 217-235 in Garrott, R.A., P.J. White & F.G.R. Watson (eds.). *The ecology of large mammals in central Yellowstone*. Elsevier Press.
- Burnham, J.C. (1992). How journal editors come to develop and critique peer review procedures. Pp. 55-62 in Mayland, H.F. & R.E. Sojka. *Research ethics, manuscript review, & journal quality*.
- Cahill, J. A., Stirling, I., Kistler, L., Salamzade, R., Ersmark, E., Fulton, T. L., ... & Shapiro, B. (2015). Genomic evidence of geographically widespread effect of gene flow from polar bears into brown bears. *Molecular ecology*, 24(6), 1205-1217.

- Campanario, J. M. (1998). Peer review for journals as it stands today—Part 1. *Science Communication*, 19(3), 181-211.
- Carroll, C., Noss, R. F., & Paquet, P. C. (2001). Carnivores as focal species for conservation planning in the Rocky Mountain region. *Ecological applications*, 11(4), 961-980.
- Carroll, C., Noss, R. F., Paquet, P. C., & Schumaker, N. H. (2003). Use of population viability analysis and reserve selection algorithms in regional conservation plans. *Ecological applications*, 13(6), 1773-1789.
- Chang, T., Hansen, A. J., & Piekielek, N. (2014). Patterns and variability of projected bioclimatic habitat for *Pinus albicaulis* in the Greater Yellowstone Area. *PloS one*, 9(11), e111669.
- Chang, T., & Hansen, A. (2015). Historic & Projected Climate Change in the Greater Yellowstone Ecosystem. *Yellowstone Science*, 23(1), 14-19.
- Chapman, J.A., J.I. Romer, & J. Stark (1955). Ladybird beetles and army cutworm adults as food for grizzly bears in Montana. *Ecology*, 36 (1), 156-158.
- Cherry, S., White, G. C., Keating, K. A., Haroldson, M. A., & Schwartz, C. C. (2007). Evaluating estimators of the numbers of females with cubs-of-the-year in the Yellowstone grizzly bear population. *Journal of agricultural, biological, and environmental statistics*, 12(2), 195-215.
- Clow, D. W. (2010). Changes in the timing of snowmelt and streamflow in Colorado: a response to recent warming. *Journal of Climate*, 23(9), 2293-2306.
- Cook, J. G., Johnson, B. K., Cook, R. C., Riggs, R. A., Delcurto, T. I. M., Bryant, L. D., & Irwin, L. L. (2004). Effects of summer-autumn nutrition and parturition date on reproduction and survival of elk. *Wildlife Monographs*, 155(1), 1-61.
- Coops, N.C., & Waring, R.H., 2011. Estimating the vulnerability of fifteen tree species under changing climate in Northwest North America. *Ecol. Model.*, 222, 2119–2129.
- Coops, N. C., Waring, R. H., Beier, C., Roy-Jauvin, R., & Wang, T. (2011). Modeling the occurrence of 15 coniferous tree species throughout the Pacific Northwest of North America using a hybrid approach of a generic process-based growth model and decision tree analysis. *Applied Vegetation Science*, 14(3), 402-414.
- Costello, C. M., Manen, F. T., Haroldson, M. A., Ebinger, M. R., Cain, S. L., Gunther, K. A., & Bjornlie, D. D. (2014). Influence of whitebark pine decline on fall habitat use and movements of grizzly bears in the Greater Yellowstone Ecosystem. *Ecology and evolution*, 4(10), 2004-2018.
- Coughenour, M. B., & Singer, F. J. (1996). Elk population processes in Yellowstone National Park under the policy of natural regulation. *Ecological Applications*, 573-593.

Craighead, J.J., J.S. Sumer, & G.B. Scaggs (1982). A definitive system for analysis of grizzly bear habitat and other wilderness resources. Monograph 1, Wildlife-Wildlands Institute, University of Montana Foundation, Missoula.

Cronin, M. A., & MacNeil, M. D. (2012). Genetic relationships of extant brown bears (*Ursus arctos*) and polar bears (*Ursus maritimus*). *Journal of Heredity*, ess090.

Crookston, N.L., Rehfeldt, G.E., Dixon, G.E., Weiskittel, A.R. (2010). Addressing climate change in the forest vegetation simulator to assess impacts on landscape forest dynamics. *For. Ecol. Manage.*, 260, 1198–1211.

Dai, A. (2013). Increasing drought under global warming in observations and models. *Nature Climate Change*, 3(1), 52-58.

Davison, J., Ho, S. Y., Bray, S. C., Korsten, M., Tammeleht, E., Hindrikson, M., ... & Cooper, A. (2011). Late-Quaternary biogeographic scenarios for the brown bear (*Ursus arctos*), a wild mammal model species. *Quaternary Science Reviews*, 30(3), 418-430.

Dawid, A. P. (1979). Conditional independence in statistical theory. *Journal of the Royal Statistical Society. Series B (Methodological)*, 1-31.

Delibes, M., Gaona, P., & Ferreras, P. (2001). Effects of an attractive sink leading into maladaptive habitat selection. *The American Naturalist*, 158(3), 277-285.

Diaz, H. F., & Eischeid, J. K. (2007). Disappearing “alpine tundra” Köppen climatic type in the western United States. *Geophysical Research Letters*, 34(18), L18707.

Doak, D. F. (1995). Source-sink models and the problem of habitat degradation: general models and applications to the Yellowstone grizzly. *Conservation Biology*, 9(6), 1370-1379.

Doak, D. F., & Cutler, K. (2014a). Re-Evaluating Evidence for Past Population Trends and Predicted Dynamics of Yellowstone Grizzly Bears. *Conservation Letters*, 7(3), 312-322.

Doak, D. F., & Cutler, K. (2014b). Van Manen et al., Doth Protest too Much: New Analyses of the Yellowstone Grizzly Population Confirm the Need to Reevaluate Past Population Trends. *Conservation Letters*, 7(3), 332-333.

Dullinger, S., Gatttringer, A., Thuiller, W., Moser, D., Zimmermann, N. E., Guisan, A., ... & Caccianiga, M. (2012). Extinction debt of high-mountain plants under twenty-first-century climate change. *Nature Climate Change*, 2(8), 619-622.

Eberhardt, L. L., White, P. J., Garrott, R. A., & Houston, D. B. (2007). A Seventy-Year History of Trends in Yellowstone's Northern Elk Herd. *The Journal of wildlife management*, 71(2), 594-602.



- Ebinger, M. R., Haroldson, M. A., van Manen, F. T., Costello, C. M., Bjornlie, D. D., Thompson, D. J., ... & White, P. J. (2016). Detecting grizzly bear use of ungulate carcasses using global positioning system telemetry and activity data. *Oecologia*, Online access, 1-14.
- Elmendorf, S. C., Henry, G. H., Hollister, R. D., Björk, R. G., Boulanger-Lapointe, N., Cooper, E. J., ... & Gill, M. (2012). Plot-scale evidence of tundra vegetation change and links to recent summer warming. *Nature Climate Change*, 2(6), 453-457.
- Erlenbach, J. A., Rode, K. D., Raubenheimer, D., & Robbins, C. T. (2014). Macronutrient optimization and energy maximization determine diets of brown bears. *Journal of Mammalogy*, 95(1), 160-168.
- Evans, S. B., Mech, L. D., White, P. J., & Sargeant, G. A. (2006). Survival of adult female elk in Yellowstone following wolf restoration. *Journal of Wildlife Management*, 70(5), 1372-1378.
- Farley, S. D., & Robbins, C. T. (1995). Lactation, hibernation, and mass dynamics of American black bears and grizzly bears. *Canadian Journal of Zoology*, 73(12), 2216-2222.
- Felicetti, L. A., Schwartz, C. C., Rye, R. O., Haroldson, M. A., Gunther, K. A., Phillips, D. L., & Robbins, C. T. (2003). Use of sulfur and nitrogen stable isotopes to determine the importance of whitebark pine nuts to Yellowstone grizzly bears. *Canadian Journal of Zoology*, 81(5), 763-770.
- Felicetti, L. A., Robbins, C. T., & Shipley, L. A. (2003). Dietary protein content alters energy expenditure and composition of the mass gain in grizzly bears (*Ursus arctos horribilis*). *Physiological and Biochemical Zoology*, 76(2), 256-261.
- Felicetti, L. A., Schwartz, C. C., Rye, R. O., Gunther, K. A., Crock, J. G., Haroldson, M. A., ... & Robbins, C. T. (2004). Use of naturally occurring mercury to determine the importance of cutthroat trout to Yellowstone grizzly bears. *Canadian Journal of Zoology*, 82(3), 493-501.
- Fortin, J. K., Schwartz, C. C., Gunther, K. A., Teisberg, J. E., Haroldson, M. A., Evans, M. A., & Robbins, C. T. (2013). Dietary adjustability of grizzly bears and American black bears in Yellowstone National Park. *The Journal of Wildlife Management*, 77(2), 270-281.
- French, S.P., M.G. French & R.R. Knight (1994). Grizzly bear use of army cutworm moths in the Yellowstone Ecosystem. *Ursus*, 9, 389-399.
- Fuller, J. A., Garrott, R. A., & White, P. J. (2007). Emigration and density dependence in Yellowstone bison. *The Journal of Wildlife Management*, 71(6), 1924-1933.
- Fuller, J. A., Garrott, R. A., & White, P. J. (2008). Emigration and density dependence in Yellowstone bison. Pages 237-254 in Garrott, R.A., P.J. White & F.G.R. Watson (eds.). *The ecology of large mammals in central Yellowstone*. Elsevier Press.

- Gardner, C. L., Pamperin, N. J., & Benson, J. F. (2014). Movement patterns and space use of maternal grizzly bears influence cub survival in Interior Alaska. *Ursus*, 25(2), 121-138.
- Garrott, R. A., Eberhardt, L. L., White, P. J., & Rotella, J. (2003). Climate-induced variation in vital rates of an unharvested large-herbivore population. *Canadian Journal of Zoology*, 81(1), 33-45.
- Gasaway, W. C., Boertje, R. D., Grangaard, D. V., Kelleyhouse, D. G., Stephenson, R. O., & Larsen, D. G. (1992). The role of predation in limiting moose at low densities in Alaska and Yukon and implications for conservation. *Wildlife monographs*, 3-59.
- Geremia, C., White, P. J., Wallen, R. L., Watson, F. G., Treanor, J. J., Borkowski, J., ... & Crabtree, R. L. (2011). Predicting bison migration out of Yellowstone National Park using Bayesian models. *PLoS one*, 6(2), e16848.
- Geremia, C., White, P. J., Garrott, R. A., Wallen, R. W., Aune, K. E., Treanor, J., & Fuller, J. A. (2009). Demography of central Yellowstone bison: effects of climate, density, and disease. Pages 255-279 in Garrott, R.A., P.J. White & F.G.R. Watson (eds.). *The ecology of large mammals in central Yellowstone*. Elsevier Press.
- Gottfried, M., Pauli, H., Futschik, A., Akhalkatsi, M., Barančok, P., Alonso, J. L. B., ... & Krajči, J. (2012). Continent-wide response of mountain vegetation to climate change. *Nature Climate Change*, 2(2), 111-115.
- Grabherr, G., Gottfried, M., & Pauli, H. (2010). Climate change impacts in alpine environments. *Geography Compass*, 4(8), 1133-1153
- Grace, J., Berninger, F., & Nagy, L. (2002). Impacts of climate change on the tree line. *Annals of Botany*, 90(4), 537-544.
- Gray, L.K., Hamann, A., 2013. Tracking suitable habitat for tree populations under climate change in western North America. *Clim. Change* 117, 289–303.
- Gresswell, R.E. (2009). Yellowstone cutthroat trout (*Oncorhynchus clarkii bouvieri*): a technical conservation assessment. USDA Forest Service, Rocky Mountain Region.
- Griffin, K. A., Hebblewhite, M., Robinson, H. S., Zager, P., Barber-Meyer, S. M., Christianson, D., ... & Johnson, B. K. (2011). Neonatal mortality of elk driven by climate, predator phenology and predator community composition. *Journal of Animal Ecology*, 80(6), 1246-1257.
- Gude, P. H., Hansen, A. J., & Jones, D. A. (2007). Biodiversity consequences of alternative future land use scenarios in Greater Yellowstone. *Ecological Applications*, 17(4), 1004-1018.
- Guilday, J. E. (1968). Grizzly bears from eastern North America. *American Midland Naturalist*, 247-250.
- Gunther, K. A., & Smith, D. W. (2004). Interactions between wolves and female grizzly bears with cubs in Yellowstone National Park. *Ursus*, 15(2), 232-238.

- Gunther, K. A., Haroldson, M. A., Frey, K., Cain, S. L., Copeland, J., & Schwartz, C. C. (2004). Grizzly bear-human conflicts in the Greater Yellowstone ecosystem, 1992-2000. *Ursus*, 15(1), 10-22.
- Gunther, K. A., Shoemaker, R. R., Frey, K. L., Haroldson, M. A., Cain, S. L., van Manen, F. T., & Fortin, J. K. (2014). Dietary breadth of grizzly bears in the Greater Yellowstone Ecosystem. *Ursus*, 25(1), 60-72.
- Gutzler, D. S., & Robbins, T. O. (2011). Climate variability and projected change in the western United States: regional downscaling and drought statistics. *Climate Dynamics*, 37(5-6), 835-849.
- Hailer, F., Kutschera, V. E., Hallström, B. M., Klassert, D., Fain, S. R., Leonard, J. A., ... & Janke, A. (2012). Nuclear genomic sequences reveal that polar bears are an old and distinct bear lineage. *Science*, 336(6079), 344-347.
- Hale, R., & Swearer, S. E. (2016). Ecological traps: current evidence and future directions. *Proc. R. Soc. B*, 283, 1824, pp. 20152647.
- Hansen, A. J., & Phillips, L. B. (2015). Which tree species and biome types are most vulnerable to climate change in the US Northern Rocky Mountains?. *Forest Ecology and Management*, 338, 68-83.
- Hansen, A., Piekielek, N., Chang, T., & Phillips, L. (2015). Changing Climate Suitability for Forests in Yellowstone & the Rocky Mountains. *Yellowstone Science*, 23(1), 36.
- Hansen, A., Ireland, K., Legg, K., Keane, R., Barge, E., Jenkins, M., & Pillet, M. (2016). Complex Challenges of Maintaining Whitebark Pine in Greater Yellowstone under Climate Change: A Call for Innovative Research, Management, and Policy Approaches. *Forests*, 7(3), 54.
- Harington, C. R., Cournoyer, M., Chartier, M., Fulton, T. L., & Shapiro, B. (2014). Brown bear (*Ursus arctos*)(9880±35 BP) from late-glacial Champlain Sea deposits at Saint-Nicolas, Quebec, Canada, and the dispersal history of brown bears. *Canadian Journal of Earth Sciences*, 51(5), 527-535.
- Haroldson, M. A., Terner, M. A., Gunther, K. A., & Schwartz, C. C. (2002). Grizzly bear denning chronology and movements in the Greater Yellowstone Ecosystem. *Ursus*, 13, 29-37.
- Haroldson, M. A., Schwartz, C. C., Cherry, S., & Moody, D. S. (2004). Possible effects of elk harvest on fall distribution of grizzly bears in the Greater Yellowstone Ecosystem. *Journal of Wildlife Management*, 68(1), 129-137.
- Haroldson, M. A., Gunther, K. A., Reinhart, D. P., Podruzny, S. R., Cegelski, C., Waits, L., ... & Smith, J. (2005). Changing numbers of spawning cutthroat trout in tributary streams of Yellowstone Lake and estimates of grizzly bears visiting streams from DNA. *Ursus*, 16(2), 167-180.
- Haroldson, M. A., & Gunther, K. A. (2013). Roadside bear viewing opportunities in Yellowstone National Park: characteristics, trends, and influence of whitebark pine. *Ursus*, 24(1), 27-41.

- Harris, R. B., Schwartz, C. C., Haroldson, M. A., & White, G. C. (2006). Trajectory of the Yellowstone grizzly bear population under alternative survival rates. *Wildlife Monographs*, (161), 44.
- Harte, J., & Shaw, R. (1995). Shifting dominance within a montane vegetation community: results of a climate-warming experiment. *Science*, 267(5199), 876-880.
- Hatala, J. A., Dietze, M. C., Crabtree, R. L., Kendall, K., Six, D., & Moorcroft, P. R. (2011). An ecosystem-scale model for the spread of a host-specific forest pathogen in the Greater Yellowstone Ecosystem. *Ecological Applications*, 21(4), 1138-1153.
- Herrero, S. (1972). Aspects of evolution and adaptation in American black bears (*Ursus americanus* Pallas) and brown and grizzly bears (*U. arctos* Linne.) of North America. *International Conference on Bear Research & Management*, 2, 221-231.
- Higgs, M. D., Link, W. A., White, G. C., Haroldson, M. A., & Bjornlie, D. D. (2013). Insights into the latent multinomial model through mark-resight data on female grizzly bears with cubs-of-the-year. *Journal of Agricultural, Biological, and Environmental Statistics*, 18(4), 556-577.
- Hilborn, R., & Mangel, M. (1997). *The ecological detective: confronting models with data* (Vol. 28). Princeton University Press.
- Hilderbrand, G. V., Schwartz, C. C., Robbins, C. T., Jacoby, M. E., Hanley, T. A., Arthur, S. M., & Servheen, C. (1999). The importance of meat, particularly salmon, to body size, population productivity, and conservation of North American brown bears. *Canadian Journal of Zoology*, 77(1), 132-138.
- Hilderbrand, G. V., Jenkins, S. G., Schwartz, C. C., Hanley, T. A., & Robbins, C. T. (1999). Effect of seasonal differences in dietary meat intake on changes in body mass and composition in wild and captive brown bears. *Canadian Journal of Zoology*, 77(10), 1623-1630.
- Hilderbrand, G. V., Schwartz, C. C., Robbins, C. T., & Hanley, T. A. (2000). Effect of hibernation and reproductive status on body mass and condition of coastal brown bears. *The Journal of wildlife management*, 178-183.
- Hirata, D., Mano, T., Abramov, A. V., Baryshnikov, G. F., Kosintsev, P. A., Vorobiev, A. A., ... & Fukui, D. (2013). Molecular phylogeography of the brown bear (*Ursus arctos*) in northeastern Asia based on analyses of complete mitochondrial DNA sequences. *Molecular Biology and Evolution*, 30(7), 1644-1652.
- Hirata, D., Abramov, A. V., Baryshnikov, G. F., & Masuda, R. (2014). Mitochondrial DNA haplogrouping of the brown bear, *Ursus arctos* (Carnivora: Ursidae) in Asia, based on a newly developed APLP analysis. *Biological Journal of the Linnean Society*, 111(3), 627-635.
- Iglesias, V., Krause, T. R., & Whitlock, C. (2015). Complex Response of White Pines to Past Environmental Variability Increases Understanding of Future Vulnerability. *PloS one*, 10(4), e0124439.

- Interagency Grizzly Bear Study Team (2012). Updating and evaluating approaches to estimate population size and sustainable mortality limits for grizzly bears in the Greater Yellowstone Ecosystem. Interagency Grizzly Bear Study Team, U.S. Geological Survey, Northern Rocky Mountain Science Center, Bozeman, Montana.
- Isaak, D. J., Luce, C. H., Rieman, B. E., Nagel, D. E., Peterson, E. E., Horan, D. L., ... & Chandler, G. L. (2010). Effects of climate change and wildfire on stream temperatures and salmonid thermal habitat in a mountain river network. *Ecological Applications*, 20(5), 1350-1371.
- Isaak, D. J., Muhlfeld, C. C., Todd, A. S., Al-Chokhachy, R., Roberts, J., Kershner, J. L., ... & Hostetler, S. W. (2012). The past as prelude to the future for understanding 21st-century climate effects on Rocky Mountain trout. *Fisheries*, 37(12), 542-556.
- Isaak, D. J., Young, M. K., Nagel, D. E., Horan, D. L., & Groce, M. C. (2015). The cold-water climate shield: delineating refugia for preserving salmonid fishes through the 21st century. *Global change biology*, 21(7), 2540-2553.
- Jacoby, M. E., Hilderbrand, G. V., Servheen, C., Schwartz, C. C., Arthur, S. M., Hanley, T. A., ... & Michener, R. (1999). Trophic relations of brown and black bears in several western North American ecosystems. *The Journal of wildlife management*, 921-929.
- Jennelle, C. S., Samuel, M. D., Nolden, C. A., & Berkley, E. A. (2009). Deer carcass decomposition and potential scavenger exposure to chronic wasting disease. *The Journal of Wildlife Management*, 73(5), 655-662.
- Jewett, J. T., Lawrence, R. L., Marshall, L. A., Gessler, P. E., Powell, S. L., & Savage, S. L. (2011). Spatiotemporal relationships between climate and whitebark pine mortality in the Greater Yellowstone Ecosystem. *Forest Science*, 57(4), 320-335.
- Johnson, C. J., Boyce, M. S., Schwartz, C. C., & Haroldson, M. A. (2004). Modeling survival: application of the Andersen-Gill model to Yellowstone grizzly bears. *Journal of Wildlife Management*, 68(4), 966-978.
- Kaeding, L. R. (2010). Relative contributions of climate variation, lake trout predation, and other factors to the decline of Yellowstone Lake cutthroat trout during the three recent decades. Dissertation, Montana State University, Bozeman.
- Kaeding, L. R. (2012). Are Yellowstone Lake temperatures more suitable to nonnative Lake Trout than to native Cutthroat Trout?. *North American Journal of Fisheries Management*, 32(5), 848-852.
- Keating, K. A., Schwartz, C. C., Haroldson, M. A., & Moody, D. (2002). Estimating numbers of females with cubs-of-the-year in the Yellowstone grizzly bear population. *Ursus*, 13, 161-174.

- Keis, M., Remm, J., Ho, S. Y., Davison, J., Tammeleht, E., Tumanov, I. L., ... & Margus, T. (2013). Complete mitochondrial genomes and a novel spatial genetic method reveal cryptic phylogeographical structure and migration patterns among brown bears in north-western Eurasia. *Journal of Biogeography*, 40(5), 915-927.
- Kevan, P. G., & Kendall, D. M. (1997). Liquid assets for fat bankers: summer nectarivory by migratory moths in the Rocky Mountains, Colorado, USA. *Arctic and Alpine Research*, 478-482.
- Klos, P. Z., Link, T. E., & Abatzoglou, J. T. (2014). Extent of the rain-snow transition zone in the western US under historic and projected climate. *Geophysical Research Letters*, 41(13), 4560-4568.
- Koel, T. M., Bigelow, P. E., Doepke, P. D., Ertel, B. D., & Mahony, D. L. (2005). Nonnative lake trout result in Yellowstone cutthroat trout decline and impacts to bears and anglers. *Fisheries*, 30(11), 10-19.
- Koel, T. M., Bigelow, P. E., Doepke, P. D., Ertel, B. D., & Mahony, D. L. (2006). Conserving Yellowstone cutthroat trout for the future of the GYE. *Yellowstone Science*, 14(2), 20-28.
- Koel, T.M., J.L.L. Arnold, P.E. Bigelow, C.R. Detjens, P.D. Doepke, B. D. Ertel, & M.E. Ruhl (2015). Native fish conservation program, Yellowstone Fisheries & Aquatic Sciences 2012-2014, Yellowstone National Park. National Park Service, Yellowstone Center for Resources, Yellowstone National Park, Wyoming, USA, YCR-2015-01.
- Krause, J., Unger, T., Noçon, A., Malaspinas, A. S., Kolokotronis, S. O., Stiller, M., ... & Bray, S. C. (2008). Mitochondrial genomes reveal an explosive radiation of extinct and extant bears near the Miocene-Pliocene boundary. *BMC Evolutionary Biology*, 8(1), 220.
- Krebs, C. J. (1995). Two paradigms of population regulation. *Wildlife Research*, 22(1), 1-10.
- Krebs, C. J. (2002). Two complementary paradigms for analysing population dynamics. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, 357(1425), 1211-1219.
- Körner, C. (2013). *Alpine Plant Life: Functional Plant Ecology of High Mountain Ecosystems* Springer.
- Kutschera, V. E., Bidon, T., Hailer, F., Rodi, J. L., Fain, S. R., & Janke, A. (2014). Bears in a forest of gene trees: phylogenetic inference is complicated by incomplete lineage sorting and gene flow. *Molecular biology and evolution*, 31(8), 2004-2017.
- Leonard, J. A., Wayne, R. K., & Cooper, A. (2000). Population genetics of Ice Age brown bears. *Proceedings of the National Academy of Sciences*, 97(4), 1651-1654.
- Lindqvist, C., Schuster, S. C., Sun, Y., Talbot, S. L., Qi, J., Ratan, A., ... & Miller, W. (2011). Complete mitochondrial genome of a Pleistocene jawbone unveils the origin of polar bear. *Proceedings of the National Academy of Sciences*, 107(11), 5053-5057.

- Liu, S., Lorenzen, E. D., Fumagalli, M., Li, B., Harris, K., Xiong, Z., ... & Wray, G. (2014). Population genomics reveal recent speciation and rapid evolutionary adaptation in polar bears. *Cell*, 157(4), 785-794.
- Logan, J. A., Macfarlane, W. W., & Willcox, L. (2010). Whitebark pine vulnerability to climate-driven mountain pine beetle disturbance in the Greater Yellowstone Ecosystem. *Ecological Applications*, 20(4), 895-902.
- López-Alfaro, C., Coogan, S. C., Robbins, C. T., Fortin, J. K., & Nielsen, S. E. (2015). Assessing Nutritional Parameters of Brown Bear Diets among Ecosystems Gives Insight into Differences among Populations. *PloS one*, 10(6), e0128088.
- Loreille, O., Orlando, L., Patou-Mathis, M., Philippe, M., Taberlet, P., & Hänni, C. (2001). Ancient DNA analysis reveals divergence of the cave bear, *Ursus spelaeus*, and brown bear, *Ursus arctos*, lineages. *Current Biology*, 11(3), 200-203.
- Loring, S., & Spiess, A. (2007). Further documentation supporting the former existence of grizzly bears (*Ursus arctos*) in northern Quebec-Labrador. *Arctic*, 7-16.
- Losee, J. (2004). *Theories of scientific progress: An introduction*. Psychology Press.
- Lubow, B. C., & Smith, B. L. (2004). Population dynamics of the Jackson elk herd. *Journal of Wildlife management*, 68(4), 810-829.
- Luo, L., Tang, Y., Zhong, S., Bian, X., & Heilman, W. E. (2013). Will future climate favor more erratic wildfires in the western United States?. *Journal of Applied Meteorology and Climatology*, 52(11), 2410-2417.
- Lütz, C. (ed.) (2011). *Plants in Alpine Regions: Cell Physiology of Adaption and Survival Strategies*. Springer.
- Macfarlane, W. W., Logan, J. A., & Kern, W. R. (2013). An innovative aerial assessment of Greater Yellowstone Ecosystem mountain pine beetle-caused whitebark pine mortality. *Ecological Applications*, 23(2), 421-437.
- Mahalovich, M. F. (2013). Grizzly bears and whitebark pine in the Greater Yellowstone Ecosystem. Future status of whitebark pine: blister rust resistance, mountain pine beetle, and climate change. Report 2470 RRM-NR-WP-13-01. US Department of Agriculture Forest Service, Northern Region, Missoula, MT.
- Marcus, W. A., J.E. Meacham, & A.W. Rodman (2012). *Atlas of Yellowstone*. Berkeley and Los Angeles: University of California Press.
- Matheus, P., Burns, J., Weinstock, J., & Hofreiter, M. (2004). Pleistocene brown bears in the mid-continent of North America. *Science*, 306(5699), 1150-1150.
- Matsushashi, T., Masuda, R., Mano, T., Murata, K., & Aiurzaniin, A. (2001). Phylogenetic relationships among worldwide populations of the brown bear *Ursus arctos*. *Zoological Science*, 18(8), 1137-1143.

Mattson, D. J., Knight, R. R., & Blanchard, B. M. (1987). The effects of developments and primary roads on grizzly bear habitat use in Yellowstone National Park, Wyoming. *International Conference on Bear Research & Management*, 7, 259-273.

Mattson, D. J., Blanchard, B. M., & Knight, R. R. (1991a). Food habits of Yellowstone grizzly bears, 1977-1987. *Canadian Journal of Zoology*, 69(6), 1619-1629.

Mattson, D. J., Gillin, C. M., Benson, S. A., & Knight, R. R. (1991b). Bear feeding activity at alpine insect aggregation sites in the Yellowstone ecosystem. *Canadian Journal of Zoology*, 69(9), 2430-2435.

Mattson, D. J., Blanchard, B. M., & Knight, R. R. (1992). Yellowstone grizzly bear mortality, human habituation, and whitebark pine seed crops. *The Journal of wildlife management*, 432-442.

Mattson, D.J. (1993). Background and proposed standards for managing grizzly bear habitat security in the Yellowstone ecosystem. Cooperative Park Studies Unit Report. University of Idaho, Moscow.

Mattson, D. J. (1995). New World Mine and Grizzly Bears: A Window on Ecosystem Management, The. *J. Energy Nat. Resources & Envtl. L.*, 15, 267.

Mattson, D. J., & Reinhart, D. P. (1995). Influences of cutthroat trout (*Oncorhynchus clarki*) on behaviour and reproduction of Yellowstone grizzly bears (*Ursus arctos*), 1975-1989. *Canadian Journal of Zoology*, 73(11), 2072-2079.

Mattson, D. J., Herrero, S., Wright, R. G., & Pease, C. M. (1996a). Science and management of Rocky Mountain grizzly bears. *Conservation Biology*, 10(4), 1013-1025.

Mattson, D. J., Herrero, S., Wright, R. G., & Pease, C. M. (1996b). Designing and managing protected areas for grizzly bears: how much is enough. *National parks and protected areas: their role in environmental protection*. Cambridge, MA: Blackwell Science, 133-164.

Mattson, D. J. (1997a). Sustainable grizzly bear mortality calculated from counts of females with cubs-of-the-year: an evaluation. *Biological Conservation*, 81(1), 103-111.

Mattson, D. J. (1997). Use of ungulates by Yellowstone grizzly bears *Ursus arctos*. *Biological Conservation*, 81(1), 161-177.

Mattson, D. J., & Reinhart, D. P. (1997). Excavation of red squirrel middens by grizzly bears in the whitebark pine zone. *Journal of Applied Ecology*, 926-940.

Mattson, D. J. (1998). Changes in mortality of Yellowstone's grizzly bears. *Ursus*, 10, 129-138.

Mattson, D. J. (2000). Causes and consequences of dietary differences among Yellowstone grizzly bears (*Ursus arctos*). Dissertation, University of Idaho, Moscow.



- Mattson, D. J., & Merrill, T. (2002). Extirpations of grizzly bears in the contiguous United States, 1850–2000. *Conservation Biology*, 16(4), 1123-1136.
- Mattson, D.J., Barber, K., Maw, R., & Renkin, R. (2004). Coefficients of productivity for Yellowstone's grizzly bear habitat. US Department of the Interior, US Geological Survey.
- Maxwell, N. (1998). *The Comprehensibility of the Universe: A New Conception of Science*. Oxford University Press.
- McLellan, B. N., & Shackleton, D. M. (1988). Grizzly bears and resource-extraction industries: effects of roads on behaviour, habitat use and demography. *Journal of Applied Ecology*, 25, 451-460.
- McLellan, B. N. (2011). Implications of a high-energy and low-protein diet on the body composition, fitness, and competitive abilities of black (*Ursus americanus*) and grizzly (*Ursus arctos*) bears. *Canadian Journal of Zoology*, 89(6), 546-558.
- McLellan, B. N. (2015). Some mechanisms underlying variation in vital rates of grizzly bears on a multiple use landscape. *The Journal of Wildlife Management*, 79(5), 749-765.
- Merrill, T., Mattson, D. J., Wright, R. G., & Quigley, H. B. (1999). Defining landscapes suitable for restoration of grizzly bears *Ursus arctos* in Idaho. *Biological Conservation*, 87(2), 231-248.
- Merrill, T., & Mattson, D. (2003). The extent and location of habitat biophysically suitable for grizzly bears in the Yellowstone region. *Ursus*, 14, 171-187.
- Merton, R. K. (1973). *The sociology of science: Theoretical and empirical investigations*. University of Chicago press.
- Middleton, A. D., Morrison, T. A., Fortin, J. K., Robbins, C. T., Proffitt, K. M., White, P. J., ... & Kauffman, M. J. (2013). Grizzly bear predation links the loss of native trout to the demography of migratory elk in Yellowstone. *Proceedings of the Royal Society of London B: Biological Sciences*, 280(1762), 20130870.
- Middleton, A. D., Kauffman, M. J., McWhirter, D. E., Cook, J. G., Cook, R. C., Nelson, A. A., ... & Klaver, R. W. (2013). Animal migration amid shifting patterns of phenology and predation: lessons from a Yellowstone elk herd. *Ecology*, 94(6), 1245-1256.
- Miller, C.R., Waits, L.P., & Joyce, P. (2006). Phylogeography and mitochondrial diversity of extirpated brown bear (*Ursus arctos*) populations in the contiguous United States and Mexico. *Molecular ecology*, 15(14), 4477-4485.
- Miller, B. W., Frid, L., Chang, T., Piekielek, N., Hansen, A. J., & Morissette, J. T. (2015). Combining state-and-transition simulations and species distribution models to anticipate the effects of climate change. *AIMS Environ Sci*, 2, 400-426.

- Morgan, J. A., Milchunas, D. G., LeCain, D. R., West, M., & Mosier, A. R. (2007). Carbon dioxide enrichment alters plant community structure and accelerates shrub growth in the shortgrass steppe. *Proceedings of the National Academy of Sciences*, 104(37), 14724-14729.
- Mowat, G., Heard, D. C., & Schwarz, C. J. (2013). Predicting grizzly bear density in western North America. *PloS one*, 8(12), e82757.
- Nakagome, S., Mano, S., & Hasegawa, M. (2013). Ancestral polymorphisms and sex-biased migration shaped the demographic history of brown bears and polar bears. *PloS one*, 8(11), e78813.
- Nielsen, S. E., Stenhouse, G. B., & Boyce, M. S. (2006). A habitat-based framework for grizzly bear conservation in Alberta. *Biological Conservation*, 130(2), 217-229.
- Nielsen, S. E., Cranston, J., & Stenhouse, G. B. (2009). Identification of priority areas for grizzly bear conservation and recovery in Alberta, Canada. *Journal of Conservation Planning*, 5, 38-60.
- Northrup, J. M., Stenhouse, G. B., & Boyce, M. S. (2012). Agricultural lands as ecological traps for grizzly bears. *Animal Conservation*, 15(4), 369-377.
- Nyakatura, K., & Bininda-Emonds, O. R. (2012). Updating the evolutionary history of Carnivora (Mammalia): a new species-level supertree complete with divergence time estimates. *BMC biology*, 10(1), 1.
- O'Brien, S.L., & F.G. Lindzey (1994). Grizzly bear use of moth aggregation sites and summer ecology of the army cutworm moth in the Absaroka Mountains, Wyoming : final report. Laramie, Wyo.: Wyoming Cooperative Fish and Wildlife Research Unit, University of Wyoming
- O'Brien, S.L., & F.G. Lindzey (1998). Aerial sightability and classification of grizzly bears at moth aggregation sites in the Absaroka Mountains, Wyoming. *Ursus*, 10, 427-435.
- Pages, M., Calvignac, S., Klein, C., Paris, M., Hughes, S., & Hänni, C. (2008). Combined analysis of fourteen nuclear genes refines the Ursidae phylogeny. *Molecular phylogenetics and evolution*, 47(1), 73-83.
- Parker, K. L., Barboza, P. S., & Gillingham, M. P. (2009). Nutrition integrates environmental responses of ungulates. *Functional ecology*, 23(1), 57-69.
- Parks, S. A., Miller, C., Abatzoglou, J. T., Holsinger, L. M., Parisien, M. A., & Dobrowski, S. Z. (2016). How will climate change affect wildland fire severity in the western US?. *Environmental Research Letters*, 11(3), 035002.
- Pauli, H., Gottfried, M., & Grabherr, G. (1996). Effects of climate change on mountain ecosystems—upward shifting of alpine plants. *World resource review*, 8(3), 382-390.

- Pauli, H., Gottfried, M., & Grabherr, G. (2003). Effects of climate change on the alpine and nival vegetation of the Alps. *Journal of mountain ecology*, 7(Suppl), 9-12.
- Pearson, R. G. (2006). Climate change and the migration capacity of species. *Trends in Ecology & Evolution*, 21(3), 111-113.
- Pease, C. M., & Mattson, D. J. (1999). Demography of the Yellowstone grizzly bears. *Ecology*, 80(3), 957-975.
- Pederson, G. T., Graumlich, L. J., Fagre, D. B., Kipfer, T., & Muhlfeld, C. C. (2010). A century of climate and ecosystem change in Western Montana: what do temperature trends portend?. *Climatic change*, 98(1-2), 133-154.
- Pickering, A. (1992). *Science as practice and culture*. University of Chicago Press.
- Pilkey, O. H., & Pilkey-Jarvis, L. (2007). *Useless arithmetic: why environmental scientists can't predict the future*. Columbia University Press.
- Polley, H. W., Mayeux, H. S., Johnson, H. B., & Tischler, C. R. (1997). Viewpoint: atmospheric CO<sub>2</sub>, soil water, and shrub/grass ratios on rangelands. *Journal of Range Management*, 50, 278-284.
- Popper, K. R. (1959). *The logic of scientific discovery*. London: Hutchinson.
- Proffitt, K. M., Grigg, J. L., Hamlin, K. L., & Garrott, R. A. (2009). Contrasting effects of wolves and human hunters on elk behavioral responses to predation risk. *The Journal of Wildlife Management*, 73(3), 345-356.
- Proffitt, K. M., Cunningham, J. A., Hamlin, K. L., & Garrott, R. A. (2014). Bottom-up and top-down influences on pregnancy rates and recruitment of northern Yellowstone elk. *The Journal of Wildlife Management*, 78(8), 1383-1393.
- Raithel, J. D., Kauffman, M. J., & Pletscher, D. H. (2007). Impact of spatial and temporal variation in calf survival on the growth of elk populations. *The Journal of wildlife management*, 71(3), 795-803.
- Rausch, R. L. (1963). Geographic variation in size in North American brown bears, *Ursus arctos* L., as indicated by condylobasal length. *Canadian Journal of Zoology*, 41(1), 33-45.
- Rehfeldt, G. E., Crookston, N. L., Warwell, M. V., & Evans, J. S. (2006). Empirical analyses of plant-climate relationships for the western United States. *International Journal of Plant Sciences*, 167(6), 1123-1150.
- Rehfeldt, G. E., Crookston, N. L., Sáenz-Romero, C., & Campbell, E. M. (2012). North American vegetation model for land-use planning in a changing climate: a solution to large classification problems. *Ecological Applications*, 22(1), 119-141.

- Reinhart, D. P., & Mattson, D. J. (1990). Bear use of cutthroat trout spawning streams in Yellowstone International Conference on Bear Research & Management, 8, 343-350.
- Rice, J., Tredennick, A., & Joyce, L. A. (2012). Climate change on the Shoshone National Forest, Wyoming: a synthesis of past climate, climate projections, and ecosystem implications. US Forest Service, General Technical Report RMRS-GTR-264.
- Robbins, C. T., Fortin, J. K., Rode, K. D., Farley, S. D., Shipley, L. A., & Felicetti, L. A. (2007). Optimizing protein intake as a foraging strategy to maximize mass gain in an omnivore. *Oikos*, 116(10), 1675-1682.
- Robbins, C. T., Lopez-Alfaro, C., Rode, K. D., Tøien, Ø., & Nelson, O. L. (2012). Hibernation and seasonal fasting in bears: the energetic costs and consequences for polar bears. *Journal of Mammalogy*, 93(6), 1493-1503.
- Rode, K. D., & Robbins, C. T. (2000). Why bears consume mixed diets during fruit abundance. *Canadian Journal of Zoology*, 78(9), 1640-1645.
- Rode, K. D., Robbins, C. T., & Shipley, L. A. (2001). Constraints on herbivory by grizzly bears. *Oecologia*, 128(1), 62-71.
- Romme, W.H., & M.G. Turner (1991). Implications of global climate change for biogeographic patterns in the Greater Yellowstone Ecosystem. *Conservation Biology*, 5(3), 373-386.
- Rosenbaum, P. R. (1984). From association to causation in observational studies: The role of tests of strongly ignorable treatment assignment. *Journal of the American Statistical Association*, 79(385), 41-48.
- Ruzycki, J. R., Beauchamp, D. A., & Yule, D. L. (2003). Effects of introduced lake trout on native cutthroat trout in Yellowstone Lake. *Ecological Applications*, 13(1), 23-37.
- Saarma, U., Ho, S. Y., Pybus, O. G., Kaljuste, M., Tumanov, I.L., Kojola, I., ... & Lyapunova, E. A. (2007). Mitogenetic structure of brown bears (*Ursus arctos* L.) in northeastern Europe and a new time frame for the formation of European brown bear lineages. *Molecular Ecology*, 16(2), 401-413.
- Salomashkina, V.V., Kholodova, M.V., Tuten'kov, O.Y., Moskvitina, N.S., & Erokhin, N.G. (2014). New data on the phylogeography and genetic diversity of the brown bear *Ursus arctos* Linnaeus, 1758 of Northeastern Eurasia (mtDNA control region polymorphism analysis). *Biology Bulletin*, 41(1), 38-46.
- Schlaepfer, M. A., Runge, M. C., & Sherman, P. W. (2002). Ecological and evolutionary traps. *Trends in Ecology & Evolution*, 17(10), 474-480.
- Schrag, A. M., Bunn, A. G., & Graumlich, L. J. (2008). Influence of bioclimatic variables on tree-line conifer distribution in the Greater Yellowstone Ecosystem: Implications for species of conservation concern. *Journal of Biogeography*, 35(4), 698-710.

Schwartz, C. C., Haroldson, M. A., Gunther, K. A., & Moody, D. (2006). Distribution of grizzly bears in the Greater Yellowstone Ecosystem in 2004. *Ursus*, 17(1), 63-66.

Schwartz, C. C., Haroldson, M. A., White, G. C., Harris, R. B., Cherry, S., Keating, K. A., ... & Servheen, C. (2006). Temporal, spatial, and environmental influences on the demographics of grizzly bears in the Greater Yellowstone Ecosystem. *Wildlife Monographs*, 161(1).

Schwartz, C. C., Haroldson, M. A., & White, G. C. (2010). Hazards affecting grizzly bear survival in the Greater Yellowstone Ecosystem. *The Journal of Wildlife Management*, 74(4), 654-667.

Schwartz, C. C., Gude, P. H., Landenburger, L., Haroldson, M. A., & Podrutzny, S. (2012). Impacts of rural development on Yellowstone wildlife: linking grizzly bear *Ursus arctos* demographics with projected residential growth. *Wildlife Biology*, 18(3), 246-257.

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

Shields, G. F., Adams, D., Garner, G., Labelle, M., Pietsch, J., Ramsay, M., ... & Williamson, S. (2000). Phylogeography of mitochondrial DNA variation in brown bears and polar bears. *Molecular phylogenetics and evolution*, 15(2), 319-326.

Simard, M., Powell, E. N., Raffa, K. F., & Turner, M. G. (2012). What explains landscape patterns of tree mortality caused by bark beetle outbreaks in Greater Yellowstone?. *Global Ecology and Biogeography*, 21(5), 556-567.

Sommer, R. S., & Benecke, N. (2005). The recolonization of Europe by brown bears *Ursus arctos* Linnaeus, 1758 after the Last Glacial Maximum. *Mammal Review*, 35(2), 156-164.

Stavros, E. N., Abatzoglou, J. T., McKenzie, D., & Larkin, N. K. (2014). Regional projections of the likelihood of very large wildland fires under a changing climate in the contiguous Western United States. *Climatic Change*, 126(3-4), 455-468.

Stokes, C. R., Tarasov, L., & Dyke, A. S. (2012). Dynamics of the North American Ice Sheet Complex during its inception and build-up to the Last Glacial Maximum. *Quaternary Science Reviews*, 50, 86-104.

Strzepek, K., Yohe, G., Neumann, J., & Boehlert, B. (2010). Characterizing changes in drought risk for the United States from climate change. *Environmental Research Letters*, 5(4), 044012.

Swenson, J. E., Sandegren, F., Brunberg, S., Segerström, P., & Segerstrøm, P. (2001a). Factors associated with loss of brown bear cubs in Sweden. *Ursus*, 12, 69-80.

Swenson, J. E., Dahle, B., & Sandegren, F. (2001b). Intraspecific predation in Scandinavian brown bears older than cubs-of-the-year. *Ursus*, 12, 81-91.

- Syslo, J. M., Guy, C. S., Bigelow, P. E., Doepke, P. D., Ertel, B. D., & Koel, T. M. (2011). Response of non-native lake trout (*Salvelinus namaycush*) to 15 years of harvest in Yellowstone Lake, Yellowstone National Park. *Canadian Journal of Fisheries and Aquatic Sciences*, 68(12), 2132-2145.
- Taberlet, P., & Bouvet, J. (1994). Mitochondrial DNA polymorphism, phylogeography, and conservation genetics of the brown bear *Ursus arctos* in Europe. *Proceedings of the Royal Society of London B: Biological Sciences*, 255(1344), 195-200.
- Teisberg, J. E., Haroldson, M. A., Schwartz, C. C., Gunther, K. A., Fortin, J. K., & Robbins, C. T. (2014). Contrasting past and current numbers of bears visiting Yellowstone cutthroat trout streams. *The Journal of Wildlife Management*, 78(2), 369-378.
- Tercek, M., Rodman, A., & Thoma, D. (2015). Trends in Yellowstone's Snowpack. *Yellowstone Science*, 23(1), 20
- Testa, J. W. (2004). Interaction of top-down and bottom-up life history trade-offs in moose (*Alces alces*). *Ecology*, 85(5), 1453-1459.
- Tranquillini, W. (1964). The physiology of plants at high altitudes. *Annual Review of Plant Physiology*, 15, 345-362.
- US Forest Service (2006). Forest plan amendment for grizzly bear habitat conservation for the Greater Yellowstone area National Forests: Final Environmental Impact Statement. US Department of Agriculture, Forest Service.
- Valdiosera, C. E., García, N., Anderung, C., Dalén, L., Cregut-Bonnoure, E., Kahlke, R. D., ... & Götherström, A. (2007). Staying out in the cold: glacial refugia and mitochondrial DNA phylogeography in ancient European brown bears. *Molecular Ecology*, 16(24), 5140-5148.
- van Manen, F. T., Ebinger, M. R., Haroldson, M. A., Harris, R. B., Higgs, M. D., Cherry, S., ... & Schwartz, C. C. (2014). Re-Evaluation of Yellowstone Grizzly Bear Population Dynamics not Supported by Empirical Data: Response to Doak & Cutler. *Conservation Letters*, 7(3), 323-331.
- van Manen, F. T., Haroldson, M. A., Bjornlie, D. D., Ebinger, M. R., Thompson, D. J., Costello, C. M., & White, G. C. (2015). Density dependence, whitebark pine, and vital rates of grizzly bears. *The Journal of Wildlife Management*, 80, 300-313.
- Vucetich, J. A., Smith, D. W., & Stahler, D. R. (2005). Influence of harvest, climate and wolf predation on yellowstone elk, 1961-2004. *Oikos*, 111(2), 259-270.
- Waits, L., Paetkau, D., Strobeck, C., & Ward, R. H. (1998). A comparison of genetic diversity in North American brown bears. *Ursus*, 307-314.

- Waits, L. P., Sullivan, J., O'Brien, S. J., & Ward, R. H. (1999). Rapid radiation events in the family Ursidae indicated by likelihood phylogenetic estimation from multiple fragments of mtDNA. *Molecular phylogenetics and evolution*, 13(1), 82-92.
- Walther, G. R., Beißner, S., & Burga, C. A. (2005). Trends in the upward shift of alpine plants. *Journal of Vegetation Science*, 16(5), 541-548.
- Warwell, M. V., Rehfeldt, G. E., & Crookston, N. L. (2006). Modeling contemporary climate profiles of whitebark pine (*Pinus albicaulis*) and predicting responses to global warming. *Proceedings of the Conference Whitebark Pine: A Pacific Coast Perspective*, US Forest Service R6-NR-FHP-2007-01, 139-142.
- Weed, A. S., Ayres, M. P., & Hicke, J. A. (2013). Consequences of climate change for biotic disturbances in North American forests. *Ecological Monographs*, 83(4), 441-470.
- Welch, C. A., Keay, J., Kendall, K. C., & Robbins, C. T. (1997). Constraints on frugivory by bears. *Ecology*, 78(4), 1105-1119.
- Wenger, S. J., Isaak, D. J., Luce, C. H., Neville, H. M., Fausch, K. D., Dunham, J. B., ... & Hamlet, A. F. (2011). Flow regime, temperature, and biotic interactions drive differential declines of trout species under climate change. *Proceedings of the National Academy of Sciences*, 108(34), 14175-14180.
- Westerling, A. L., M. G. Turner, E. A. Smithwick, W. H. Romme, & M. G. Ryan. 2011. Continued warming could transform greater Yellowstone fire regimes by mid-21st century. *Proceedings of the National Academy of Sciences*, 108(32), 13165-13170.
- Williams, J. E., Haak, A. L., Neville, H. M., & Colyer, W. T. (2009). Potential consequences of climate change to persistence of cutthroat trout populations. *North American journal of fisheries management*, 29(3), 533-548.
- White, D., Jr., K.C. Kendall, H.D. Picton (1998a) Grizzly bear feeding activity at alpine army cutworm moth aggregation sites in northwest Montana. *Can J Zool* 76: 221-227.
- White, Jr, D., Kendall, K. C., & Picton, H. D. (1998b). Seasonal occurrence, body composition, and migration potential of army cutworm moths in northwest Montana. *Canadian journal of zoology*, 76(5), 835-842.
- White, P. J., Wallen, R. L., Geremia, C., Treanor, J. J., & Blanton, D. W. (2011). Management of Yellowstone bison and brucellosis transmission risk—Implications for conservation and restoration. *Biological Conservation*, 144(5), 1322-1334.
- Wright, G. J., Peterson, R. O., Smith, D. W., & Lemke, T. O. (2006). Selection of northern Yellowstone elk by gray wolves and hunters. *Journal of Wildlife Management*, 70(4), 1070-1078.
- Wyoming Game & Fish Department (2015). Draft Wyoming Game and Fish Department chronic wasting disease management plan. Wyoming Game & Fish Department, Cheyenne.

Wyoming Game & Fish Department (2016). Wyoming Game and Fish Department 2015 Chronic Wasting Disease Surveillance. Wyoming Game & Fish Department, Wildlife Health Laboratory, Cheyenne.

Yu, L., Li, Q. W., Ryder, O. A., & Zhang, Y. P. (2004). Phylogeny of the bears (Ursidae) based on nuclear and mitochondrial genes. *Molecular phylogenetics and evolution*, 32(2), 480-494.

Zager, P., & Beecham, J. (2006). The role of American black bears and brown bears as predators on ungulates in North America. *Ursus*, 17(2), 95-108.



## Attachment 2. Primer on Nutritional Ecology of Bears

to accompany

David J. Mattson, Ph.D., Wyoming Wildlife Advocates, Comments on the US Fish & Wildlife Service proposal to remove grizzly bears in the Yellowstone ecosystem from the list of endangered and threatened wildlife protected under the US Endangered Species Act (ESA); Federal Register 81(48): 13174-13227; And Related Materials

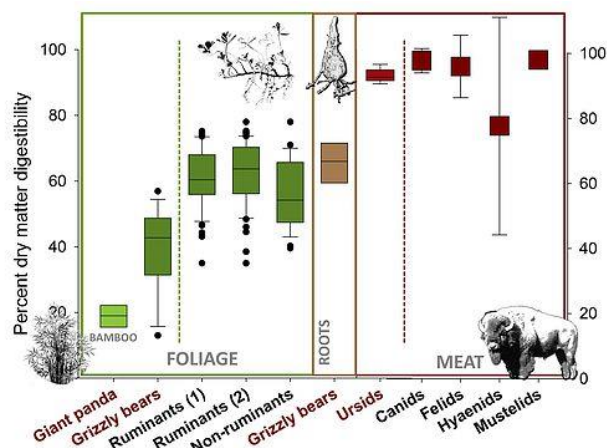
### Digestion

Bears are omnivores, which simply means that they eat a varied diet potentially comprised of either almost wholly meat or almost wholly vegetation. Yet they have the simple monogastric digestive tract of a carnivore lacking specialized chambers able to sustain anaerobic fermentation by symbiotic microbes. More to the point, they lack a rumen and a cecum, although there is evidence of some microbial fermentation in the bears' simple large intestine. As a result, they obtain little nutritional benefit from the fiber that they ingest. This fiber can comprise 10-30% of the foliage they graze or browse, which means, in turn, that their most digestible foods consist of those rich in either digestible protein or fat or containing high concentrations of simpler carbohydrates such as fructose, sucrose, or starch.

### Comparative digestion in bears & herbivores

Figure 1 illustrates the general digestive plight—or strategy—of bears in contrast to fore- and hindgut fermenters (i.e., ruminants and non-ruminants), as well as in comparison to other carnivores. This graph illustrates the relative digestibility of several broad categories of foods by bears and other taxa (with percent digestibility shown as medians and interquartile ranges). For the purposes here, bears are parsed out in different ways, with giant pandas and grizzly bears differentiated for illustrating digestion of foliage and roots, and all bears lumped together as "ursids" for illustrating digestion of meat. These data come from multiple sources.

The basic patterns are pretty obvious. Bears are as well able as any other carnivore to digest most of the meat they eat—around 90% plus. By contrast, grizzly bears digest roughly 20% less of the foliage they consume compared to ruminants and 10% less when compared to non-ruminant herbivores. Starchy roots are digested by grizzly bears with about the same efficiency as foliage is digested by ruminants—which makes roots a comparatively beneficial vegetal food for bears, at least when reckoned simply in terms of digestibility.



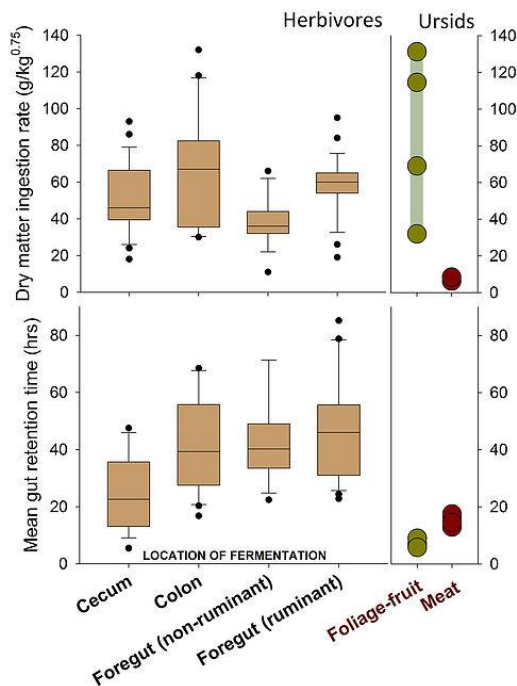
**Figure 1. Percent dry matter digestibility of different types of foods by mammals of different higher-order taxa.**

But the other key element of a digestive strategy is not just how well an animal can digest a given gram of ingested food, but also how many grams are being ingested in total. In other words, an animal can compensate to some extent for low digestibility by increasing the throughput of ingested food, which seems to be the strategy adopted by bears, especially giant pandas.

Figure 2 illustrates this pattern. Again, broad categories of animals are differentiated with non-ruminant herbivores separated by whether most fermentation of fiber occurs is the cecum versus the colon. Bears (i.e., ursids) are differentiated by whether they are ingesting foliage and fruit versus wholly meat. The top graph shows the rate at which these different types of animals ingest food, standardized to metabolism-corrected body mass, whereas the bottom graph shows the mean time that digesta is retained in the digestive tract (i.e., gut; the inverse of the rapidity of transit).

All of this suggests that, when possible, bears ingest vegetal material at a higher rate and retain it for a far shorter period of time compared to specialized

herbivores, especially in contrast to foregut fermenters (i.e., ruminants). This would partly compensate for the lower efficiency with which bears digest most vegetal food. By contrast, bears ingest meat at a slow rate and retain it for roughly twice as long as they do their vegetal food. For the high digestibility of meat to be realized, bears probably need to retain it longer in the digestive tract, but still not as long as herbivores dependent on fermentation retain foliage or browse. Meat also probably passes through the gut more slowly simply because there is less accompanying fiber to hasten it along compared to when bears eat vegetation.

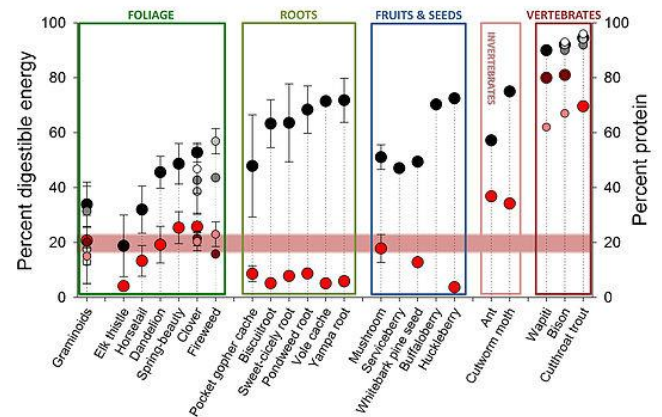


**Figure 2. Ingestion rates and transit times for digesta by mammals with different digestive adaptations and by ursids eating meat versus vegetal foods.**

The implications of these patterns for bears and bear foraging seem pretty obvious. Bears should prefer meat whenever they can get it, at least until sated, and up until a need to balance nutrient intake comes into play. Beyond that, roots (and berries) should be preferred vegetal foods, but only if the energy required for acquisition does not unfavorably alter the overall energetic equation—which, in the case of roots, is probably often the case because of the potentially considerable costs of excavation. Finally, bears should be able to profit from grazing only when they have access to large amounts of readily acquired and comparatively digestible foliage. And, as shown below, digestibilities of foliage can vary widely, not only among sites, but also among plant species and seasons.

## Specific foods

In keeping with the broad patterns described above, the digestibilities of specific bear foods vary widely. Emblematic of this, Figure 3 shows the percent of energy contained in different foods that is digested by grizzly bears (the black, gray, and white dots). The varying shades of gray, from black to white, correspond to digestibilities during different seasons in instances where there is documented seasonal variability: black for spring, dark gray for estrus, light gray for early hyperphagia, and white for late hyperphagia. The reddish dots represent the percent of each food that is comprised of protein, again with seasonal variation denoted by varying shades: bright red for year-round or spring values; burgundy for mid-season; and white for late-season. All of these foods are specific to the Yellowstone ecosystem.



**Figure 3. Percent digestible energy and percent protein for different grizzly bear foods common to the Yellowstone ecosystem.**

Meat from any source is more digestible than other types of food. Roots, insects, and fruits and seeds are of comparable digestability, but with roots and fruits offering far less protein. Most of the digestible energy in these vegetal foods is contained in sugars and starches, with the proviso that much of the protein in ants, in particular, is bound up in chitin. Finally, the digestible energy in foliage varies widely, with forbs such as clover, fireweed, and dandelion offering the most, and elk thistle, horsetail, and grasses and sedges (i.e., graminoids) the least.

As a final note on Figure 3: The pinkish horizontal band corresponds to the optimal level of protein in bear diets; the point being that grizzlies would be hard-pressed to maintain an optimal level of protein intake if they subsisted solely on vegetal foods, especially roots, fruits, and seeds.

## Protein & Energy Effects

Nutrition obviously entails more than just the digestibilities of different foods. The absolute and relative amounts of various macronutrients (e.g., proteins, lipids, and carbohydrates) are critical elements of nutrition, as are the absolute and relative amounts of digestible energy. Even though all of these additional nutrient-related aspects of nutrition are correlated with the digestion of various foods in the gut, there are additional consequences that play out through metabolic processes involved in the creation and use of body protein, fat, and glucose--i.e., protein biosynthesis and proteolysis, lipogenesis and lipolysis, and gluconeogenesis and glycolysis. Moreover, the density of digestible energy in foods matters for reasons that transcend simple nutrient composition. Resting metabolism varies widely in close synchrony with nutrient-specific processes and related energy expenditure--with consequences for levels of heat production in the body (i.e., thermogenesis).

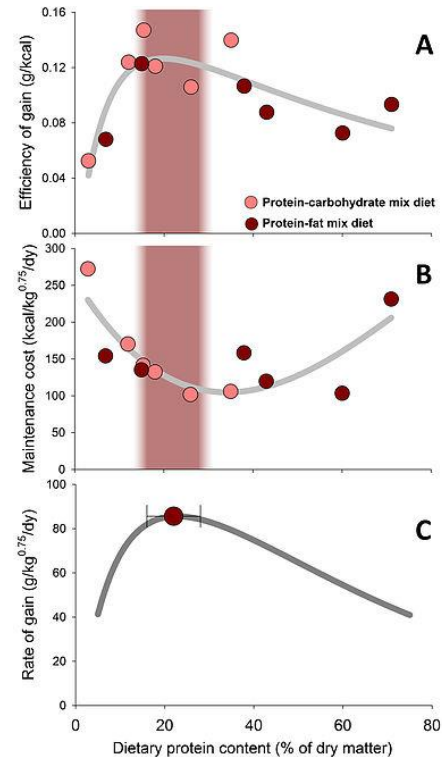
The net result of all of this is not only variation in the efficiencies of energy, protein, lipid, and glucose metabolisms, but also variation in the composition, efficiency, and total level of body mass accretion or loss. Different combinations of relative and absolute amounts of protein, fat, carbohydrates, and digestible energy in the diet can determine whether an animal gains or loses body mass, and whether that mass gain or loss is comprised of lean body mass or fat reserves.

With respect to bears, then, this amounts to a lot of complexity when it comes to understanding the ramifications of different diets.

### Efficiencies, protein, & growth

Given that a bear eats a diet containing ample digestible energy (say 800 kcal per kg raised to the 0.75 power per day), it turns out that there can be both too little and too much protein when it comes to efficiencies of gain in body mass. The graphs in figure 4 are relevant to this point, adapted from those in a paper on which Joy Erlenbach was lead author—a paper in which she synthesized a lot of research specific to bear nutrition. Each figure features a bunch of dots of two different colors corresponding to the metabolic and accretional consequences for bears fed diets comprised

of different macronutrients, including diets rich in protein or carbohydrates (salmon colored) as well as diets rich in protein or fat (burgundy).



**Figure 4. Effects of dietary protein content on (A) efficiency of mass gain, (B) energetic maintenance costs, and (C) rate of mass gain by grizzly bears fed diets of different protein content.**

The main points? The top figure (A) shows that the efficiency of weight gain rises rapidly to a peak as diet protein increases from roughly 1% to 15% and then gradually declines, all of this with the density of diet energy remaining roughly the same. Correspondingly, the middle figure (B) illustrates a decline in resting metabolism (i.e., energetic costs of maintaining the body) as diet protein increases from 1% to roughly 30%, after which maintenance costs increase. When you put these two trends together you get the bottom figure (C) which shows the predicted total rate of gain per kg of body mass, standardized to the expected basal metabolic rate for carnivores (i.e., raised to the 0.75 power); a rapid rise as diet protein increases, followed by a steady decline.

It turns out that the predicted level of diet protein at which rates of gain in body mass peaks (roughly 21%) corresponds almost exactly with the mean diet protein content of diets selected by bears when given a free choice of what to eat (22% plus or minus 6%)--shown by the large burgundy dot and horizontal error bars in figure 4C.

From this a person could conclude that the optimal protein content of a bear's aggregate diet is around 22%, at least as far as growth of body mass is concerned--and without considering whether that growth is primarily in terms of lean body mass or fat; but with some important provisos. This rule of thumb for diet protein holds for a given energy concentration in the diet (in this case, around 800 kcal/kg 0.75/day) and for bears of intermediate body size. But bear size does affect nutrition in several ways, as does energy concentration of the diet (see below).

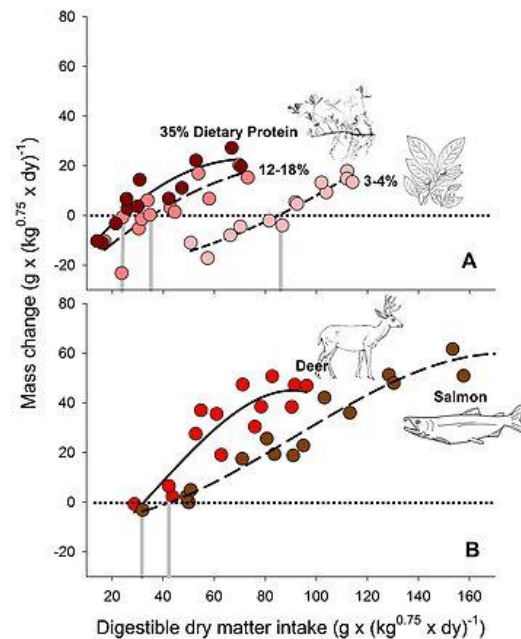
This all begs the question of why a diet protein content of around 20% yields greater growth rates than, say, 60%--all of this, of course, standardized to a given volumetric intake and to the metabolic rate expected at a given body mass. As a start, all else equal, elevated diet protein causes greater heat production in the body compared to elevated carbohydrates or fats. This thermic effect is called diet-induced thermogenesis (DIT). Much of this elevation in metabolic rate (as shown in figure 4B, above) is attributable to the thermic properties of protein synthesis, including increased heat production and reduced energetic efficiency. Depending on total diet composition, some of the increased heat production associated with a high-protein-content diet can be attributable to heightened formation of glucose (gluconeogenesis) above and beyond what would occur with a high-carb diet.

What about the effects of too little protein? Generally speaking, if a bear's diet is deficient in protein, it compensates by increasing the volume of intake, usually of foods rich in carbohydrates (think berries and roots; see Digestion). But the results above pertain to an isocaloric intake, that is, a constant or equal intake of calories. So the results explicitly pertain to differences in diet composition, not amount of energy intake. As figure 4B above shows, the metabolic rate of bears fed a low-protein diet increases substantially, which, because of the resulting increased energy expenditure, leads to decreased absolute and relative rates of gain in body mass. Why? Ultimately, because an increased proportionate consumption of fats or carbohydrates when bears are fed a diet low in protein leads to a chain of energy consumptive phenomena. The sympathetic nervous system is stimulated, which increases production

of the hormone norepinephrine, which stimulates brown adipose tissue metabolism, which results in an elevated metabolic rate; in the end, more energy expenditure and less weight gain.

## Intake, protein, and growth

At this point it is worth looking at what happens (unlike above) when the amount of dry matter ingested and digested by bears varies, adding to this variation in diet protein content. And, of course, the complement to variation in diet protein is complementary variation in diet fat or carbohydrates.



**Figure 5. Change in mass of bears feed diets of different protein content as a function of total digestible dry matter intake.**

The graphs in figure 5 summarize the results of several studies done in Charlie Robbins' lab, unified by a design that allowed bears to eat different amounts of digestible dry matter (the horizontal or x axis) while measuring responses in terms of change in body mass--i.e., growth (the vertical or y axis). All of this is standardized to the metabolism-corrected mass of the involved bear and considers diets with different amounts of protein, ranging from berries (3-4%) to deer and salmon (nearer 70% or more). In addition to the data points and curves describing the response in mass gain to variation in dry matter intake I've also benchmarked where each curve transitions from mass loss to mass gain (the vertical gray line).



The basic patterns are pretty obvious. In all instances weight gain tends to plateau (i.e., tends towards an asymptote) as intake increases. At some point, increased intake does not yield increased mass gain; the bears reach the limits imposed by internal metabolic processes. But this plateau is considerably higher (45-60 g per kg raised to 0.75 per day) for meat diets (B) compared to vegetal diets (nearer 20 g; A). Even so, the transition from weight loss to weight gain is similar (around 20-40 standardized ingested grams) for meat diets and vegetal diets having at least 12-18% protein content, the latter of which is within the lower range of optimal (see above). The biggest deviant is the low-protein-content diet comprised of berries. Weight gain only occurs when the standardized volumetric intake is high--in excess of 80 g, which is roughly 2-4 times higher than for other diets.

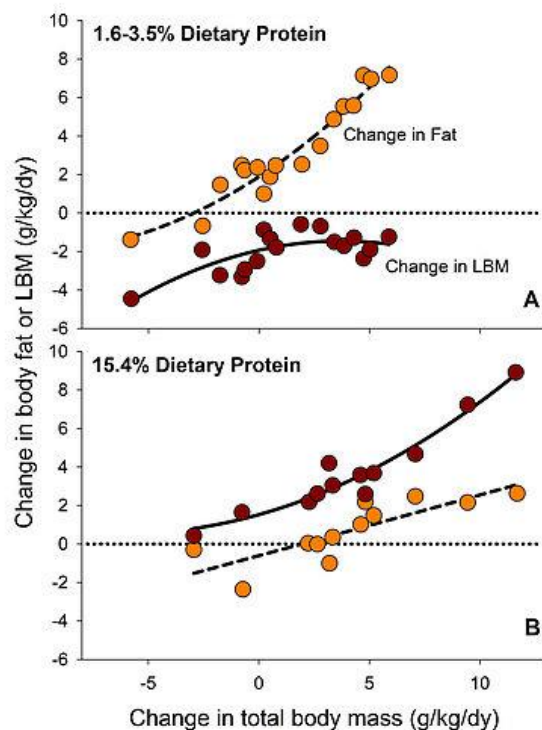
The implications? Even given the standardized metabolic inefficiencies associated with a protein-rich diet shown in figure 4, bears can grow much more rapidly on such a diet, especially if they have access to large volumes. The most notable example of this circumstance would be along salmon spawning streams during the height of spawning runs, which is why we see very large coastal brown bears. By contrast, bears with access primarily to berries have to eat relatively large volumes to gain mass and, even so, the potential for growth is relatively limited. This holds for bears in the interior regions of British Columbia, northeast Washington, northern Idaho, and northwest Montana. One important proviso to all of this is that there is no distinction made regarding the tissues in which weight gain occurs, principally whether in fat or lean body mass, which introduces the next topic.

### Intake, protein, energy, & composition of growth

So a key question is whether the location of accreted (or lost) of body mass is as fat or lean tissue. Of relevance to this question, the graphs in figure 6 show differences in allocation of gain (or loss) for diets of two different protein contents: a berry diet comprised of 1.6-3.5% protein in A, and a mixed diet comprised of 15.4% protein in B. The red dots and associated trend line show changes in lean body mass (LBM) for each diet; the orange dots and associated trend line, changes in body fat.

All of the gain in body mass at a very low diet protein is as fat (A), whereas the majority of gain at moderate diet protein is in lean body mass (B). Moreover, bears eating a very-low-protein diet consistently lose lean body mass, which is an untenable situation. An important note: These patterns are as much a reflection of the fact that a

vegetal diet low in protein (as in A) is necessarily rich in carbohydrates, whether glucose, sucrose, or starch (see [Digestion](#)). So the patterns in these figures reflect not only protein metabolism but also metabolic processes associated with varying concentrations of digestible carbohydrates, especially related to lipogenesis and protein biosynthesis.

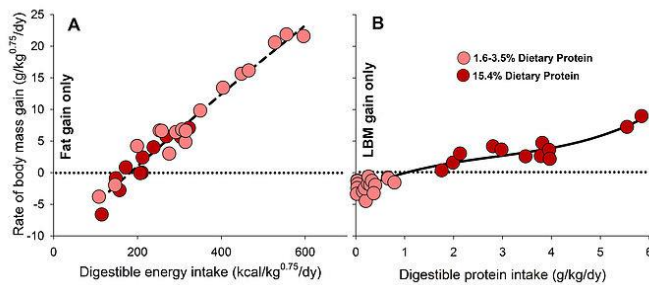


**Figure 6. Change in lean body mass and body fat of bears fed diets of different protein content.**

The implication? If a bear, eat a diet rich in carbohydrates and get fat while potentially losing lean body mass. Admix some amount of protein in the diet and you will maintain if not gain lean body mass. So a carbohydrate-rich diet with enough protein to maintain LBM makes more sense for a female needing to put on fat to reproduce; protein more sense for a male needing to grow physically large, which fits [patterns of dimorphism](#) among bears.

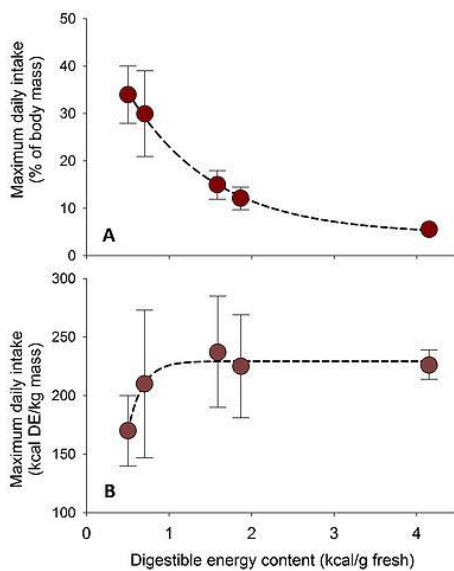
So now bring *diet energy*, as such, into the picture, and slightly recast the dynamics of total intake per day, at least for protein. Figure 7 shows the relation between standardized accretion of body fat and standardized ingestion of energy--regardless of the contributing macronutrient. And this for various diets comprised of very low (1.6-3.5%, the pink dots) and closer to optimum (15.4%, the red dots) concentrations of protein. In short, as intake of energy increases, so does accumulation of body fat. But more importantly, bears tend to gain more

body fat (as above) on diets low in protein content, which is tantamount to saying on diets rich in either carbohydrates or fats. In fact, high-fat diets contain the highest concentrations of digestible energy, which translates into high rates of body fat gain.



**Figure 7. Rate of body mass gain standardized to metabolic rate as a function of total digestible energy and digestible protein intake for diets of two different protein compositions.**

Figure 7B complements figure 7A by showing rates of lean body mass gain related to the total intake of digestible protein--with both values standardized. Not surprisingly, the more protein that a bear ingests and digests, the more lean body mass it accretes, with highest rates of both associated with diets containing a higher concentration of protein. And, as in the figure 6, protein intake on diets very low in protein content (1.6-3.5%, e.g., berries) does not allow even for maintenance of LBM. By contrast, the rate of LBM gain is remarkably high (8-9 grams per kg of body mass raised to the 0.75 power) at the highest rates of protein intake (around 6 grams per kg of body mass); in other words, in excess of a 1:1 translation.



**Figure 8. Maximum daily intake of digestible energy as a function of dietary digestible energy concentration.**

Figure 8 illustrates an interesting phenomenon. Even when bears eat a diet increasingly rich in calories, overall intake of energy, standardized to body mass, doesn't correspondingly increase, especially once a threshold of 1 kcal of digestible energy per gram of fresh food is reached. This is most clearly illustrated in figure 8B; figure 8A shows the same trend standardized to body mass as percent of total mass.

Just to be clear, larger bears can and do ingest more absolute amounts of digestible energy during a given day, even as the digestible energy in the food they eat increases from 1 to 2 and even 4 kcal per gram. The point is that the energy *per kg of mass* doesn't increase and, as a percentage of total mass, even decreases, which pertains to efficiencies as much as anything.

To put this another way, a diet richer per gram in digestible energy--as would be the case with a diet rich in fat or protein--doesn't necessarily translate into a lot more digested energy for any kg of mass that a bear might be carting around. Related back to [digestion](#), this pattern fits the much lower rates of transit and accompanying higher rates of digestion for ingested food for bears fed a diet of meat.

I conclude this section on the effects of nutrients, per se, with a few points that are either not adequately encompassed by the data presented above or that simply need additional clarification, and then end by quoting an elegant synopsis of nutritional fundamentals for bears that was included by Joy Erlenbach in her 2014 paper.

First, diets comprised solely of fruit are a potential problem for bears, especially if the involved bear is large in size. The low protein content and high glucose or fructose content of fruit diets require bears to eat exceptionally large volumes just to maintain LBM, but with resulting high rates of energy intake. This energy either needs to be dissipated as heat (diet-induced thermogenesis) or converted to body fat through lipogenesis, which is notably elevated on diets rich in fructose--one of the main sugars in blue- and blackberries. Large bears are notably much less efficient than small bears at harvesting any given concentration of fruit, which means that mass standardized consumption of fruit is maximized for large bears at rates far less than what they need to meet protein and even energy requirements. Hence, fruit-eating is more often a strategy of smaller bears or bear species (e.g., juveniles, females, and black bears) than it is of those that are larger (e.g., adult males and grizzly bears; for more on

the implications of size see Foraging efficiency and Body mass effects below).

Second, bears prefer fat-rich foods and diets. In instances where captive bears had free access to diets of different composition they ended up eating diets from which they obtained roughly 68% of metabolisable energy from fats. Fats provide the highest concentrations of digestible energy of all macronutrients and are, in turn, the most efficiently converted of any to body fat. And ample body fat, to the point of obesity, is a center-piece of the bear life strategy. Moreover, unlike diets rich in protein or carbohydrates, diets rich in fat do not trigger auto-regulatory reductions in intake, which also contributes to high rates of body fat accumulation on high-fat diets. Or, put another way, diets comprised mostly of protein or carbohydrates are not optimal for most bears.

Third, related to the points immediately above, bears are energy maximizers. In fact, as noted by Joy Erlenbach,

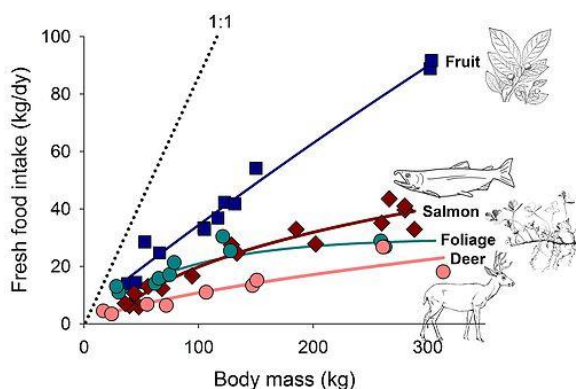
bears exhibit some of the highest levels of standardized energy intake observed for any mammal. When offered unlimited access to food these rates can be twice what some early researchers such as James Kirkwood considered to be the maximum rate likely or possible, and up to 18 times greater than the expected basal metabolic rate for carnivores, which is a lot of energy.

In conclusion, quoting Joy Erlenbach, bears live by three "rules" when it comes to intake of energy and nutrients:

- (1) Maximize energy intake while optimizing dietary protein intake.
- (2) Select lipids over digestible carbohydrates, which reduces dietary protein while maximizing food energy density.
- (3) If lipids are not available, use digestible carbohydrates to optimize diet protein.

## Body Mass Effects

The relationship shown in figure 9 is an interesting and compelling introduction to the effects of body mass on foraging efficiencies and weight gain of bears. Each dot represents the results of a controlled experiment involving one bear allowed free access to different kinds of foods. All of these data, again, are thanks to research by Dr. Charles Robbins and his graduate students at Washington State University.



**Figure 9. Total ad libitum fresh food intake as a function of mass of the involved bear.**

At one level, figure 9 shows something that might be considered self-evident: larger bears tend to ingest greater volumes when given unlimited access to food. But, then, they would need to given their greater

energetic needs, even accounting for the lower rate at which metabolic needs increase relative to each increment of body mass (at roughly the 0.75 power). Energy consumption, even at rest, increases nonetheless.

But the interesting thing is that the rate at which intake increases varies substantially among foods, but especially for berries in contrast to everything else. You might expect intake of protein-rich foods such as deer or salmon to increase at a lesser rate as body mass increases. Each gram of such a food delivers a substantial amount of digested energy entailing a comparatively slow rate of passage through the gut, with gut length and passage rate scaling at less than a 1:1 rate with body size (see [Digestion](#)). And intake of deer is probably less than intake of salmon at any given body mass because of the comparatively greater effort required to process a gram of tissue from a deer compared to a more easily ingested and chewed gram of fish.

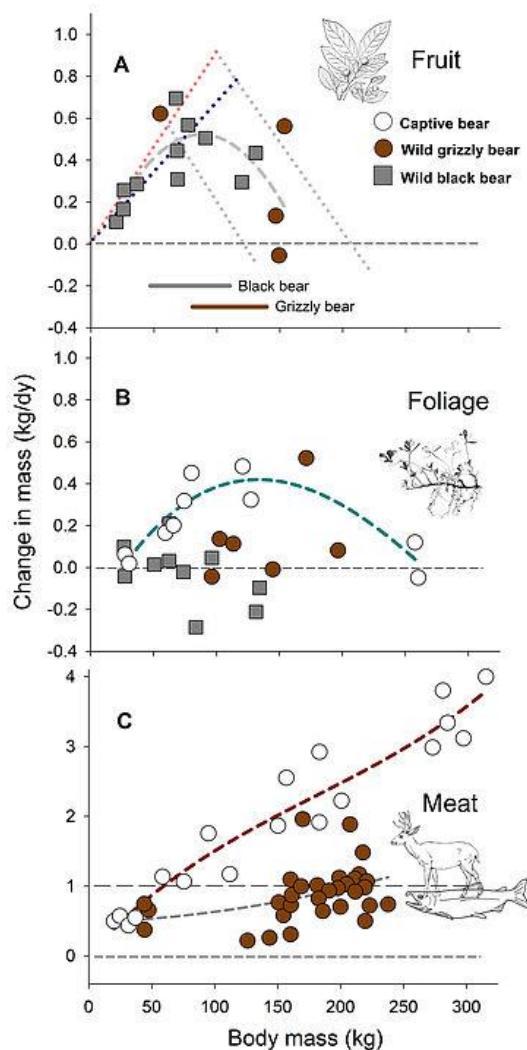
It would be reasonable to expect that intake of foliage would increase at roughly the same rate as intake of berries given that both of these are vegetal foods. So, why is the intake of foliage so depressed compared to berries for large bears? For the answer, see the section below on [Foraging Efficiencies](#). But, in short, when bears graze, ingestion is partly limited by the time it takes to chew a mouthful of fibrous foliage, which means that bite rate drops as a function of bite size; which means

that bears need large standing volumes of tall-statured foliage to increase total ingested volumes in defiance of the limits imposed by chewing time--which rarely happens.

Insofar as berries are concerned, figure 9 only pertains to bears offered unlimited access to food. Which begs the question of why such large volumes are ingested as body mass increases? Unlike with foliage, processing time for berries, once ingested, is not of great consequence. Moreover, bears are highly motivated to ingest large volumes of protein-deficient berries (see Digestion) in an effort to meet their protein requirements, but with a resulting glut of digested energy which is either expended as heat or stored as body fat (see the section above on Protein and Energy Effects).

But where things get really interesting is when you look at per day rates of gain in body mass as a function of bear size--especially under circumstances where the involved bears did or did not have access to unlimited amounts of different kinds of food.

The graphs in figure 10 summarize this relationship for a number of individual bears that ate fruit (A), grazed foliage (B), and consumed meat from either deer or salmon (C). The open circles denote the results for captive bears; the brown dots, results for grizzly bears in the wild; and the gray squares, for black bears in the wild. Importantly, the captive bears had access to unlimited amounts of the various foods, whereas the wild bears typically did not.



**Figure 10.** Daily change in body mass as a function of beginning body mass of the involved bear for (A) fruit, (B) foliage, and (C) meat, differentiating salmon (open dots) from deer (solid brown dots).

Going over these graphs in reverse order, from bottom to top starting with meat: notice that, unlike with foliage and fruit, the trend lines for captive (dotted) and wild (solid) bears increase without reaching a plateau or peak, which means that bears are able to grow increasingly large even as their body mass increases. When fed unlimited amounts of meat, these gains can be phenomenal--upwards of 4 kg per day for a 300 kg bear. Moreover, no bear lost body mass eating a diet comprised mostly of meat. And, it is worth emphasizing that these gains were mostly as lean body mass, and despite the depressed per kg energetic efficiencies of a high protein diet (see Protein and energy effects).

With foliage, it is perhaps not surprising that a number of wild bears seemed to lose body mass when subsisting almost wholly on such a food. Foliage is not very nutritious or digestible (see Digestion). No wild bear but one gained much weight. But, the important trend is the one documented for captive bears with access to unlimited amounts of foliage (the dashed line). These captives were able to gain weight up until around 125 kg of body mass, after which gains declined, even into negative territory around 250 kg. In other words, the modest increases in ingested volumes of foliage that occurred at large body masses (see above) could not offset the increased energetic needs of a large bear, even given a less than 1:1 scaling of unit volume metabolic rate with body mass.

Something very similar was evident for wild bears subsisting on berries. Gains increased, peaking for bears of around 100 kg mass, and thereafter declined, even into negative territory for one c. 150 kg grizzly. To explain this pattern requires additional explanation of figure 10A. The ascending dotted red and blue lines denote the theoretical maximum rates of gain for bears eating unlimited quantities of serviceberries and huckleberries;



that is, for captive bears. But this theoretical maximum is obviously not achieved, primarily because of the limits imposed by foraging inefficiencies under field conditions; for example bite sizes and bite rates. These limits are described by the descending gray lines--the farthest left associated with a bite size of 1.7 berries and a bite rate of 55 per minute, the farthest right with a bite size of 2.5 berries and a rate of 90 per minute. The point being that foraging efficiencies take a major toll on what bears can realize from eating berries, with major implications for even modest-sized bears. Notably, though, at peak, daily gains for wild bears eating berries were over three times greater than gains for wild bears eating foliage: roughly 0.5 versus 0.15 kg per day.

There are some important implications of all this: Most important, if you are a bear weighing much in excess of 100 kg, weight gains are going to be greatest on a meat diet, not a berry or foliage diet. And much of these gains will be in lean body mass (see [Protein and energy effects](#)). So, given the consistently greater size of adult males compared to other bears--typically in excess of 150

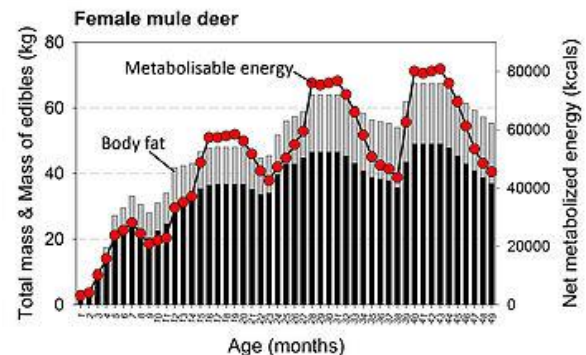
kg--you would expect adult males to eat disproportionate amounts of meat, which is indeed the case. And, adopting such a strategy, you would expect males to grow ever larger over time, which seems to be the case as well. But all of this is with an important proviso: If you are female weighing somewhere between 100-150 kg, rates of body fat accumulation will probably be greatest on an energy-rich but protein-poor berry diet, as long as you can eat large volumes, closer to 2.5 berries per bite, at 90 bites per minute.

One important additional proviso: None of the graphs above deal with foods rich in fat, but containing adequate protein. More concretely, we don't have a clear picture of the nutritional benefits entailed for bears eating army cutworm moths and whitebark pine seeds: two of the most important bear foods in the Yellowstone ecosystem. Even so, it is not too hard to imagine that these foods are among the best bear foods of all.

## Diet Meat Effects

Meat is handy shorthand for denoting a food comprised mostly of protein and fat. As I describe in the section devoted to [digestion](#), protein and fat are the most digestible of all nutrients and, because of that, the essential ingredients of an energy-rich diet. Put a slightly different way, meat is the most concentrated form of protein and fat commonly eaten by bears. Given that we can only rarely directly measure the nutrient composition of bear diets, it is useful at times to use the fraction of meat (or berries, for that matter, to denote little protein) as a proxy and, from that, get a general sense of how a protein- and energy-dense diet affects outcomes such as body size and female reproduction, which is what I address below.

It is worth noting that not all meat is equal. Fractions of water, protein, and fat vary with the season and from prey animal to prey animal. Emblematic of this variability, I've created a summary in figure 11 of variation in the mass of edibles, including body fat and metabolisable energy, for a representative source of meat: female mule deer.



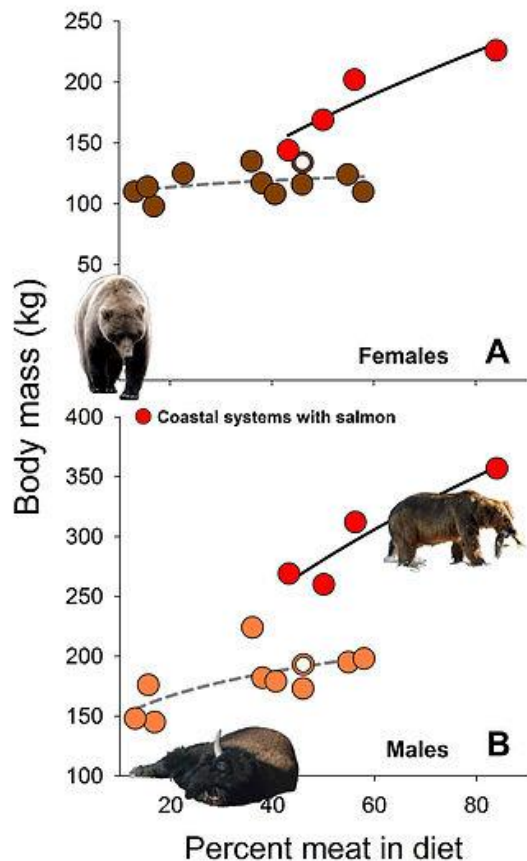
**Figure 11. Total mass, amount of fat, and total metabolisable energy of female deer carcasses as a function of deer age.**

The amount of edibles increases (obviously) with animal age, up to around age 4 in the case of mule deer; the fraction of body fat varies with the season; and, with all of this, the amount of metabolisable energy available to a carnivore such as bears varies substantially seasonally and with age of the prey animal.

The graphs in figures 12 and 13 show data that I assembled from North American study areas reporting both the body mass of grizzly bears captured for research purposes as well as information sufficient to determine the percent of the bear diet that was

comprised of meat. On the meat front, Garth Mowat was the primary source, based on either direct measures or estimates derived from interpolation of one form or another. I differentiate adult males from adult females, and areas where bears had access to abundant spawning salmon from those where the primary source of meat was land-dwelling herbivores. I also denote the Yellowstone area with a white-centered dot.

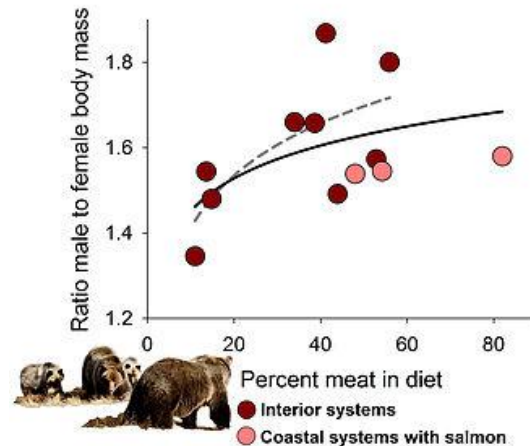
Figure 12 shows trends towards larger size among populations of grizzlies that consume more meat, but more so for males than for females. The trend among females that eat terrestrial meat is barely discernable, and that of salmon-eating bears is substantially greater than the trend among populations of grizzlies that eat terrestrial herbivores.



**Figure 12. Population-averaged body mass of female (A) and male (B) grizzly bears as a function of population-averaged meat in the diet.**

Figure 13 shows an increase in the ratio of male body mass to female body mass as the percentage of meat in the collective bear diet increases. In other words, size dimorphism of the sexes is greater where bears eat more meat, especially terrestrial meat (the burgundy dots). This is just a different way of representing the lesser

response of females versus males to increasing amounts of dietary meat, noting, again, that the trend is greater among interior versus coastal salmon-eating populations. The dampened trend for all populations, including coastal ones, is shown by the solid line whereas the trend for interior populations alone is shown by the dashed line.



**Figure 13. Ratio of population-averaged male and female body mass as a function of population-averaged meat in the diet.**

The different responses of males versus females and of coastal versus interior populations to increased dietary meat beg for explanation. I can only speculate, but I suspect that differences between the sexes have to do with differences in diet within any given population, as well as differences in sex-linked physiological responses to dietary protein--all driven, in turn, by differences in the reproductive strategies of male versus female grizzlies.

More specifically, although responses of the two sexes to dietary protein have not been explicitly studied (or at least reported) for bears, we do know a fair amount about this phenomenon in two other omnivores: swine and humans. In both *Sus scrofa* and *Homo sapiens*, males and females fed the same amount of protein differ in the efficiency with which they accumulate lean body mass. Not surprisingly, males are more efficient than females. So if such were true for bears as well, this phenomenon could plausibly contribute to the greater population-level response of male versus female grizzly bears to elevated dietary meat.

Moreover, study after study has shown that, on average, male grizzlies eat more meat compared to female grizzlies in any given population. This could partly be a result of motivation and resulting dietary preferences. It could also partly be the consequence of on-average larger males being better able to dominate a

concentrated food source, as is typical of packages of meat. So, differences in diet between males and females could also explain some differences in population-averaged body size between the sexes.

But what about the differences between coastal and interior ecosystems; between areas with spawning salmon compared to areas without? As I describe in the section devoted to the effects of diet protein, bears fed as much salmon as they can eat can grow to a much larger size (albeit at a slower rate) compared to bears fed deer. As the research in that section also shows, a diet exceedingly rich in protein (as would be the case with

salmon) actually leads to less efficient accretion of body mass. But this lesser efficiency (as perhaps manifest in the lesser rate of gain among salmon-fed bears) can be more than offset by access to large volumes of food, as would certainly be the case--and for sustained periods of time--in most of the Pacific coastal areas with multiple runs of spawning salmon. So, the point here is that the greater response of population-averaged body mass to increasing dietary meat among grizzlies with access to salmon may simply be a consequence of these bears having access to a veritable glut of energy-rich food perhaps more than it has anything to do with protein content of salmon, as such.

---

## Foraging Efficiency

The rate at which a bear of a given size can ingest, masticate, and swallow food is a critical aspect of nutrition. It sets the stage for how much can be passed through the gut, which is particularly important when it comes to vegetal foods. Bears depend upon passing large volumes of foliage through their digestive tract if they are to stay ahead energetically when eating such a fibrous food (see [Digestion](#)). And, when it comes to berries and roots, they likewise need to ingest large volumes to compensate for the very low protein content of these foods--but with the derivative benefit of ingesting relatively high concentrations of digestible energy (see [Protein & energy effects](#)).

Given this imperative to ingest large volumes when bears eat vegetal foods, it is with such foods that the consequences of fine-scale variation in foraging efficiency are starkest--at the scale of bite size and bite rate, which is why researchers such as Charlie Robbins and Lisa Shipley have focused on berries and foliage in their investigations of foraging efficiency by bears. And it is their research that I feature here, most of which was executed under Dr. Robbin's tutelage by Christy Welch and Karen Rode.

### Effects of forage density & stature

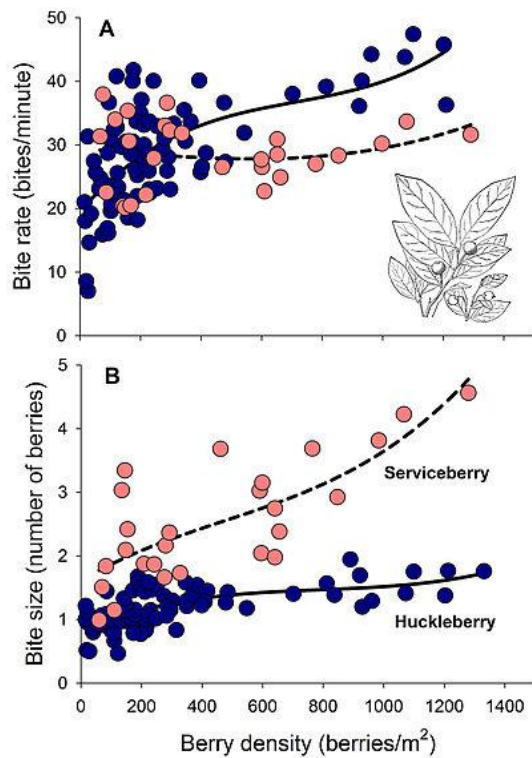
Figure 14 shows the effects of berry density on the size and rate of bites by bears. Bite rate and size are perhaps self-evidently the two immediate determinants of the total rate at which food is ingested, at least as far as the mouth cavity. After that, the rate and efficiency of mastication take over; e.g., chewing.

The two graphs in figure 14 feature two berry-producing species that are of widespread importance to bears: serviceberry (*Amelanchier alnifolia*; salmon-colored dots)

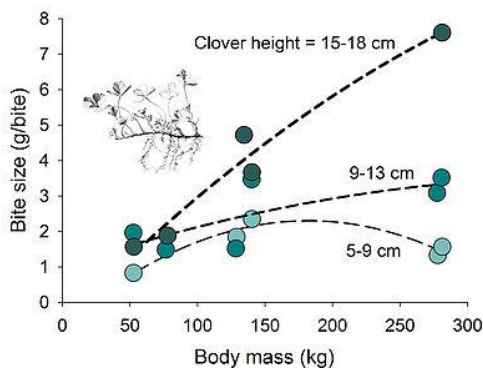
and huckleberry (*Vaccinium membranaceum*; blue dots). There are substantial differences between these two species in how berries are presented to a potential forager. Serviceberries grow in attenuated terminal bunches which allow large-mouthed foragers such as bears to harvest multiple berries in a single bite. By contrast, huckleberries tend to grow singly and dispersed, which means that bears need to employ a strategy of taking numerous small bites that are often contaminated with the accompanying detritus of leaves.

These morphologic differences are clearly evident in the relations of bite rate (A) and bite size (B) to variations in berry density for each species, where each dot represents one feeding trial involving a single bear. Put succinctly, bite size, but not bite rate, increases substantially as densities of serviceberries increase. The opposite is true for huckleberry. Bite rate, but not bite size, increases with density. More to the point, different strategies are imposed on bears by physical configurations of the berries they eat. As a result, morphologic features are as important as digestible energy in determining the overall energetic benefits of exploiting different patches of berries.

The same is true for grazed foliage. Figure 15 shows how bite sizes of clover vary with both the size of the involved bear and, more to the point here, with stature of the grazed plant--this under circumstances where the clover is uniformly dense. Basically, the relatively small sizes of bites taken by small bears are essentially unaffected by the stature of the grazed plant. By contrast, even though large bears are constrained to bites no larger than those of small bears when grazing plants <9-13 cm (3.5-5") tall, they reap huge comparative benefits (at least in terms of bite size) if they can find patches of herbaceous plants that average >15 cm (6") tall.



**Figure 14. Bite rate and size of serviceberry and huckleberry by bears as a function of berry density.**



**Figure 15. Size of bites of clover as a function of clover height and mass of the involved bear.**

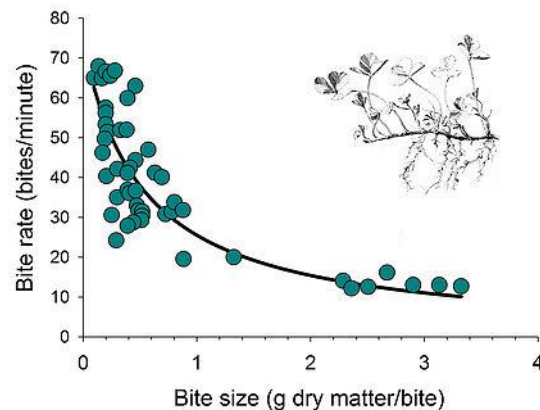
In short, the small dentition and jaws of small bears mean that they don't benefit from increases in the stature of grazed foliage, whereas the larger dentition and jaw of large bears allow them to exploit and benefit from greater vertical expression of biomass; which amounts to a constraint imposed by foliage stature on large but not small bears. This, in turn, exacerbates the intrinsic energetic problems for large bears when they try to subsist on a diet of stems and leaves. Which is to

say, they typically can't, whereas small bears more commonly can (see [Body mass effects](#)).

### Bite rate vs Bite size

The relationship between bite size and bite rate further elucidates the basic mechanics of bear grazing and, along with this, some fundamental constraints imposed on bears trying to subsist on foliage. Figure 16 shows this relationship; again, each dot represents a single trial involving a single bear.

The inverse relationship is not surprising. A larger bite requires more processing time, which intrinsically constrains bite speed (i.e., bite rate). But the important feature here is the rapid diminishment in bite rates with increases in bite size.



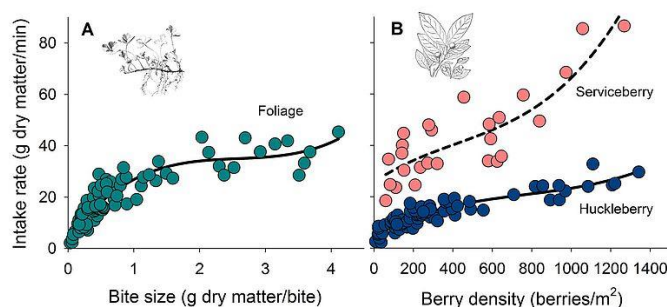
**Figure 16. Bite rate as a function of bite size of clover for bears of a given size and clover of a given stature.**

The implications? If a bear, it probably makes more sense to seek out patches of foliage to graze that allow for small rapid bites. And, if you are large, you are probably not going to benefit much in the end from being able to take larger bites of taller-statured foliage (as above), which partly explains why, in places such as Yellowstone, smaller bears seek out and heavily graze very dense short-statured patches of clover and bluegrass--commonly referred to as "grazing lawns."

### Total rate of intake

Regardless of proximal biomechanics, the bottom line for bears is the total rate at which they can ingest foliage, berries, or any other vegetal food. Again, total rate of intake is especially critical for bears when it comes to vegetal foods (see above), in contrast to when they eat foods such as meat.

The graphs in figure 17 show total rate of intake (grams of dry matter per minute) as a function of key constraining factors. In the case of both serviceberry and huckleberry (B) intake (not surprisingly) increases with the density of each type of berry in a given patch. But the response for serviceberry is dramatically greater than the response for huckleberry because serviceberries (as I describe above) grow in terminal clumps that make it much easier for bears to harvest when compared to the more dispersed single berries of a huckleberry bush. That being said, huckleberry is considerably more digestible than serviceberry (see [Digestion](#)), which probably negates the benefits of the latter species rooted solely in ingestible volumes.



**Figure 17. Intake rate of (A) clover and of (B) serviceberry and huckleberry as a function of bite size and berry density, respectively.**

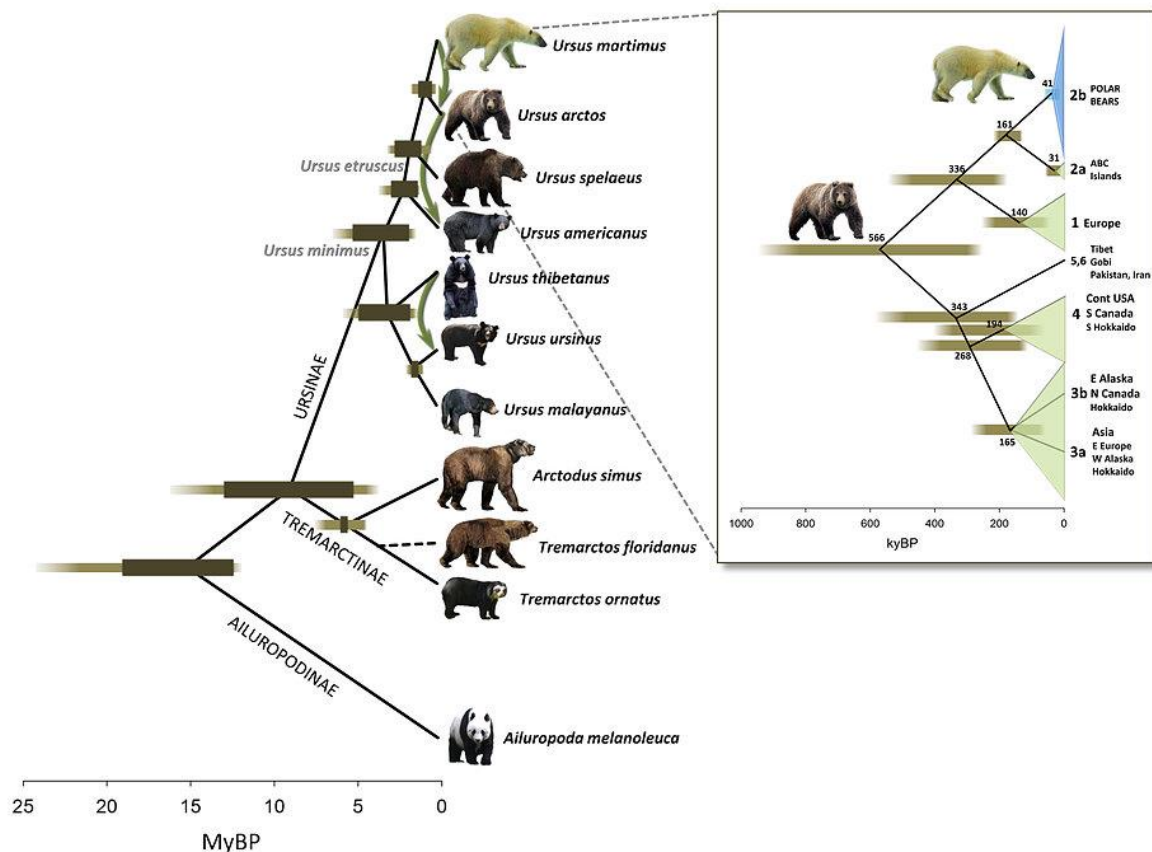
Figure 17A shows intake rate as a function of bite size for clover, one of the choicest of grazed bear foods. Why bite size rather than forage density? Simply because the research that produced these data essentially held density constant by insuring that bears had access to thick patches of foliage within which researchers varied composition and stature. Perhaps the point of this is that anything less would presumably be a non-starter for a food as fibrous and relatively indigestible as foliage (see [Digestion](#)). But the key point of graph A is that ingested volumes increase with bite size at first, but then rapidly reach a plateau (i.e., asymptote). This pattern is consistent with the depressive effect of bite size on bite rate (see above), ultimately rooted in the limits imposed by a need to chew foliage and then, after that, rate of passage through the gut.



## Attachment 3. Primer on Taxonomy & Biogeography of *Ursus arctos* to accompany

David J. Mattson, Ph.D., Wyoming Wildlife Advocates, Comments on the US Fish & Wildlife Service proposal to remove grizzly bears in the Yellowstone ecosystem from the list of endangered and threatened wildlife protected under the US Endangered Species Act (ESA); Federal Register 81(48): 13174-13227; And Related Materials

### Evolutionary relations



**Figure 1. Consensus tree on the phylogeny of Ursidae, including an inset showing relations between *Ursus maritimus* and *U. arctos* as well as the diversification of *U. arctos* into various Clades. Gene flow subsequent to species separations is shown by the green arrows. Ranges of uncertainty in times of divergence are denoted by the length of the horizontal green bars at each node. Source are given below.**

Figure 1 illustrates what taxonomists call a "consensus tree" describing relationships and timing of divergence among species within the family Ursidae, as well as (in the inset) relationships and divergence times for various subgroups of the species *Ursus arctos* (the brown and grizzly bears). The polar bear *Ursus maritimus* is included here for reasons that will be addressed shortly. This so-called consensus has been reached only within the last few

years, and may be revised in light of new research. But the main part of it will likely hold over time. An important feature to be noted, in addition to the main branching, is the green arrows. These arrows indicate on-going gene flow between "species," which has led to some of the confusion and disagreements over relations and dates of divergence among different species. Note the gene flow from polar bears to grizzly bears, and from

grizzly bears to black bears, which suggests inter-fertile breeding, albeit under presumably rare circumstances.

Surviving bear species of the family Ursidae are, for the most part, relatively recent in origin. The most ancient surviving derivative is the giant panda (*Ailuropoda melanoleuca*) which, although most closely related to bears, is so different as to have led taxonomists to put into a separate family, or even cluster it with raccoons. Another main split is between species of the subfamilies Tremarctinae and Ursinae. This split happened about 6-13 million years ago (mya), giving rise to bear species that evolved and survived mainly in North America (the Tremarctine bears), and those that evolved primarily in Eurasia (the Ursine bears). The only surviving bear of the Tremarctine lineage is the Spectacled bear (*Tremarctos ornatus*) of South America, although prior to the end of the last Ice Age a number of Tremarctine bears had existed and flourished. Perhaps the most spectacular of these bears was the Giant short-faced bear (*Arctodus simus*), which was a giant as much as 6 feet tall at the shoulder that survived until roughly 13,000 plus or minus 300 years ago (this in years corrected for bias in carbon dating).

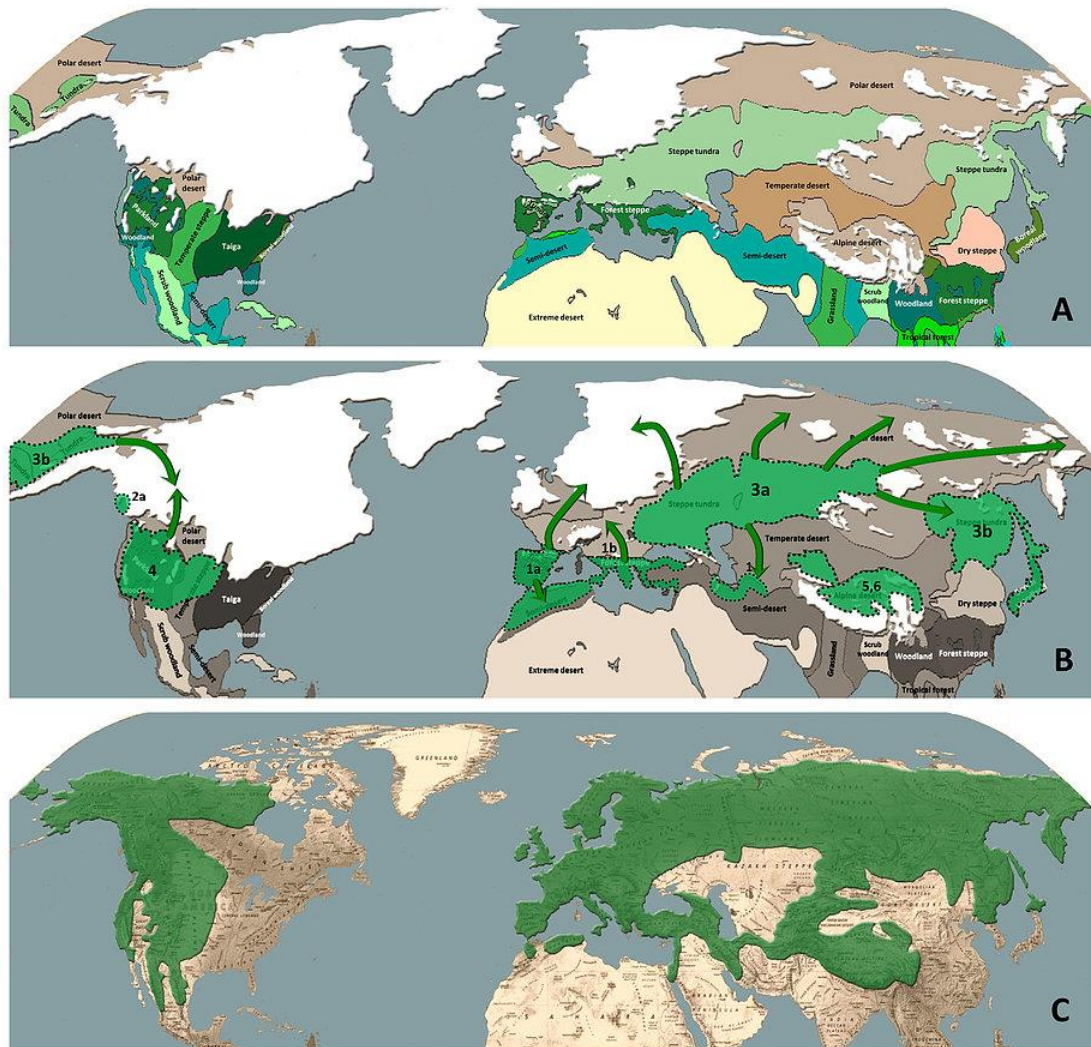
But the main focus here is the species *Ursus arctos*, which encompasses the grizzly bears living in Yellowstone. Grizzlies and their kin the Polar bear and Eurasian cave bear (*U. spelaeus*) split from the lineage giving rise to the American black bear (*U. americanus*) roughly 3 mya. These species all shared a common ancestor called *U. minimus*, which gave rise as well to an intermediary form called *U. etruscus*. Barring the American black bear, these species are all best represented by fossils that have been found in Europe and western Asia.

More recently, the branch giving rise to the cave bears split from the brown bear lineage in Eurasia roughly 1-3 mya and, more recent yet, the polar bear lineage split from brown bears about 200-500 thousand years ago (kyBP). There is persisting disagreement among those who study phylogeny regarding when "the" polar bear split happened--some arguing as long as a million years ago, others as recent as 300 thousand years ago. The waters remain muddy because this so-called split has continued to be blurred by interbreeding among brown and polar bears. Whatever the conclusion, polar bears are closely related to brown bears.

But even before the divergence of polar bears, brown bears began to diversify into lineages, or clades, most of which have survived to the present. The major split between brown bears that live in Europe (Clade 1, along with an anomalous bunch on the ABC Islands of Alaska--Clade 2a) and brown bears that live elsewhere (Clades 3-6) occurred around 300-900 kyBP. The reasons for this complex of Clades has a lot to do with how various lineages of brown bears were split and more-or-less isolated during the course of the Ice Ages, which is covered immediately below under Evolutionary biogeography. Of particular relevance to Yellowstone's grizzlies: all of them belong to Clade 4, which appears to have been isolated in central North America when, according to Chris Stokes and collaborators, the Pleistocene ice sheets of North America coalesced across the northern span of the continent for the last time roughly 70 kyBP, albeit with what seems to have been a temporary opening around 55 kyBP. Clade 4 split from the various lineages of Clade 3 (currently concentrated in Asia and Alaska) around 200-350 kyBP. Clade 4 currently survives nowhere other than the in the center of North America and on the island of Hokkaido, which testifies to the Eurasian ancestry of all brown bears, including bears of this clade.

Information in this section is based on a host of sources, including for the carnivoran supertree, Bininda-Emonds et al. (1999) and Nyakatura & Bininda-Emonds (2012); phylogeny of Ursidae writ large, Waits et al. (1999), Lorielle et al. (2004), Yu et al. (2004), Krause et al. (2008), Pages et al. (2008), and Kutschera et al. (2014); the unrelenting discourse on relations between polar bears and other bear species, Lindqvist et al. (2011), Cronin & MacNeil (2012), Hailer et al. (2012), Miller et al. (2012), Nakagome et al. (2013), Liu et al. (2014), and Cahill et al. (2015); and on divergence and nature of brown bear clades, Waits et al. (1998), Leonard et al. (2000), Shields et al. (2000), Matsushashi et al. (2001), Miller et al. (2006), Hirata et al. (2013, 2014), and Solomashkina et al. (2014).

## Evolutionary biogeography



**Figure 2. A somewhat speculative reconstruction of the Pleistocene biogeography of *Ursus arctos*, with (A) a reconstruction of Northern Hemispheric vegetation during the Last Glacial Maximum (LGM); (B) the LGM distribution of *Ursus arctos*, by Clade, including glacial refugia and subsequent recolonizations; and (C) the distribution of *U. arctos* circa 10,000 year bp.**

The three maps in figure 2 attempt to summarize much of what's relevant to understanding the current population-level genetic diversity evident among today's brown and grizzly bears—all included within the single species *Ursus arctos*. Most of what's presented in these maps is a result of the synthesis published by Davison and his colleagues in 2011. Parenthetically, the notion of "subspecies" has

passed out of favor in application to brown bears, and been replaced instead with the concept of "clades," each of which represents enough genetic differentiation to warrant speculations about reasons for the divergence. This recent convergence by taxonomists on the notion of clades is in stark contrast to a 1918 publication of C.H. Merriam in which he described over 70 "species" of grizzly bears



in North America alone. The shift has been a result of both increased reliance on information from the genome along with increased appreciation for how plastic brown bear morphology can be (morphology of the skull was the main basis for Merriam's distinctions).

One key to understanding the current genetic diversity of brown bears resides in understanding the distribution of this species during the last Ice Age, which was, in turn, a reflection of vegetation and climate--especially the distribution of ice sheets and exceptionally harsh polar climates. Geneticists speculate that the main explanation for current differences in genomes of bears living in different parts of Eurasia and North America has to do with where their ancestors found refuge--often in isolation--during the different Ice Ages of the Pleistocene, and how they moved and mixed during warmer intervals, especially the current warm period that led to terminal melt of ice sheets between 18,000 and 6,000 years ago.

With that in mind, the map in Panel A, above, shows a plausible reconstruction of ice sheets and vegetation during the height of the last glaciation, roughly 25,000-15,000 years ago. You can see that much of the main range of brown bears in Eurasia was covered by polar desert and what many have called steppe tundra--a kind of tundra with substantially more grass than is common in boggy shrub-dominated tundras of today. This abundance of grass meant that a corresponding abundance of large herbivores could live there, including horses, mammoths, rhinos, giant bison, and more. Overall, though, the main range of Eurasian brown bears (the vast majority of the brown bears alive at the time) was quite dry and bitterly cold.

The map in Panel B shows a speculative reconstruction of the Ice Age distributions of the various modern-day clades, each denoted by its own number (see Evolutionary relations for more details). As you can see, Clade 1 was hunkered down in the southern part of Europe while Clade 3 was distributed throughout the steppe tundra of Asia. Clades 5 and 6, which persist as the genetically and morphologically distinct bears of the Tibetan Plateau and Gobi Desert, were thought to be more or less isolated in high-elevations of south-central Asia. Note that Clade 4 is the sole representative south of the North American ice sheet. More on where and when Clade 4 got there a little later. Also of interest,

the green arrows in Panel B show how each of the clades spread and colonized during the late Pleistocene and early Holocene (our current warm period). Clade 1 moved north to occupy most of Europe, but Clade 3 was the big winner, with bears of this lineage spreading into eastern Europe and surging once again into Alaska via Beringia. Clade 3 bears also moved south in North America to mingle with Clade 4 bears moving north in what is now Alberta.

The final map above, in Panel C, shows (in green) how the distribution of brown bears settled out after all of the surges and retreats that occurred with warming and ice melt--by roughly 1000-2000 years ago. Of note, brown bears occurred in the Atlas Mountains of Africa as well as in Mediterranean coastal mountains of the Middle East. They also spread south into Mexico in North America and ended up retreating to an eastern boundary on this continent that aligned with the Great Plains.



**Figure 3. Somewhat speculative routes and timings of migrations by *Ursus arctos* Clades from Eurasia to North America during the late Pleistocene along with a reconstruction of ice sheets prior to the Last Glacial Maximum, including a potential ice-free corridor that could have allowed for early passage of Clade 4 bears south.**

The map in Figure 3 provides a little more detail on when and how the various clades of grizzly bears represented in North America arrived. The earliest colonists were apparently of Clades 2 and 4, along with a sprig of Clade 3 called 3c. Clade 4 continued south, occupying west-central North America prior to closure of the last ice-free corridor, which some think might have happened as early as 70,000 years ago (kyBP), although with a brief opening perhaps around 55 kyBP. During this same period bears of Clade 2 (specifically, 2a) made it to the ABC (Admiralty, Baranof, Chichigof) Islands of Alaska. The early southward movement of brown bears into the region encompassing Yellowstone is evidenced by current distributions of the various clades, as well as by a single find of skeletal remains near Edmonton, Alberta, that dates to roughly 32 kyBP (corrected for bias in carbon dating).

Interestingly, of these early colonizing clades, 2a and 4 survived in their interior continental and island refuges whereas 2c and 3c eventually disappeared.

The final colonists, all across Beringia into and via Alaska, were of Clade 3. Clade 3b comprised an

earlier wave of colonization that occurred perhaps during and immediately after the last glacial maximum, whereas Clade 3a represents the most recent and last wave of migrants, arriving just prior to when the land bridge of Beringia disappeared. (Remember from the Map in Panel B above, Clade 3a bears had farther to go compared to Clade 3b bears before reaching Beringia.) Modern-day grizzly bears in eastern Alaska consist of descendants of the Clade 3b colonists, whereas those in western Alaska consist of descendants of the Clade 3a new-comers.

The main source of information for the material in this section is Davision et al. (2011), but augmented by the numerous publications that describe Pleistocene refugia and related brown bear lineages in Eurasia, including Taberlet & Bouvet (1994), Matsushashi et al. (2001), Saarma et al. (2007), Sommer & Benecke (2005), Valdiosera et al. (2007), Keis et al. (2013), Kutschera et al. (2014), and Salomashkina et al. (2014). Mathues et al. (2001) describe the *U. arctos* remains found near Edmonton, Alberta. Stokes et al. (2012) are the source for delineations of ice sheet margins prior to the Last Glacial Maximum.

---

## Early prehistory: 70,000-10,000 years ago

Up until the early 2000s most scientists thought that grizzlies had not arrived in the middle part of North America until after the last continental Ice Sheets had melted enough to allow passage of bears from Beringia (which included all of modern-day Alaska) through an ice-free corridor along the eastern edge of the Rocky Mountains (see the maps below)--probably around 13,000 years ago (all of the ages here are corrected for biases in radiocarbon age). However, the discovery of grizzly bear remains near Edmonton, Alberta, dating to roughly 32,000 (or 32k) years ago turned this assumption on its head. Recent analyses of genetic material from North American grizzly bears have reinforced the idea that grizzlies arrived much earlier, probably during the last opening in the Alberta ice-free corridor, prior to closure at the height of the last Ice Age, roughly 55,000-18,000 years ago. Recent research by Chris Stokes and his colleagues suggests that a long-lasting opening between the Cordilleran (to the west) and Laurentide (to the east) continental ice sheets occurred between 80k and 65k years ago, with a

possible brief opening again around 55k years ago. So, grizzlies probably arrived--and presumably then persisted--as early as 70k or as late as 55k years ago.

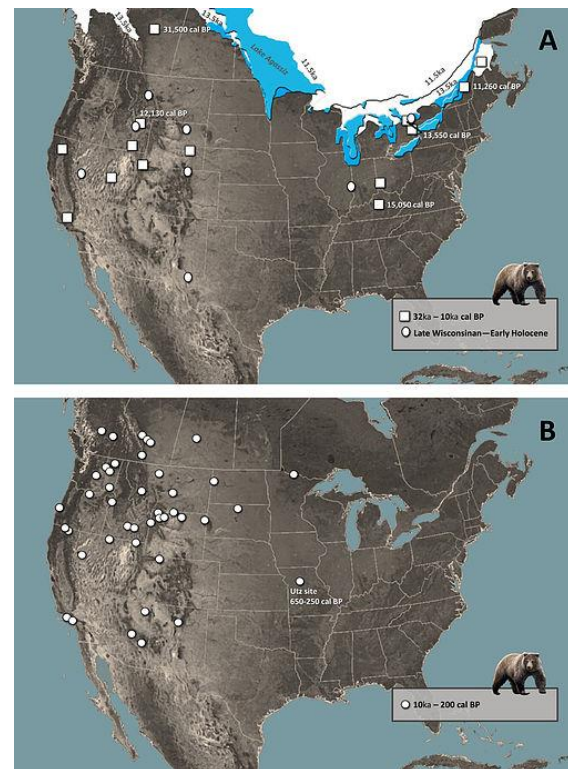
As I noted in the previous section, figure 3, above summarizes current thinking about the several migrations of brown bears from Asia into and through North America (parenthetically, grizzlies are brown bears, all *Ursus arctos*). An early wave of bears carrying genetic material identified with Clades 2a, 2c, 3c, and 4 (roughly the equivalent of subspecies) arrived in eastern Beringia around 70k years ago, having successfully crossed over the Bering Land Bridge. Of those bears, those of Clade 4 managed to successfully complete the journey into the middle part of the continent, presumably along the eastern edge of the Rocky Mountains. They were then isolated with closure of the ice-free corridor, intermingling with other grizzlies of the newly-arrived Clade 3b only after reopening of the ice-free corridor around 14-11k years ago (see the maps below). Shortly after, the Bering Land Bridge was

closed to additional migrants by rising sea levels. Parenthetically, some researchers have theorized that grizzlies also got to the mid-continent by following ice-free coastal areas of modern-day Alaska and British Columbia--prior to the opening of Alberta's ice-free corridor. Land levels at these ice free margins were dramatically elevated as a compensatory ("forebulge") response to depression of the Earth's crust by the ice sheet farther inland. Migrating coastal grizzlies presumably subsisted largely on marine resources.

Figure 4 shows the distributions of grizzly bear remains from two different periods: In panel A, from 32-10k years ago, with all but the ones near Edmonton dating to less than 15.5k years ago; and, in panel B, from 10k to 200 years ago--up to essentially historical times. In panel A the extent of the ice sheets and bordering glacial melt lakes are shown at 13.5 and 11.5k years ago. Note Lake Agassiz (see the discussion above about climate). Most of the remains are not radiocarbon-dated.

The map in panel A constitutes pretty conclusive evidence that grizzly bears occurred in eastern North America between roughly 15.5 and 11k years ago. But by 10k years grizzlies seem to have been gone in the East. All of the specimens post-10k roughly coincide with the historical distribution of grizzlies. The one exception is the Utz site in Missouri. This specimen was apparently found during excavations of a prehistoric Indian settlement. I tried to track down the original publication documenting this find, but without success. My current suspicions are that either: (1) the specimen was misidentified or, if authentic, then (2) the result of a series of trades among tribes that transported grizzly bear remains from farther west to this site in Missouri.

In addition to the sources that I mention in the section on biogeography, I also reference Guilday (1968), Loring & Spiess (2007) and Harington et al. (2014) for more information on *Ursus arctos* in eastern North America. The Utz site is described by Berry & Chapman (1942).



**Figure 4. Locations of *Ursus arctos* remains in central North America for two different time periods: (A) 32-10k years bp; and (B) 10k-200 years bp. Locations are shown as either white dots or white squares.**



# United States Department of the Interior

## FISH AND WILDLIFE SERVICE

**Ecological Services**  
**5353 Yellowstone Road, Suite 308A**  
**Cheyenne, Wyoming 82009**



SEP 03 2014

In Reply Refer To:  
06E13000/WY14F0040

John P. Moore III, Pinedale District Ranger  
Bridger-Teton National Forest  
P.O. Box 220  
Pinedale, Wyoming 82941

Dear Mr. Moore:

Thank you for the 2014 Supplement to the 2013 Supplement and 2010 Amendment to the 1999 Biological Assessment for Livestock Grazing on the Northern Portions of the Pinedale Ranger District (Project) and letter dated April 5, 2014, received in our office on April 9, requesting re-initiation of formal consultation. The U.S. Fish and Wildlife Service (Service) has reviewed the Biological Assessment in accordance with section 7(a)(2) of the Endangered Species Act (Act) of 1973, as amended (50 CFR §402.14), and the enclosed Biological Opinion addresses your "may affect, likely to adversely affect" determination for the threatened grizzly bear (*Ursus arctos horribilis*). Please note that the enclosed Biological Opinion is valid through 2019.

The Service thanks the Bridger-Teton National Forest staff for their coordination on this Project and continued efforts to ensure the conservation of federally listed species. If you have any questions or comments regarding this letter, please phone Ann Belleman at (307) 421-5839 or contact our office at the letterhead address above.

Sincerely,

R. Mark Sattelberg  
Field Supervisor  
Wyoming Field Office

Enclosures (3)

cc: BTNF, Forest Biologist, Jackson, WY (G. Hanvey) (via-email)  
WGFD, Statewide Non-Game Bird and Mammal Program Supervisor, Lander, WY  
WGFD, Statewide Habitat Protection Coordinator, Cheyenne, WY (M. Flanderka)

**ENDANGERED SPECIES ACT SECTION 7 CONSULTATION**

**BIOLOGICAL OPINION**

**for the 2014 Supplement to the 2013 Supplement and 2010 Amendment to  
the 1999 Biological Assessment for Livestock Grazing on the Northern  
Portions of the Pinedale Ranger District**

**06E13000-2014-F-0040**

**Agency:** U.S. Forest Service  
Bridger-Teton National Forest  
Pinedale, Wyoming

**Consultation Conducted by:** U.S. Fish and Wildlife Service  
Wyoming Field Office  
Cheyenne, Wyoming

**Date Issued:** September 3, 2014

## Table of Contents

INTRODUCTION.....	1
Consultation History.....	2
EXECUTIVE SUMMARY.....	3
PURPOSE and ORGANIZATION of this BIOLOGICAL OPINION.....	4
Analytical Framework.....	4
I. DESCRIPTION OF THE PROPOSED ACTION.....	5
Conservation Measures for Grizzly Bears.....	7
II. STATUS OF THE SPECIES.....	10
Species Description.....	10
Life History.....	11
Population, Status and Distribution.....	12
Conservation.....	18
Threats.....	22
III. ENVIRONMENTAL BASELINE.....	25
Action Area.....	25
Status of the Grizzly Bear within the Action Area.....	26
Factors Affecting the Condition of the Grizzly Bear in the Action Area.....	30
The Role of the Action Area in the Survival and Recovery of the Grizzly Bear....	32
IV. EFFECTS OF THE ACTION.....	33
Direct and Indirect Effects of the Proposed Action.....	33
Effects of Interrelated or Interdependent Actions.....	38
V. CUMULATIVE EFFECTS.....	38
VI. CONCLUSION.....	38
VII. INCIDENTAL TAKE STATEMENT.....	40
Amount or Extent of Take Anticipated.....	41
Effect of the Take.....	42
REASONABLE AND PRUDENT MEASURES.....	43
TERMS AND CONDITIONS.....	43
CONSERVATION RECOMMENDATIONS.....	45
REINITIATION – CLOSING STATEMENT.....	45

LITERATURE CITED.....	47
APPENDIX A.....	A-1

### **List of Tables**

Table 1. Estimated grizzly bear population size (individuals) and population growth rate by Recovery Zone/Ecosystem.....	13
Table 2. Known and probable grizzly bear mortalities in the GYA, 1997-2012...	17
Table 3. Livestock-related grizzly bear conflicts, relocations, and mortalities from nine allotments, 1999-2009 and 2010-2013.....	28
Table 4. Livestock-related female and male grizzly bear mortalities from nine Allotments and percent of all documented GYA mortalities, 2010-2013.....	28

### **List of Figures**

Figure 1. Grazing allotments on the northern portion of the Pinedale Ranger District.....	6
Figure 2. Grizzly bear ecosystems in the conterminous 48 States.....	14

## INTRODUCTION

This document transmits the U.S. Fish and Wildlife Service's (Service) biological opinion (BO) for the Bridger-Teton National Forest's (Forest) 2014 Supplement to the 2013 Supplement and 2010 Amendment to the 1999 Biological Assessment for Livestock Grazing on the Northern Portions of the Pinedale Ranger District (U.S. Forest Service 2014; hereafter, BA or Project) and its determination of "may affect, likely to adversely affect" grizzly bear (*Ursus arctos horribilis*). The Forest requested reinitiation of formal consultation in a letter dated January 16, 2014, received on January 21, for the following reasons:

- Incidental take, in the form of lethal removal, of adult female grizzly bears over the period of three consecutive years beginning in 2013 and ending in 2015 was likely to exceed the amount identified in the Service's 2013 Appended BO. In the 2013 BO Incidental Take Statement, the total number of grizzly bears the Service anticipated to be incidentally taken was 11 in any consecutive 3-year period, but only three of the 11 bears could be females (equal to or greater than two years of age). In 2013, incidental take of two male and two female bears occurred, suggesting incidental take of more than one female bear was likely over the next two years.
- Because additional removals of female bears was probable during the 2014 and 2015 grazing seasons, the Forest also elected to incorporate new and revised non-discretionary design features (Grizzly Bear Conservation Measures) in the Upper Green Project area allotment Annual Operating Instructions. While these actions are intended to further reduce conflicts, the new measures changed the conditions from those described in the 2013 Supplemental BA and 2013 Appended BO.

The Forest submitted the 2014 Supplemental Biological Assessment on April 5, 2014, which we received on April 9. The Forest made subsequent changes to the BA's Conservation Measures and corrected errors, and submitted those via letter, dated May 23, 2014, received on May 27. We have incorporated those changes and corrections. This BO is in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended 50 CFR §402.14, and is based on new and supplemental information, on-going telephone conversations with the Forest Biologist and other Forest Service and Service personnel, numerous discussions and meetings with the Forest, Wyoming Game and Fish Department, and Upper Green River area permittees, and other sources of information.

Because the number of amendments and supplemental documents for this Project may cause confusion to the agencies, permittees, and public, and because of new information about grizzly bear numbers and use in the Project area's nine allotments, we are providing a new BO. This BO includes a detailed explanation of the incidental take statement (ITS) derivation (Appendix A) and a new ITS, which incorporates new information and describes a change in the way take will be assigned. This BO supersedes the 1999, 2011, and 2013 BOs and is valid from the date of signing through the end of 2019. A complete Project record of this consultation is on file in the Service's Cheyenne Field Office. When referring to this BO, please include our project number, 06E13000-2014-F-0040.



## Consultation History

The consultation history was provided in the 2010 BA and updated in the 2013 and 2014 BAs and associated 2011 and 2013 Service BOs. The Service consolidated the histories into one document, which is now part of the Project record. To summarize the history, the Forest developed a BA in 1997 to assess the effects of livestock (sheep) grazing on the Elk Ridge Complex allotments (31,430 acres) and eventually included six additional permitted allotments: Badger Creek, Beaver-Twin, New Fork-Boulder, Pot Creek, Roaring Fork, and Upper Green River (total of 175,758 acres). The six additional allotments included Wagon Creek and Noble Pasture, which were later split as separate allotments. The BA was amended in January 1999 based on further discussions between the Forest and the Upper Green River Cattle Association permittees and their attorney, after which formal consultation was initiated. The Service completed a subsequent BO (WY97F002, July 16, 1999), which included incidental take by lethal removal of 5 grizzly bears (4 males and 1 female) for on-going grazing activities. The duration of the BO was not specified and non-lethal take was not quantified.

Since the original consultation in 1999, the grizzly bear population in the Greater Yellowstone Ecosystem has expanded and as a result, grizzly bear conflicts increased with Forest management activities, including livestock grazing. In 2009, the Forest reached the level of take identified in the 1999 BO and reinitiated consultation on livestock grazing in the northern portions of the Pinedale Ranger District in March 2010. The Forest expanded the original Project area from six to nine allotments (the Elk Ridge complex of sheep allotments plus eight cattle allotments, encompassing 207,188 acres), due in part to adjacency of additional allotments and associated grizzly bear activity. The Service issued an amended BO in January 2011 (WY10F0225) that anticipated incidental take of 6 grizzly bears within any consecutive 3-year period.

In May 2011, the Service issued a letter (WY11TA0217) to the Forest in which we provided two changes to the January 2011 BO. The first change incorporated the Forest's minor modifications to grazing management on six of the cattle allotments. The second involved the Forest's effects determination change from "no effect" to "may affect, not likely to adversely affect" the endangered Kendall Warm Springs dace and our subsequent concurrence regarding potential effects from cattle herding on the portion of the "Driveway" adjacent to Kendall Warm Springs. The "Driveway" (known as the Green River Drift Trail) is used for moving cattle from lower elevations onto and off the Forest in spring and fall, respectively, and generally extends for 200 feet on either side of the roads along the Green River bottom. While not considered part of, or managed like the allotments, the Driveway is located adjacent to or within the boundaries of the nine allotments.

In a letter dated August 11, 2012, the Forest reinitiated formal consultation upon reaching the level of incidental take in the Upper Green River area grazing allotments of 6 grizzly bears in a consecutive 3-year period. Later that month, take was exceeded. Seven grizzly bears were trapped and lethally removed during the 2011-12 grazing seasons: 4 bears in 2011 and 3 bears in 2012. Because the livestock grazing season in the allotments was scheduled to end in mid-

October 2012, the Service felt the appropriate action was to provide an amended, short-term ITS to the Forest. We issued the amended BO and ITS on September 5, 2012, which included an additional 3 grizzly bears to be lethally removed due to grazing conflicts in the Upper Green River area allotments. The amended ITS was valid only until the end of the 2012 grazing season, when livestock were removed from the allotments according to each allotment's ending date (provided in Table 1, page 6 of the 2010 BA; dates varied from September 20 to October 15). No additional grizzly bears were removed during the remainder of 2012. Because the amended ITS was only valid for a short-term period and the Project would undergo additional formal consultation prior to the next (2013) grazing season, new terms and conditions and other conservation recommendations were not included.

The Forest then reinitiated formal consultation in April 2013 and the Service responded with an Appended BO in June of 2013 in which we anticipated incidental take of no more than 11 grizzly bears (3 females and 8 males) within any consecutive 3-year period as a result of livestock grazing within the Upper Green Livestock Management Area.

By the end of the 2013 grazing season, 4 grizzly bears were incidentally taken (2 females and 2 males) and the Forest anticipated additional females would be taken before the end of the consecutive 3-year period. The Forest reinitiated formal consultation in January 2014 despite not yet having reached the maximum number of females anticipated to be incidentally taken as a result of the Project.

Since the fall of 2013, on-going discussions and numerous meetings, via telephone and in person, occurred between Service biologists and staff, Forest biologists and staff, Upper Green River area permittees, and Wyoming Game and Fish Department (WGFD) biologists and managers regarding the Project. Informal discussions also occurred with several non-governmental organizations, including Natural Resources Defense Council and Sierra Club, regarding Forest conservation measures in the 2014 BA Supplement, existing Terms and Conditions in the Appended 2013 BO, and other measures that they felt should be considered for the 2014 BA supplement and subsequent 2014 BO.

## **EXECUTIVE SUMMARY**

This document analyzes the effects on the threatened grizzly bear from proposed livestock (sheep and cattle) grazing and associated activities on nine allotments in the Bridger-Teton National Forest's northern portions of the Pinedale Ranger District. The Forest determined that livestock grazing and associated activities are likely to adversely affect grizzly bears due to grizzly bear/livestock conflicts and potential management relocations or lethal removals of grizzly bears from the nine allotments. These management actions are considered incidental take in the form of harm under the ESA. Incidental take is any take of listed animal species that results from, but is not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or the applicant.

A special rule under the ESA is in effect for grizzly bears in the 48 conterminous states of the United States (50 CFR 17.40(b), Special Rule). Under the terms of the Special Rule, certain activities are exempted from take prohibitions including the defense of human life and the removal of nuisance bears when the taking conforms to the requirements specified in the regulations 17.40(b)(1)(i)(B) through (F). Although the act of relocating or lethally removing nuisance grizzly bears in accordance with the special rule is an exception to the taking prohibition (50 CFR 17.40(b)(1)(i)(C)), the exception does not address all forms of take that may be associated with permitting grazing. The Service anticipates take in the form of harm to grizzly bears as a consequence of livestock grazing and the associated livestock management operations in habitats commonly used by grizzly bears.

In this BO, we conclude that the effects of livestock grazing on the nine allotments, as proposed, are not likely to jeopardize the continued existence of the grizzly bear. Incidental take of grizzly bears is described in the **Effects of the Action** section and how take was quantified is described in the **Incidental Take Statement** and **Appendix A**. We anticipate that up to 11 grizzly bears may be lethally removed within any consecutive 3-year period and up to 18 bears are likely to be relocated in any consecutive 3-year period due to management actions related to livestock grazing activities on the nine allotments. This opinion is valid through the end of 2019. We believe that anticipating incidental take for consecutive 3-year periods and limiting the duration of the BO to the end of 2019 will allow for more frequent review of changing conditions and incorporation of new science as it becomes available.

## **PURPOSE and ORGANIZATION of this BIOLOGICAL OPINION**

In accordance with the requirements of section 7(a)(2) of the Act and its implementing regulations, the formal consultation process culminates in the Service's issuance of an Opinion that sets forth the basis for a determination as to whether the proposed Federal action is likely to jeopardize the continued existence of listed species or destroy or adversely modify critical habitat, as appropriate. The regulatory definition of jeopardy and a description of the formal consultation process are provided at 50 CFR<sup>1</sup> 402.02 and 402.14. If the Service finds that a proposed Federal action is not likely to jeopardize a listed species but anticipates that it is likely to cause incidental take of the species, then the Service must identify that take and exempt it from the prohibitions against such take under section 9 of the Act through an Incidental Take Statement. No critical habitat has been designated for grizzly bears, so only jeopardy will be analyzed in this Opinion.

### **Analytical Framework for the Jeopardy Analysis**

In accordance with policy and regulation, the jeopardy analysis in this BO relies on four components:

---

<sup>1</sup> CFR represents the Code of Federal Regulations which is a codification of the general and permanent rules published in the Federal Register by Executive departments and agencies of the Federal Government. It is published by the Office of the Federal Register National Archives and Records Administration. More information can be found at <http://www.gpoaccess.gov/cfr/index.html>

- *Status of the Species*, which evaluates the range-wide condition of grizzly bears, the factors responsible for that condition, and its survival and recovery needs;
- *Environmental Baseline*, which evaluates the condition of grizzly bears in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of grizzly bears;
- *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on grizzly bears;
- *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on grizzly bears.

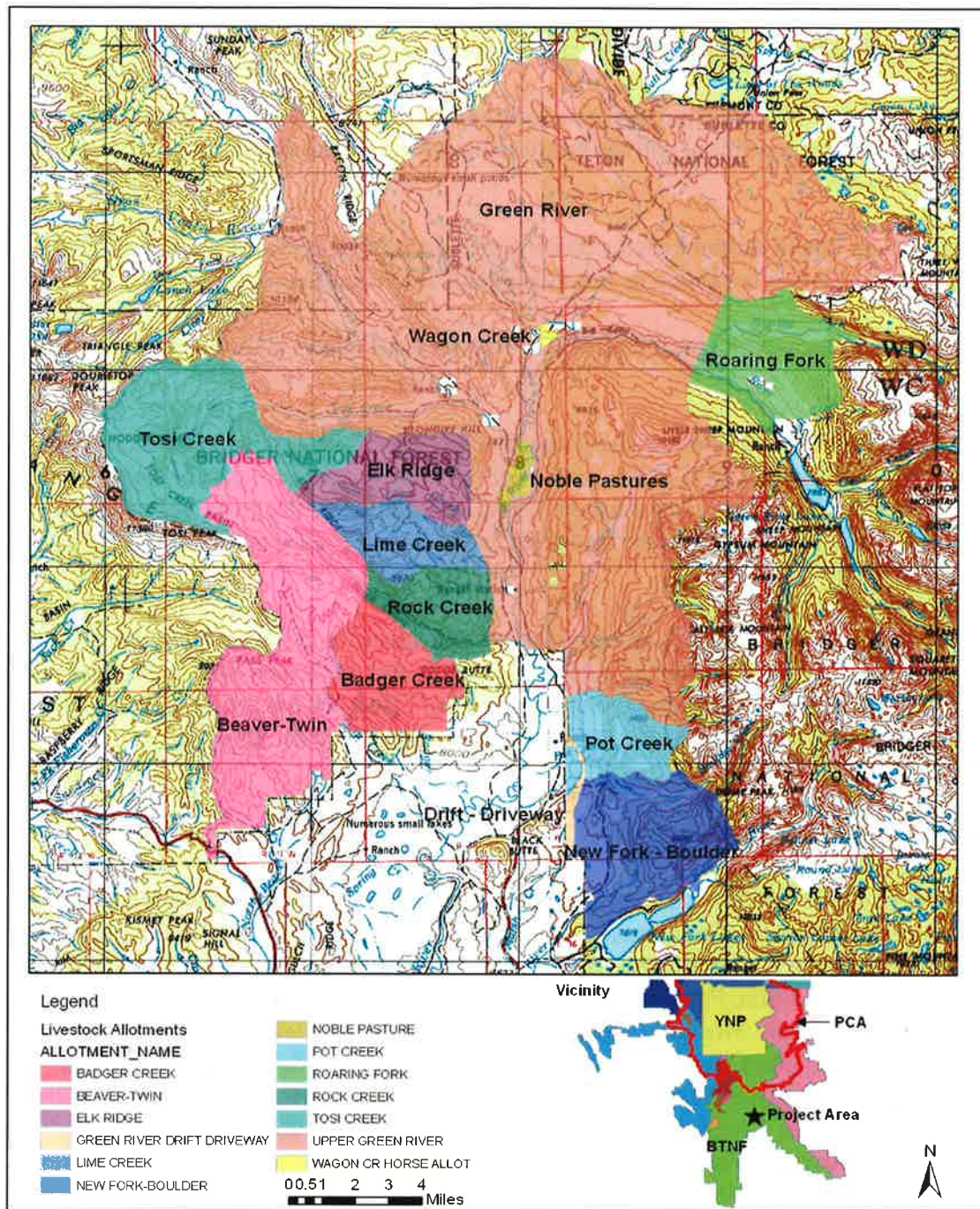
In accordance with policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the current status of grizzly bears, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of grizzly bears in the wild.

The jeopardy analysis in this BO places an emphasis on consideration of the rangewide survival and recovery needs of grizzly bears and the role of the action area in the survival and recovery of grizzly bears as the context for evaluating the significance of effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

## **I. DESCRIPTION OF THE PROPOSED ACTION**

The 2014 BA discussed the potential effects to grizzly bears from continuing authorized, commercial, domestic cattle and sheep grazing on the following nine allotments in the northern portion of the Bridger-Teton National Forest's Pinedale Ranger District: 1) Badger Creek, 2) Beaver-Twin Creeks, 3) Noble Pastures, 4) Roaring Fork, 5) Upper Green River (which includes Mud Lake/Fish Creek, Mosquito Lake Pastures, Teepee/Tosi/Kinky S, Moose/Gypsum, and Kinky Creek N), 6) Wagon Creek, 7) New Fork-Boulder, 8) Pot Creek, and 9) Elk Ridge Complex. The Elk Ridge Complex includes four domestic sheep allotments (3,750 ewes/lambs; Elk Ridge, Rock Creek, Lime Creek, and Tosi Creek); all remaining allotments are grazed by cattle (11,236 cows/calves); see Figure 1 below. The allotment management plans for the cattle allotments provide for approximately 46,100 Animal Unit Months (defined as the amount of forage needed by an animal unit, such as one mature 1,000 pound cow and her calf, for one month of grazing).





**Figure 1. Grazing allotments on the northern portion of the Pinedale Ranger District (2010 BA).**

Note: The Elk Ridge Complex is considered one sheep allotment and includes Tosi Creek, Elk Ridge, Lime Creek, and Rock Creek. The Wagon Creek horse allotment is for cattle.

The nine grazing allotments encompass 207,188 acres, of which 119,889 acres are considered suitable for grazing. Lands characterized as not capable or unsuitable for grazing include slopes greater than 30 percent, conifer canopy cover exceeding 30 percent (inadequate forage due to shade), dense timber (prevents cattle access), perennial surface water sources greater than 1 mile distant, unique habitats (bogs, fens, some wetlands), and key wildlife habitat areas (such as winter ranges). All nine allotments are located within occupied grizzly bear habitat. The grazing management plan and allotments remain unchanged from previous consultations and are fully described in the 2014 BA (see Figure 2, p. 7).

Livestock grazing and associated activities include the presence of sheepherders and range riders, their associated sheep- and cow-camps, sheepherding dogs, and horses. Grazing-related activities are scattered throughout the allotments depending on activity type, and they occur for varying lengths of time during some or all of the grazing season. For example, range riders tend to be dispersed throughout the allotments, while sheep camps and herders are concentrated in specific locations when sheep are penned at night.

### *Forest Conservation Measures*

As part of the proposed action, the Forest provided a list of grizzly bear Conservation Measures, some of which were in previous BAs, some were new, and some were later modified, including one that was eliminated (modifications were sent via electronic mail and hard copy to the Service on May 23, 2014). We integrated the modified Conservation Measures (indicated by an asterisk (\*)) into those from the 2014 Supplemental BA (pp. 36-39) and provide them verbatim below. They have been identified as necessary to minimize potential adverse effects to grizzly bears and to meet the intent of the ESA relative to the Forest Service's responsibilities under the ESA section 7(a)(1). The Conservation Measures will be applied to permit provisions for the nine allotments (identified in the Forest's Annual Operating Instructions) beginning in 2014.

### **Conservation Measures for Grizzly Bears**

1. The FS will request re-initiation of consultation in the event of significant changes to the grazing situation.
2. All livestock depredation will be reported to U.S. Fish and Wildlife Service (Service), U.S Forest Service (USFS), and Wyoming Game and Fish Department (WGFD). Agency contact representatives and contact information will be identified annually prior to each grazing season. The notification protocol for reporting depredation incidents will be as follows:
  - ✓ Initial suspected depredations -- Permittee and/or their employees (Rider) → WGFD Bear Specialist → USFS District Rep (designated by the Pinedale District Ranger)
  - ✓ Confirmed livestock depredation and initiation of trapping sessions -- WGFD Bear Specialist → Permittee + USFS District Rep → SO [Supervisor's Office] Forest Biologist

- ✓ Bear capture events -- WGFD Bear Specialist → FWS Rep + Permittee + USFS District Rep → SO Forest Biologist
  - ✓ Bear (Lethal) Removal events -- WGFD Bear Specialist + FWS Rep → Permittee + USFS District Rep → SO Forest Biologist → FWS Consultation Bio
  - ✓ Bear Relocation events -- WGFD Bear Specialist + FWS Rep → Permittee + USFS District Rep → SO Forest Biologist → FWS Consultation Bio + SO Forest Bio on Forest to which bear was relocated
3. Annual meetings with representatives of the Service, BTNF, WGFD, and Upper Green River permittees to discuss the conservation measures and notification protocol summarized in #2 above will be held prior to each grazing season.
  4. Livestock depredations will be investigated and managed by WGFD or its authorized agent following Interagency Nuisance Bear Guidelines (pp. 51-70 in Interagency Grizzly Bear Guidelines; U.S. Fish and Wildlife Service 1986).
  5. Bear Sanitation Guidelines will be followed for all camps associated with livestock operations as described and defined in Food Storage Order 04-00-104. Where outdoor toilets are available in Range Camps, keep doors closed and make toilets as "bear proof" as possible.
  6. Herders and riders are required to watch all livestock closely for sick, injured, or stray animals. At least 2 herders per sheep band will be required.
  7. Forest Service employees designated by the Pinedale District Ranger will monitor allotments on a regular basis.
  8. \* On Sheep Allotments: 1) All sheep carcasses will be removed as soon as possible; and, 2) all sick or injured animals will be removed or treated. In the event that compliance with this measure is not physically possible, an exception may be granted per the discretion of the Pinedale District Ranger and/or his designated representative. In the event that herder safety is deemed an issue, an exception may be allowed as described in CM #11 below.
  9. \* *Note: this measure was eliminated in the modifications.*
  10. On Cattle Allotments: 1) All carcasses **located within ½ mile** of Green River Lakes Road, Union Pass Rd, FS 605, 660, 663B and 663C, GRL and Whiskey Campgrounds, private cabins, Kendall and Fish Creek guard station, permitted cow camps, permitted outfitter camps, Waterdog Lakes, and North Beaver and Tosi trailheads will be removed if possible or moved so that the carcass is at least **½ mile away** from the above described facilities, trailheads or roads; 2) All carcasses in locations not described in 1 above that pose a health or safety hazard to the public or to the environment will be removed if

possible or moved so that the carcass is at least **¼ mile from** live streams, springs, lakes, riparian areas, system roads and trails, developed recreation areas, dispersed camping sites, and picnic sites; and 3) All sick or injured animals will be removed or treated. In the event that compliance with this measure is not physically possible, an exception may be granted per the discretion of the Pinedale District Ranger and/or his designated representative. In the event that rider safety is deemed an issue, an exception may be allowed as described in CM #11 below.

11. \* Exceptions to requirements for removing or moving carcasses described in **CM #8 and #10** may be granted by the Pinedale District Ranger and/or his/her designated representative if human rider or herder safety is of concern. Rider or herder safety concerns include the possible presence of a grizzly bear in the immediate vicinity of carcasses, and carcasses being located in hazardous terrain such that attempting to move or remove may not be possible or unsafe. In such cases, a USFS employee or the WGFD bear specialist will be notified immediately of the hazard location and need for exception.
12. \* **It is recommended** that all permittees and their representatives (herders, riders, or other employees) will carry Bear Spray while working within allotments; spray canisters should be holstered or otherwise carried so that they are available for use in the event of encounters with bears; storing spray canisters in back packs, saddle bags, and vehicles are acceptable methods of storage during non-working time periods. Only brands of Bear Spray certified by the Interagency Grizzly Bear Committee (IGBC) are acceptable.
13. \* Because night penning is known to be effective at deterring bears and reducing grizzly bear/sheep conflicts when properly deployed, night penning of sheep will be implemented each night unless an exception is granted by the District Ranger or his/her representative. A minimum of **eight to ten** 164-foot long panels will be deployed to fence bands of up to 1300 head of sheep; exceptions may be granted or employed by the by the District Ranger or his/her representative on a case by case basis. Night pens will be located no closer than 50 feet from existing FS system roads and trails. The fence must be properly deployed and grounded with an electric charge of 5000 volts and 0.2 Joules. It is the permittee's responsibility to educate employees on the proper use and installation of electric fences; to be effective, electric fencing must be in proper working condition, properly installed, and fully functional after deployment. The fence will be turned off and taken down during any extended period of non-use by livestock exceeding 18 hours.
14. Continue to identify and implement opportunities that reduce the potential for grizzly bear conflicts.
15. Through the permitting process and at annual meetings, the USFS will make grazing permittees aware of their responsibilities under the Endangered Species Act (ESA) in regard to laws and regulations concerning the taking of grizzly bears (Interagency Grizzly Bear Guidelines 1986).



16. Continue to work in cooperation with the Service, the Wyoming Game and Fish Department, and the Interagency Grizzly Bear Study Team to identify and collect information related to the habitat use, survival, reproduction, and depredation tendencies of grizzly bears inhabiting Livestock Grazing Allotments on Northern Portions of the Pinedale Ranger District. With assistance of cooperators listed above, the Forest will continue to support trapping efforts to capture and radio collar bears in the Upper Green project area and initiate the data collection process described.
17. \* The Forest will initiate a re-assessment of the Grizzly Bear Habitat Security analysis initially completed in 2009 for the 2010 Amended BA. The analysis would be used to identify areas within the Upper Green Project Area that currently provide for less than desirable grizzly bear security values as defined in the Grizzly Bear Conservation Strategy. This analysis may identify the locations of “user created” motorized routes not authorized for motorized uses in the current Travel Management Plan for the Pinedale Ranger District that could be physically closed or reclaimed to improve security habitat within the Upper Green Project area.
18. The Forest will investigate and explore additional means of reducing grizzly bear/livestock conflicts, which will include assessments of: 1) changing classes of livestock (from cow/calf pairs to yearlings); 2) cattle herding; and, 3) the use of guard dogs. Where appropriate, and when permittees are willing participants, study sites may be developed within allotments to “test” new management actions.

## **II. STATUS OF THE SPECIES**

Please note that the literature, 1993 Recovery Plan, and other documents such as the 2007 Conservation Strategy use three different ecosystem terms related to grizzly bears in northwestern Wyoming, southwestern Montana, and southeastern Idaho: Greater Yellowstone Area (GYA), Greater Yellowstone Ecosystem (GYE), and Yellowstone Grizzly Bear Ecosystem (YGBE). These terms all describe the Yellowstone ecosystem and for this BO, we regard them as more or less synonymous because the geographic scale at which any distinctions occur does not affect project analyses or potential impacts.

### **Species Description**

The grizzly bear is one of two subspecies of the brown bear that occupy North America. Grizzly bear coloration varies from light brown to almost black, with guard hairs often paled at the tips. Grizzly bears are generally larger than black bears (*Ursus americanus*) and can be distinguished from them by longer, curved claws, humped shoulders, and a more concave face. In the lower 48 States, male grizzly bears average 400 to 600 pounds and female grizzly bears average 250 to 350 pounds. Adult grizzly bears stand 3.5 to 4.5 feet (ft) at the hump when on all fours, and can exceed 8 ft in height when standing on their hind legs. The Yellowstone grizzly bear population is discrete from other grizzly populations, has markedly different genetic characteristics, and

exists in a unique ecological setting where bears use terrestrial mammals as their primary source of nutrition (Mattson 1997, 70 FR 69865). A more complete discussion of the biology and ecology of this species may be found in the Grizzly Bear Recovery Plan (Service 1993).

## **Life History**

*Home range and dispersal:* Most areas currently inhabited by the species are in contiguous, relatively undisturbed mountainous habitat with high topographic and vegetative diversity. Grizzly bears require large areas to fulfill their basic biological needs, including food and shelter. Their home ranges average 130 to 1,300 square kilometers (sq km) (50 to 500 square miles (sq mi)). Within its home range, a grizzly bear uses a diverse mixture of forests, moist meadows, grasslands, and riparian habitats to complete its life cycle. Grizzly bears generally prefer large, remote areas of habitat for feeding, denning, and reproduction that are isolated from human development (Service 1993). They require dense forest cover for hiding and security. In the GYA, lodgepole pine forests are a large and dynamic part of grizzly bear habitat. Long distance movements of some grizzly bears increase the risk of contact with highway crossings, hunters, recreationists, livestock, and a variety of other developments and activities associated with human use.

*Diet:* The grizzly bear is an opportunistic omnivore that uses a wide variety of plant and animal food sources. The literature provides comprehensive information on food items that grizzly bears consume. A recent synthesis of this information summarized that they consume up to 234 different foods, 75 of which are eaten on a regular basis, with the higher caloric foods being army cutworm moths, various ungulate species such as elk and moose, cutthroat trout, and whitebark pine seeds (IGBST 2013). Combined food habit studies from the GYA show that grizzly bears not only display dietary plasticity among individuals and in different portions of the ecosystem, but also across seasonal, annual, and decadal time periods (IGBST 2013).

Grizzly bears in the GYA have the highest percentage of meat consumption in their diet of any inland grizzly bear population with about 40 to 80 percent comprised of some form of animal matter (male bears tend to consume higher percentages of meat) (Jacoby et al. 1999 as cited in Robbins et al. 2006). Meat in the grizzly bear's diet varies by season and available forage. Ungulates are an especially important food source for bears in the spring and fall (Knight *et al.* 1984), and use of carcasses in Yellowstone National Park is well documented (Podrutzny and Gunther 2001).

Army cutworm moths are an important food source for some bears in the GYA (Mattson *et al.* 1991). Army cutworm moths congregate in remote, high altitude alpine talus areas and feed on alpine flowers. These moths provide important dietary fat in the fall, when grizzly bears are preparing for hibernation, and are also positively correlated with bear reproductive success (Bjornlie and Haroldson 2001). During times of great moth abundance, White *et al.* (1999, as cited in Robison et al. 2006) estimated a grizzly bear may eat up to 40,000 moths per day and more than one million per month, representing 47 percent of its annual caloric budget. Army cutworm moth congregation sites are in remote areas and therefore, potentially reduce human-

bear conflicts by isolating the bears. Spawning cutthroat trout in streams surrounding Yellowstone Lake have been an important food source for grizzly bears (Mattson and Reinhart 1995). Grizzly bears will eat ants (Mattson 2001) and earthworms (Mattson *et al.* 2002); small mammals, such as pika and marmots, form a relatively minor portion of the bear's diet. In addition to eating wild ungulates, some grizzly bears consume domestic ungulates to varying degrees in some portions of the GYA, either in the form of carrion or as prey.

Grizzly bears also eat a variety of vegetative foods. Whitebark pine seeds are an important fall source of food to some bears when seeds are available (as a mast species, whitebark pines only produce good crops every 2 to 3 years). Those bears with access to whitebark pines consume the seeds that they scavenge from red squirrel cone caches (Mattson and Reinhart 1997). Studies show that in years when the whitebark pine seed crop is low, there is an increase in human-bear conflicts (Haroldson *et al.* 2003). This is likely due to bears seeking alternative food sources, such as exotic clover species (Reinhart *et al.* 2001) and yampa, which occur at lower elevations and closer to humans. In addition to pine seeds supplying a food source high in fat, good whitebark pine seed crops also keep some grizzly bears occupied at high elevations far from intense human use. Other grizzly bear seasonal plant use includes roots (Mattson 1997), graminoids, horsetail, forbs, and fruits, such as whortleberry and huckleberry (Knight *et al.* 1984, Mattson *et al.* 1991). Bears also eat limited amounts of mushrooms.

*Den site selection:* Grizzly bears generally construct dens in areas far from human disturbance at elevations of approximately 2,000 to 3,050 meters (6,500 to 10,000 ft). Grizzly bears den from the end of September to the last week in April or early May, with entrance and emergence dates affected by the gender and reproductive status of the bears. Denning bears can be disturbed by winter sport activities, such as snowmobiling; studies have focused on minimizing disturbance by controlling access to important denning areas (Haroldson *et al.* 2002, Podrutzny *et al.* 2002). If pregnant female bears are disturbed in their dens and this disturbance causes them to relocate to a new den prior to parturition, negative consequences can occur in the form of reduced cub fitness and survival (Linnell *et al.* 2000, Swenson *et al.* 1997).

## **Population, Status and Distribution**

Historically, the grizzly bear ranged in the United States from the Great Plains to the Pacific Coast and from the northern U.S. border with Canada to the southern border with Mexico. It is believed the grizzly bear population in the contiguous American West numbered over 50,000 individuals prior to the 18th century (Service 1993). Their numbers greatly declined during the past two centuries.

The grizzly bear was listed as threatened in the conterminous 48 states in 1975 (70 FR 69858) due to concerns about the bear's population status within its remaining range. In the contiguous U.S., the grizzly population has been reduced to roughly 2 percent of its former range. As of 2011, the estimated total population of grizzly bears in the lower 48 states was approximately 1,650 individuals (Table 1; Service 2011) (Note: by incorporating the 2013 GYA population estimate of 629 bears (a minimum), the lower 48 states total now exceeds approximately 1,700).

They currently occupy parts of British Columbia and Alberta in Canada, and Montana, Idaho, Wyoming, Washington, and Alaska in the United States.

The 1993 Grizzly Bear Recovery Plan outlines recovery strategies for the various grizzly bear ecosystems. The Plan defines a recovered population as one that can sustain the existing level of known and unknown human-caused mortalities that exist in the ecosystems and are well-distributed throughout their recovery zones. Within the contiguous United States, six recovery zones associated with the various ecosystems (shown in Figure 2) were identified (Service 2011): (1) Northern Continental Divide; (2) Cabinet-Yaak; (3) Selkirk; (4) North Cascades; (5) Greater Yellowstone Area; and (6) Bitterroot. The Bitterroot ecosystem is not currently occupied by grizzly bears. (Note: the 1993 Recovery Plan originally described the Yellowstone ecosystem recovery zone as Yellowstone Grizzly Bear Ecosystem Recovery Zone; it's now referred to as the Greater Yellowstone Area, or GYA, Recovery Zone. The GYA Recovery Zone covers the same geographic area and is known as the Primary Conservation Area under the 2007 Final Conservation Strategy for the Grizzly Bear in the Greater Yellowstone Area; Recovery Zone and Primary Conservation Area are sometimes used synonymously.)

Grizzly bear recovery zones (RZ) were established to include areas large enough and of sufficient habitat quality to support a recovered bear population in each zone. According to the 1993 Recovery Plan, a recovery zone is defined as that area in each grizzly bear ecosystem within which the population and habitat criteria for achievement of recovery will be measured. However, the GYA RZ recovery criteria have since been updated to include criteria applicable to the entire GYA ecosystem, such as population estimates and mortality thresholds.

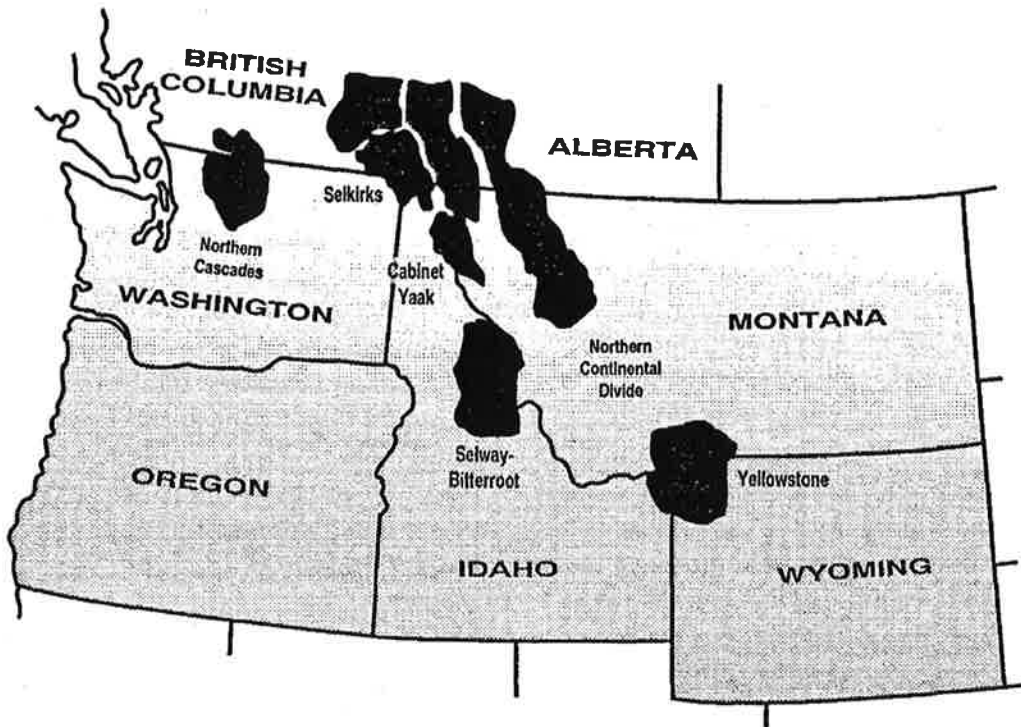
**Table 1. Estimated grizzly bear population size (individuals) and population growth rate by Recovery Zone or Ecosystem (Service 2011, Haroldson et al. 2013).**

Recovery Zone or Ecosystem	Estimated Population Size	Trend (% change annually)
Greater Yellowstone Area Ecosystem	629 or 741*	+0 to 2%
Northern Continental Divide RZ	930	+3%
Cabinet-Yaak RZ	42	-3.8%
Selkirk RZ	88**	+1.9%
North Cascades RZ	<20	unknown
Bitterroot RZ	0	n/a

\*Reflects two methods for estimating population (see Greater Yellowstone Area subsection below).

This population estimate covers the entire ecosystem. The GYA includes our defined action area.

\*\*Estimate includes 30 in U.S. and 58 in Canada.



**Figure 2. Grizzly bear ecosystems in the conterminous 48 States (Service 1993).**

Habitat degradation and fragmentation, and negative human/bear interactions are the primary factors responsible for grizzly bears' current threatened status (Service 2011). Grizzly bears preferentially use large areas with a low density of roads and low levels of human activity. Secure habitat is an important component for minimizing habitat degradation and fragmentation, and is defined as areas larger than 10 acres (ac) in size and greater than 500 meters (m) from an open road (Interagency Conservation Strategy Team 2007). The average amount of secure habitat in each recovery zone ranges from 53 percent in the Selkirks to 86 percent in the GYA (Service 2011).

**Northern Continental Divide (NCDE):** Grizzly bears are well distributed throughout the NCDE Recovery Zone and their range has expanded outside of the recovery zone boundary to the east, and somewhat to the west and south (Service 2013). The Grizzly Bear Management Plan for Western Montana identifies 37,460 sq km (14,463 sq mi) of the NCDE as occupied, including some intervening habitat between the NCDE and the Cabinet-Yaak. The estimate of average annual population growth was re-calculated in 2012 with a resulting rate of 3.03 percent per year across the time period from 2004-2011 and a total population estimate of approximately 930-942 bears. The NCDE population of grizzly bears is contiguous with grizzly bears in Canada, resulting in high genetic diversity (Proctor et al. 2012, as cited in Service 2013). Grizzly bears are well distributed throughout the NCDE Primary Conservation Area and Zone 1 although density is higher inside the Primary Conservation Area (see Kendall et al. 2008, 2009; Mace and Roberts 2011, as cited in Service 2013).

**Cabinet-Yaak (CYE):** The CYE Recovery Zone is estimated to contain at least 40-45 grizzly bears (Kasworm et al. 2007, as cited in Service 2011). Separate population estimates were made for the Cabinet Mountains and the Yaak River drainage because there is not any documented movement of grizzly bears between these two portions of the Recovery Zone (RZ). The Cabinet Mountains lie south of the Yaak River drainage and contain about 60 percent of the recovery zone. There are approximately 15 individuals in the Cabinet Mountains and 25-30 individuals in the Yaak portion of the recovery zone (Kasworm et al. 2007, as cited in Service 2011). There are another estimated 24 grizzly bears in Canada directly across the border from the Yaak (Proctor et al. in press, as cited in Service 2011).

**Selkirks (SE):** The estimated population size is 88 grizzly bears in the SE RZ, with 30 in the U.S. and 58 in Canada (Proctor et al. in press, as cited in Service 2011). While this population estimate represents a substantial increase in bears in the SE since 1999, it must be interpreted cautiously until more accurate data are available. The estimate for the U.S. portion of the SE is based on expert opinion (Wakkinen 2010, as cited in Service 2011). It is estimated that the population of grizzly bears in the SE is slowly increasing at a rate of 1.9 percent annually.

**North Cascades (NCASC):** The population in the NCASC is estimated to be fewer than 20 animals within the 24,605 sq km (9,500 sq mi) RZ. The population in adjacent British Columbia is estimated to be less than 25 grizzly bears within a 9,800 sq km (3,784 sq mi) area (North Cascades Grizzly Bear Recovery Team 2004, as cited in Service 2011). The distribution of grizzly bears within the NCASC is unknown due to a lack of data (Service 2011).

**Greater Yellowstone Area (GYA):** The 23,828 sq km (9,209-sq mi or 5.89 million ac) GYA RZ includes portions of Wyoming, Montana, and Idaho and portions of six National Forests (Beaverhead, Bridger-Teton, Custer, Gallatin, Shoshone, and Caribou-Targhee), Yellowstone and Grand Teton National Parks, John D. Rockefeller, Jr. Memorial Parkway, Bureau of Land Management, and adjacent private and State lands.

The range of grizzly bears in the entire GYA has increased, as evidenced by the 48 percent increase in occupied habitat between the 1970s and early 2000s, and it is still expanding (Pyare et al. 2004, Schwartz et al. 2002, IGBST 2013). The most recent estimate of the known area occupied by grizzly bears in the entire GYA is approximately 50,280 sq km (19,413 sq mi or 12,424,320 ac) (Bjornlie 2013).

The GYA represents the most distant portion of the current grizzly bear range in the U.S. and has been the primary focus of grizzly bear recovery efforts to date. Range expansion and population increases, including into southern portions of the GYA, have been concurrent with the Forest implementing the actions described in the proposed action, and with other Federal and non-federal actions described in the baseline below. This means that historical activities comparable to the proposed action have had little to no discernible effect on the population's trend toward recovery.

Recovery efforts have been very successful and the number and distribution of grizzly bears in this population have exceeded target recovery levels for the last several years. For example, the population of independent female grizzly bears has grown from less than 30 in 1983 to more than 250 today (Schwartz et al. 2011, Haroldson and Frey 2013). Recovery work continues to reduce grizzly bear mortalities and ensure habitat standards for maintaining a recovered population in this ecosystem.

Best available science suggests the GYA ecosystem grizzly bear population is stable to slightly increasing. In 2012, estimates of the number of grizzly bears in the GYA were 629 or 741 depending on the methods used to estimate population size (see **Conservation** section for details) (Haroldson et al. 2013). Current analysis indicates that this grizzly bear population grew an average of 4 percent or more annually from 1983-2001. The population's rate of growth slowed during 2002-2011 to 0 to 2.2 percent, likely because of the increase in grizzly bear density in the GYA (IGBST 2012, IGBST 2013). The grizzly bear population in the GYA met its recovery goals in the mid-1990s, has exceeded recovery goals every year since, and may be nearing carrying capacity (IGBST 2013).

The Service proposed to establish a Distinct Population Segment of the grizzly bear for the GYA and surrounding lands and concurrently delist it from the ESA on November 17, 2005 (70 FR 69854; Service 2005). The final rule to delist the grizzly bear was published on March 28, 2007, and became effective April 30, 2007 (72 FR 14866; Service 2007a). An order was issued by the Federal District Court in Missoula on September 21, 2009, which enjoined and vacated the delisting of the GYA grizzly population. In compliance with this order, the GYA grizzly population is again treated as a threatened population under the ESA. The District Court decision was appealed on two primary issues: (1) adequacy of regulatory mechanisms after delisting (i.e., the Conservation Strategy) and (2) the potential threat of whitebark pine decline on the GYA grizzly bear population. The 9<sup>th</sup> Circuit Court of Appeals rendered a decision in November 2011 and reversed the District Court decision regarding the adequacy of protections provided under the Conservation Strategy but upheld the District Court decision that the Service had not sufficiently articulated that whitebark pine decline was not a threat to the GYA grizzly population. The Service is currently addressing the whitebark pine issue.

Human-grizzly bear interactions have been increasing in the GYA due, in part, to increasing human use and development, increasing bear numbers, and bears and people both expanding their range of occupancy, thereby increasing the chances of adverse encounters. The frequency of grizzly bear-human conflicts is inversely associated with the abundance of natural bear foods (Gunther et al. 2004). Mortalities from grizzly bear-human conflicts currently are a primary source of grizzly bear mortality (see IGBST annual reports and mortality database). Table 2 summarizes the 461 known and probably grizzly bear mortalities from 1997 to 2012 in the GYA (IGBST 2014a).



**Table 2: Known and probable grizzly bear mortalities in the GYA, 1997-2012.**

Cause of Mortality	Number of Bear Mortalities	Percent of Total Mortality
Natural injury or deformity	2	0.4
Predation	30	6.5
Malnutrition	3	0.7
Old age	6	1.3
Poached/malicious	22	4.8
Hunting DLP*	99	21.5
Hunting mistaken ID	24	5.2
Backcountry camp illegal	3	0.7
Backcountry camp DLP*	10	2.2
Front country DLP*	6	1.3
Front country mgmt removal	80	17.4
Human aggr/injury/fatality - mgmt removal	11	2.4
Sheep related illegal	1	0.2
Sheep depredation mgmt removal	6	1.3
Cattle depredation mgmt removal	31	6.7
Mgmt capture mortality	3	0.7
Research capture mortality	6	1.3
Road kill	22	4.8
Hunting related illegal	1	0.2
Horse depredation mgmt removal	1	0.2
Specific undetermined	87	18.9
Poisoning	1	0.2
Non-hunting backcountry DL*	6	1.3
<b>Total</b>	<b>461</b>	<b>100.0</b>

DL (and DLP) means Defense of Life (and DL or Property).

The Forest Service has decreased its authorization of sheep grazing in the GYA over the past two decades. However, grizzly bear conflicts with livestock in general in the GYA continue to occur, which can lead to management relocations or lethal removals of grizzly bears. During the period from 2009-2011, Gunther *et al.* (2012) identified four areas in the GYA as having 57 percent (385 of 672) of grizzly bear-human conflicts (including grazing, which is a human-related activity). These included: (1) the Green River area (154 conflicts; where the nine allotments are located), (2) the North and South Forks of the Shoshone River (125 conflicts), (3) the Clarks Fork area (56 conflicts), and (4) the Gardiner Basin (50 conflicts). Conflicts from sources other than livestock are widely distributed but tend to concentrate along major river corridors. In 2012, most (87 percent) of the Wyoming conflicts occurred outside the Recovery Zone, with similar rates on private lands (49 percent) versus Federal and State lands (51 percent). Outside the National Parks (in WY), 5 of 12 grizzly bears were removed due to livestock depredations

(DeBolt et al. 2013). The majority of conflicts on Forest Service lands in Western Wyoming occurred on the Bridger-Teton National Forest, including the Upper Green River watershed (livestock depredations).

## **Conservation**

Prior to the 2007 final rule to delist the grizzly bear, the Service: (1) finalized the 2003 Conservation Strategy (Interagency Conservation Strategy Team 2007) that guides post-delisting monitoring and management of grizzly bears in the GYA, (2) appended the habitat-based recovery criteria to the 1993 Recovery Plan and the Conservation Strategy, and (3) appended the 1993 Recovery Plan and the Strategy with an updated and improved methodology for calculating total population size, known to unknown mortality ratios, and sustainable mortality limits for the entire GYA grizzly bear population (Service 2007b).

The State and Federal implementation plans within the 2007 Final Conservation Strategy for Grizzly Bears provide a framework for managing the Primary Conservation Area (PCA; synonymous with the Recovery Plan's Recovery Zone) and adjacent areas of suitable grizzly bear habitat. The PCA is the area considered the adequate seasonal habitat needed to support the recovered Yellowstone grizzly bear population for the foreseeable future and allow bears to continue to expand outside the PCA. A recovered grizzly bear population is one having high probability of existence into the foreseeable future (greater than 100 years) and for which the five factors in Section 4(a)(1) of the ESA have been successfully addressed. The PCA was designed specifically with these five factors in mind. Due to grizzly bear relisting in 2009, the 1993 Recovery Plan and subsequent 2007 demographic and habitat-based recovery criteria supplements (USFWS 2007b, 2007c) are the current monitoring and management documents in use in addition to existing forest plan direction. The 2007 Conservation Strategy and recently published literature and reports also provide best available science and are incorporated into project analyses, monitoring, and other considerations.

The Interagency Grizzly Bear Study Team (IGBST) is an interdisciplinary group of scientists and biologists responsible for long-term monitoring and research efforts on grizzly bears in the GYA. Their main objectives are to monitor the status and trend of the GYA grizzly bear population and determine patterns of grizzly bear habitat use and the relationship of land management activities to the welfare of the grizzly bear population. These include monitoring population and habitat components in the GYA per the Recovery Plan and 2007 revised Demographic Recovery Criteria (Service 2007b) and Habitat-based Recovery Criteria (USFWS 2007c). Population monitoring includes status and trend, numbers, reproduction, and mortality, and specifically:

- (1) Monitoring unduplicated females with cubs of year (COY) and estimating total population size for the entire GYA based on modeled estimates of females with COY;
- (2) Monitoring distribution of females with young of all ages and having a target of at least 16 of 18 Bear Management Units (BMU; described in more detail below) within the RZ/PCA occupied

at least 1 year in every 6, and no two adjacent BMUs can be unoccupied over any 6-year period; and

(3) Monitoring all sources of mortality for independent females and males within the entire GYA.

The population components are discussed below. Habitat monitoring includes documenting abundance of four major foods throughout the GYA (winter ungulate carcasses, cutthroat trout spawning numbers, bear use of army cutworm moth sites, and whitebark pine cone production). The habitat monitoring information as well as procedures to accomplish all of these tasks are described in the IGBST's annual reports (see website: [www.nrmssc.usgs.gov/research/igbst-home.htm](http://www.nrmssc.usgs.gov/research/igbst-home.htm)) and other references.

Based on changes in vital rates and subsequent age structure, the IGBST's 2011 demographic monitoring results indicated the trajectory for the annual grizzly bear population estimate (based on females with COY) was increasing. These changes triggered a demographic review in February 2012. From that review, proposed changes were made and included both counting females with COY for population estimation and documenting known and probable mortalities for assessing annual mortalities limits within a new Demographic Monitoring Area (DMA), which encompasses 49,931 sq km (19,278 sq mi; IGBST 2012). Current population and mortality estimates are based on the Conservation Management Area (CMA), which encompasses 95,225 sq km (36,767 sq mi; see figures in 2014 BA, p. 8; Haroldson et al. 2013). The CMA is the boundary within which sighted females with COY are used for population estimation. We include both the current CMA and proposed DMA population estimates below.

(1) Monitoring unduplicated females with COY and estimating total population size:

Current Conservation Management Area Estimate: In 2012, there were 124 verified sightings of females with COY within the current CMA count line, and of those sightings, 49 unduplicated, or unique, females were differentiated using the rule set described by Knight et al. (1995). The number of COY observed was 94, with a mean litter size of 1.92. The trend and rate of change for the number of unique females with COY in the population are estimated by averaging linear and quadratic models, which resulted in 58 females with COY, which exceeds the demographic objective of 48 specified in the Demographic Recovery Criteria for the GYA. Forty-eight females is equivalent to a population of approximately 500 total individuals. The estimated total population derived from this data was 610 grizzly bears in the GYA (Haroldson et al. 2013). The population estimate for 2013 is 629 bears in the GYA (Interagency Grizzly Bear Study Team 2014b).

Proposed Demographic Monitoring Area Estimate: Within the proposed DMA count line, there were 109 verified sightings of females with COY and of those, 43 unduplicated females with COY were differentiated in 2012. Sighting frequencies for these families produce a model-averaged estimate of 57 unduplicated females with COY (Haroldson et al. 2013). Changes between these two methods will be small because nearly all females with COY are sighted within the proposed DMA count line (IGBST 2012). However, applying the updated vital rates

produces larger changes to the estimated population size, which was 718 grizzly bears in the GYA. The reason is due primarily to increases in survival rates for independent male bears, and subsequent changes in the ratio between independent-aged females and males in the modeled population this produces (Haroldson et al. 2013). Estimates for 2013 are 59 females with COY, mean litter size of 2.17, and a population of 741 bears in the GYA (IGBST 2014b).

Research by Schwartz et al. (2008, as cited in IGBST 2012) on the existing CMA counts of females with COY and the associated rule set of Knight et al. (1995) used to estimate population size has demonstrated these counts are biased low. The proposed DMA estimate solves many of the problems inherent in Knight et al. (1995) and may produce an unbiased estimate for the annual number of females with COY in the GYA (IGBST 2012). Because vital rates and trend have changed, it is appropriate to use updated vital rates and ratios for specific population segments (Haroldson et al. 2013). Revised thresholds have not yet been adopted by the Yellowstone Ecosystem Subcommittee of the Interagency Grizzly Bear Committee. Regardless of method used, both population estimates based on females with COY continue to exceed the recovery objective of 500 bears in the entire GYA as established by the Service's Recovery Plan and 2007 revised Demographic Recovery Criteria supplement.

(2) Monitoring distribution of females with young of all ages:

The Recovery Zone is divided into smaller areas called Bear Management Units (BMUs) for the purpose of habitat evaluation and monitoring. BMUs were designed to:

- Assess the effects of existing and proposed activities on grizzly bear habitat without having the effects diluted by consideration of too large an area;
- Address unique habitat characteristics and bear activity and use patterns;
- Identify contiguous complexes of habitat meeting year-long needs of the grizzly bear; and
- Establish priorities for areas where land use management needs would require cumulative effects assessments.

The target is to have at least 16 of 18 BMUs within the RZ occupied at least 1 year in every 6, and no two adjacent BMUs can be unoccupied over any 6-year period. In 2012, 15 of 18 BMUs had verified observations of female grizzly bears with young, and 18 of 18 BMUs contained verified observations of females with young in at least 4 years of the 6-year period, 2007-2012 (Haroldson 2013).

(3) Monitoring all sources of mortality for independent females and males within the entire GYA:

The long-term survival of the Yellowstone grizzly bear population over the next 100 to 200 years is contingent upon minimizing average annual mortality within the total population and especially that of adult females (Knight and Eberhardt 1984, 1985). There were 54 known and probable mortalities in the GYA during 2012, of which 34 mortalities were attributable to human causes (16 of those were management removals due to livestock depredation and site conflicts) (Haroldson and Frey 2013).

In 2013, there were 24 documented mortalities of females and males (10 and 14, respectively) with estimated total mortality of 18 females and 20 males (includes documented mortality and estimated unreported losses) (unpublished data, IGBST 2014). IGBST evaluates the sustainability of annual grizzly bear mortalities that occur within the current CMA and proposed DMA boundaries and estimates limits, or thresholds, derived from the model-averaged estimate for females with COY (see IGBST 2005 and 2006 annual reports for procedures). Sustainable mortality limits for 2013 were 24 females and 25 males; therefore both genders were within established mortality thresholds (unpublished data, IGBST 2014).

The 2007 Demographic Recovery Criteria supplement (Service 2007b) states that mortality thresholds are not to be exceeded in more than 2 consecutive years for females, or more than 3 consecutive years for males or cubs (Service 2007b). The Recovery Plan's threshold for mortality from all causes of adult (i.e. independent, older than 2 years old) females is 9 percent of the total GYA population of adult females (Service 2007b). The revised mortality threshold recommended by the IGBST is 7.6 percent for adult females (IGBST 2012). Although the revised threshold is a smaller percentage, it may represent a larger number of bears because of the growing population and statistical methodology. Across the GYA, mortalities of adult female grizzly bears (from all causes) in 12 of the past 14 years were lower than the threshold set to sustain an increasing population (see IGBST annual reports).

The mortality threshold for cubs (i.e., dependent offspring) is 9 percent (Service 2007b); IGBST has recommended revising this to 7.6 percent of the total estimated population of dependent cubs (IGBST 2012). Unlike the threshold for independent females, only human-caused mortalities are counted against the threshold for cubs. The mortality limit for dependent cubs in the GYA has never been exceeded.

Although the population trajectory is generally independent of male survival rates (IGBST 2012), the annual mortality threshold for independent males is set at 15 percent. The mortality limit for independent males was exceeded in 2008, 2010, and 2011 (the latter fractionally, by less than one bear). The mortality limit for independent males was again exceeded in 2012 under the current protocol (Service 2007b); however, the number of mortalities would be lower than the limit under the revised protocol recommended by IGBST (2012). The two methods lead to different conclusions because IGBST recommends not counting mortalities occurring outside of the area considered suitable habitat against the threshold. This change means that grizzly bear mortalities in areas where long-term expansion or occupancy is likely unsustainable would not be counted against mortality thresholds. The revised protocol also limits the count of grizzly bear mortalities to areas where systematic data collection efforts occur (IGBST 2012). The increase in mortalities of independent males exceeding the 15 percent threshold may be related to independent subadults dispersing into marginal habitat at the edges of the current GYA range.

These data and previous IGBST annual reporting data for the entire GYA indicate that the population continues to meet Demographic Monitoring Criteria. Mortality limits are carefully monitored and controlled and mortalities are generally within established thresholds. Recent levels of mortality in the GYA have been sustainable and there has not been an observed decline

in survival of independent-aged bears through 2011 (IGBST 2014). The population is stable to slightly increasing and it continues to expand outward in the ecosystem, particularly into peripheral areas.

Grizzly bears achieved recovery goals in the mid-1990s despite long-term, on-going human-related activities throughout the GYA. Per the current demographic monitoring protocol, the current population estimate of approximately 629 grizzly bears is conservative, with bears likely totaling in excess of 700 in the GYA (Haroldson et al. 2013), based on the proposed count line and methodology. Regardless of method used, all population estimates exceed the recovery objective of 500 bears established by the Service's 1993 Grizzly Bear Recovery Plan and 2007 revised Demographic Recovery Criteria. In addition, grizzly bear mortalities in the GYA have, overall, remained within existing sustainable mortality thresholds.

The long-term conservation of grizzly bears in the GYA continues to depend largely on managing bear-human conflicts (including human-related activities such as livestock grazing), which can result in human-caused mortality of grizzly bears. Efforts focusing on education, proper food storage and disposal of bear attractants, infrastructure management, and compliance and enforcement of permit requirements will help prevent these incidents and is part of the overall management strategy for grizzly bears in the GYA.

## **Threats**

Human activities resulting in conflicts and subsequent mortality and displacement were the main reasons the grizzly bear was listed as threatened (Interagency Conservation Strategy Team 2007). Managing human-caused bear mortality is a goal of the Recovery Plan and is essential to maintaining a viable grizzly bear population (Service 1993). Bear-human conflicts are incidents in which bears injure people, damage property, kill or injure livestock, damage beehives, obtain anthropogenic foods, or damage or obtain garden and orchard fruits and vegetables (Gunther et al. 1999).

Grizzly bear-human interactions and conflicts have been increasing in the GYA due, in part, to increasing human use and development, increasing bear numbers, and bears and people both expanding their range of occupancy, thereby increasing the chances of adverse encounters. The most important issues to control on the landscape are levels of human activities. Key issues include those related to food storage, livestock allotments, and motorized access, which incorporates secure habitat standards for road densities and other criteria (Interagency Conservation Strategy Team 2007). Isolation from human activities is extremely important for bear survival, as grizzly bears can habituate to humans and become conditioned to anthropogenic foods quickly, subsequently changing them into nuisance bears. Nuisance bears often must be relocated or lethally removed from the population.

The frequency of grizzly bear-human conflicts is inversely associated with the abundance of natural bear foods (Gunther et al. 2004). Years in which natural grizzly bear food production and availability are high can result in younger age classes of grizzly bears accustomed to fairly

good food availability. A year of drought and poor food production can compel grizzly bears to search widely for food. Such wide ranging movements can bring grizzly bears into closer contact with humans, increasing bear-human conflicts and resultant management actions.

Whitebark pine seeds have provided an important food source for some grizzly bears. White pine blister rust and mountain pine beetles, which have had severe, negative consequences on whitebark pine in portions of the northern Rocky Mountains, occur in the GYA and have resulted in significant whitebark pine mortality. However, even where whitebark pine is available, it is not consistently used every year due to the stochastic nature of masting events. Also, whitebark pine is, and has historically been, absent from the home range or diet of a sizeable portion of the GYA grizzly bear population, and a recent food synthesis report indicated that various study findings do not indicate a strong dependence among GYA grizzly bears on whitebark pine seeds (IGBST 2013).

With the decline of whitebark pine in the GYA, grizzly bears over the past decade have exhibited reduced selection for whitebark pine habitat, and corresponding increased consumption of meat (IGBST 2013). Bear movements and home range size did not change with the change in diet, and recent analyses suggest that grizzly bear body condition and fecundity rates have not changed with the changing diet (IGBST 2013). However, the change in diet may lead to an increased probability that grizzly bears would seek out livestock or be in areas with an increased probability of negative interactions with humans.

The Yellowstone cutthroat trout, once an important food source for those grizzly bears adjacent to Yellowstone Lake and its tributaries in the 1970s and 80s, has been negatively influenced by introduced lake trout (which are less available to bears due to their deeper water habits) (Reinhart *et al.* 2001), drought, and whirling disease caused by an exotic parasite (Haroldson *et al.* 2005 and others, as cited in Gunther *et al.* 2012). Data from 2012 indicate numbers of spawning cutthroat trout continue to be low in most of the Yellowstone Lake tributary streams, and in North Shore and West Thumb streams, they've decreased significantly since 1989. Removal of lake trout from Yellowstone Lake continues, and in 2012, 301,966 were caught and removed. Population modeling suggests that recent increased removal efforts may have halted lake trout population growth and continued catch at these rates may begin reducing the population (Gunther *et al.* 2013).

Winter-killed and neonate ungulates are an important food supply, but ungulate populations vary widely in numbers and are influenced by weather and other conditions. The reintroduction of wolves has increased competition for ungulate prey and winter-killed carrion. Army cutworm moths, which also provide important food for bears in some high elevation areas, could be affected by pesticide use in agricultural areas. Some years have higher moth activity than others, and 2012 was a record year for the number of grizzly bear observations or telemetry relocations at moth sites, including females with COY (Bjornlie and Haroldson 2013).

Changing climate conditions have the potential to impact some grizzly bear food sources in the GYA. Climate change may result in possible shifts in grizzly bear habitat use in response to



declines in food resources. As mentioned, food habit studies from the GYA show that grizzly bears display dietary plasticity and consume a wide variety of foods (IGBST 2013). The extent and rate to which food sources will be impacted is difficult to foresee with any level of confidence. Other than potential impacts to food resources, the mountainous regions characterized by the Middle Rockies Ecoregion (includes the GYA) generally possess the habitat components necessary for grizzly bear persistence despite a changing climate. These components include hiding cover, topographic variation necessary to ensure a wide variety of seasonal foods, steep slopes used for denning, and remoteness from humans (72 FR 14906; Service 2007a).

Land ownership and management practices continue to affect bear-human conflict patterns. While the Forest Service has decreased its authorization of sheep grazing in the GYA over the past two decades, grizzly bear conflicts with livestock, in general, in the GYA continue to occur. On Forest Service lands, livestock depredations are the most common type of conflict (62 percent); whereas on private lands, the most common reported conflicts involve grizzly bear damage to property and obtaining anthropogenic foods, such as garbage, bird seed, dog food, and apples (76 percent). There are relatively few bear-human conflicts on National Park Service lands, and of the 8 conflicts in 2011, 5 were due to anthropogenic foods and 3 were surprise encounters.

Habitat may be compromised, degraded, or lost from management activities, commercial or recreational developments, and other human-related actions, resulting in grizzly bear displacement. They may also experience isolation from fragmentation of available habitat due to construction of major highways that block or restrict movement, and from inadequate provisions for linkages on minor roads and highways. Other sources of human-caused grizzly bear mortalities include mistaken identification by big game hunters, malicious killing, defense of human life or property, and accidental death (vehicle strike, electrocution, etc.). Bears are relocated or lethally removed to defend human life or property, usually because bears have become dangerously bold as a result of food conditioning and human habituation at campsites, lodges, resorts, and private residences, or they become habituated predators of livestock (Knight and Judd 1983).

The 1975 listing of grizzly bears in the conterminous U.S. identified genetic isolation of some populations of grizzly bears as a potential threat (40 FR 31734). Loss of genetic diversity is a potential concern for GYA grizzly bears because of the large distances between this and other U.S. populations (Service 2011). The 1993 Recovery Plan characterizes the Yellowstone population as isolated from other populations, and suggested genetic management may become appropriate for this population (Service 1993). A genetic study by Miller and Waits (2003) suggests that heterozygosity (i.e. genetic variation) was historically low in the GYA population, even before the decline of grizzly bears in the 20<sup>th</sup> century, and that the viability of the population is unlikely to be affected by genetic factors in the next several generations.

### III. ENVIRONMENTAL BASELINE

The preamble to the implementing regulations for section 7 (Service 1986) contemplates that the evaluation of "...the present environment in which the species or critical habitat exists, as well as the environment that will exist when the action is completed, in terms of the totality of factors affecting the species or critical habitat...will serve as the baseline for determining the effects of the action on the species or critical habitat." The regulations at 50 CFR 402.02 define the environmental baseline to include "the past and present impacts of all Federal, State, or private actions and other human activities in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process."

The analysis presented in this section supplements the above Status of the Species section by focusing on the current condition of grizzly bears in the action area (or similar areas where we have available data), the factors responsible for that condition, inclusive of the factors cited above in the regulatory definition of the environmental baseline, and the role the action area plays in the survival and recovery of the grizzly bear.

#### Action Area

Action area, as defined by the ESA's implementing regulations (50 CFR 402.02), is all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (our emphasis). Action is defined in the regulations as "...all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies in the United States or upon the high seas. Examples include, but are not limited to: (a) actions intended to conserve listed species or their habitat; (b) the promulgation of regulations; (c) the granting of licenses, contracts, leases, easements, rights-of-way, permits, or grants-in-aid; or (d) actions directly or indirectly causing modifications to the land, water, or air. For this Project, the area where "land, water, or air" that is likely to be affected is land administered by the U.S. Forest Service where grazing, trailing, and associated actions authorized by the Forest would occur.

The action area includes all nine livestock allotments (207,188 acres; Figure 1), plus the surrounding area where the scent and noise levels caused by livestock grazing are likely to extend. Noise may be caused by the sounds of livestock, herders, riders, dogs, etc. The spatial extent of livestock scent and noise on adjacent lands would be highly variable, depending on topographic and weather conditions, and the species (e.g., humans or grizzly bears) detecting those factors. The research by Guo et al. (2005) on more concentrated livestock operations (in Minnesota) identified an odor detection distance of up to approximately 3 miles by humans, but this information is difficult to extrapolate to livestock grazing on open range and how far livestock modifications to "land, water, or air" would be detectable by a grizzly bear. The distance grizzly bears would detect livestock grazing-related odors and noise outside of the nine allotments is unknown, because grizzly bears are suspected to have a keen sense of smell (Craighead 1976), much greater than that of humans. Craighead (1976) documented grizzly bear

movements of approximately 18 miles to feed on a carcass, but did not explain how or when the carcass was detected, or how researchers attributed the bears' movement to carcass presence. Detectability appears to be site specific. Another grizzly took 60 hours to locate a carcass 1.7 miles away when wind conditions were unfavorable Craighead (1976). These studies of wild prey carcasses suggest that grizzly bear movement towards the scent of such carcasses is highly variable, and depends on the individual bear, the prey item, weather and topographic conditions, or other factors such as available food resources. Craighead and Mitchell (1982) reported that many grizzly bears moved distances of 5-12 km (3.1 to 7.5 mi) to carcasses in Yellowstone National Park, and one adult male moved 30 km (18.6 mi). The smell emanating from carcasses is different from live animals, both of which occur on the allotments.

For purposes of defining the action area, we selected a distance of 7.5 miles beyond the perimeter of the collective nine allotment boundaries based on the maximum distance many of the bears traveled to carcasses in Craighead and Mitchell's (1982) study. Because not every area within the allotment boundaries is used by livestock, there are some areas that are not affected by the action (livestock grazing). In these cases, the 7.5-mi margin around the allotment boundary used to delineate the action area will represent an overestimate of area affected. In contrast, adjoining or nearby (within 7.5 mi) allotments with active grazing will, in essence, override or contribute to odors and noises from these nine allotments. But without more detailed information on livestock pattern of use to inform an adjustment to the action area boundary, we believe this is the most reasonable representation of action area (the area where "land, water, or air" that is likely to be affected is land ... where grazing ... and associated actions ... would occur) based on best available science.

In addition to the nine allotments, the action area also includes: areas in the Bridger and Fitzpatrick Wilderness Areas, where grazing habitat is mostly unsuitable and there are no other allotments – located along the east side of the nine allotments; portions of the adjoining Warm Springs, Fish Lake, Salt Creek, and Union Pass active grazing allotments on the Shoshone National Forest Wind River Ranger District - along the north and northeast sides; a mix of primarily Forest lands inside and outside the Gros Ventre Wilderness and some private lands - along the west and northwest sides; and a mix of primarily private lands with some state and Federal lands (Bureau of Land Management and Forest) - along the south side. Most of the action area is considered occupied by grizzly bears.

### **Status of the Grizzly Bear within the Action Area**

Grizzly bears continue to expand outward in the GYA, including and beyond the action area. Grizzly bear distribution in the GYA increased 38.3 percent from 2004 to 2010, with the greatest expansion occurring in the northern and southern regions of the range (the latter includes the action area). The increase in distribution likely reflects bears continuing to expand into suitable but unoccupied habitats on the edge of their current distribution. Within the last few years, grizzly bears have been documented in the southern Wind River Range and central Wyoming Range – both of which are located south of the action area and at the periphery of the GYA.

*Estimated Population:* The population size and rate of growth at the small geographic scale of the action area are unknown so we extrapolate from data covering the entire GYA and the limited data available from within and immediately outside of the nine allotments. The GYA rate of population growth slowed the last several years to approximately 0 to 2 percent. We recognize that the rate of growth in the action area could be higher than this because bears have been increasing in number and are expanding their range on the periphery. However, lacking more site-specific data, we assume the overall GYA rate of increase also applies to the action area.

The BA indicated there were 12 collared bears using the nine allotments in 2013 (based on telemetry data). Most of the collared bears using the nine allotments are conflict bears or adult males so there is little information on movements of non-conflict females. Only one collared grizzly bear has denned within the nine allotments since 2000, although it appears 1 to 2 females (not collared) also have successfully denned there (DeBolt 2013, pers. comm.). Within 10 km (6.2 mi) of the allotments, 5 female and 4 male collared grizzly bears have denned since 2003 (IGBST 2014c). Because the number of known (collared) bears is a subset of all bears using the allotments, we assume collared bears represent a fraction of the actual number of resident and transient bears within the allotment boundaries.

Most radio-collared bear locations in the allotments occur from mid-late June through September, which follows livestock on/off dates, but also vegetation green-up and elk and moose parturition. Cattle are moved from lower elevations in the southern portions of the allotments to higher elevations throughout summer, which, in some areas, may influence grizzly bear presence and habitat use. Although it is unknown how many grizzly bears are likely to occur within the allotment boundaries or action area during any given time period, we consider the following estimates for purposes of this analysis.

The Upper Green project area's nine allotments encompass approximately 1.7 percent of the occupied grizzly bear habitat in the GYA. Applying the two methodologies' estimates of grizzly bear population in the GYA (629 and 741 grizzly bears) (IGBST 2014b) and assuming a uniform distribution of grizzly bears throughout their range (in the absence of better data), we calculate about 11-13 grizzly bears occur within the nine allotments, which is similar to the number of collared bears. We recognize this is likely an underestimate given what we know about the number of collared bears using the nine allotments (conflict bears and adult males).

Our defined action area (allotment acres (207,188) plus acres within 7.5-mi radius extending out from allotments (802,467 ac)) totals 1,009,655 acres, which equals 8.1 percent of the occupied grizzly bear habitat in the GYA. Applying 8.1 percent to the current grizzly bear population estimates (629 and 741), we calculate 51 to 60 bears may use the entire action area (including the nine allotments). The number of grizzly bears in any given location, e.g., action area, fluctuates throughout the season based on food availability and other factors; however, this information provides some context for analyzing effects from grazing.

*Conflicts/Relocations/Mortalities:* The 2014 BA (pp. 17-26) and 2010 BA (p. 33) provided comprehensive livestock-related grizzly bear conflict, relocation, and mortality information within the nine allotment boundaries from 2010–2013 and 1999–2009, respectively; we’ve summarized this data in Table 3.

**Table 3. Livestock-related grizzly bear conflicts, relocations, and mortalities from nine allotments, 1999-2009 and 2010-2013 (2014 and 2010 BAs).**

Years	Number (average/year)		
	Conflicts	Relocations	Mortalities
1999-2009	276 (25)	26 (2.4)	5 (0.5)
2010-2013	164 (41)	13 (3.3)	12 (3)

In Table 4, we compared the 2010-2013 mortality data from Table 3 to the GYA mortalities by gender (IGBST 2014c).

**Table 4. Livestock-related female and male grizzly bear mortalities from nine allotments and percent of all documented GYA mortalities, 2010-2013 (IGBST 2014c).**

Year	Female Mortalities		Male Mortalities	
	Number	Percent	Number	Percent
	UG	(UG:GYA)	UG	(UG:GYA)
2010	0	0	1	3.8
2011	1	6.3	3	18.8
2012	1	9.1	2	9.5
2013	2	20	2	14.3

Livestock-related mortalities of females did not occur until 2010 in the GYA (and 2011 in the nine allotments) (IGBST 2014a). While the percent of female grizzly bear mortalities was 20 percent of the documented total in 2013 (and 11.1 percent of the estimated total mortality, which is documented plus unreported losses), it represents only 2 female bears in the entire GYA.

Grizzly conflicts in general on the nine allotments are largely related to livestock depredations, with the majority of depredations occurring in the Upper Green Allotment. However, this allotment is disproportionately large, encompassing approximately 60 percent of the nine-allotment area with 68 percent of the cattle. Total livestock depredations across all nine allotments increased annually from a low of 21 in 2010 to a high of 45 in 2013, and tended to peak in August. Depredations on sheep trended downward annually from a high of 14 in 2010 to a low of 1 in 2013. (Note: conflict numbers include depredation incidents that are only reported,

investigated, and verified; therefore, the conflict information is likely an underestimate of total grizzly bear/livestock conflicts in the area.)

Based on data from the 2010 and 2014 BAs, the numbers of conflicts and lethal management removals on the nine allotments have increased during the last four years compared to the period from 1999 to 2009, while the number of relocations tends to fluctuate from year to year. In addition to a growing and expanding grizzly bear population, the increases may be due, in part, to bears being previously trapped and relocated - either in these allotments or elsewhere in the GYA - and ending up in subsequent conflict situations in the Upper Green River area one too many times (DeBolt, 2013, pers. comm.). There was a notable decrease in sheep allotment conflicts from 2010 to 2012, mostly likely due to use of electric panels for night-penning.

Lethal removals from year to year may appear cyclic, in that once a targeted offender is removed, there would likely be a lapse in the number of subsequent conflict and removal situations. The number of relocations can vary considerably from year to year and we do not know exactly why. However, environmental conditions and natural food availability can impact the number and timing of relocations (and removals). For example, the amount of snowpack may have an effect on grizzly bear activity and whether or not they must range more widely in spring to find food (Thompson 2014, pers. comm.). Bears that range widely may increase their likelihood for negative encounters. Therefore, the numbers of relocations and removals vary from each other and from year to year. With an increase in number and range expansion of bears, we see increased levels of management actions, but this would be expected in areas of expansion.

As the grizzly bear population has increased and expanded in the GYA, there has been a corresponding increase in mortalities and this trend is also apparent in livestock-related mortalities, particularly on the periphery of the ecosystem. We would expect this as the population expands into areas with significantly more livestock grazing. Although livestock-related mortalities are increasing within the nine allotments, we must consider these mortalities relative to the entire GYA and that all mortalities within the GYA, including those in the allotments, generally remain below established mortality thresholds.

Within our defined action area but outside of the nine allotments (807,467 acres), there are approximately 15 adjacent or nearby allotments, of which most are actively grazed. During the same 4-year period (2010-2013), there were only 32 grizzly bear/livestock-related conflicts and no lethal removals of bears in the portion of the action area outside of the nine allotments (we do not have relocation data; Archual 2014, pers. comm.). While there were lower numbers of conflicts (and no mortalities) in the area outside the nine allotments, there is also less grazing relative to the nine allotments. For example, on Forage Reserves, grazing does not occur every year. Similarly, within the wilderness areas, there are areas unsuitable for grazing, and some of the allotments are now closed. Also, allotments to the south (on Bureau of Land Management and private) are not experiencing the level of grizzly bear use that is occurring to the north. Despite increasing conflicts and mortalities, survival of adult males, which is the group most often involved in cattle depredations, has increased in the GYA during the past decade.

However, there is no evidence that changes in any mortality factor, including lethal removals resulting from cattle depredations on these nine allotments, have contributed to a detectable change in grizzly bear survival in the GYA.

*Female Survival and Source/Sink Habitat:* The 2014 BA (pp. 29-30) indicated that female survival was modeled specifically for the project area's nine allotments by M. Haroldson, IGBST (USFS 2010), based on the female grizzly bear survival analyses performed by Schwartz et al. (2010). Schwartz et al. (2010) used data from radio-marked bears to model annual survival of grizzly bears (1983-2003) to identify landscape features that best described spatial differences in rates of grizzly bear mortalities, spatially depict the differences in grizzly bear survival across the GYA, and demonstrate how this model can be linked with demographic factors to identify source and sink habitats. According to their model, survival of independent grizzly bears improved as secure habitat and elevation increased, but declined as road density, number of homes and site developments increased. Although grizzly bear management and other cattle-related bear deaths were accounted for in Schwartz et al. (2010), their model was essentially a human-risk model and differences in survival on the landscape were not related to the amount of time bears spent on cattle or sheep allotments in the GYA, or both types combined.

The model results for this Project indicated that only two allotments had mean female grizzly bear survival estimates over 91 percent, the threshold level that identifies source habitat for grizzly bears. (This threshold was based on the estimate of sustainable mortality from Harris et al. (2006, as cited in Schwartz et al. 2010) that resulted in increasing population growth ( $\lambda \geq 1.0$  with 95 percent probability) for the GYA grizzly bear population.) All other allotments were below this threshold (2014 BA, Figure 20, p. 30), indicating sink ( $\lambda < 1$ ) habitat for grizzly bears (Schwartz et al. 2010). We could infer from model results that landscape features important for grizzly bears are inadequate across most of the nine allotments and therefore, we would expect lower survival of female grizzly bears. We discuss this further below.

### **Factors Affecting the Condition of the Grizzly Bear in the Action Area**

The habitat conditions on the nine allotments, and we assume for at least some of the lands surrounding the allotments within our defined action area, are biologically suitable for grizzly bears and are considered occupied. As stated in the 2014 BA (p. 26), "(T)he Upper Green Project Area provides abundant and widely distributed food and cover for grizzly bears in the project area during the late spring, summer, and fall. The Green River proper, and the middle-lower reaches of its tributaries, flow through open valleys and support well-developed willow riparian communities with abundant herbaceous vegetation (forbs, grasses, sedges) used by bears, particularly during the spring. The bottomlands also support dense patches of conifers available as bedding and security habitat. Offspring of ungulates (early summer) and carrion of elk, moose, mule deer, and pronghorn are used by bears. Domestic cattle and sheep within active allotments also provide prey and carrion during grazing seasons."

According to the BA, almost 15,000 acres of whitebark pine occur in pure and mixed stands at high elevations throughout the nine allotments. However, the recent pine beetle infestation has



resulted in severe declines of mature, cone-bearing whitebark pine trees within the Upper Green Project Area (Johnson 2014). As a result, current conditions will likely shift some grizzly bears' food habitats to other food sources (such as meat and forbs) within their home ranges.

The availability of habitat that is secure from human disturbance is an important factor affecting grizzly bear survival in the GYA (Schwartz et al. 2010). Although the IGBST monitors secure bear habitat throughout the GYA, the National Forests and National Parks are not required to limit the loss of secure habitat to road development or human use outside the RZ. The action area is outside the RZ; however, the BA indicated that road management standards in the Forest Plan limit open road density in some areas (BA p. 27), including portions of the nine allotments.

As mentioned, grizzly bear conservation depends upon the successful management of grizzly bear-human interactions, as most grizzly bear deaths are attributable to grizzly bear-human conflicts. The amount of secure habitat and density of roads have the greatest effect on grizzly bear survival (Schwartz et al. 2010). The 2014 BA security analysis (pp. 27-29) indicated that within the nine allotments, only two have secure habitat over 90 percent, two have between 60 to 90 percent secure habitat, and the rest are below 50 percent (see Fig. 19b, p. 29). To address this, the Forest added Conservation Measure #17 to "... identify areas within the Upper Green Project Area that currently provide for less than desirable grizzly bear security values as defined in the Grizzly Bear Conservation Strategy. This analysis may identify the locations of 'user created' motorized routes not authorized for motorized uses in the current Travel Management Plan for the Pinedale Ranger District that could be physically closed or reclaimed to improve security habitat within the Upper Green Project area."

Based on landscape features related to human risk, such as road densities and secure habitat described above, the model results of female survival indicated that most of the Project area's nine allotments may be a potential sink for grizzly bears. From these results, we could infer grizzly bear survival within the Project area's nine allotments may be lower than the GYA average of 91 percent. If we consider the abundant and widespread livestock grazing on these nine allotments with subsequent conflicts, relocations, and some lethal removals of bears concurrent with associated sink habitat, then we might also expect a slower, zero, or possibly a negative rate of population growth within the nine allotments. However, if we consider this information in the context of both the demographic and habitat-based recovery criteria, we must recognize that all mortalities within the GYA, which include those on the nine allotments, generally remain below established GYA mortality thresholds despite on-going livestock-related activities and that the nine allotments and action area are outside of the RZ, where road densities and secure habitat loss are not limited.

The 7.5-mi area outside the boundary of the nine allotments has approximately 15 other grazing allotments that are wholly or partially within the action area; most are actively grazed, two are forage reserves, and two are closed. Based on the secure habitat map in the 2014 BA (Figure 19a, p. 28), significant portions of the action area (outside of the nine allotments) provide secure habitat, particularly along the east and west sides of the nine allotments. Some of these allotments have experienced grizzly bear-livestock conflicts in the past 4 years (2010-2013) and

most were on the north side of the action area. All 32 conflicts were cattle-related and there were no grizzly bear mortalities (Archual 2014, pers. comm.). While we lack similar secure habitat and source/sink analyses on the entire action area, our action area outside of the nine allotments encompasses a much larger geographic area and has a broader spectrum of uses and habitat conditions, as well as fewer livestock-related grizzly bear conflicts and mortalities. If analyses of landscape features were conducted for the action area, we might see a dilution in overall results when compared to the nine allotments.

It's likely that some bears learn depredatory behaviors outside the action area then move into the action area and repeat those behaviors, becoming repeat offenders. The reverse likely happens as well, with bears learning depredatory behaviors within the action area and repeating those behaviors elsewhere. Those bears subsequently may be relocated or lethally removed from the population. While there is very limited information on grizzly bear use in the Upper Green River area, we assume that some bears are not depredating livestock and are using natural food resources, including wildlife and wildlife carcasses, on the landscape. Some grizzly bears likely feed on livestock carcasses provided by other bears' or wolves' depredation actions, but do not subsequently prey on livestock themselves (Anderson et al. 2002).

In addition to on-going livestock grazing, some recreational activities occur in the action area, such as camping, fishing, and hunting. These activities, in particular hunting in densely vegetated or riparian areas, have the potential to result in chance encounters between humans and grizzly bears, leading to subsequent self-defense actions that injure or kill bears. There was one hunter self-defense killing in the last 7 years (in 2012).

Overall, the action area is distant from large human population centers, has few roads in good condition, and supports limited recreational activity away from the Green River corridor, except during the late summer and fall big-game hunting seasons. These factors reduce grizzly bear disturbances by humans and limit grizzly bear-human conflicts, other than those associated with livestock management and surprise encounters with big game hunters. Because there is a lack of data on grizzly bear use to help inform livestock and bear management, the Forest's Conservation Measure #16 allows for the continuation of addressing basic questions regarding bear status and use of the Upper Green River area. While it will be several years before any information becomes available, it is an important step to help in understanding local bear use.

### **The Role of the Action Area in the Survival and Recovery of the Grizzly Bear**

What happens to grizzly bears in the action area and specifically within the nine allotments is of most importance relative to the survival and recovery of grizzly bears. A small number of bears from the entire GYA population will continue to depredate livestock within the action area (and nine allotments), resulting in their relocation or lethal removal. The mortalities resulting from proposed Project grazing activities count toward established GYA annual mortality thresholds and recent levels of mortality in the GYA have been sustainable as discussed in the **Conservation** section. Mortalities occurring in the action area, along with other losses, could cause total estimated mortalities to exceed limits in the GYA, which in turn, could potentially

impact population growth. However, data do not suggest these mortalities are affecting the survival of independent-aged bears or population growth at the level of the GYA or rangewide (IGBST 2014c). Given the conflict history and increasing numbers of livestock-related lethal removals on the nine allotments and action area, and despite long-term, on-going human-related activities throughout the GYA, grizzly bears have achieved recovery goals since the mid-1990s.

#### IV. EFFECTS OF THE ACTION

##### Direct and Indirect Effects of the Proposed Action

The implementing regulations for section 7 define “effects of the action” as “...the direct and indirect effects of an action on the species together with the effects of other activities that are interrelated or interdependent with that action, which will be added to the environmental baseline...” “Indirect effects” are defined in the regulations as “...those that are caused by the proposed action and are later in time, but still are reasonably certain to occur” (Service 1986, p. 19958).

The potential direct and indirect effects to grizzly bears from proposed livestock grazing action are: (1) a change in the quality and quantity of grizzly bear habitat and the availability of food; (2) attraction to the nine allotments because of livestock presence; (3) habituation or conditioning of grizzly bears to humans, livestock, or related food sources; (4) displacement of grizzly bears from habitat as a result of humans and other activities associated with livestock grazing; and (5) relocations or mortalities due to management actions or self-defense by herders, riders, permittees, or others associated with livestock grazing.

The effects to grizzly bears from adding up to 3,750 sheep (ewe/lamb pairs) and 11,236 cattle (cow/calf pairs) on the landscape are discussed separately in the following sub-sections, although these effects can be connected. For example, introducing livestock into the landscape changes the availability of food, which may lead to a grizzly bear feeding on cattle or sheep, thereby increasing the likelihood of a bear/human interaction. Some of these effects may result in incidental take, (“... to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture ...”) mostly likely in the form of harm.

##### *Change in the quality and quantity of grizzly bear habitat and the availability of food:*

As stated in the **Life History** section above, grizzly bears are opportunistic omnivores that use a wide variety of plant and animal food sources. Because grizzly bears across the GYA are able to find adequate food resources and given the habitat conditions present on the nine allotments, we assume conditions within the action area also provide adequate natural food resources throughout their active (non-hibernating) period. Natural foods can vary significantly within seasons and from year to year due to adverse or extreme weather conditions. For example, in drought years, some natural foods may be unavailable, such as berries; similarly, whitebark pine nuts may be unavailable during a non-masting year. However, grizzly bears consume a wide variety of

vegetation, roots, tubers, and other foods not consumed by domestic ungulates, and exhibit plasticity in their ability to switch between food resources.

As cattle and sheep graze across the landscape, there is less forage available for grizzly bears and their ungulate prey; however, livestock are widely scattered across the landscape and they forage over broad areas. Of the more than 200,000 acres in the nine allotments, approximately 42 percent are unsuitable for livestock grazing. While we lack data on exactly what foods grizzly bears and wild ungulate prey are using in the area, based on the characteristics of unsuitable grazing lands and the abundant and widely distributed food and cover available within the nine allotments (BA p. 26), we assume that at least some of the remaining unsuitable acres provide foraging opportunities for grizzly bears and their wild prey.

Night penning of sheep concentrates them into confined areas, potentially leading to habitat degradation. To reduce impacts to vegetation, the Forest's Annual Operating Instructions require sheep pens be moved regularly. Per Forest standards and guidelines, overall range conditions on the nine allotments, including riparian zones, are good with a few exceptions. In addition, the Forest must ensure adequate forage is maintained for wild ungulates (Murphy 2014, pers. comm.). Therefore, under the proposed action, we would expect competition for forage between livestock, grizzly bears, and wild ungulates, and impacts from depletion of that forage, to be minimal. Although competition may be minimal, adding livestock to the landscape is a significant habitat modification (potential food source).

*Attraction to the nine allotments because of livestock presence:*

Grizzly bears are suspected to have a keen sense of smell (Craighead 1976), which likely attracts them to livestock and livestock carcasses associated with the proposed action. As mentioned in the **Action Area** section, grizzly bear movement towards the scent of prey and carcasses is highly variable, and depends on the individual bear, the prey item, weather and topographic conditions, and other factors.

Wherever such prey, including livestock, and carcasses are available within grizzly bear-occupied habitat, bears may be drawn to the area. Domestic livestock and livestock carcasses in grizzly bear habitat may disrupt grizzly bears' normal behavior patterns by attracting bears away from their normal feeding and sheltering areas. This change in habitat use and behavior has the potential to make affected grizzly bears more susceptible to conflicts with humans. To address this issue, under the proposed action, all sheep carcasses will be removed as soon as possible (Conservation Measure #8) and some cattle carcasses will be removed depending on location (Conservation Measures #10).

Anderson et al. (2002) noted, "(W)hile carcass removal may reduce the concentration of bears in an area, it may not prevent bears from developing depredatory tendencies or repel depredating bears from grazing areas." Livestock carcass availability also will be reduced by implementation of good animal husbandry and herding practices to minimize stray animals and sickness (Conservation Measure #6). In addition, the Forest will explore additional means of reducing

grizzly bear/livestock conflicts (Conservation Measure #18). Based on implementation of these Conservation Measures, the likelihood that grizzly bears would be attracted to carcasses associated with proposed livestock grazing will be minimized on sheep allotments and reduced on portions of the cattle allotments.

We recognize that complete cattle carcass removal from the allotments is not possible due to the large and remote areas grazed by livestock on the nine allotments and the difficulty in locating all carcasses over such vast areas, or locating them in a timely manner. As a result, livestock and livestock carcasses will continue to attract some bears, and in some cases, direct adverse effects from subsequent bear relocations or lethal removals are anticipated.

*Habituation or conditioning of grizzly bears to humans, livestock, or related food sources:*

Grizzly bear habituation to humans and human activities can lead to conflicts with grizzly bears, which may ultimately lead to their relocation, harm, or death (McClellan 1989). Habituation is the loss of a bear's natural wariness of humans, resulting from continued exposure to human presence, activity, noise, etc. A bear habituates to other bears, humans, or situations when such interactions give it a return in resources, such as food, that outweighs the cost of the stress that precedes habituation (McArthur Jope 1980). Human-habituated bears can lose fear of people and develop unsafe behaviors. Food-conditioned bears often end up obtaining human food or garbage and learn to associate people with food rewards. Human-habituated or food-conditioned bears are more vulnerable to killing because of their tolerance to people, and some are subsequently removed from the population.

Generally, the frequency of grizzly bear-human conflicts is inversely related to the abundance of natural bear foods (Gunther et al. 2004). When native bear foods are abundant, conflicts with property or anthropogenic foods tend to be infrequent. When native bear foods are scarce, the frequency of grizzly bears damaging property and obtaining anthropogenic foods tends to increase, especially in late summer and fall when bears are gaining weight prior to denning. However, livestock depredations tend to occur independently of the availability of natural bear foods (Gunther et al. 2004, Gunther et al. 2012). Because grizzly bears seem prone to preying on livestock independent of natural food availability, and because of bears' demonstrated ability to learn foraging behavior, we assume that once a grizzly bear has preyed on livestock, it likely becomes habituated to the situation or conditioned to feed on them.

Grizzly bear depredation of domestic sheep and cattle is well documented. Most situations where grizzly bears are exposed to domestic sheep result in conflict or depredation (Knight and Judd 1983), although some grizzly bears coexist with livestock and never prey on them. Grizzly bear predation on sheep and cattle likely will result in the affected bears seeking out domestic livestock to supplement natural foods. This in turn will likely cause a disruption of natural grizzly bear movements and an increased potential for bear-human conflicts. Once a bear successfully obtains a food reward at a particular location, the site is usually periodically re-checked for more food (Stokes 1970, Meagher and Phillips 1983, Wilson et al. 2005).

The resulting change in feeding behavior constitutes an adverse effect to grizzly bears because it disrupts their normal behavior patterns. The adverse effect of feeding on domestic livestock and altered behavioral patterns does not, by itself, cause injury to the involved grizzly bear. However, a small percentage of grizzly bears that have killed and eaten livestock are more likely to be the subject of bear/livestock or bear/human conflicts in the future that may lead to its authorized relocation or lethal removal from the wild population.

The risk of bear/sheep conflicts is minimized by implementation of Conservation Measure #13 described in the **Proposed Action** section. Grizzly bears may depredate sheep during the daylight hours when sheep are not penned. However, the continual presence of sheepherders and their dogs reduces this potential. At night, when grizzly bears are most likely to attack, sheep will be bedded in a small area and sheepherders will be present to implement best management practices. The probability of bear/cattle encounters, conflicts, and subsequent habituation and conditioning is likely reduced in areas with the presence of riders; however, there will be large areas grazed without rider presence and we expect habituation and conditioning, particularly in cattle allotments, to continue.

Some grizzly bears can become food conditioned to human garbage or livestock feed if sheep and cow camps are left unclean. Bears that become food conditioned can become nuisance bears resulting in management actions such as relocation or lethal removal. To address potential food storage issues, the Forest will implement the Food Storage Order (Conservation Measure #5), which requires appropriate human food and garbage and livestock feed storage. In addition, Conservation Measure #7 will ensure that the Forest will monitor allotments on a regular basis.

Conservation Measures will reduce or eliminate some potential for human habituation or food conditioning on the nine allotments. However, the presence of livestock and livestock carcasses will continue to attract some bears, and in some cases, direct adverse effects from subsequent bear relocations or lethal removals are anticipated.

*Displacement of grizzly bears from habitat as a result of humans and other associated activities:*

Some bears may be displaced by noise and other disturbances on allotments from humans, sheepherding dogs, vehicle use, and other activities associated with livestock grazing. The level of grazing-related activities varies from day to day and throughout the season, depending on where livestock and camps are located, availability of forage, and other factors.

Grizzly bears generally try to avoid human contact. The proposed livestock grazing would increase human-related disturbance in occupied grizzly bear habitat. While we know displacement of grizzly bears is likely to occur, we do not know how often it will occur or how far bears will be displaced in each instance. We assume that displacement means some grizzly bears would spend less time foraging within portions of their home ranges. However, only 58 percent of the nine allotments provides suitable grazing habitat. Based on the habitat description in the BA, we assume there are other available natural food sources and less human disturbance in the areas considered unsuitable for grazing. Additionally, any areas with suitable grazing

habitat but not currently being grazed, as well as habitat within the surrounding portion of the action area, would likely provide food resources. The large extent of available grizzly bear habitat likely means most bears displaced by the proposed action will be able to find comparable suitable habitat nearby, but bears may be displaced, at least occasionally on up to 42 percent of the nine allotments.

*Direct mortality due to management actions or self-defense by herders, riders and others:*

According to IGBST annual reports, the Upper Green River area, which includes our action area, has been a grizzly bear conflict hotspot for several years. Grizzly bears have been expanding their range and while they've occurred in the area for many years, it is likely that the number of bears in the area has increased. Bears that live in or move through the area are likely to encounter livestock that are widely scattered throughout the allotments beginning in mid-June. It is likely some of those bears will feed opportunistically on livestock carcasses and some may learn to depredate livestock, in turn, becoming repeat offenders. This process will continue as long as livestock are on the landscape, resulting in future grizzly bear-livestock conflicts, with some bears becoming chronic depredators.

Results from research conducted on the Forest's Blackrock-Spread Creek and Grand Teton National Park's Elk Ranch East grazing allotments during 1994 to 1996 suggested that removal of chronic depredators can reduce livestock losses significantly and may be key to addressing conflicts with grizzly bears on rangelands (Anderson et al. 2002). Their conclusion that lethal removal of depredating grizzly bears may be a short-term solution, as conflicts may temporarily decrease until other bears learn depredating behaviors and the scenario repeats itself. We consider lethal removal as a management tool available for specific, chronic depredation situations, to be used in conjunction with other measures that focus on preventing and minimizing the causes of grizzly bear/livestock conflicts. As mentioned, data do not show that management relocations from or removals of a limited number of grizzly bears on these allotments have had a significant impact on the entire GYA grizzly bear population.

Capturing, transporting, and relocating bears impair behavioral patterns by disrupting feeding and sheltering as bears adjust to a new location or, in some cases, travel back to the area in which they were relocated from. Relocations give bears a second or third chance, and bears that are relocated are collared and subsequently monitored. Some bears stay out of trouble post-relocation, while others do not. From a biological perspective, relocations do not have the substantial adverse effect that lethal removals have. However, relocation is a form of harm (injury) due to trapping, physically moving, and releasing a bear into a different location, which would significantly disrupt, at least temporarily, a bear's feeding and sheltering behaviors. Lethal removal is harm from direct take (kill). Rarely, grizzly bears may be removed from the wild and placed in zoos or sanctuaries.

Direct mortality due to self-defense actions by herders, riders, and others involved in grazing activities has occurred infrequently in the nine allotments but is an adverse effect to bears. Self-defense by humans engaged in livestock grazing activities will always be a risk. While these



interactions have occurred infrequently, we anticipate they could occur again, resulting in direct adverse effects to bears. The Forest's Conservation Measures #3, 12, and 15 will continue to ensure grazing-related personnel understand their responsibilities of working in grizzly bear habitat.

### **Effects of Interrelated or Interdependent Actions**

The implementing regulations for section 7 define interrelated actions as those that are a part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration. Effects to grizzly bears from livestock grazing and other related actions on the nine allotments are described above. At this time, we are unaware of any other activities that are interrelated or interdependent with the proposed action.

## **V. CUMULATIVE EFFECTS**

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this Opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

The Service is not aware of any future non-Federal actions reasonably certain to occur in the action area. Ongoing actions in the action area, such as recreational use, hunting, and livestock grazing on private lands, and their impacts on grizzly bears are discussed in the **Environmental Baseline** section, above, and are expected to continue. The Service is not aware of any reasonably foreseeable circumstances that would significantly alter existing State, tribal, local, or private activities in the action area from what is described in the environmental baseline section.

## **VI. CONCLUSION**

After reviewing the 2014 supplemental BA, the current status of the grizzly bear in the action area, previous sources of information incorporated by reference, and the Forest's commitment to implement their Conservation Measures, it is the Service's biological opinion that the effects of livestock grazing on the nine allotments in the northern portions of the Bridger-Teton National Forest's Pinedale Ranger District, as proposed, are not likely to jeopardize the continued existence of the grizzly bear. Although we anticipate some level of take of grizzly bears primarily due to management relocations from and mortalities within the allotments, it is our opinion that the proposed action will not appreciably reduce the survival and recovery of grizzly bears. No critical habitat has been designated for grizzly bears; therefore, none will be affected.

The Service has reached this conclusion by considering the following:

1. The grizzly bear population within the GYA has experienced significant increases and exceeded the recovery zone goals established in the Grizzly Bear Recovery Plan (Service

1993). This population grew at an average rate of 3 to 4 percent or more annually, although the rate has slowed in recent years as bear numbers in parts of the GYA approach carrying capacity. Current population estimates for the GYA are 629 and 741 bears with a stable to slightly increasing growth rate (0 to 2 percent). In addition, the range of the grizzly bear in the GYA has expanded, as evidenced by the increase in occupied habitat in the GYA since the 1970s (Pyare *et al.* 2004, Schwartz *et al.* 2002, Bjornlie *et al.* 2013 Figure 2). As bears have expanded into new areas, including less secure habitats and locations with more human activities, the number of bear-human interactions has increased; however, most estimates of mortality rates do not exceed the mortality rate thresholds, suggesting the population can withstand the current level of mortalities. The aforementioned range expansion and population increase occurred concurrently with the Forest implementing prior grazing actions similar to those described in the proposed action, and with other Federal and non-federal actions described in the environmental baseline section, above. This means that historical activities comparable to the proposed action have had little to no discernible effect on the population's trend toward recovery.

2. The Forest is committed to implementing its 2014 Conservation Measures as well as Forest Plan direction. These actions include managing livestock carcasses, requiring food storage guidelines at all camps associated with livestock operations, and monitoring allotments on a regular basis. The Conservation Measures are intended to reduce the potential for grizzly bear/livestock and grizzly bear/human conflicts.
3. Although grizzly bear/livestock conflicts will continue and individual grizzly bears will likely be adversely impacted by management relocations and lethal removals, the overall core population of grizzly bears of the GYA is expected to remain relatively unaffected by grazing activities in the Upper Green River area. The adverse effects from the proposed livestock grazing on grizzly bears will occur in an area that constitutes only a small portion of the grizzly bear's range in the GYA. Therefore, while adverse effects to individual grizzly bears are anticipated, considering the large amount of grizzly bear habitat in the GYA, resource management within such habitat, and the status of the grizzly bear, we do not expect the level of adverse effects to appreciably diminish the numbers, distribution, or reproduction of grizzly bears.
4. Finally, the level of incidental take provided below will have a relatively minor impact on the overall population of this species. While we cannot predict exactly how much future grizzly bear mortality will occur in the nine allotments, we do not anticipate future levels of incidental take in the Upper Green area will differ significantly from the past few years. Mortality is expected to remain within the constraints of recovery criteria mortality limits established by the Recovery Plan and revised supplements. The estimated loss of no more than 11 bears within any consecutive 3-year period through 2019 represents a relatively minor impact on the overall GYA population of this species, which, as noted above, has increased significantly in distribution and abundance. The anticipated level of grizzly bear mortality caused by the proposed action falls within the scope of recovery criteria mortality limits established under the Grizzly Bear Recovery Plan that were

developed to facilitate the further increase in grizzly bear numbers and distribution in the GYA (Service 1993).

Range expansion and population increases, including into southern portions of the GYA, have been concurrent with the Forest implementing the actions described in the proposed action, and with other Federal and non-federal actions described in the baseline below. This means that historical activities comparable to the proposed action have had little to no discernible effect on the population's trend toward recovery.

In summary, we have determined that the proposed action is not likely to appreciably diminish the reproduction, numbers, or distribution of grizzly bears in the GYA. If the adverse effects of the proposed action on grizzly bears are not significant at the recovery area scale, then those effects are unlikely to be discernible at the rangewide scale. On that basis, we conclude that the effects of the proposed action are not likely to appreciably reduce the likelihood of the survival and recovery of grizzly bears in the wild.

## **VII. INCIDENTAL TAKE STATEMENT**

Section 4(d) and 9 of the ESA, as amended, prohibit the take of listed species of fish or wildlife without a special exemption. The ESA defines take as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct. A special rule under the ESA is in effect for grizzly bears in the 48 conterminous states of the United States (50 CFR 17.40(b), Special Rule). Under the terms of the Special Rule, taking is prohibited except as provided in paragraphs 17.40(b)(1)(i)(B) through (F). The exceptions to the take prohibition include the defense of human life and the removal of nuisance bears when the taking conforms to the requirements specified in the regulations.

Although the Special Rule exempts relocations and removal of nuisance grizzly bears, there are exceptions to the take prohibition for grizzly bears but the exceptions do not address all sources of incidental take that may result from the proposed Federal action. For example, harm is further defined by regulation (50 CFR 17.3) to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns such as breeding, feeding, or sheltering. Incidental take is any take of listed animal species that results from, but is not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or the applicant. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered a prohibited taking provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the Bridger-Teton National Forest so that they become binding conditions of any grant, permit, or Allotment Management Plan issued by the Forest, as appropriate, for the exemption in section 7(o)(2) to apply. The Forest has a continuing duty to regulate the activity covered by this Incidental Take Statement. If the Forest (1) fails to implement the terms and conditions or (2) fails to require the applicant to adhere to the terms and conditions of the Incidental Take Statement through

enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of the incidental take, the Forest must report the progress of the action and its impact on the species to the Service as specified in the Incidental Take Statement [50 CFR 402.14(i)(3)].

### **Amount or Extent of Take Anticipated**

Although the act of relocating or lethally removing nuisance grizzly bears in accordance with the special rule is an exception to the taking prohibition (50 CFR 17.40(b)(1)(i)(C)), the exception does not address all forms of take that may be associated with permitting grazing. The Service anticipates take in the form of harm to grizzly bears as a consequence of livestock grazing and the associated livestock management operation in habitats commonly used by grizzly bears. The habitat modification of adding a significant additional potential food source that subsequently results in the death or injury of bears is “take” in the form of harm. The likely depredation of some of the permitted livestock represents an impairment of natural feeding behavior that will in some cases ultimately lead to management relocations or lethal removals of grizzly bears. In addition, grazing and associated activities have the potential for other adverse effects to grizzly bears (e.g., displacement, habituation, increased exposure to other potential sources of mortalities, etc.) as described in the Biological Opinion’s “Analysis for Effects of the Action.” However, it would be speculative for the Service to assume these other potential effects will in fact result in incidental take and identify a specific level of incidental take attributable to these other potential adverse effects.

The level of “take” in the form of harm is difficult to detect and quantify. Therefore, in such cases the Service uses surrogate measures to gauge the level of “take” in the form of harm. In this Incidental Take Statement, we are anticipating that the level of incidental take resulting from the proposed action in the form of harm is proportional to the number of grizzly bears that are killed within the nine allotments. We base this on the fact that both the level of take through harm and bear mortalities (even when excepted by the Special Rule) will correlate to the level of bear use and grazing use within the nine allotments. Specifically, the Service believes this level of take in the form of harm is proportional to the management actions for nuisance bear control in compliance with the Interagency Grizzly Bear Guidelines (IGBC 1986) or from defense of life or illegal killings, when grazing or associated activities are reasonably believed to have contributed to the injury or death of the grizzly bear (e.g., direct connection to grazing, such as the management of bear depredating livestock, or indirect connection to grazing, such as a bear illegally killed while feeding on a livestock carcass, etc.). Although we are including some cases of illegal mortality of grizzly bears within our surrogate used to quantify incidental take, the illegal killing or injury of grizzly bears (such as shooting by private citizens) is not exempted by either the special regulations or this biological opinion.

Conflicts and subsequent management relocations and removals continue to occur and it is incumbent upon the Service to identify a level of take that is reasonably likely to occur. The Service estimated a level of incidental take that is based on the best available science and we do not anticipate any other incidental take as a result of the proposed action. We have provided a

detailed description of what the Incidental Take Statement is and how we derived the amount of take in Appendix A.

**The Service anticipates that a total of 11 grizzly bear mortalities within any consecutive 3-year period and 18 relocations within any consecutive 3-year period will occur on the nine allotments as a result of the proposed action. The period in which this biological opinion is anticipated to be in effect is through the end of 2019.** This BO supersedes the 1999, 2010, and 2013 BOs. We believe that anticipating incidental take for consecutive 3-year periods and limiting the duration of the BO to 2019 will allow for more frequent review of changing conditions and incorporation of new science as it becomes available. The Service has identified this level of take primarily based upon the following considerations (see Appendix A for details):

- (1) grizzly bear demographic changes: population stabilizing to increasing at 0 to 2 percent per year; grizzly bears expanding their range, including in the Upper Green River area;
- (2) historic levels of conflict and management actions that have occurred in this area, with emphasis on the last 3 years (2011 through 2013);
- (3) unknowns that may negatively affect bears; and
- (4) discussions with grizzly bear specialists from the Service, Wyoming Game and Fish Department, and the U.S. Forest Service.

Trapping, releasing, relocating, and lethally removing bears are considered on a case-by-case basis but follow standard protocols in the Interagency Grizzly Bear Guidelines. When incidental take in the form of lethal removal occurs, that take is identified with a location and type (e.g., livestock depredation, human food use, etc.). **For livestock-related take (by lethal removal) within the nine allotments, we will attribute or assign that take to the location where the bear originally learned or exhibited livestock conflict behavior.** For example, when we know the origin (Point A) of a grizzly bear-livestock conflict and that bear is subsequently trapped, collared, and relocated, then it engages in livestock conflict at a different location (Point B) and is lethally removed, then incidental take will be attributed or assigned to Point A. Livestock-related take of bears previously relocated for non-livestock conflicts will be attributed to where the livestock-related take occurs. Other situations will be handled on a case by case basis. Ultimately, the Service's Grizzly Bear Recovery Coordinator, in close coordination with Wyoming Game and Fish Department (for conflicts in Wyoming), makes the final determination on take.

### **Effect of the Take**

In this BO, the Service has determined that this level of anticipated take is not likely to jeopardize the continued existence of the grizzly bear. This is based in part, on the fact that measured population parameters in past years have met established recovery plan levels, while bear mortalities have generally been below the threshold levels established in the recovery plan. However, the Service anticipates that the direct and indirect effects of implementing grazing on

northern portions of the Pinedale Ranger District could maintain or add to the existing level of incidental take. The Service is using a surrogate measure to gauge the level of "take" in the form of harm. The measure we are using is the number of bear relocations from the action area and mortalities in the nine allotments that result from management of depredating grizzly bears or from defense of life or illegal killing, where grazing activities are likely to have contributed to the injury or death of the bear. No critical habitat for the grizzly bear has been designated; therefore none will be destroyed or adversely modified.

### **REASONABLE AND PRUDENT MEASURES**

The reasonable and prudent measures, with their implementing terms and conditions and the reporting criteria, are designed to minimize the impact of incidental take that might otherwise result from the authorized activities under the Livestock Grazing on the Northern Portions of the Pinedale Ranger District. If, during the course of the authorized activities, any level of incidental take has exceeded the amount anticipated in the Incidental Take Statement, such take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The Forest must immediately provide information related to the circumstances of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

The Service believes the following reasonable and prudent measure (RPM) is necessary and appropriate to minimize take of grizzly bear. These are the same as in the previous BO.

RPM 1. Minimize grizzly bear/livestock and grizzly bear/human conflicts related to grazing activities on the nine allotments.

### **TERMS AND CONDITIONS**

In order to be exempt from the prohibitions of Section 9 of the Act, the Bridger-Teton National Forest must comply with the following terms and conditions, which implement the reasonable and prudent measures described above. The terms and conditions (T&C) described below are non-discretionary, and must be undertaken by the Forest so that they become binding conditions of any grant or permit issued, as appropriate, for the exemption in section 7(o)(2) to apply. The Forest has a continuing duty to regulate the activity covered by this Incidental Take Statement. If the Forest (1) fails to assume and implement the terms and conditions or (2) fails to require the applicant to adhere to the terms and conditions of the Incidental Take Statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse.

T&C1. If 5 or more grizzly bears are lethally removed, including 3 or more females, related to grazing activities on the nine allotments in any given year, the Forest will contact the Service to discuss the adequacy of existing mechanisms to minimize additional take. Similarly, the Forest will contact the Service if and when the amount of incidental take or relocations is reached.

T&C2. In conjunction with the Forest's Conservation Measures #3 and #7 (annual meetings and monitoring allotments on a regular basis, respectively), the Forest will, at their annual meeting or no later than the date livestock are turned out for the season, define what their "regular" monitoring schedule will be for the upcoming grazing season (e.g., once per week and additionally as needed to respond to situations). **The Forest has improved its recent monitoring efforts; however, the Service believes additional documentation explaining how and when this monitoring will be conducted is necessary to adequately achieve this Term and Condition.**

T&C3. Because night penning has been effective at deterring bears and reducing grizzly bear/sheep conflicts in the past, night penning of sheep will continue to be implemented as described in the Forest's Conservation Measures.

T&C4. The Forest will, in coordination with the Service, annually (or more often as necessary) review the effectiveness of the Forest's Conservation Measures and other management efforts outlined in the 2014 Biological Assessment as they apply to all allotments and describe the progress of the proposed action, including impacts to the grizzly bear (50 CFR ' 402.14(1)(3)). This review shall consider adverse effects resulting from Project activities, including grizzly bear and grazing conflicts and resolutions for these nine allotments within the Forest, and will be in writing.

*Reporting:* In order to document the review process and improve understanding of the effectiveness of the Conservation Measures and other measures, the Forest will complete an annual report, using the report template provided in Appendix B, with the following:

- The number, bear gender, and allotment locations of conflicts and incidental take (relocations and lethal removals);
- Description of the grizzly bear/livestock conflicts and bear relocation outcomes, if known;
- The Forest's actions to implement and monitor compliance of its Conservation Measures and appropriate grazing regulations as described in the 2014 BA proposed action related to grazing activities on the nine allotments, and the Reasonable and Prudent Measure and implementing Terms and Conditions;
- Description of violations, such as food storage or improper use of night pens.

The Forest has improved its documentation of those efforts; however, the Service believes more detailed documentation is necessary to adequately achieve this Term and Condition.

**This annual report will be submitted to the Service's Wyoming Field Office by April 15 of the subsequent years (e.g., 2014 grazing season report will be due April 15, 2015).**

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed



action. If, during the course of the action, this level of incidental take is reached, such incidental take represents new information requiring re-initiation of consultation and review of the reasonable and prudent measures provided. The Federal agency must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures and development of additional terms and conditions.

### **CONSERVATION RECOMMENDATIONS**

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species.

Conservation recommendations (CR) are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. Depending on the outcome of future livestock/grizzly bear conflicts in the Upper Green Project area, some of the following recommendations may be considered for addition to required Terms & Conditions as appropriate.

- CR1. Continue to educate livestock grazing permittees and their employees about their responsibilities relating to conservation of grizzly bears, the potential occurrence of grizzly bears on grazing allotments, the risks of working in bear country, the protected status of the grizzly bear, the need for heightened awareness of bears, appropriate personal safety measures, and proper behavior in bear country.
- CR2. Where possible, avoid important grizzly habitat components such as riparian areas, travel corridors and drainages, and berry stands for intense livestock use.
- CR3. Increase the number of riders on allotments where conflict is chronic or to respond to periods of increased livestock/grizzly bear conflict.
- CR4. Identify alternative areas to relocate livestock should livestock/grizzly bear conflicts continue to occur. Similarly, restrict livestock from, and rest pastures in allotments with chronic conflicts. Consider alternative pastures and allotments outside of the Upper Green River area.
- CR5. Consider alternative methods to reduce grizzly bear/livestock conflicts, such as switching from cow/calf pairs to yearlings, herding or bunching cattle, using guard dogs, and using aversive conditioning tools.

### **REINITIATION – CLOSING STATEMENT**

This concludes formal consultation on the proposed action described in your 2014 Supplement to the 2013 Supplement and 2010 Amendment to the 1999 Biological Assessment for Livestock

Grazing on the Northern Portions of the Pinedale Ranger District and January 16, 2014 request for formal consultation for cattle and sheep grazing on nine allotments in the northern portion of the Bridger-Teton National Forest's Pinedale Ranger District. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: (1) the amount or extent of incidental is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

Thank you for your assistance in the conservation of endangered, threatened, and proposed species. If you have any questions or comments on this biological opinion or your responsibilities under the Act, please contact our office at the letterhead address or phone Ann Belleman at (307) 421-5839.

## LITERATURE CITED

- Anderson, C.R., M.A. Ternent and D.S. Moody. 2002. Grizzly bear-cattle interactions on two grazing allotments in northwest Wyoming. *Ursus* 13:247-256.
- Archual, P. 2014. "Upper Green grazing consultation request for information" email message from A. Belleman to P. Archual, July 25, 2014.
- Bjornlie, D. 2013. Unpublished data re: estimate of known area occupied by grizzly bears in the Greater Yellowstone Area.
- Bjornlie, D. and M. Haroldson. 2001. Grizzly bear use of insect aggregation sites documented from aerial telemetry and observations. Pages 44-51 in C. C. Schwartz and M. A. Haroldson, Eds. Yellowstone grizzly bear investigations: Annual report of the Interagency Grizzly Bear Study Team, 2000. U.S. Geological Survey, Bozeman, Montana.
- Bjornlie, D. and M. Haroldson. 2013. Grizzly bear use of insect aggregation sites documented from aerial telemetry and observations. Pages 39-42 in F.T. van Manen, M.A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2012. U.S. Geological Survey, Bozeman, Montana, USA.
- Craighead, F.C. 1976. Grizzly bear ranges and movement as determined by radiotracking. In Bears: Their Biology and Movement, Vol. 3, A Selection of Papers from the Third International Conference on Bear Research and Management, Binghamton, New York, USA, and Moscow, U.S.S.R. June 1974. IUCN Publications New Series No. 40 (1976), pp. 97-109.
- Craighead, F.C. and J.A. Mitchell. 1982. Grizzly bear; *Ursus arctos*. Pages 515-556 in Wild Mammals of North America. The Johns Hopkins University Press.
- DeBolt, B. 2013. Personal communication: telephone discussion on conflict grizzly bears in Bridger-Teton National Forest Upper Green River area. April 23, 2013.
- DeBolt, B., Z. Turnbull, M. Boyce, K. Bales and Z. Gregory. 2013. Grizzly bear-human conflicts in Wyoming. Pages 60-61 in F.T. van Manen, M.A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2012. U.S. Geological Survey, Bozeman, Montana, USA.
- Gunther, K.A., M.T. Bruscino, S. Cain, J. Copeland, K. Frey, M.A. Haroldson and C.C. Schwartz. 1999. Grizzly bear – human conflicts, confrontations, and management actions in the Yellowstone Ecosystem 1999. Interagency Grizzly Bear Committee Yellowstone Ecosystem Subcommittee Report. Pages 55-108 in C.C. Schwartz and M.A.

- Haroldson, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 1999. U.S. Geological Survey, Bozeman, Montana. 192pp.
- Gunther, K. A., M. A. Haroldson, K. Frey, S. L. Cain, J. Copeland, and C. C. Schwartz. 2004. Grizzly bear--human conflicts in the Greater Yellowstone Ecosystem, 1992-2000. *Ursus* 15(1):10-22.
- Gunther, K.A., B. Aber, M.T. Bruscino, S.L. Cain, K. Frey, M.A. Haroldson and C.C. Schwartz. 2012. Grizzly bear-human conflicts in the Greater Yellowstone Ecosystem. Pages 48-52 *in* F.T. van Manen, M.A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2011. U.S. Geological Survey, Bozeman, Montana, USA.
- Gunther, K.A., E. Reinertson, T.M. Koel, and P.E. Bigelow. 2013. Spawning cutthroat trout. Pages 35-38 *in* F.T. van Manen, M.A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2012. U.S. Geological Survey, Bozeman, Montana, USA.
- Guo, H., L.D. Jacobson, D.R. Schmidt, R.E. Nicolai, J. Zhu and K.A. Janni. 2005. Development of the OFFSET model for determination of odor-annoyance-free setback distances from animal projection sites: Part II: Model development and evaluations. *Transactions of the American Society of Agricultural Engineers*, 48(6):2269-2276.
- Haroldson, M. 2013. Occupancy of bear management units by females with young. Page 19 *in* F. T. van Manen, M. A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2012. U.S. Geological Survey, Bozeman, Montana, USA.
- Haroldson, M. Ternant, K. A. Gunther, and C. C. Schwartz. 2002. Grizzly bear denning chronology and movements in the Greater Yellowstone Ecosystem. *Ursus* 13:29-37.
- Haroldson, M. S. Podruzny, and R. Renkin. 2003. Whitebark pine cone production. Pages 41-43 *in* C. C. Schwartz and M. A. Haroldson, eds. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2002. U.S. Geological Survey, Bozeman, MT.
- Haroldson, M. and K. Frey. 2013. Estimating sustainability of annual grizzly bear mortalities. Pages 24-30 *in* F. T. van Manen, M. A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2012. U.S. Geological Survey, Bozeman, Montana, USA.

- Haroldson, M. A., F. T. van Manen, and D. D. Bjornlie. 2013. Estimating number of females with cubs-of-the-year. Pages 11–18 *in* F. T. van Manen, M. A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2012. U.S. Geological Survey, Bozeman, Montana, USA.
- Interagency Conservation Strategy Team. 2007. Final conservation strategy for the grizzly bear in the Greater Yellowstone Area. 86 pp. plus Appendices.
- Interagency Grizzly Bear Committee. 1986. Interagency Grizzly Bear Guidelines. Interagency Grizzly Bear Committee. 100 pp.
- Interagency Grizzly Bear Study Team. 2009. Yellowstone grizzly bear mortality and conflict reduction report. Interagency Grizzly Bear Study Team, U.S. Geological Survey, Northern Rocky Mountain Science Center, Bozeman, Montana, USA.
- Interagency Grizzly Bear Study Team. 2012. Updating and evaluating approaches to estimate population size and sustainable mortality limits for grizzly bears in the Greater Yellowstone Ecosystem. Interagency Grizzly Bear Study Team, U.S. Geological Survey, Northern Rocky Mountain Science Center, Bozeman, Montana, USA.
- Interagency Grizzly Bear Study Team. 2013. Response of Yellowstone grizzly bears to changes in food resources: a synthesis. Report to the Interagency Grizzly Bear Committee and Yellowstone Ecosystem Subcommittee. Interagency Grizzly Bear Study Team, U.S. Geological Survey, Northern Rocky Mountain Science Center, Bozeman, Montana, USA.
- Interagency Grizzly Bear Study Team. 2014a. Unpublished data from IGBST. On file, IGBST, Northern Rocky Mountain Science Center, U.S. Geological Survey, Bozeman, Montana, USA.
- Interagency Grizzly Bear Study Team. 2014b. Preliminary population estimates of females with cubs-of-the-year. Yellowstone Ecosystem Subcommittee Meeting. Jackson, WY. Spring 2014.
- Interagency Grizzly Bear Study Team. 2014c. Q & A Interagency Grizzly Bear Study Team (IGBST) – Upper Green River Allotments. Unpublished report constituting a response to questions concerning cattle-livestock relationships on the Upper Green River, Wyoming, cattle allotments brought forward by the Bridger-Teton National Forest. On file, IGBST, Northern Rocky Mountain Science Center, U.S. Geological Survey, Bozeman, Montana, USA.
- Johnson, T. 2014. “Whitebark for Upper Green,” email message Belleman to Johnson, July 7, 2014.

- Knight, R. R. and S. L. Judd. 1983. Grizzly bears that kill livestock. International Conference for Bear Research and Management 5:186-190.
- Knight, R. R. and L. L. Eberhardt. 1984. Projected future abundance of the Yellowstone grizzly bear. Journal of Wildlife Management 48:1434-1438.
- Knight, R. R., D. J. Mattson, and B. M. Blanchard. 1984. Movements and habitat use of the Yellowstone grizzly bear. Interagency Grizzly Bear Study Team, Montana State University, Bozeman, Montana.
- Knight, R. R. and L. L. Eberhardt. 1985. Population dynamics of Yellowstone grizzly bears. Ecology 66(2):323-334.
- Knight, R. R., B. M. Blanchard, and L.L. Eberhardt. 1995. Appraising status of the Yellowstone grizzly bear population by counting females with cubs-of-the-year. Wildlife Society Bulletin 23:245-248.
- Linnell, J. D. C., J. E. Swenson, R. Anderson, and B. Barnes. 2000. How vulnerable are denning bears to disturbance? Wildlife Society Bulletin 28(2):400-413.
- Mattson, D. J. 1997. Selection of microsites by grizzly bears to excavate biscuitroots. Journal of Mammalogy 78:228-238.
- Mattson, D. J. 2001. Myrmecophagy by Yellowstone grizzly bears. Canadian Journal of Zoology 79:779-793.
- Mattson, D. J., B. M. Blanchard, and R. R. Knight. 1991. Food habits of Yellowstone grizzly bears, 1977-1987. Canadian Journal Zoology 69:1619-1629.
- Mattson, D. J. and D. P. Reinhart. 1995. Influences of cutthroat trout (*Onchorhynchus clarki*) on behavior and reproduction of Yellowstone grizzly bears (*Ursus arctos*), 1975-1989. Canadian Journal of Zoology 73:2072-2079.
- Mattson, D. J. and D. P. Reinhart. 1997. Excavation of red squirrel middens by grizzly bears in the whitebark pine zone. Journal of Applied Ecology 34:926-940.
- Mattson, D. J., M. G. French, and S. P. French. 2002. Consumption of earthworms by Yellowstone grizzly bears. Ursus 13:105-110.
- McArthur Jope, K.L. 1980. Habituation of grizzly bears to people: a hypothesis. Bears: Their Biology and Management, Vol. 5, A Selection of Papers from the Fifth International Conference on Bear Research and Management, Madison, Wisconsin, USA. February 1980 (1983), pp. 322-327.

- McClellan, B. N. 1989. Relationships between human industrial activity and grizzly bears. *International Conference on Bear Research and Management* 8:57-64.
- Meagher, M and J.R. Phollips. 1983. Restoration of natural populations of grizzly and black bears in Yellowstone National Park. *International Conference on Bear Research and Management* 5:152-158.
- Miller, C.R. and L.P. Waits. 2003. The history of effective population size and genetic diversity in the Yellowstone grizzly (*Ursus arctos*): Implications for conservation. *Proceedings of the National Academy of Sciences* 100(7):4334-4339.
- Murphy, K. Telephone conversation between A. Belleman and K. Murphy regarding overall range conditions in the Upper Green River area. July 19, 2014.
- Podruzny, S. and K. Gunther. 2001. Spring Ungulate Availability and Use by Grizzly Bears in Yellowstone National Park. Pages 33-36 in C.C. Schwartz and M.A. Haroldson, editors. *Yellowstone Grizzly Bear Investigations: Annual report of the Interagency Grizzly Bear Study Team, 2000*. U.S. Geological Survey. Bozeman, Montana.
- Podruzny, S.R., S. Cherry, C. Schwartz, and L. Landenburger. 2002. Grizzly Bear Denning and Potential Conflict Areas in the Greater Yellowstone Ecosystem. In press.
- Pyare, S., S. Cain, D. Moody, C. Schwartz, and J. Berger. 2004. Carnivore re-colonisation: reality, possibility, and a non-equilibrium century for grizzly bears in the southern Yellowstone Ecosystem. *Animal Conservation* 7:1-7. As cited in: USFWS. 2005. *Endangered and Threatened Wildlife and Plants; Designating the Greater Yellowstone Ecosystem Population of Grizzly Bears as a Distinct Population Segment; Removing the Yellowstone Distinct Population Segment of Grizzly Bears From the Federal List of Endangered and Threatened Wildlife; Proposed Rule*. *Federal Register* 70 (221):69854-69884.
- Reinhart, D. P., M. A. Haroldson, D. J. Mattson, and K. A. Gunther. 2001. Effects of exotic species on Yellowstone grizzly bears. *Western North American Naturalist* 61(3):227-288.
- Robbins, C.T., C.C. Schwartz, K.A. Gunther and C. Servheen. 2006. Grizzly bear nutrition and ecology studies in Yellowstone National Park. *Yellowstone Science* 14(3):19-26.
- Robison, H.L., C.C. Schwartz, J.D. Petty, and P.F. Brussard. 2006. Assessment of pesticide residues in army cutworm moths (*Euxoa auxiliaris*) from the Greater Yellowstone Ecosystem and their potential consequences to foraging grizzly bears (*Ursus arctos horribilis*). *Chemosphere* 64: 1704-1712.



- Schwartz, C. C., M. A. Haroldson, K. A. Gunther, and D. Moody. 2002. Distribution of Grizzly Bears in the Greater Yellowstone Ecosystem, 1990-2000. *Ursus* 13:203-212.
- Schwartz, C. C., M. A. Haroldson, and G.C. White. 2010. Hazards affecting grizzly bear survival in the Greater Yellowstone Ecosystem. *J of Wildlife Mgmt.* 74(4):654-657.
- Schwartz, C. C., M. A. Haroldson, and K. West, editors. 2011. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2010. U.S. Geological Survey, Bozeman, MT, USA.
- Stokes, A.W. 1970. An ethologist's views on managing grizzly bears. *BioScience* 20:1154-1157.
- Swenson, J. E., F. Sandegren, S. Brunberg, and P. Wabakken. 1997. Winter den abandonment by brown bears *Ursus arctos*: causes and consequences. *Wildlife Biology* 3(1):35-38.
- Thompson, D. 2014. "Question re: # of grizz relocations" email message from A. Belleman to D. Thompson. July 28, 2014.
- U.S. Fish and Wildlife Service. 1975. Endangered and threatened wildlife and plants; determination of threatened status for the grizzly bear; final rule. *Federal Register* 40:31736.
- U.S. Fish and Wildlife Service. 1986. Interagency Cooperation – Endangered Species Act of 1973, as amended; Final Rule. *Federal Register*, June 3, 1986. Vol. 51, No. 106 [also see 50 Code of Federal Regulations Part 402].
- U.S. Fish and Wildlife Service. 1993. Grizzly bear recovery plan. Missoula, MT. 181 pp.
- U.S. Fish and Wildlife Service. 2005. Endangered and threatened wildlife and plants; designating the Greater Yellowstone Ecosystem population of grizzly bears as a distinct population segment; removing the Yellowstone distinct population segment of grizzly bears from the Federal List of Endangered and Threatened Wildlife. *Federal Register* 70: 69854-69883.
- U.S. Fish and Wildlife Service. 2007a. Endangered and threatened wildlife and plants; final rule designating the Greater Yellowstone Area population of grizzly bears as a distinct population segment; removing the Yellowstone distinct population segment of grizzly bears from the Federal List of Endangered and Threatened Wildlife; 90-day finding on a petition to list as endangered the Yellowstone distinct population segment of grizzly bears. *Federal Register* 72:14866-14938.
- U.S. Fish and Wildlife Service. 2007b. Revised demographic recovery criteria for the Yellowstone Ecosystem; supplement to the 1993 Grizzly Bear Recovery Plan. 34pp.

- U.S. Fish and Wildlife Service. 2007c. Habitat-based recovery criteria for the Yellowstone Ecosystem; supplement to the 1993 Grizzly Bear Recovery Plan. 52pp.
- U.S. Fish and Wildlife Service. 2011. Grizzly bear (*Ursus arctos horribilis*) 5-year review: summary and evaluation. Missoula, MT. 2005pp.
- U.S. Fish and Wildlife Service. 2013. Draft NCDE Grizzly Bear Conservation Strategy. April 2013. 148 pp.
- U.S. Forest Service. 2010. 2010 amendment to the 1999 biological assessment for livestock grazing on the northern portions of the Pinedale Ranger District. Bridger-Teton National Forest. 50pp. plus attachment.
- U.S. Forest Service. 2013. 2013 supplement to the 2010 amendment to the 1999 biological assessment for livestock grazing on the northern portions of the Pinedale Ranger District. Bridger-Teton National Forest. 17 pp.
- U.S. Forest Service. 2014. 2014 Supplement to the 2013 Supplement and 2010 Amendment to the 1999 Biological Assessment for Livestock Grazing on the Northern Portions of the Pinedale Ranger District. 55pp.
- Wilson, S.M., M.J. Madel, D.J. Mattson, J.M. Graham, J.A. Burchfield and J.M. Belsky. 2005. Natural landscape features, human-related attractants, and conflict hotspots: a spatial analysis of human-grizzly bear conflicts. *Ursus* 16(1):117-129.

## **Appendix A. Details of the Livestock Grazing on the Northern Portions of the Pinedale Ranger District Incidental Take Statement.**

### **What is an Incidental Take Statement?**

An incidental take statement (ITS) anticipates how much take of a listed species is likely to result from a proposed action and exempts action agencies (and those with applicant status as determined by the action agency; in this case, the livestock grazing permittees using the nine allotments) from the Endangered Species Act's (ESA) section 9 prohibitions on take if they comply with the reasonable and prudent measures and implementing terms and conditions of the ITS. Incidental take is "... takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant." Take is further defined as, "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct.

The Service issues an ITS, which includes the amount of incidental take (IT) we anticipate will occur for the project. Authorization of the actual taking is different from how many grizzly bears, in this case, the Service anticipates will be taken as the result of an action (livestock grazing). We do not authorize take, such as the action of physically trapping and relocating or lethally removing grizzly bears, in the biological opinion.

IT is usually expressed as a number of individuals but can be a change in habitat characteristics affecting the species (e.g., acres of habitat). The amount of take (number of relocations or lethal removals of grizzly bears) is based on the best available science and professional judgment and does not provide lower or higher levels of take for management flexibility or to satisfy public opinion.

### **Special Rule for Grizzly Bears**

In addition to the grizzly bear listing as threatened under the ESA, there is a special rule in effect for grizzly bears in the 48 conterminous states of the United States (50 CFR 17.40(b), Special Rule). The Special Rule indicates that taking is prohibited except as provided in paragraphs 17.40(b)(1)(i)(B) through (F). The exceptions to the take prohibition include the defense of human life and the removal of nuisance bears, such as those with a history of livestock conflicts, when the taking conforms to the requirements specified in the regulations.

Although there are exceptions to the take prohibition for grizzly bears, the exceptions do not address all sources of incidental take, such as harm, that may result from the proposed Federal action, in this case, livestock grazing on the nine allotments. However, the level of take from

other sources of harm is difficult to detect and quantify. Therefore, in such cases the Service uses surrogate measures to gauge the level of “take” in the form of harm.

In this Incidental Take Statement, we are anticipating that the level of incidental take resulting from the proposed action in the form of harm is proportional to the number of grizzly bears that are killed within the nine allotments. We base this on the fact that both the level of take through harm and bear mortalities (even when excepted by the Special Rule) will correlate to the level of bear use and grazing use within the nine allotments (we also considered bear use in the entire action area as part of our surrogate). Specifically, the Service believes this level of take in the form of harm is proportional to the management actions for nuisance bear control in compliance with the Interagency Grizzly Bear Guidelines (IGBC 1986) or from defense of life or illegal killings, when grazing or associated activities are reasonably believed to have contributed to the injury or death of the grizzly bear (e.g., direct connection to grazing, such as management of a bear depredating livestock, or indirect connection to grazing, such as a bear illegally killed while feeding on a livestock carcass, etc.). Although we are including some cases of illegal mortality of grizzly bears within our surrogate used to quantify incidental take, the illegal killing or injury of grizzly bears (such as shooting by private citizens) is not exempted by either the special regulations or this biological opinion (BO).

#### **What Does it Mean When Incidental Take is Reached or Exceeded?**

Upon reaching the anticipated level of IT in a biological opinion, any additional take associated with the action would not be covered by the ITS and would be a violation of the taking prohibitions of sections 4(d) and 9 of the ESA. Because exceeding the amount of IT may result in legal consequences, agencies will often reinstate consultation with the Service to seek compliance with the ESA. For the current biological opinion, if the level of IT is reached, the Forest will coordinate with the Service to review those activities and circumstances that are resulting in the take of grizzly bears, as well as the effectiveness of the Forest’s Conservation Measures and the Service’s Reasonable and Prudent Measures and implementing Terms and Conditions. The agencies will also review any new information since the date the biological opinion was rendered. At this point, the Forest may request to reinstate consultation with the Service.

Reaching or exceeding the level of anticipated take does not, by itself, require halting an ongoing action (e.g., grazing activities) during reinstatement process. In the interim period between the reinstatement and completion of a new or amended biological opinion, the Service would not expect the Federal agency (or permittee or licensee) to cease all operations unless it was clear that the impact of the additional taking would cause an irreversible and adverse impact on the species (in this case, additional lethal take of grizzly bears) (H.R. Rep. No. 567, 97<sup>th</sup> Cong., 2d Sess. 27 (1982)). However, if take occurred during this interim period (in excess of the ITS), that

take would not be covered by the existing biological opinion and would, in all likelihood, constitute a violation of the ESA. Because circumstances vary and additional take may not occur, the action agency must make the ultimate decision whether or not to continue the action, taking into consideration the additional requirements of ESA sections 7(a)(2) and 7(d).

### **How the Service Derived the Amount of IT for the Nine Allotments:**

There are a variety of ways to consider IT for this Project and as a result, it's difficult to estimate an amount. For example, we could look at the last 3, 5, or 10 years of data or we could consider how relocations may or may not affect the amount of take. We also recognize there are differing opinions about the number of lethal bear removals this ITS should include. However, we base the amount of IT on our analysis of the proposed action's impacts and the factors discussed in the BO and below, which include best available science and professional judgment. While the ITS covers only the nine allotments, we considered additional factors outside of the nine allotments to estimate the amount of take we anticipate may occur.

The Service used the best scientific data available, including information from discussions with grizzly bear specialists with the Service, Wyoming Game and Fish Department, and the U.S. Forest Service. We considered both qualitative and quantitative factors to derive an amount of IT that was as reasonable and logical as possible. The Service also relied upon professional judgment to ensure the ITS represents the best estimate we were able to produce. As described in the BO, the Service believes the levels of IT will not jeopardize the continued existence of grizzly bears.

Qualitatively, FWS considered the following:

- likelihood for mortality from proposed Project implementation
- conservation measures and their effectiveness at reducing the risk of mortality
- season and timing of proposed Project activities (e.g., winter vs. summer; day vs. night)
- areas with bear expansion (primarily on the periphery of the GYA)
- juxtaposition of these nine allotments to similar activities in the action area
- other sources of grizzly bear mortalities (e.g., hunter conflicts)
- unknown factors such as the number of bears using the nine allotments, fluctuating environmental conditions (e.g., drought) that may affect available foods, illegal shooting, and other human uses in the vicinity.

Quantitatively, the Service considered the following:

- Rate of population growth in the GYA: currently 0 to 2 percent per year in the GYA but unknown specifically on the nine allotments;
- Number of conflicts, relocations and lethal removals from Project-related activities over the last 3- and 5-year periods on the nine allotments and within the action area; see Table A-1;

- Duration of the project: in this case, through 2019.

Based on the number of conflicts, relocations from, and removals in the nine allotments during the last 3- and 5-year periods, we identified an average of 40 to 43 conflicts and approximately 3 to 4 relocations and 2 to 4 lethal removals per year, respectively (Table A-1). Because of increases in size and range of the bear population and in the number of conflicts on the nine allotments, particularly in the last 5 years, we did not use data from a longer period (10 years). Results based on data from the 10-year time period were diluted and did not accurately represent changed conditions.

*Lethal Removals:* Livestock-related lethal bear removals typically involve bears that previously learned depredation or other grazing-related nuisance behaviors and were subsequently relocated in an attempt to curb that behavior. Once bears learn those behaviors, some may become repeat offenders if exposed to similar conditions. Therefore, we considered lethal removals in the last 3- and 5-year periods in several ways:

- (1) The total number of lethal removals that occurred in the nine allotments regardless of where the bears originally learned livestock depredation behaviors and were subsequently relocated from;
- (2) The number of removals including only bears previously relocated from the action area (and returned to the nine allotments); and
- (3) The number of removals including only bears previously relocated from the nine allotments (and returned to the nine allotments).

Because we are changing how IT is attributed or assigned to this Project, we did not consider the first option. Livestock-related IT of bears on the nine allotments will now be traced back and attributed to where the bear originally learned that behavior and was relocated from. As mentioned in the BO, if a bear learned livestock depredation or other grazing-related nuisance behaviors elsewhere than the nine allotments (Point A) and is subsequently lethally removed within the nine allotments (Point B), then IT will be attributed to Point A. Livestock-related take of bears previously relocated for non-livestock conflicts will be attributed to the where the livestock-related take occurs. Other situations that do not fit this scenario will be handled on a case by case basis.

The remaining second and third options incorporate where bears learn nuisance behaviors. We know from Interagency Grizzly Study Team annual reports that three grizzly bears were relocated (due to livestock conflicts) from within the 7.5 mile portion of the action area surrounding the nine allotments within the last 3 years (Table A-1, fifth column), returned, and

eventually engaged in livestock conflicts within the nine allotments, subsequently resulting in lethal removal. Because the original relocation sites were in close proximity to the nine allotments, effects from grazing on the nine allotments may extend out that distance (described in BO Action Area section), and some bears are likely using multiple allotments both inside and outside of the nine allotments, we believe it is reasonable to consider these bears in our estimation of take. We recognize IT of these 3 lethally removed bears will not count toward the Project ITS; however, the boundary around the perimeter of the nine allotments is not biologically based and is irrelevant to a bear. Based on our logic, we believe the second option is the most reasonable for estimating IT - the number of lethal grizzly bear removals we anticipate on the nine allotments includes bears previously relocated from the action area. In Table A-1, we then focus on the fifth and sixth columns.

The number of lethally removed bears from the nine allotments (and previously relocated from the action area) in the last 3- and 5-year periods was 8 and 9 bears, with an average of 2.7 and 1.8 bears per year, respectively (rounded up for a whole bear). Table A-1 shows conflicts, relocations, and lethal removals have all increased since 1999. Based on our decision to consider IT in 3-year consecutive periods and the average number of bears per year is 2.7 and 1.8 in the last 3- and 5-year periods, then multiplying each times 3 years (for a 3-year consecutive period) equals a total of 9 and 6 bears (rounded up to account for a whole bear), respectively. However, averaging the last 5 years of data results in a less accurate representation of the population and conflict changes we've noticed during the last 3 years. Therefore, we believe focusing on the last 3 years is more appropriate. Incorporating the current 0 to 2 percent rate of population growth would not change our estimate (or negligibly).

We then consider the qualitative factors in conjunction with the estimated amount of take and use professional judgment to conclude whether or not our estimate is logical and reasonable. We anticipate that there will be future lethal removals on the nine allotments, the GYA grizzly bear population is expanding into peripheral portions of the GYA, and the nine allotments are juxtaposed with adjacent or nearby allotments in the action area which also have grazing activities. However, there are unknown factors, such as drought and the bear population in this area at any given time, which introduce uncertainties into our estimate. As a result, we believe it's reasonable to increase the amount of IT we anticipate in a consecutive 3-year period from 9 to 11 grizzly bears to account for uncertainties and unknowns.

Therefore, we anticipate IT of up to 11 grizzly bears in any consecutive 3-year period on these nine allotments, through the end of 2019. We believe that anticipating incidental take of 11 grizzly bears for consecutive 3-year periods and limiting the duration of the BO through 2019 will allow for more frequent review of changing conditions and incorporation of new science as it becomes available.



*Note:* In the previous 2013 BO ITS, we delineated the anticipated level of IT by gender, which we believed was an appropriate approach based on the best available science at the time. The 2013 BO included 3 female bears in the ITS, and it was because the level of IT for females was being approached that the Forest reinitiated consultation. However, female mortalities in the GYA have, overall, remained below the established mortality thresholds and take of females on the allotments, while increasing slightly, continues to number two or less individuals per year (see BA, Figure 11, p. 16). Furthermore, the population is stable to slightly increasing and recovery goals have been attained despite IT of both male and female grizzly bears. These factors lead us to believe we do not need to specify a level of IT by gender for this project.

In year 4, the consecutive 3-year period will be based on years 2, 3, and 4; that is, IT that occurred in year 1 is no longer counted. Similarly, year 5 is based on years 3, 4, and 5, and IT that occurred in year 2 is no longer counted. While this level of incidental take is anticipated for this Project only, we then consider the effects from this level of IT to the entire GYA grizzly bear population, acknowledging that these removals are already accounted for in the established mortality thresholds per the 1993 Grizzly Bear Recovery Plan's Demographic Recovery Criteria (Service 2007) and monitored by the Interagency Grizzly Bear Study Team. Finally, we do not believe this anticipated level of IT will jeopardize the grizzly bear.

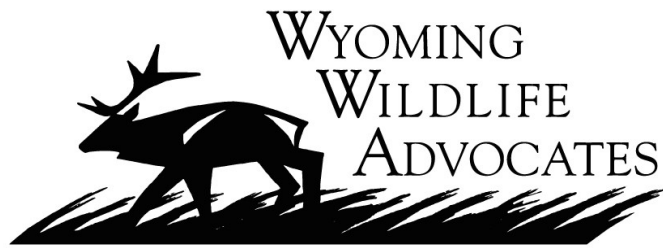
*Relocations:* In the 1999, 2011, and 2013 BOs, the Service did not quantify a level of take for relocations. However, relocations, regardless of the short duration of effects, are take in the form of harm. Therefore, the Service must anticipate and enumerate a level of harm.

The numbers of relocations tend to fluctuate considerably from year to year; for example, the number of relocations from 2010 to 2012 was 6, 0, and 5, respectively (total of 11 in a 3-year period; Table A-1, 3<sup>rd</sup> column), while one year later, from 2011 to 2013, the numbers were 0, 5, and 2, respectively (total of 7). The variables affecting take in general are broad, as mentioned above and in the **Effects of the Action** section, which makes it difficult to quantify a level of relocations. The variables affecting relocations are compounded by not fully understanding why relocations fluctuate, and averaging over a 3-year period may not result in an accurate estimate, as we have seen by the 11 relocations from 2010 to 2013. In addition, relocations represent a larger subset of bears than those lethally removed due to livestock conflicts (most lethally removed bears due to livestock conflicts were relocated at least once).

Considering the highest number of relocations that occurred in the last several years (6 in 2010), it's reasonable to anticipate similar numbers of relocations will occur in any given year in the future. Therefore, using the highest number (6) of relocations times our consecutive 3-year period, totals 18 relocations in any consecutive 3-year period through the end of 2019. Based on the limited data available, this amount incorporates wide fluctuations and unknowns and we believe it reasonably represents the number of future relocations from the nine allotments.

**Table A-1. Grizzly bear-livestock conflict/relocation/lethal removal data for Upper Green River area (compiled from IGBST annual reports and BTNF 2008, 2014 Upper Green BAs)**

Year	# Conflicts	# Relocations from 9 Allotments	# Lethal Removals in 9 Allotments w/Relocations regardless of origin (origin from Action Area=Col 5+6)	# Lethal Removals in 9 Allotments w/Relocations from Action Area outside of 9 allotments	# Lethal Removals in 9 Allotments w/Relocations from 9 allotments only	Avg # Lethal Removals in 9 Allotments Last 3 yrs (Cols. 4, 5+6)	Avg # Lethal Removals in 9 Allotments Last 5 yrs (Cols. 4, 5+6)	Average Conflict/Relocation 9 allotments (Cols. 2, 3)	
								Last 3 Yrs	Last 5 Yrs
1999	29	1	0						
2000	11	0	0						
2001	36	3	0						
2002	20	2	1						
2003	27	3	0						
2004	7	3	0						
2005	42	4	1						
2006	27	0	0						
2007	21	2	0						
2008	25	1	3						
2009	36	4	0	0	0				
2010	35	6	1	0	1				
2011	37	0	4 (3)	1	2				
2012	46	5	3 (1)	0	1				
2013	46	2	4	2	2	3.7, 2.7	2.4, 1.8	43/2.3	40/3.4



**David J. Mattson, Ph.D.**

## **Wyoming Wildlife Advocates**

**Comments on the**

**US Fish & Wildlife Service proposal to remove grizzly bears in the Yellowstone ecosystem from the list of endangered and threatened wildlife protected under the US Endangered Species Act (ESA); Federal Register 81(48): 13174-13227**

**And Related Materials**

May 5, 2016

## Introduction

On behalf of Wyoming Wildlife Advocates, this package of materials constitutes my review of the Rule and related materials (hereafter the Rule) issued by the US Fish & Wildlife Service (the Service) covering a proposal to remove grizzly bears in the Yellowstone ecosystem from the list of endangered and threatened wildlife protected under the US Endangered Species Act (ESA). The Rule itself was published in the Federal Register 81(48): 13174-13227; I obtained additional related materials from the Service's web site under Docket no. FWS-R6-ES-2016-0042: FXES111309000000C6-156-FF09E42000. These additional materials include the draft 2016 Conservation Strategy plus appendices (hereafter the CS) and the draft Grizzly Bear Recovery Plan Supplement: Revised Demographic Criteria (hereafter the RP).

Together, these materials comprise an astounding 675 plus pages (not counting cover pages), of which 54 pages are triple column, 9-point font, with a provision in the Rule for a mere 60 days within which to submit any comments. Up front, this allocation of such limited time to come to terms with such a large amount of highly complicated materials defies any explanation that invokes a genuine interest on the part of the Service in revision and improvement. That being said, my intent here is provide comments and critiques in hopes that the Service will genuinely engage with the substance of what I offer.

The package of materials assembled by the Service in support of its proposed Rule clearly represents a huge effort on the part of what I am sure are well-intentioned people. However, I see room for major improvement ranging from revision of framing concepts, to inclusion of major bodies of currently neglected research, to improved interpretation of the science that is referenced, to remedy of the many points of internal illogic. My comments cover this entire spectrum.

## My Credentials

I am currently Lecturer and Visiting Senior Scientist at the Yale School of Forestry and Environmental Studies, Adjunct Faculty at Northern Arizona University, Science Advisor for Wyoming Wildlife Advocates, and Research

My review adheres to two sets of standards invoked by the Service on pages 13175 and 13176 of the Rule; first, the conventional standard of the ESA requiring use of "the best scientific and commercial information available," and, second, a purported desire on the part of the Service to insure that the Rule is "based on scientifically sound data, assumptions, and analysis." Tacit to this second set of standards is a laudable recognition on the part of the Service that the scientific information most recently published in a scientific journal can, in fact, be junk; hence a need to consider the very merits of this corpus of science, including the nature of the data used, the veracity of analyses employed, and the validity of interpretations, not only in the science products themselves, but also by the Service in application of the science to this Rule.

I also assume in my review that the best available science includes all publicly available data or information of direct relevance to the soundness of this Rule, subject to the same kinds of summaries and interpretations employed by the Service, and regardless of whether it is included in a peer-reviewed journal. For example, I draw heavily on graphic representation and simple statistical analyses of summary data published by the Interagency Grizzly Bear Study Team (IGBST). I also draw at times on other publicly available databases. This approach is based, in turn, on the assumption that there is good faith on the part of the Service—along with a genuine interest in improvement—rather than a focus on dismissing inconvenient input on the basis of some legalistic or less-than-logical technicalities.

My review that follows is organized by numbered main topics with subtopics within, each highlighted in green. The references cited in my comments are in **Attachment 1**.

Associate with the Northern Rockies Conservation Cooperative. My former positions, prior to retirement from the U.S. Geological Survey, included Research Wildlife Biologist, Leader of the Colorado Plateau

Research Station, and Western Field Director of the MIT-USGS Science Impact Collaborative, all with the USGS. I hold degrees in Forest Resource Management and Forest Ecology. My doctorate is in Wildlife Resource Management from the University of Idaho.

I have studied large carnivores for over 30 years. This research has included the incorporation of ecological information from mountain lions and grizzly bears into demographic, habitat, and risk management models as well as investigations of foraging, predation, and relations with humans. My human-dimensions research spans nearly 23 years and has focused on social, political, and organizational dynamics that shape policies and practices of carnivore and other conservation programs. As part of this focus I routinely teach classes on relations between science and policy. My research has been reported in over 120 peer-reviewed publications, including work featured in *Science* and *Ecology* and as

part of invited talks at the Smithsonian, American Museum of Natural History, the American Institute of Biological Sciences, and International Conferences on Bear Research and Management.

Of more direct relevance to these comments, I have studied grizzly bears in the Yellowstone ecosystem since 1979. I was part of the Interagency Grizzly Bear Study Team 1979-1993 and held primary responsibility for field investigations of the IGBST between 1984 and 1993. During this 16- year period I spent most of March-October documenting grizzly bear foraging behavior and involved in other related field projects. My grizzly bear-focused research resulted in over 60 publications, including several that are considered classics in the field of bear research. I continue to closely follow grizzly bear research in the Yellowstone ecosystem with an interest in improving not only the science, but also the use of scientific results in authoritative decision-making.

---

**1.** Given current monopolistic scientific arrangements, the Service should use a much more cautious tone when invoking IGBST science in the Rule and remove what is currently a pattern of systematically inflated claims based on this body of science. They also need to give serious consideration to patterns of evidence that call into question IGBST science, many of which are described in this review.

**1.1.** Virtually none of the most recent science published in peer-reviewed journals by the IGBST and used by the Service in this Rule is reliable.

This problem follows from the simple fact that the IGBST, in concert with the Service, has maintained a monopoly on virtually all of the data of direct relevance to the Rule. There is only one Yellowstone grizzly bear population and only one set of data that has been collected from this population; and none of these data, but a pittance, have been available to any researchers or research teams other than the IGBST and those scientists whom the Team has invited to collaborate. A monopoly such as this debars replication, disallows alternative models and hypotheses, provides ample scope for bias, and cannot be corrected by peer review (see my following point).

Transparency and open access to data and/or to relevant systems is at the core of scientific advancement (e.g., Popper 1959, Merton 1973, Pickering 1992, Maxwell 1998, Losee 2004, and many more). There is no substitute or sufficient remedy when such conditions are lacking. In the absence of ample opportunity for others to independently check, test, replicate, contest, and advance a body of research, those who enjoy a monopoly predictably fall prey to well-documented phenomena, including confirmation bias and groupthink, especially when they are part of a closed or mostly closed research team. They can also more easily fall prey to political influence and the sway of money, especially when there are those involved in crafting or internally reviewing the research who have an outside vested interest, and doubly so when such people provide substantial funds. All of this holds for the IGSBT and the science it has produced during the last decade, which is the purported foundation for this Rule.

These intrinsic problems are further amplified by the fact that most of the science produced by the IGBST and invoked by the Service entails complex models and

complex assumption-ridden statistical methods. Such is the case for all of the results germane to judging the demographic and genetic plight of Yellowstone's grizzly bears. Yet it is well known to even half-way thoughtful scientists that there is no one correct model, and that model-building is perhaps the most vagarious and bias prone of scientific undertakings (see Point 4.2 below). The best we can collectively hope for is that a range of relevant models are produced by as many truly independent researchers as possible for collective deliberations. Unfortunately, what we have is the opposite of this: a closed enterprise under IGBST and Service auspices, privileged with fielding a few chosen models produced under predictably biasing circumstances. Again, as I describe in my next key point, no amount of peer review can correct for this.

I anticipate that the Service's response to this critique will be to list all of the scientists who have been invited by the Service and the IGBST to collaborate on scientific undertakings. Such a list would be largely irrelevant to the basic point I make here, which is that scientific progress and reliability require free and unhindered access to systems and/or data for use by independent investigators as part of independent inquiry.

There are potentially several ways to interpret what appear to be patterns of systematic bias in public statements made by IGBST scientist—and patterns there are. But there is little doubt about the highly problematic structural configurations of the environment within which IGBST scientists have produced the science relied upon disproportionately by the Service in this rule, and which virtually guarantee the production of unreliable science. Put another way, the burden should be on the Service to articulate a compelling argument for how and why a veritable monopoly on the relevant scientific enterprise guaranteed or even increased the odds of reliable scientific outcomes.

**1.2. Peer review is unlikely to detect much less correct for bias in IGBST science introduced by monopolistic arrangements.**

The IGBST operates under the auspices and authority of the US Geological Survey (USGS). In its various policy documents, the USGS makes many claims regarding the efficacies of peer review, including the assertion that “peer review...insures the scientific quality of USGS information (USGS Manual, 502.4, Fundamental Science Practices) and “peer review, as cornerstone of scientific practice, validates and ensures the quality of published USGS science” (USGS Manual, 502.3, Fundamental Science Practices). It is these claims that apparently undergird the Service’s and the IGBST’s defense of a monopolistic scientific enterprise. In keeping with these policy statements by USGS, the Service and IGBST commonly claim in public that peer review will detect error and ensure, if not guarantee, the quality and reliability of the IGBST’s science. In fact, these assumptions appear to be behind the Service’s elicitation of peer review by three select reviewers as a presumed corrective for error during further development of the Rule.

Put bluntly, the claims made on behalf of peer review by the Service, USGS, and IGBST are not empirically substantiated. The corpus of scientific inquiry into the efficacies and problems of peer review (e.g., Burnham 1990, Armstrong 1997, Campanario 1998, Bacchetti 2002, Biagioli 2002, Benos et al. 2007, and many more) has shown that error is detected at about a rate one would expect by chance, and that, if anything, peer review is about adhering to dominant paradigms and drawing support from the predictably commonplace

reviewers who adhere to them as well. (Not coincidentally, the IGBST has published over 75% of its research since 2004 in *The Journal of Wildlife Management* and *Ursus*, both of which could be considered bastions of dominant paradigms.)

Because of empirically-based concerns about peer review, there has been a corresponding groundswell of criticism of peer review in the scientific community. About the best that thoughtful defenders of peer review can say for this practice is something akin to what Winston Churchill said about democracy: “Democracy is the worst form of government, except for all the others.” Although defenses—and critiques—such as this still allow a constructive place for peer review, they are hardly a basis for putting faith in this process as some sort of guarantor of scientific quality.

Peer review clearly functions as a mechanism for censorship, improvement, maintenance of identity amongst a community of self-styled elites, and a device to be used for political advantage. Unfortunately, claims on behalf of peer review by the Service, the USGS, and the IGBST bespeak a political enterprise more than they reflect any objective and empirically-based assessment of what peer review has to offer (see Appendix 2 for an elaboration of this argument). As above, the burden should be on the Service to provide an empirically-based and compelling argument for how, in fact, peer review corrects for the potential bias-inducing effects at play in this situation. This burden weighs all the heavier because of the monopolistic arrangements I describe immediately above.



**2.** The frames currently used by the Service and the IGBST to organize information about the interrelations of food quality and quantity, hazards, and birth and death rates are deficient and do not reflect the best available science.

**2.1.** The Service fails to coherently address the joint dimensions of diet that include food quality and the characteristic hazards associated with consumption of a given food. Because of this failure, the Service's representation and analysis of the interaction of hazards with quality/quantity is haphazard and prone to selective manipulation in service of the immediate argument. This translates into patently deficient logic and analysis throughout the Rule and CS.

The demographic implications of consuming a given food will be defined at a population level by effects on both birth and death rates. Effects on fecundity will be predictably mediated by effects on the condition of reproductive females and the extent to which those effects translate into reproductive rate. Effects on death rate will be dictated by the characteristic hazards associated with using a particular food. A high quality food with positive effects on birth rates can either be associated with foraging opportunities concentrated in highly secure habitat or the opposite. This latter set of circumstances, where a high-quality food lures an animal into a highly lethal environment, has become the focus of scientific inquiry organized under the rubric of "ecological traps" (e.g., Delibes et al, 2001, Schlaepfer et al. 2002, Hale & Swearer 2016), which is interrelated with but distinct from source-sink dynamics (Kristan 2003).

The concept of ecological traps is not new to bear researchers. Most notably, Joe Northrup and Scott Nielson deployed this concept (with Nielson using slightly different terminology) in geospatial conservation assessments for grizzly bears in Alberta (Nielson et al 2006, 2009; Northrup et al. 2012). Moreover, there have been several highly congruent landscape-level assessments of hazards for Yellowstone grizzly bears (Carroll et al 2001, 2003; Merrill & Mattson 2003; Johnson et al 2004; Schwartz et al. 2010) which have been directly relevant to judging the hazards of using different foods with different geographic distributions

(e.g., livestock, whitebark pine, and cutthroat trout), albeit without explicit integration of hazards and productivity under rubrics such as ecological trap.

Yet the Service does not deploy the concept of ecological traps; nor do they, in fact, deploy any explicit framework by which the nutritional benefits and entailed hazards of any given diet or dietary shift are simultaneously considered. Throughout the Rule and CS, nutritional aspects are examined in isolation from effects on survival. This is a major failing given that the Rule and CS devote much text to presumably assessing the consequences of the dietary changes afoot with Yellowstone's grizzly bears, related to the loss of most whitebark pine and cutthroat trout, and the apparent shift of surviving bears to eating more army cutworm moths and meat from terrestrial mammals—among other things. The integration of hazards with nutrition needs to occur if for no other reason than the overwhelming evidence for variation of the hazards incurred by adults when using foods of otherwise similar nutritional quality: e.g., much lower for bears eating whitebark pine seeds and trout compared to bears consuming a diet of meat from ungulates, or any other food that brings bears near and into conflict with people.

At a minimum, the Service needs to differentiate major grizzly bear foods according to some sort of matrix that distinguishes high-quality foods entailing characteristically high hazards from high-quality foods entailing characteristically low hazards, and furthermore differentiate whether the hazards are born primarily by dependent young, independent bears (adults and adolescents), or both. This latter distinction is important to any assessment because 80-90% of all independent-aged grizzlies die from human-related causes (e.g., Schwartz et al. 2006) whereas many dependent young bears die for "natural" reasons, including predation by other bears. Hazards associated with humans are thus thrown into sharper relief in any assessment of dietary shifts among adult bears, whereas hazards associated with potential "natural" predators are a more prominent

consideration in assessing changes for cubs and yearlings. Parenthetically, the Service also needs to assess the hazard-related consequences of shifts in

**2.2.** The Service fails to adequately frame and address the many environmental changes that have occurred in Yellowstone's grizzly bear range during the last 15 years. As a result, the Service has no basis for judging the effects of any single change, including loss of whitebark pine. This problem partly derives from the fact that the Service relies almost exclusively on science produced by the IGBST, which is similarly deficient in its conceptualizations.

All of Yellowstone's grizzly bear data have been collected as part of an observational study, which translates into serious demands on analysts if they are to arrive at even half-way defensible conclusions regarding cause and effect. Observational studies are almost invariably beset by a host of causal dynamics, many of which interact or are correlated in time and space. As a result, isolating the effect of one factor on an outcome of interest—say, the effect of whitebark pine seed consumption on grizzly bear birth rates—requires somehow accounting for and controlling the effects of all other casual factors of any probable significance.

In practical terms, this requires building replete conceptual models of the system of interest that incorporate as much knowledge about prospective ecological drivers as possible; identifying valid measurable surrogates for each of these drivers; and then incorporating them into some kind of model as covariates or causal variables. Sir Ronald Fisher, the father of modern statistics, was amongst the first to recognize this imperative when he stated “make your theories elaborate” as a precondition for taking the step from association to causation in observational studies. William Cochran, who elaborated on the use of covariates in analyzing data collected from observational studies of complex systems, laid the foundation for following seminal work (e.g., Dawid 1979, Rosenbaum 1984, Hilborn & Mangel 1997) on the importance of having considered enough factors to ensure that the resulting models were sufficient; that is, not likely to substantially change with the introduction of additional covariates. And so on.

consumption of lower-quality foods (e.g., any roots or foliage).

Given the extent to which the Service depends upon science produced by the IGBST, this issue of sufficiency raises the question of whether the conceptual and statistical models produced by the IGBST were defensible—or not; whether they adequately attended to all of the factors that prior knowledge would suggest were drivers of variation in, say, birth and death rates of Yellowstone's grizzly bears. If the conceptual underpinnings of the analyses undertaken by the IGBST were *prima facie* inadequate, there is all the more reason for skepticism of their results, especially in the face of contradictory evidence.

In short, the conceptual models and resulting statistical results produced by the IGBST have been patently inadequate. The Study Team has failed to address a number of potential drivers of birth and death rates, and has not adequately dealt with the high degree of spatial and temporal correlation that besets many of these factors. To date, the IGBST has only considered routine effects (bear sex and age class), plus whether a bear was trapped for research or management purposes (as a surrogate for whether the bear was food-conditioned, habituated, or not); management jurisdiction and nearness to roads (as a surrogate for human lethality and exposure to humans); bear density (through suspect indices; see my later comment on this); and, in earlier analyses, size of whitebark pine cone crops (Schwartz et al. 2006). Spatial representations of whitebark pine forests and density were added recently by Van Manen et al. (2015).

At a minimum, by slavishly relying on the IGBST's science, the Service has failed to address in any sort of integrated way the effects of on-going increases in use of army cutworms and the sites where these insects aggregate; the effects of losing virtually all of the cutthroat trout spawning in streams tributary to Yellowstone Lake since the mid-1990s; the effects of major declines in most elk and some bison herds, also since the mid-1990s; the effects of a severe drought between 1998 and 2008; the effects of a short-term masking trend towards increased

per tree cone crops on whitebark pine since roughly 1997; increasing exploitation of livestock and the remains of hunter-killed elk since roughly 2006; and the extent to which trout losses, ungulate herd declines, losses of whitebark pine, increases in cone crops, increases in availability of moths, and putative increases in bear density were highly correlated in time, sometimes in space, and sometimes as an interaction of both. This multitude of tangled effects probably constitutes as severe an analytic challenge as any analysts have faced trying to divine cause and effect in an ecological system. This complexity also increases the odds that bias can and will be introduced in the necessary simplifications made by the IGBST, its collaborators, and the Service—by the choices of what effects to consider, and how.

In fact, bias is amply evident in the extent to which the IGBST structured its post-2009 inquiry into grizzly bear vital rates as an artificially simplified contest between the extent of whitebark pine forests, on the one hand, and bear density (e.g., density dependence), on the other (see also my comment below on use of the density-dependence concept by the Service and the IGBST). It hardly seems a coincidence that the 2009 and 2011 Court rulings over-turning the Service's 2007 delisting rule were based on the extent to which the Service was perceived to neglect and misrepresent the body of science showing a major effect of whitebark pine seed availability on grizzly bear vital rates. And even during the period of litigation, the Service was contending that bear density alone was driving changes in vital rates, and that losses of whitebark pine were minor. It is hard to avoid concluding that the post-2009 science produced by the IGBST was (and is) merely the fulfillment of a politically-driven agenda.

**2.3.** The Service fails to use the best available science in its conceptualization of factors driving levels of human-caused grizzly bear mortality. As a result, the Service conflates static spatial delineations of so-called secure habitat with what is, in fact, a highly dynamic set of factors driving current increases in human-caused mortality.

The Service repeatedly states in both the Rule and the CS that maintenance of a select number of GIS-delineated

At this point I need to clarify my critique with reference to the standard practice reported by the IGBST in virtually all of its publications, which is to generate *pro forma* lists of rote models containing permutations of variables that they considered, along with AIC values for each. Such lists do not address the IGBST's and Service's failure to consider certain effects altogether and the Study Team's consistent under-use of useful measures of model goodness-of-fit and predictive value. As I noted above, these are all critically important considerations in the production of models designed to address the complexities of open ecological systems, which, if neglected, can result in nothing more than misleading if not useless results (see Pilkey & Pilkey-Jarvis 2009).

As a bottom line, this problem of deficient conceptualization of the ecological system debars any confidence in how the Service represents or otherwise uses science produced by the IGBST. One option would be to put the Rule on hold and allow for additional investigations of alternative models by independent researchers. Another option would be, at a minimum, for the Service to acknowledge the limitations of the science they rely on, clarify the resulting uncertainties and ambiguities, and adopt a suitably precautionary approach.

But regardless of deficiencies in the research produced by the IGBST, this does not excuse the Service from deploying a conceptual framework sufficient to the complex and demanding task of assessing the effects on Yellowstone grizzly bears of all the environmental changes that have occurred since the time of Listing. In fact, nowhere is there any evidence of the Service deploying such a frame.

spatial habitat attributes at 1998 levels within the PCA will insure that rates of human-caused mortality will be no higher in the future than those that occurred during roughly 1988-1998. These spatial attributes include road densities, the extent of areas >500m away from human infrastructure (so-called "secure" habitat), and numbers of livestock allotments.

These arguments are substantively deficient in several regards. First, the Service fails to recognize that human-

caused mortality is driven by two distinct phenomenon, one with a major geospatial dimension, the other largely without: the simple distinction between how often bears encounter people (frequency of contact) and the likelihood that the encounter will end up lethal for the involved bear (lethality of encounter). Second, and related to the first, the equivalence of static landscape features with main drivers of human-caused mortality is simple-minded and thereby misses several other key factors that render a static geospatial analysis patently deficient.

Taking each of these failings in turn, first, Mattson et al. (1996a, 1996b) provide a clear articulation of the logic behind and implications of distinguishing between frequency and lethality of human-bear encounters as determinants of total human-caused bear mortality. Numbers of deaths can be high under conditions of low-frequency contact, as typified by encounters between grizzly bears and big game hunters or grizzly bears and wildlife managers operating at the behest of livestock producers; and numbers of deaths can be low under conditions of high-frequency contact, as typified by encounters between habituated bears and masses of tourists along National Park roads. It is human lethality, not frequency of encounter as such, that differentiates these kinds of scenarios.

Interestingly, the Service awkwardly and tacitly implies these distinctions in its references to research that has purported to explain variation in grizzly bear mortality rates on the basis of management jurisdictions or delineations (NPS lands versus the PCA versus outside the PCA; Schwartz et al. 2006, 2010). Without explicitly saying so, these effects derive almost wholly from variation in human lethality, which varies, in turn, as a function of whether people tend to be well-armed (e.g., big game hunters), associated with features that generate conflict (e.g., livestock allotments), and tolerant (or not) of grizzly bears (e.g., most amenity migrants versus most livestock producers). And, importantly, human lethality can vary by orders of magnitude over time, as between the 1800s-early 1900s and the period after which grizzly bears were protected under the ESA (Mattson & Merrill 2002). Likewise, the Service tacitly argues in its many claims for the efficacies of its ESA-mandated management that declines in human lethality

were a result of better garbage management, food storage, and education.

The main point here is that human lethality can vary widely in time and space as a function of human attitudes and behaviors. It is a highly dynamic phenomenon that contributes every bit as much as frequency of human-bear contact to total grizzly bear mortality. The Service does not recognize this, which results in other deficiencies in its argument that I refer to elsewhere.

Second, and related, a static spatial representation of absolute lethality of the Yellowstone landscape (which the Service tacitly does through its invocation of a static spatial baseline) fails to recognize that grizzly bears may spend more or less time near people—both inside and outside of so-called secure areas—as a function of social interactions amongst bears and changes in the abundance and distribution of key foods. As important, these redistributions of bears can expose them to people of varying lethality. Grizzly bears can encounter highly lethal people in so-called secure areas at varying rates depending on factors that motivate the bears. The main example of this is grizzly bears encountering elk hunters in the backcountry at frequencies that vary depending upon how strongly the bears orient to the offal left behind from elk kills by hunters (Haroldson et al. 2004). All of this plays out in so-called “secure” areas. And, as I point out elsewhere, bear mortalities resulting from conflicts with elk hunters have skyrocketed since roughly 2007, again, mostly located in what the Service is calling “secure” habitat.

The main point here is that grizzly bears are free agents motivated by a search for preferred food (e.g., Mattson et al. 1992, Haroldson et al. 2004) as well as avoidance of other bears (Mattson et al. 1987, McLellan & Shackleton 1988). These movements and resulting redistributions with respect to humans can systematically change over time (as claimed by Costello et al. 2014), at various scales, with resulting changes in exposure of even the same numbers of bears to varying hazards and levels of risk associated with humans—resulting in varying levels of human-caused mortality even with the same amount of so-called “secure” habitat. The Service essentially ignores all of this in its unqualified claims that maintaining a static spatial baseline dating back to 1998

will somehow insure the security of grizzly bears (e.g., pages 13182 & 13184).

For this and other reasons articulated in my critique, the Service needs to account in its habitat management

prescriptions for all of the social and dietary changes since 1998 that have resulted in increased exposure of grizzly bears to human hazards synchronous with no net change (or increase) in livestock allotments and human infrastructure.

**3. The Service employs a simple-minded and unsubstantiated conception of carrying capacity as a basis for in turn making unsubstantiated claims regarding the number of bears able to be sustained in the PCA and DMA, and past and likely future effects of food quality and quantity on Yellowstone's grizzly bear population.**

The Service's representation of carrying capacity ( $K$ ) throughout the Rule and CS is almost wantonly simple-minded and seemly constructed to serve the sole purpose of supporting assertions that (1) there is no more room for grizzly bears in the PCA (and DMA), (2) that no deleterious habitat trends are afoot that might compromise current conditions, and, because of that, (3) the population is secure, recovered, and ready to be delisted.

The gratuitous figure on page of the Rule is emblematic of the Service's problematic use of the carrying-capacity concept. Here, they show  $K$  as being static and unchangeable, with population size fluctuating around it—presumably as a representation of what has happened and will continue to happen with Yellowstone's grizzly bear habitat and population. In fact, this representation is utterly at variance with both reality and the several references that the Service cites as if for substantiation.

In fact, carrying capacity not only changes from year to year, but also exhibits long-term trends as a function of long-term changes in availability of critical resources—most importantly, food. As I have pointed out throughout my critique (and as the Service tacitly admits in many places), carrying capacity has changed for grizzly bears in the Yellowstone ecosystem as a function of changes in food availability. Since the mid-1990s positive changes can readily be attributed to increasing consumption of moths in the Absaroka Mountains and increases in the Northern Range bison herd. The more numerous negative changes can be attributed to functional extirpation of cutthroat trout in Yellowstone Lake; 50-70%+ loss of mature cone-producing whitebark

pine throughout the ecosystem; major declines in virtually all of the ecosystem's elk herds; and major recent declines in the Central Yellowstone Park bison herd. A major decade-long decline is also plausibly attributable to the epic drought that lasted 1998-2008 (see the graphs I present under point 10). In the net,  $K$  almost certainly declined during the last 20 years. Put another way, it defies reason and all available evidence to credibly argue otherwise—which is what the Service tries to do in the Rule.

Another key point is that, when reckoned against total size of a population that is expanding in distribution,  $K$  must be assessed not only for a given area, but also for the cumulative area occupied by the expanding population. This is relevant for Yellowstone's grizzly bear population given that its distribution has apparently expanded by 30-40% (Bjornlie et al. 2013) at the same time that the population was "stable"; i.e., not increasing in numbers. In other words, approximately the same number of grizzly bears was sustaining themselves by occupying an ever-larger area, which presumably cumulatively encompassed an equal or greater amount of food; increasingly including livestock on the periphery of the ecosystem (see my point 9).

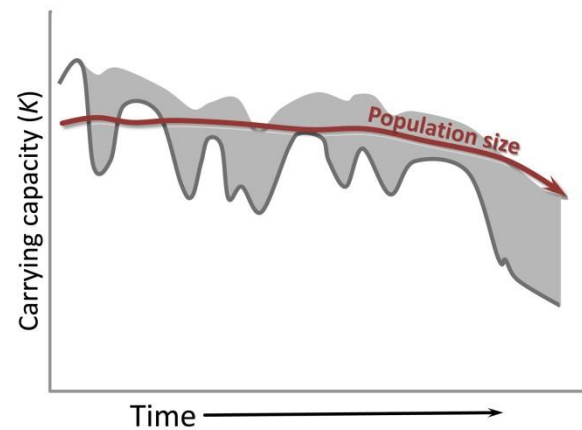
Figure 3.1 encapsulates all of these points in graphic form and is presented as a corrective for the egregiously misleading figure offered by the Service in the Rule. Here carrying capacity for the core of the ecosystem is shown by a dark gray line as an annually highly variable value, but with a long-term decline over the long run. The effect of bears expanding into new areas is shown by the light-gray-shaded area above, constituting a mitigating offset for losses in the core. Population size is shown by the red

arrow, and actually exhibits less variation than occurs in  $K$  itself. This arises from the fact that grizzly bears can buffer themselves somatically and behaviorally from inter-annual variation in habitat productivity (e.g., Herrero 1972), and because grizzly bear populations are subject to potentially long lags between when habitat change occurs and when this change is manifest in population size (Doak [1995], McLellan [2015]; see my point 5 about lag effects).

As a bottom line,  $K$  for Yellowstone's grizzly bear habitat has certainly varied widely and has probably declined substantially. To the extent that the bear population has reached "carrying capacity," this probably has more to do with declines in  $K$  than to increases in population size, as such. Understood this way, being at carrying capacity is not an argument for current or long-term security, but rather an argument for current and long-term vulnerability. By itself, a population at  $K$  is not an argument one way or another for judging recovery.

The Service needs to correct its misleading and simple-minded representations of carrying capacity along with

relations of  $K$  to population size in its risk assessment. In service of this end, the Service has my permission to use the graphic above in the Rule and related materials.



**Figure 3.1.** A more realistic conceptual portrayal of how size of the Yellowstone grizzly bear population (in red) has reflected—or related to—carrying capacity, in the core (dark gray), and accounting for the mitigating effects of population expansion into new areas (light gray).

**4.** The Service employs "density-dependent effects" in this Rule with little apparent understanding of the concept and with no reference to, and in contravention of, the most reliable and straight-forward scientific reckoning of trends in grizzly bear density in the Yellowstone ecosystem.

The Service claims throughout the Rule that changes in the demography of Yellowstone's grizzly bear population since the mid-1980s have been driven largely (if not solely) by changes in population density, entraining "density-dependent effects." On this basis the Service then goes on to dismiss effects attributable to changes in abundance of whitebark pine—or any other food. The primary basis for this oft-repeated claim is Van Manen et al. (2015), although with parenthetical reference to Schwartz et al. (2006), who also purport to have detected "density-dependent effects." The Service, citing Van Manen et al. (2015), attributes declines in survival rates of cubs and yearlings to increasing bear densities, but otherwise flags few other effects of density on either birth or death rates.

The Service's claims suffer from an invocation of naïve if not downright misleading conceptions of density-dependence and from critical—even fatal—failings of the cited research. Its claims that density has increased since around (or even before) 2000 are also contradicted by straight-forward and unambiguous scientific data, and otherwise have little scientific credibility. In short, the Service's invocation of density is one of many slender broken reeds upon which its arguments are based.

Starting with the most straight-forward point first: grizzly bear densities almost certainly did not increase in the Yellowstone ecosystem during the 2000s and after. As the Service frequently asserts, the population "stabilized" during this period, meaning few if any increases in numbers of bears. A trend line fit to Mark-

Resight-based estimates of population size (a less bias-prone method compared to the Chao2-based approach) substantiate this assertion, with the added possibility of population declines since around 2006-2007 (see the bottom graph in figure 5.3.1). At the same time, the distribution of the population increased by roughly 40% (Bjornlie et al. 2013). Simple math shows that if you have the same number of individuals spread out over a substantially larger area ( $n/\text{area}$ ), density axiomatically decreases. To the extent that demographic rates of the Yellowstone grizzly bear population have changed at all during the last 15 years, it is almost certainly not because of increased bear densities—at least by our most straight-forward and unambiguous reckonings of density.

Turning more specifically to the methods employed by Schwartz et al. (2006) and Van Manen et al. (2015): In the case of Schwartz et al. (2006), they used a time-specific population-wide index of “density” based explicitly on annual counts of females with COY. As I point out elsewhere (my point 19), this index of population size almost perfectly mirrors changes in efforts by researchers and managers to find bears, along with changes in the intrinsic sightability of the bears they were seeking. By contrast, the correlation between annual counts of females with COY and actual population size is unknown and almost certainly meaningless if not deceptive. Moreover, the index used by Schwartz et al. does not account for steady increases in the distributional extent of the population (e.g., Schwartz et al. 2006b, Bjornlie et al. 2013), which introduces further unaccounted-for bias. Compounding these intrinsic problems is the fact that Schwartz et al. (2006), like Van Manen et al. (2015), did not control for a number of major temporal changes in abundance of key foods that were correlated with their purported index of bear density (e.g., cutthroat trout, elk, bison, and army cutworm moths), which debars any isolation of a density effect—even assuming a valid index—and introduces major statistical problems related to covariance of explanatory variables.

In contrast to Schwartz et al. (2006a), Van Manen et al. (2015; and Bjornlie et al. 2014) used a purported index of population density that varies not only by year, but also with respect to a grid of cells sized to approximate the extent of female home ranges. Because of this spatial and temporal resolution, the Bjornlie/Van Manen index

gives the reassuring impression of high-resolution precision to those looking at their results with an uncritical eye—which seems to be the case for the Service.

In fact, this index is yet another instance of a metric with no known relationship to the parameter it purports to indicate (i.e., bear density), and almost certainly substantially contaminated by, in this case, efforts of researchers and managers to capture and collar grizzly bears. Briefly, the density index is directly based on the number of bears trapped and radio-marked in a given area during a given year, weighted by rote survival rates to “extrude” [sic] these bears forward and backward through time, after which the “extruded” bears are stacked and added to come up with a purported index of density. Van Manen and Bjornlie attempt to “validate” this index, *prima facie* biased by trapping effort, by correlating it with two other metrics that have no known relationship to density—other than what Van Manen and Bjornlie assert through argumentation. More tellingly, the population-level results of the arcane and unsubstantiated Van Manen/Bjornlie density index contradict the straight-forward calculation I describe immediately based on estimates of total population size and distribution.

And, again, because both Bjornlie et al. (2014) and Van Manen et al. (2015) fail to account for numerous other major changes in Yellowstone’s grizzly bear habitat—also correlated in both time and space with their purported density index (see my point 10)—they have no basis for isolating any density effect, even assuming the index they use is valid. Given all of these problems with the Van Manen/Bjornlie density index, the burden is clearly on the Service to reconcile the contradictions between, on the one hand, the best available science regarding population size and distribution and, on the other, grossly deficient science that uses a *prima facie* problematic unproven index of density in context of patently inadequate analyses that fail to account for most of what is likely to affect grizzly bear birth and death rates (as per most of my review here). More to the point, the Service does not, in fact, use the best available science regarding density effects and, instead, relies almost solely on science of comparatively little merit.



Finally, the Service and the IGBST research that it invokes employ a simple-minded and often misleading conception of “density-dependence” that offers little insight of relevance to the deliberations of this Rule. As one insightful and well-respected population ecologist put it: “Density is not a mechanism” (this from Charles Krebs [1995, 2002]). What he meant by this is that birth and death rates of animals are driven by levels of predation, disease, and intra- and interspecific competition, along with the quality and abundance of foods, especially those eaten by females. If population density has any effect at all, it is through somehow modifying these critical factors. There is no direct effect of density, even in New York on a subway. Invoking density as an explanation for anything is equivalent to assuming that animals are ping-pong balls moving at random, with each ball equal in all of its effects.

To the extent that density has any effect, it necessarily interacts with carrying capacity and changes in the microscale and mesoscale distributions of individual bears in reflection of dietary changes driven by changes in availability of foods. In other words, at the same exact density, the frequency and lethality of interactions among bears can vary substantially depending on total abundance of food and the extent to which these foods are concentrated in time and space—as with differences in British Columbia between coastal areas with salmon spawning runs and interior areas with abundant by

widely-distributed berries. The upshot of this is that a simple shift in diet among Yellowstone’s female grizzly bears from pine seeds to terrestrial meat (see my comments under point 9) could substantially modify levels of interactions with other bears, especially males, and without any change in bear densities.

Parenthetically, as I point out elsewhere (point 17), changes in cub and yearling survival rates can be plausibly explained simply by changes in foraging behaviors of female bears, and without needing to resort to poorly conceptualized and unsubstantiated claims regarding density. Survival rates of cubs and yearlings have probably declined simply because adult female grizzlies are eating more meat and incurring substantially more hazards for their dependent offspring; hazards primarily, but not solely, related to increasing odds of predation by other adult bears and wolves.

The Service needs to upgrade its conceptualization of density effects; recognize deficiencies in the science it currently invokes to justify its density-related arguments; adopt, instead, the best available science; and, finally, realize that changes in demography and trend of Yellowstone’s grizzly bear population are almost certainly a result of changes in food availability, diet, carrying capacity, and distributions—not increasing densities and presumed “density-dependent” effects.

**5.** The Service fails to adequately address the issue of lag effects in the Rule. There are no habitat-based standards proffered by the Service that would trigger reviews by the IGBST or Service; nor is there any history of the IGBST seriously engaging in its research with the existing suite of monitored habitat indicators; nor is there any history of managers or researchers in the Yellowstone ecosystem seriously considering any habitat trends except in response to litigation or threat posed by research published by other researchers.

On page 13224 of the Rule the Service addresses the issue of lags between changes in habitat and manifestation of these changes in population size and trend by asserting: “...the IGBST will monitor a suite of indices simultaneously to provide a highly sensitive system to monitor the health of the population and its habitat and to provide a sound scientific basis to respond to any changes or needs with adaptive mgmt. actions. This “lag effect” is only a concern if the sole method to

detect a change in habitat is monitoring changes in population size. ... [W]e feel confident that we will be able to detect the consequences of significant changes in habitat.”

This treatment of an important even critical issue by the Service is deficient in several regards. First, the only standards proffered by the Service that would trigger an authoritative review by the IGBST or Service are linked



solely to population size—or mortality rates as a partial function of population size. Second, the history of how habitat trends have historically been treated by the IGBST and the Service provides no basis for trust. Third, there is no indication that the IGBST or the Service are responding to current evidence of unfolding lag effects with anything other than dismissal. And, fourth, the current suite of habitat indicators is lacking. Parenthetically, “feeling” confident seems a poor substitute for concrete authoritative measures and a history of competence and attention. Taking each issue in turn:

**5.1. The Service does not describe any habitat-based standards in the Rule that would trigger authoritative reviews by the IGBST or Service.**

According to the Rule, the only standards that would trigger an authoritative review by the IGBST or Service are linked to population size—or mortality rate as a partial function of population size. There are no triggers that link to trends in foods or other important features of habitat; all such effects are presumably filtered through population responses before warranting some sort of significant response by either state or federal managers.

In other words—and contrary to the Service’s current innuendo—the provisions of the Rule that fundamentally matter ignore lags effects and solely invoke lagged population responses as a basis for triggering any meaningful management response.

**5.2. The IGBST and Service have responded historically to lag-inducing trends in food and habitat with inattention or dismissal, and almost solely in reaction to litigation or threats posed by independently-published research. This is not a basis for trust.**

The Service deploys what is essentially a “trust us” argument in its description of how the IGBST and managers will respond to trends in the “suite of indicators”—and this in the absence of any authoritative provisions for triggering a response (as per 5.1). Put bluntly, history provides no basis for trust.

In fact, history shows that the IGBST and Service and have responded to changes in foods and habitat (e.g.,

whitebark pine) either with inattention, dismissal, and, if attentive, only in response to litigation or research that threatens current hegemony. For example, nowhere in any of the IGBST research published during the last 10 years is there evidence that this research group has explicitly considered trends in the existing suite of habitat indicators that it monitors—with the exception of cone counts on whitebark pine transects (more on this later). Trends related to cutthroat trout, moths, spring carrion, and numbers of hunters and park visitors are reported each year in IGBST Annual Reports, and then essentially ignored in any analyses of grizzly bear movements or demography.

On a more positive note, the IGBST and Service have seriously engaged with the effects of changes in whitebark pine abundance on grizzly bear movements and demography. However, as I describe elsewhere in these comments, these efforts are fatally flawed and seemingly politically motivated. As evidence, the science on whitebark pine effects undertaken by the IGBST—at the behest of the Service—has almost solely been in response to either litigation or a challenge by independent researchers. The Service describes on pages 13175-1376 how rulings by the Montana federal District Court and 9<sup>th</sup> Circuit Court of Appeals motivated the current crop of whitebark pine-focused science. Prior to that, the treatise by Schwartz et al. (2006) covering whitebark pine effects did so primarily in response to a publication (Pease & Mattson 1999) that authoritatively flagged the issue as something to be considered.

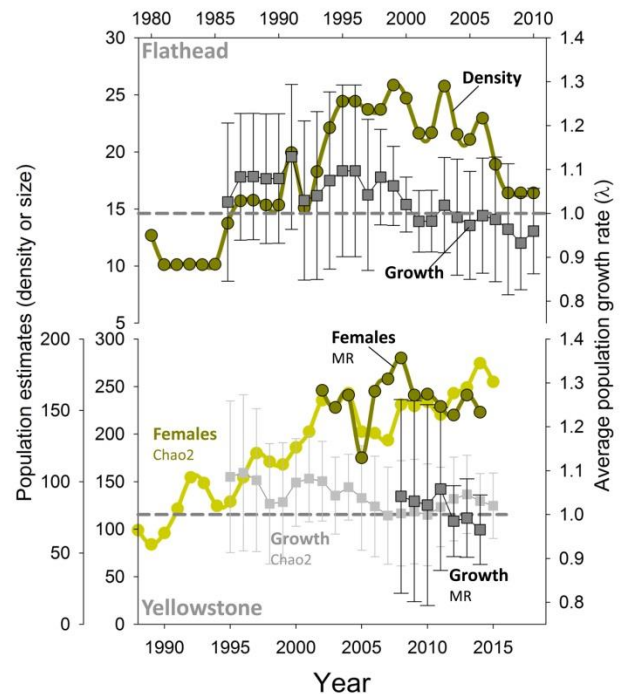
Likewise, improvements in methods for monitoring population and mortality occurred in response to outside research that flagged short-comings in current approaches: Keating et al. (2002) and Cherry et al. (2007) in response to Mattson (1997c); and Cherry et al. (2002) in response to Mattson (1998). Spatially-explicit appraisals of habitat suitability and hazards by Schwartz et al. (2010, 2012) occurred in response to Merrill & Mattson (2003) and Johnson et al. (2004). The point here is that, during the last 15 years, the IGBST and Service have not demonstrated an interest in proactively addressing potentially lag-inducing habitat trends—or other science issues of import for that matter.

**5.3.** The IGBST and Service have shown no response to current evidence of lagged environmentally-driven changes in population size and trend; if anything, the response has been dismissal and denial.

Over 20 years ago Doak (1995) explicitly related the concept of lag effects to dynamics of the Yellowstone grizzly bear population. More recently, McLellan (2015) demonstrated lag effects of this nature for a grizzly bear population in the North Fork of the Flathead River drainage of British Columbia and Montana. A sustained crash in huckleberry production began in 1996 followed by the beginning of a correspondingly sustained decline in population growth rate the year after. However, tellingly, a definitive and dramatic decline in population size did not manifest until 11 years later—beginning in 2007—after which the population declined substantially.

Lag effects are highly relevant to judging the current status of Yellowstone's grizzly bear population given the major declines in major food sources that have occurred during the last 15 years, most notably, the terminal decline in whitebark pine seed availability beginning in 2007. Yet, if anything, the Service portrays a static world for Yellowstone's grizzly bears in its portrayal of carrying capacity (see my comment 3), while at the same time claiming that all changes will be subsumed by the bears' remarkable—even magical—absorptive omnivory and resilience.

Figure 5.3.1 is illustrative of unfolding lag effects for Yellowstone's grizzly bear population, referenced to data from the Flathead study taken from McLellan (2015). At top I've presented trend data for population size and growth rate for the Flathead grizzly bear population; my representation of growth rate is based on a 6-year moving average of proportional change in population size from one year to the next (i.e.,  $\lambda$  = lambda). Green dots represent population density and gray squares represent growth rate. The take-away from the Flathead data is that population growth rate began to decline almost as soon as berry production tanked around 1996, but didn't turn negative until roughly 5-years later. More importantly, population size, as such, didn't begin a substantial long-term decline until 10-11 years after the berry drought started.



**Figure 5.3.1.** Trend data for the grizzly bear population in the North Fork of the Flathead, top (McLellan 2015), and for the Yellowstone grizzly bear population, bottom. Dark green dots represent best estimates of density or total population size, and the dark gray squares, derivative estimates of population growth rate ( $\lambda$ ; as a 6-yr running average). Uncertainty bars around estimates of growth rate represent standard deviations. Yellowstone estimates based on the highly-biased Chao2 estimator are shown as yellowish-green dots and as light gray squares.

I show Yellowstone data in the bottom graph of figure 5.1. The darker green dots represent estimates of population size using the Mark-Resight (MR) method, which is less biased than the flawed Chao2 method adopted by the Service (see my point 19). The dark gray squares represent a running average of population growth rate based on MR population estimates. I also show population estimates using the Chao2 method (in light yellowish-green) and derivative estimates of growth rate (in light gray). The take-away point here is that average population growth began to decline around 2008, shortly after the onset of terminal declines in whitebark pine seed availability, and became negative (i.e, showing decline) only in 2012. Meanwhile, total population size has appeared more-or-less-static, with the slight suggestion of a down-turn during recent years.

Trends unfolding for Yellowstone's grizzly bear population bear an uncanny resemblance to trends that unfolded in the North Fork of the Flathead between 1996 and 2006, which substantiates concerns about on-going lag effects in Yellowstone, with worse yet to come. More to the point, the IGBST and Service show no evidence of, first, acknowledging these dynamics or, second, responding to them.

**5.4. The foods and habitat features currently monitored by the IGBST, and presumably comprising the suite referenced by the Rule, are inadequate.**

The IGBST currently monitors and reports on availability and grizzly bear use of moth sites, cutthroat trout streams, and spring carrion on ungulate winter ranges, along with numbers of cones on whitebark pine at fixed transects.

These monitoring efforts are inadequate because they fail to include foods or aspects of foods that are of unambiguous importance to detecting early signals of change in Yellowstone's grizzly bear habitat. More specifically, the IGBST needs to add numbers of elk and bison in various ecosystem herds as well as aerial extent of whitebark pine to its suite of indicators. The IGBST itself shows that meat from ungulates is becoming

increasingly important to Yellowstone's grizzly bears (Schwartz et al. 2014, Ebinger et al. 2016) and that aerial extent of whitebark pine forests is a critical dimension of grizzly bear habitat (Bjornlie et al. 2014, Van Manen et al. 2015).

**5.5. The Service needs to make substantial revisions to the Rule to insure that lag effects are adequately dealt with.**

The Service needs to make several substantive changes to the Rule designed to remedy the short-comings that I describe here. For one, the Service needs to set meaningful standards linked to monitored foods and habitat features that will authoritatively trigger reviews by the IGBST and Service. These standards and associated triggers should be designed to anticipate and help mitigate for unfolding changes that will likely drive lagged responses in population size and trend. For another, the Service needs to add numbers of elk and bison in the ecosystem as well as aerial extent of mature whitebark pine to the suite of habitat features to be monitored by the IGBST. Finally, The Service needs to demonstrate that it takes the issue of lag effects seriously by acknowledging and accounting for unfolding trends—in contrast to its current pattern of denial and dismissal.

**6. The Service fails to use the best available science when describing the taxonomy and evolutionary biogeography of Yellowstone's grizzly bears. Instead, the Service uses outdated science to categorize Yellowstone's grizzly bears as part of a purported continent-spanning subspecies when the best available science clearly shows that the Yellowstone population is part of a clade (Clade 4) with an ancient and unique history, a restricted distribution, and warranting consideration as an evolutionarily unique and threatened genetic lineage.**

The Service makes reference in the Rule to an antiquated research paper (Rausch 1963) as a basis for lumping Yellowstone's grizzly bears in with a presumed subspecies that spans the entirety of western North America. The best available science, comprised of a large body of post-1995 research, clearly and emphatically shows that Yellowstone's grizzlies are, instead, part of the Clade 4 lineage. This matters because Clade 4 brown bears have a unique and ancient history and a current distribution that is restricted to central-western North America and an isolate on the island of Hokkaido. In

North America, Clade 4 bears probably extend no farther north than central Alberta and British Columbia, which makes them the most fragmented Clade in North America, and collectively as threatened as the Clade 1 bears of Europe and Clade 5 and 6 bears of southern and southeastern Asia. The details of all this are elaborated in Attachment 2, which I have included both as substantiation for my comments and to assist the authors of the Rule, who are apparently unacquainted with the referenced body of literature on brown bear taxonomy and biogeography.

As brief background, Clade 4 brown bears were probably the first representative of *Ursus arctos* to migrate across Beringia into North America, certainly before 30,000 years before present, and perhaps as early as 70,000+ years ago. By all indications, bears of this clade were then isolated south of the continental ice-sheets for 10s of thousands of years. As the ice sheets melted during the early Holocene, Clade 4 bear migrated north where they encountered more recently arrived Clade 3 brown bears moving south from Beringia. With arrival of Europeans, Clade 4 grizzlies bore the brunt of post-1800 extirpations, and are unique among all North American Clades in being the most diminished of all. Yellowstone's grizzlies currently represent the southernmost relic of Clade 4 brown bears.

The Service does not make reference to this unique evolutionary and biogeographic circumstance of Yellowstone's grizzly bears anywhere in the current delisting package. This is a major omission. Nor does the Service anywhere make mention of the unique and much diminished status of Clade 4 grizzly bears. If duly considered, all of this information would logically support a larger vision for recovery of this Clade, including explicit provision for connectivity of Yellowstone's grizzlies with other Clade 4 populations farther north, which the Rule

does not currently include. Moreover, such a perspective would lead to recognition of the special taxonomic and historical status of Yellowstone's grizzly bears, all of which would argue for a more cautious approach than is currently being taken by the Service.

In short, the Service needs to update its taxonomic reference for Yellowstone's grizzly bears; describe the unique evolutionary and biogeographic status of this population; develop an explicit plan for recovery of at least the US portion of Clade 4 grizzly bears, including an explicit provision for connectivity amongst all representative populations; and put the move to delist Yellowstone's grizzly bear population on hold until such plans and provisions have been developed.

In making this recommendation I realize that I am calling into question the very standards by which the Service has chosen to judge recovery of Yellowstone's grizzly bears, which is a logical consequence of the Service's failure to update the Recovery Plan for this population so as to reflect the massive amount of "best available science" that has been produced since the early 1990s. In other words, this critique is a commentary on the Service's failure to exercise due diligence, including following through with its own 2011 recommendation to update and revise the Yellowstone grizzly bear Recovery Plan.

**7. The Service fails to account for the nutritional ecology of grizzly bears in its assessment of recent dietary shifts because it inaccurately, incompletely, and erroneously represents the best available science. This arises from the extent to which the Service engages in tortuous logic and selective even grossly incomplete representations of relevant research. Because of this, the Service reaches patently erroneous conclusions.**

The Service's representation of nutritional ecology is a critical aspect of its overall argument that historical and prospective food losses, and resulting dietary shifts, "do not and will never pose a threat" to Yellowstone's grizzly bears. The Service claims that grizzly bears are not just omnivorous, but "*extremely* omnivorous," and, on top of that, "display *great* diet plasticity." As evidence of this claim, the Service then cites Gunther et al. (2014), that Yellowstone's grizzlies are documented to eat over "260 species of foods...representing 4 of the 5 kingdoms of life." Thereafter the Service asserts outright or by innuendo that one food is basically as good as another—this despite giving lip service on page 13178 to the fact

that energy concentration and nutrient content vary among foods—and that Yellowstone's grizzly bears are thereby well able to substitute one food for another. The Service then goes on to presumably substantiate this assertion by offering presumed evidence for how losses of whitebark pine and cutthroat trout have not affected birth and death rates of the population.

Put bluntly, the Service's treatment of nutritional ecology reads more like propaganda than it does like a deliberative consideration of the best available science to arrive at a prudent conclusion. In other words, the Service misconstrues, misrepresents, and altogether

misses a considerable body of relevant science in apparent service of reaching a preordained/pre-decisional outcome. The short-comings of the Services representations are so egregiously deficient that I feel compelled to offer a corrective primer on nutritional ecology (hereafter, the Primer; Attachment 3) as an attachment to these comments. But more specifically:

The nutritional quality of foods available to and eaten by grizzly bears in the Yellowstone ecosystem varies by orders of magnitude. Mattson et al. (2004) as well as the Primer provide a summary of digestibilities and protein content for Yellowstone's bear foods. In other words, all foods are not equal insofar as digestible protein and energy are concerned. Moreover, and perhaps more importantly, bear foods are especially disparate in concentrations of dietary fat. Fat is perhaps the most important of all nutrients to bears (Erlenbach et al. 2014), and is uniquely abundant in army cutworm moths, whitebark pine seeds, and late-season ungulates such as elk and bison (Mattson et al. 2004, Erlenbach et al. 2014).

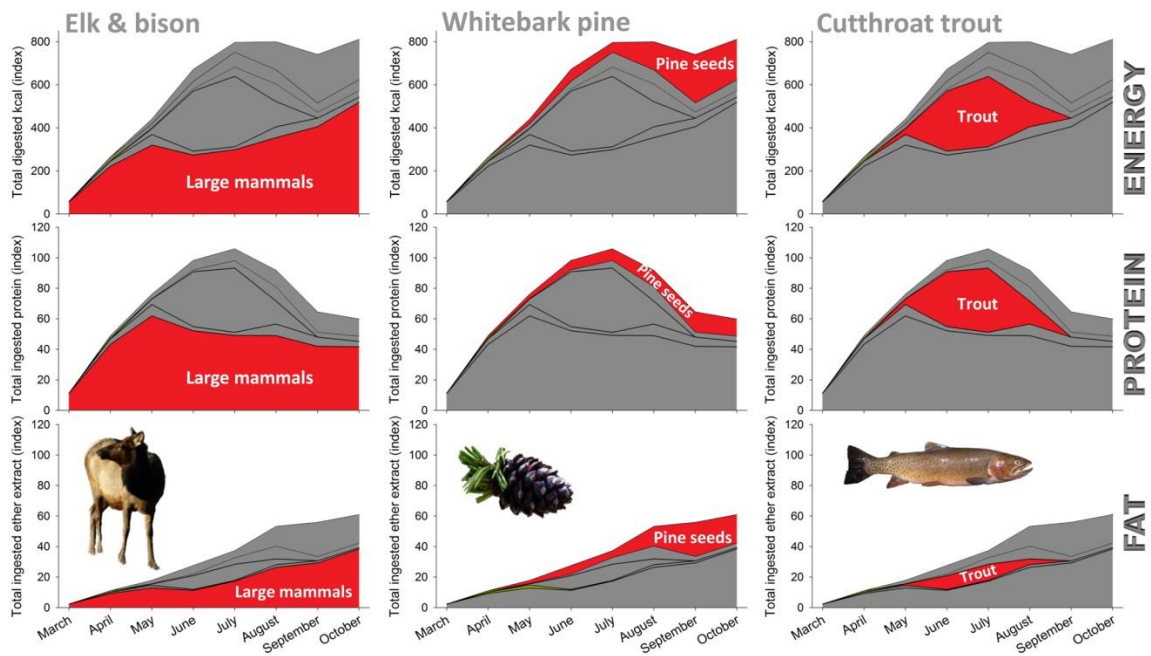
On top of this, the density, architecture, and comparative nutrient contents of foods have a major effect on foraging efficiencies, efficiencies of weight gain, and accretion of fat versus lean body mass among bears, with subsequent effects on mass dynamics during and after hibernation (The Primer; e.g., Farley & Robbins 1995; Atkinson et al. 1996; Welch et al. 1997; Hilderbrand et al. 1999a, 1999b; Rode & Robbins 2000; Rode et al. 2001; Felicetti et al. 2003; Robbins et al. 2007; McLellan 2011; Robbins et al. 2012; Erlenbach et al. 2014). Generally speaking, smaller bears fare better than larger bears on fleshy fruits and grazed foliage, whereas larger bears disproportionately benefit from eating meat (The Primer). Even so, all bears are beset by a need to balance the energy and protein concentrations of their diet to maintain lean body mass and accrue fat (The Primer). On top of this, the energetic costs of extraction vary among foods substantially, to the extent that extraction costs largely negate the greater digestible energy available in most root foods (Holcroft & Herrero 1984, Mattson 1997a, Mattson et al. 2004). In other words, foods are of varied relative benefit to bears based on body mass, sex, and overall diet composition. Not all foods are equal, nor are all foods equal to different bears.

Parenthetically, and at risk of stating the obvious, bears are not Latin taxonomists. In other words, bears are not wandering around in the woods with a copy of the *Flora of the Pacific Northwest* keying out different foods before they eat them—say, differentiating one *Poa* from another, or *Poa* from wheatgrass. In other words, taxonomic distinctions have little or no relevance for grizzly bears. As per what I outline immediately above, differences among foods arise from characteristic densities and architectures at foraging sites, the energetic expenses of extraction, and per gram densities of energy and nutrients—and how all of this varies seasonally and from one year to the next. In other words, the fact that Yellowstone's grizzly bears eat "260 species of foods...representing 4 of the 5 kingdoms of life" is largely irrelevant, disingenuous, and prey to artificial inflation based on the resolution of taxonomic distinctions employed (e.g., should we be talking about genera, or species, or even subspecies?).

With this as background, it is worth looking critically at where Yellowstone's grizzly bears obtained most of their energy and nutrients—say, between 1977 and 2003—and the comparative importance of vegetal foods that the Service in places features so prominently as potential generic dietary alternatives to whitebark pine seeds and cutthroat trout; and elk, for that matter (see below).

Figure 7.1 immediately below offers a seasonal picture of relative contributions of different foods to digested energy and ingested protein and fat of Yellowstone's grizzly bears for the period 1977-1993, differentiating contributions from large herbivores (elk and bison; Mattson 1997b), cutthroat trout, and whitebark pine seeds. This representation is based on a sample of >6000 bear feces collected over a 16 year period throughout the Yellowstone ecosystem, and corrected for differential detectabilities (Hewitt & Robbins 1996) and digestibilities (Mattson et al. 2004) of each food, and then further adjusted to reflect the proportional numbers of bears out of dens (Haroldson et al. 2002) as well as varied levels of monthly feeding activity (Mattson et al. 1991a). But this comes with a proviso. Consumption of army cutworm moths is underrepresented in this sample of feces because of the remoteness of the sites where this food is eaten by grizzlies.





**Figure 7.1. Seasonal fractional contributions of ungulates (elk & bison, left), whitebark pine seeds (center), and cutthroat trout (right) to the 1977-1992 diet of Yellowstone's grizzly bears, differentiating digested energy (top row) from ingested protein and fat (middle and bottom rows, respectively). This representation accounts for detectabilities, digestibilities, and monthly population-level differences in overall consumption and is based on a corrected sample of >6000 grizzly bear fecal remains. Army cutworm moths are under-represented because of sampling issues.**

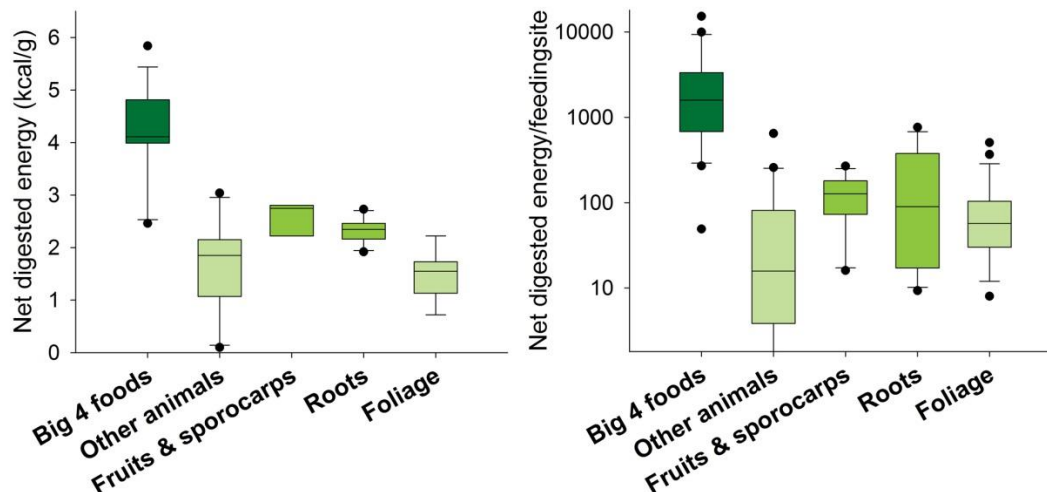
The key point of this graph is that ungulate meat, cutthroat trout, and whitebark pine seeds (plus army cutworm moths, more on that later) historically contributed the overwhelming majority of energy and nutrients to Yellowstone's grizzly bear diet. This representation is broadly consistent with similar estimates corrected for detection, digestibility, and prevalence made by Mattson et al. (2004:26-28) and Lopez-Alfaro et al. (2013). Parenthetically, the major contribution of ungulate meat to Yellowstone's grizzly bear diet correlates well with other independent estimates made on the basis of feeding site examinations (Mattson 1997b) and analysis of isotopes in tissues collected from captured or killed bears (Jacoby et al. 1999; Schwartz et al. 2014).

Insofar as army cutworm moths are concerned, the evidence for their dietary importance is more circumstantial, but nonetheless compelling. First, when the composition of feces collected on or near moth sites is corrected for differential passage through the digestive tract, moths comprise 80-90% of the total (Mattson et al. 1991b). Second, the numbers of bears seen on moth sites has climbed steadily since the mid-1980s and currently

accounts for hundreds of sightings (300-400 recently) and, since 1996, roughly 15-45% of all initial sightings of unduplicated females with cubs-of-the-year (IGBST 2015), the range depending on the specific year. Third, high levels of bear activity on moth sites are sustained over a 2-month period, from roughly mid-July through mid-September (see my point 11.5). Taken together, this evidence is consistent with moths being a major food for grizzly bears within range of moth sites.

Put another way, given the overwhelming reliance by Yellowstone's grizzly bears on essentially four foods (lumping elk and bison together as ungulates), major losses of any one are almost certainly to have major impacts. The Service confesses to major losses of cutthroat trout and whitebark pine. Moreover, as I point out below, elk populations have declined substantially since the mid-1990s, with prospects of army cutworm moths being hit hard by climate warming (see my point ). This begs the question of whether plausible alternative foods are (and would be) of sufficient quality, simply from a nutritional perspective, to compensate for the losses of the euphemistic "big 4" that we've seen.

Figure 7.2 summarizes information on the net digested energy estimated to be obtained by Yellowstone grizzly bears from five different groups of foods on a per gram basis and from a given feeding bout (or feeding site). These data come from (Mattson et al. 2004) and



**Figure 7.2. Box and whisker diagrams showing the energetic benefits of different categories of foods, including the “big 4” (ungulates, army cutworm moths, whitebark pine seeds, and cutthroat trout) and other categories of foods that include items plausibly turned to in compensation for losses among the “big 4.”**

The pattern is pretty obvious. Even accounting for outlier items, the “big 4” are energetically superior to any other foods that might be used by bears in compensation for losses, including other animal foods (e.g., rodents and ants) and fruits and fungi (i.e., sporocarps); and this without taking into account the landscape-level abundance of foods or the extent to which they occur at sites in such a way as to favor efficient use (which relates to the density, architecture, and ease of extraction issues).

There is another important point that further belies any tacit or outright claims by the Service that changes in food abundance can be blithely accommodated by “extremely omnivorous” and “resilient” grizzly bears. This point relates to continent-wide differences in grizzly bear densities and the extent to which these densities reflect differences in habitat productivity. Perhaps the seminal paper putting all of this together is Mowat et al. (2013). These authors show that grizzly bear densities

differentiate the “big 4” (ungulates, cutthroat trout, whitebark pine seeds, and army cutworm moths) from other categories including foods that might be included in dietary shifts in response to losses of current dietary mainstays.

systematically vary by orders of magnitude as a direct function of habitat productivity. The most obvious difference is between coastal areas with spawning salmon and interior areas without. But, even in interior areas, densities can, again, vary by orders of magnitude in reflection of various factors that are surrogates for overall productivity.

The final point of relevance here is that the Service’s argument of potential last resort has no merit. In other words, these comments extensively cover the Service’s numerous fatal errors and failings that debar any dismissal of changes in foods and diet as drivers of historical and prospective future changes in demography of Yellowstone’s grizzly bears. In fact, there is ample evidence for detrimental effects arising from losses of whitebark pine, cutthroat trout, and elk, including major increases in mortality arising from the greater reliance of bears on meat—which has included consumption of livestock.

**8.** The Service fails to account for the effect of recent widespread losses of whitebark pine by its reliance on fatally flawed science produced by the IGBST. This IGBST research fails to account for temporal and spatial variation in availability of whitebark pine seeds as well as temporal and spatial variation in other critically important bear foods. As a result, no confidence can be placed in conclusions reached by the Service regarding the effects any driver of grizzly bear birth and death rates, including losses of whitebark pine.

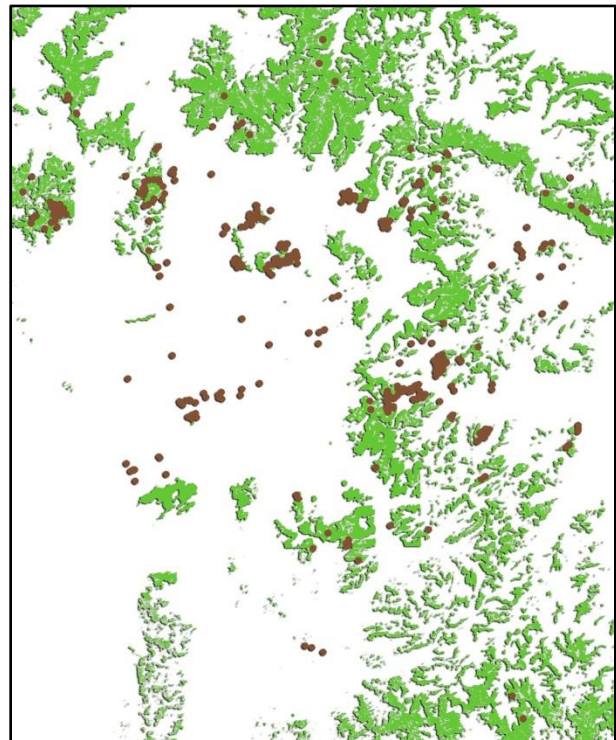
**8.1.** The Service fails to accurately account for the spatial distribution of cone-producing whitebark pine trees when making its many claims regarding the lack of historical importance of pine seeds. This failure follows, in part, from the Service's near exclusive reliance on spatial analyses produced by the IGBST that were based on a map of whitebark pine distribution containing substantial errors of omission.

The IGBST used a map of whitebark pine distribution for its spatial representation of whitebark pine forests that was derived from remote sensing. This map was used for analyses of grizzly bear demography, home ranges, and habitat selection (Costello et al. 2014, Bjornlie et al. 2014, Van Manen et al. 2015), and was the basis for the Service's claims that roughly 23-33% of all recent bear ranges were comprised of <1% whitebark pine forest.

Put succinctly, the map of whitebark pine distribution used by the IGBST is contaminated by large errors of omission. Even more egregiously, this map shows large areas as being without mature whitebark pine which, in fact, contained significant enclaves of mature cone-producing trees. These omissions are the entire basis for claims made by Bjornlie et al. (2014), Costello et al. (2014) and later by the Service in its Rule and CS that a significant percentage of grizzly bear ranges lacked access to cones produced by mature whitebark pine trees. Quite simply, these claims are unfounded and false.

I base this conclusion on comparing the distribution map used by the IGBST with the distribution of sites where grizzly bears were documented by the IGBST to feed on whitebark pine seeds between 1977 and 1996 (Fig. 8.1.1). Feeding on whitebark pine seeds was documented by field crews during the course of investigations that involved humans being standing on the ground, looking at the remains of whitebark pine cones savaged by grizzly bears, and then looking upwards at the canopy, almost invariably to observe mature whitebark pine trees. Or,

put another way, compared to remotely-sensed maps, these ground observations are a more definitive reckoning of, not only the presence of cone-producing whitebark pine, but also the presence of these trees in sufficient numbers to support grizzly bear consumption of pine seeds.



**Fig. 8.1.1.** This map shows the distribution of known instances where grizzly bears fed on whitebark pine seeds (dark brown dots) relative to the mapped distribution of whitebark pine used by the IGBST in recent analyses relied upon by the Service (in green). The numerous feeding sites far outside the mapped distribution correspond with the central plateaus of Yellowstone National Park.

The map in Figure 8.1.1 shows the distribution of known grizzly bear feeding on pine seeds as dark brown dots superimposed on the map of whitebark pine distribution that the IGBST used in analyses undertaken by Bjornlie et al. (2014), Costello et al. (2014), and Van Manen et al. (2015) shown in green. The mapped distribution contains



only 42% of all known instances of grizzly bear feeding on pine seeds. Being generous and assuming, for inexplicable reasons, that IGBST field crews had a systematic tendency to erroneously locate feeding sites as much as 200 m outside the mapped distribution of whitebark pine, the level of inclusion increases to only 63%. Fully 25% of feeding sites are located >650 m away from the nearest mapped whitebark pine. Importantly, almost all of the pine seed feeding sites missed by the mapped distribution are located at lower elevations, and of those missed by the farthest distance, almost all are on the central plateaus of Yellowstone National Park, which is precisely where Bjornlie et al. (2014), Costello et al. (2014), and the Service (repeatedly) claim that grizzly bear home ranges contained little or no mature whitebark pine.

In short, Bjornlie et al. (2014), Costello et al. (2014), and the Service, in turn, are simply wrong in claiming that 23-

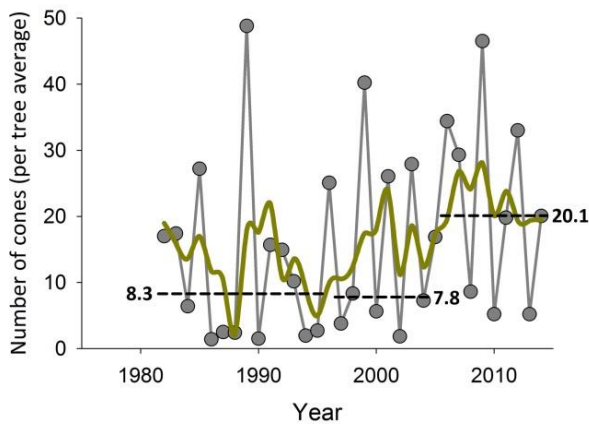
**8.2.** The Service fails to account for the impacts of recent widespread losses of whitebark pine on Yellowstone's grizzly bears because it relies on science that is fatally flawed. This IGBST science conflates the extent of whitebark pine forests with levels of cone and seed availability, thereby misrepresenting periods of pine seed abundance as periods of pine seed shortage, and periods of pine seed shortage as periods of pine seed abundance.

At the risk of stating the obvious, Yellowstone's grizzly bears do not eat whitebark pine trees, as such. Rather, they eat the seeds contained in whitebark pine cones, most of which they obtain by raiding larders made by red squirrels (e.g., Mattson & Reinhart 1997). As a result, any annual or even multi-annual representation of whitebark pine seed availability to Yellowstone's grizzly bears needs to be in terms of cone or seed production, not the number of cone-producing trees, as such, or even the aerial extent of forests containing mature whitebark pine. Yet the IGBST conflates temporal trends in abundance of mature trees with seed production in its recent analyses of the effects of whitebark pine on grizzly bear demography (e.g., Van Manen et al 2015).

This matters because during and after massive numbers of mature trees had died from an outbreak of mountain

33% of historic grizzly bear ranges contained little or no whitebark pine and, from that, further claiming that whitebark pine was unimportant to a corresponding percentage of bears. In fact, very few grizzly bear home ranges probably contained little or no whitebark pine. The exact percentage is still unknown given that I do not have access to the home range delineations used by IGBST scientists, but this percentage is almost certainly trivial. In addition to the error made by Bjornlie et al. (2014) in their temporal representations of pine seed availability (see below), this additional error makes the Bjornlie research and related Service claims based on it baseless. Furthermore, the major errors of omission in the map of whitebark pine distribution used by Costello et al. (2014) and Van Manen et al. (2015) introduce yet more error and bias into these researchers' analyses, on top of the fatal errors introduced by their treatment of annual variation in availability of whitebark pine seeds (see below).

pine beetles, median annual cone production apparently increased by as much as 2.5-fold on surviving trees. Figure 8.2.1 shows counts of cones on whitebark pine trees monitored on fixed transects by the IGBST, averaged per annum over all monitored trees. The running three-year average of annual values is shown as a yellow-green line, which is relevant because of the somatic and behavioral averaging that goes with the three-year reproductive cycle of Yellowstone's female grizzly bears. In addition, I show medians of annual averages for three time periods corresponding with breaks in long-term trends. Of relevance to my point here, the median for the period 2006-2014 is roughly 2.5-times greater than the median for either 1982-1995 or 1997-2004. In other words, at the same time that we were losing—or had lost—perhaps the majority of cone-producing trees in the ecosystem (Macfarlane et al. 2013), cone production on the remaining trees increased by over 2-fold.

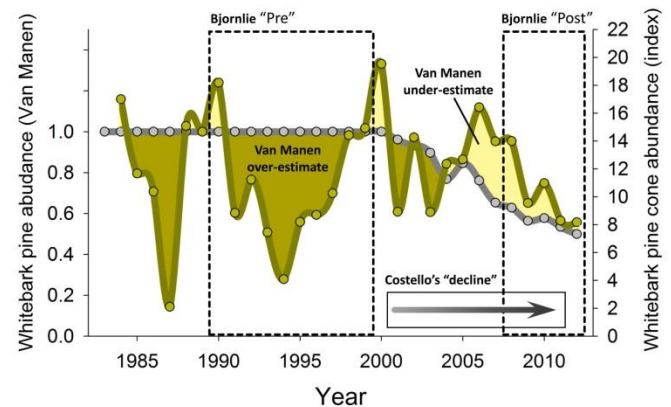


**Figure 8.2.1. Average number of cones counted on whitebark pine trees at fixed transects by the IGBST between 1982 and 2014 (gray dots) along with a 3-yr moving average of these values (yellow-green line) and medians calculated for annual values for three different time periods (dashed lines).**

As noted before, the IGBST purports to represent availability of pine seeds with remotely-sensed estimates of the aerial extent of mature whitebark pine trees. These estimates are shown in Figure 1 of Van Manen et al. (2015). One way to integrate information about the size of cone crops on surviving trees with an estimate of the numbers of such survivors is to simply multiply the index generated by Van Manen et al. (2015) by the average number of cones on live trees at fixed transects, as per Figure 8.2.1. This logically produces an index of the total landscape-level abundance of seed-containing cones available to Yellowstone's grizzly bears during any given year. This is, in fact, the relevant metric for use in any analysis of bear demography or movements given that, as I noted before, bears eat seeds not trees. The results of this metric, along with an annually averaged representation of the data in figure 1 of Van Manen et al. (2015), are shown in Figure 8.2.2: the index of cone availability as the dark yellow-green line and the index of tree abundance as the gray line.

There is one important error to note even in the way that Van Manen et al. (2015) represent the aerial extent of whitebark pine forests: they neglected to include the considerable losses that occurred during 1988 as a result of massive wildfires. The constant abundance that they show between 1983 and roughly 2000 should actually drop by around 17% (3-50%, depending on the precise area; Mattson 2000) between 1988 and 1989. In addition to blatantly ignoring cone production, this is itself a non-

trivial error even in the metric they do use—an error that I correct in generating the estimate of total seed availability.



**Figure 8.2.2. The IGBST index of mature whitebark pine is shown by the dotted gray line; the index of landscape-level cone availability, accounting for losses of trees to bark beetles and the 1988 wildfires, is shown by the dotted green line; and time periods relevant to errors in three key IGBST research publications are denoted by the first author's name and, in the case of Bjornlie et al. (2014), by dashed boxes, in the case of Costello et al. (2014), by an arrow, and, in the case of Van Manen et al. (2015), by the extent of erroneous over- and under-estimations.**

But more importantly, the index of cone availability shows a dramatically different inter-annual pattern compared to the index of tree availability. More specifically, pine seeds were least available during two early periods that the IGBST claimed were typified by the greatest abundance of whitebark pine. By contrast, the large average increase in cone crops on surviving trees largely mitigated losses to bark beetles that occurred during the early 2000s. It was only after 2006 that losses of trees to beetles began to swamp the effects of larger cone crops, resulting in the onset of a terminal decline. More to the point here, the IGBST under-represented availability of pine seeds during the early 2000s by its reliance on an index of tree abundance.

These errors are fatal and, more specifically, render the results of Bjornlie et al. (2014) and Van Manen et al. (2015) meaningless if not downright wrong. Both papers are central to the Service's arguments in the Rule and CS. The IGBST misrepresented early periods of cone shortage as periods of cone abundance and later periods of cone abundance as periods of cone shortage. They and the

Service got things pretty much entirely backward, barring the terminal decline beginning in 2006.

Figure 8.2.2 shows in more detail the implications of this problem for the three referenced papers. The analysis of home ranges by Bjornlie et al. (2014) was based on the premise that the period 1988-1989 was a period of pine seed abundance, and the period 2007-2012 a period of pine seed dearth. In reality there was greater pine seed availability during the later period compared to the earlier periods. They got it entirely backwards. Likewise, the analysis of demography by Van Manen et al. (2015) grossly over-estimated pine seed abundance during 1983-1989 and substantially underestimated pine seed abundance during 2005-2010, which turned their assumptions upside down.

Having made this point in reference to the veracity of recent IGBST analyses and the Service's arguments that derive from them, I need to at the same time make clear that losses of mature whitebark pine trees are real and on-going (e.g., Logan et al. 2014). Looking to the future, even though losses have been largely masked by increases in per tree cone production—especially during the early 2000s—such natural mitigations will eventually run the course. When that happens, consequences will almost certainly unfold that are even more dramatic than any we have so far seen. In fact, the record number of grizzly bears dying during 2015 is a likely preview of more of the same to come.

**9. The Service fails to account for—or even acknowledge—convincing evidence of major deleterious consequences arising from losses of whitebark pine in the Yellowstone ecosystem. Most prominently, these consequences include compensatory increases in consumption of meat from ungulates by Yellowstone's bears and, with that, dramatic increases in meat-related bear-human conflicts and resulting human-caused bear deaths.**

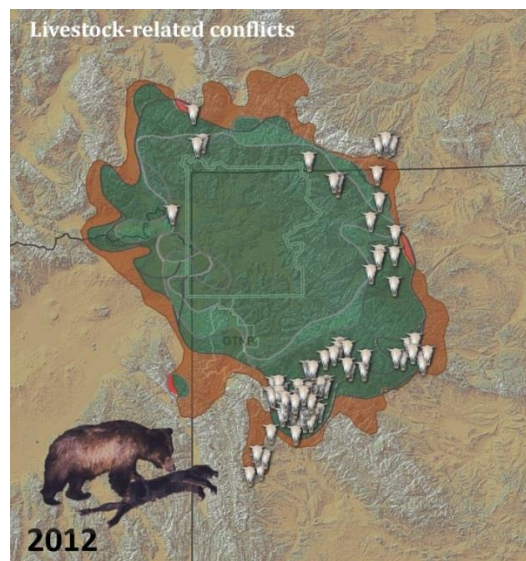
Throughout the Rule and the CS the Service freely asserts that losses of whitebark pine have had little impact on the Yellowstone grizzly bear population. These assertions are based wholly on fatally-flawed IGBST science and on the Service's own misrepresentations of the nutritional ecology of bears. I critique the Service's deficient representation of what we know about nutritional ecology elsewhere (point 7). Points 8 and 10, immediately before and following, describe fatal flaws in recent IGBST research that renders this science useless at best, but which the Service liberally invokes as a primary basis for its many correspondingly flawed arguments. In short, the Service has no basis for dismissing the potential impacts of losing whitebark pine in the Yellowstone ecosystem.

Perhaps more important, the Service does not acknowledge nor present the compelling body of evidence showing major deleterious changes in grizzly bear behavior and demography coincident with terminal losses of whitebark pine—and cutthroat trout—in the Yellowstone ecosystem. These changes include increasing consumption of meat from terrestrial sources

and, along with this, a dramatic increase in meat-related conflicts with people, leading to increases in numbers of human-caused deaths. Moreover, the decline in cub and yearling survival rates that the Service attributes to "density-dependent effects" (citing IGBST [2012] and Van Manen et al. [2015]) is more plausibly attributable to the consequences of reproductive females eating more meat in the wake of trout and whitebark pine losses. All of these changes have ultimately manifested in a dramatic rise in known and probable grizzly bear deaths that correlates perfectly with terminal losses of whitebark pine, and which amounts to a substantial increase in grizzly bear death rates at a time when the population has reached stasis and even begun to decline (see point 19.4).

Taking each of these points in turn, there is ample evidence of grizzly bears eating more terrestrial meat coincident with losses of whitebark pine and cutthroat trout. Mattson (1997) first noted that grizzlies in Yellowstone tended to eat more meat during years of poor whitebark pine seed crops—this at a time when Jacoby et al. (1999), and Mattson (2000) showed that,

compared to females, male grizzly bears ate up to twice as much terrestrial meat, and all of this prior to widespread losses of whitebark pine that began during the early 2000s.



**Figure 9.1.** This map shows the current distribution of Yellowstone's grizzly bear population in relation to livestock-related conflicts that occurred during 2012 (each represented by a cattle skull) and the distribution of moth sites (encompassed by yellow-green blobs). Grizzly bear distribution is differentiated by the area occupied by bears prior to circa 2000 in green and areas occupied since then in orange.

In the wake of losses of cutthroat trout during the late 1990s and early 2000s and whitebark pine during the mid- to late-2000s, overall consumption of terrestrial meat has trended upward (Schwartz et al. 2014, Ebinger et al. 2016), with much of that increase fueled by increased predation on elk calves (Fortin et al. 2013, Middleton et al. 2013) and scavenging of offal from elk killed by big game hunters (Orozco & Miles 2013). Even more consequentially, grizzly bear exploitation of livestock has increased dramatically, almost all of it concentrated on the periphery of the ecosystem in areas first occupied by bears after the mid-1990s and early 2000s—and much of this figuratively downslope from moth sites also first occupied during this same period (see maps of conflicts presented each year in IGBST Annual Reports; also, see the map in figure 9.1 at left which shows data for an emblematic year together with locations of moth sites). As important for the population, differences between the sexes in consumption of meat have diminished (Fortin et al. 2013, Schwartz et al. 2014)

presumably as females increasingly resort to eating meat in the wake of losing other key foods.

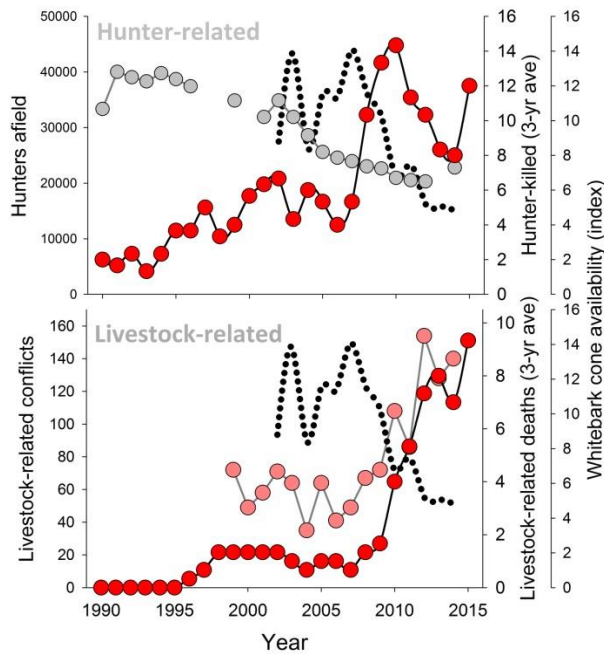
In short, grizzly bears in the Yellowstone ecosystem seem to be eating more meat from elk and livestock, with most livestock consumption concentrated on the ecosystem periphery, and with little current difference in dietary meat between males and females. And meat now potentially accounts for the majority of energy and nutrients for both sexes.

Nutritionally, this dietary shift has probably not been detrimental. Mattson et al. (2004) and the Primer on Nutritional Ecology attached to these comments clearly show that meat is a high-quality bear food, and that during fall ungulates can offer bears a substantial quantity of fat. As a result, there is no reason to expect major changes in female fecundity, which is consistent with recent data on reproduction (e.g., litter sizes as reported in IGBST Annual Reports).

The problem with meat consumption arises from the entailed hazards for any grizzly bears engaging in this activity (see my point related to a frame that jointly accounts for both hazards and nutrition). Figure 9.2 shows, at top, trends in numbers of grizzly bears dying because of conflicts with big game (primarily elk) hunters together with trends in number of hunters afield and, at bottom, trends in numbers of livestock-related human-bear conflicts and numbers of bear dying because of these conflicts. All of these data come from IGBST databases or Annual Reports. Each figure also shows terminal declines in whitebark pine cone/seed availability that I describe more fully under point 8.2.

The temporal correlation between declines in cone availability and stark increases in meat-related conflicts and deaths is quite good. Given that bears seem to be compensating for losses of whitebark pine by eating more meat, these astounding increases in meat-related grizzly bear deaths can hardly be considered a coincidence.



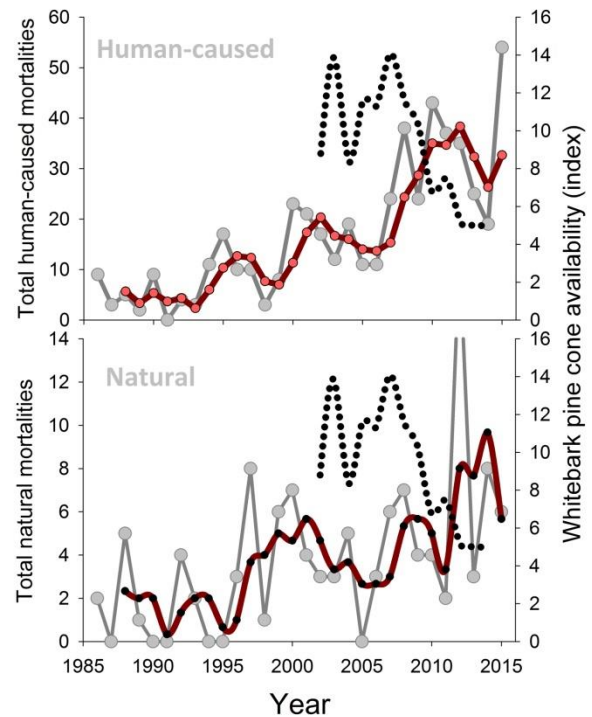


**Figure 9.2. Trends in numbers of grizzly bears killed (top) because of conflicts with big game hunters (red dots) and (bottom) conflicts over livestock (red dots as well). Gray dots in the top graph show numbers of hunters afield and pink dots in the bottom graph, total numbers of livestock-related conflicts. The black dotted lines show trends in whitebark pine cone availability since onset of losses to bark beetles.**

On top of this, rather than being ascribed to “density-dependent effects,” the increased death rates of cubs and yearling seen recently in Yellowstone are more plausibly ascribed to the increased hazards for these vulnerable young bears arising from their mothers eating more meat. (Parenthetically, see my critique of how the Service uses the concept of density-dependence under point 4). These hazards for young bears derive partly from the human-associated hazards incurred by their mothers, but also from hazards associated with increased predation by wolves and other bears (for more on this, see my point 17).

As a bottom line, dramatic increases in total known and probable grizzly bear deaths in the Yellowstone ecosystem—both natural and human-caused—are clearly correlated with terminal declines in availability of whitebark pine seeds (Figure 9.3). Much of this increase

is equally clearly driven by the consequences of dietary shifts entrained by loss of whitebark pine, as per the shift to eating more meat.



**Figure 9.3. Trends in total numbers of known-probable human-caused grizzly bear deaths, top, and probable natural deaths, bottom. The gray lines are annual counts and the red trend lines running 3-year averages. The black dotted lines show trends in whitebark pine cone availability since onset of losses to bark beetles.**

Taken together, this constitutes compelling evidence for substantial deleterious population-level effects arising from loss of whitebark pine (and cutthroat trout) in the Yellowstone ecosystem, with more foreseeable negative effects yet to come (see my critique of the Service’s treatment of trout, ungulates, whitebark pine, and moths, especially in relation to climate change). Quite simply, the Service has no credible basis for dismissing losses of whitebark pine as being inconsequential. In fact, the Service’s representation of this issue appears arbitrary and capricious. The Service needs to correct what amounts to an egregious error in its analysis supporting this Rule.

**10.** The Service fails to account for major changes in abundance of other key bear foods besides whitebark pine because of its reliance on unsubstantiated rhetorical arguments and fatally deficient IGBST research in the Rule. This IGBST research does not include any explicit consideration of an epic decade-long drought or variation in abundance of cutthroat trout, elk, bison, and army cutworm moths in its analyses of movements and demography. The Service consequently has no scientific basis for any claims regarding drivers of change in the demography and movements of Yellowstone's grizzly bears.

The Service relies heavily—almost exclusively—on recent research published by the IGBST. The Service invokes this research as its primary basis for claiming that recent losses of whitebark pine have not resulted in any changes in the demography of Yellowstone's grizzly bears. The three seminal papers cited repeatedly on pages of the Rule are Bjornlie et al. (2014), Costello et al. (2014), and Van Manen et al. (2015), the first dealing with changes in home ranges, the second, changes in movements and habitat selection relative to whitebark pine and secure habitats, and, the third, changes primarily in death rates. The first and last conclude that losses of whitebark pine to bark beetles, 2001-2012, had no effect, and that all changes could be attributed to changes in bear densities. Notably, these papers claim to have looked at both spatial and temporal variation—but limited only to considerations of density and extent of whitebark pine forests.

Elsewhere I address fatal errors in how the IGBST—and Service—addressed availability of whitebark pine seeds to grizzly bears both in space and time (point 8). I also cover problems with both the IGBST's density argument and density index under a different comment (point 4). Here I point out another fatal flaw in the IGBST's and Service's analysis that is rooted in lack of attention to a number of major changes in Yellowstone's grizzly bear habitat—in addition to changes in whitebark pine abundance. All of these ignored dynamics are of *prima facie* importance given that they pertain to availability of patently important grizzly bear foods, including elk, bison, cutthroat trout, army cutworm moths, and foods affected by levels of drought (also see my point 11.1).

Before delving into particulars of the neglected factors, it is worth reiterating my first comment (1.1): most of the science produced by the IGBST and invoked by the Service entails complex models and complex assumption-ridden statistical methods. Such is the case for all of the results germane to judging the demographic plight of

Yellowstone's grizzly bears. Yet it is well known to even half-way thoughtful scientists that there is no one correct model, and that model-building is perhaps the most vagarious and bias prone of scientific undertakings. Moreover, any credible inference based on complex models of open ecological systems depends almost entirely on insuring that all factors likely to have had a significant effect on outcomes of interest (i.e., changes in demography) were accounted for. Isolating the effect of any single factor such as bear density or whitebark pine abundance depends upon controlling for the effects of every other factor of plausible importance.

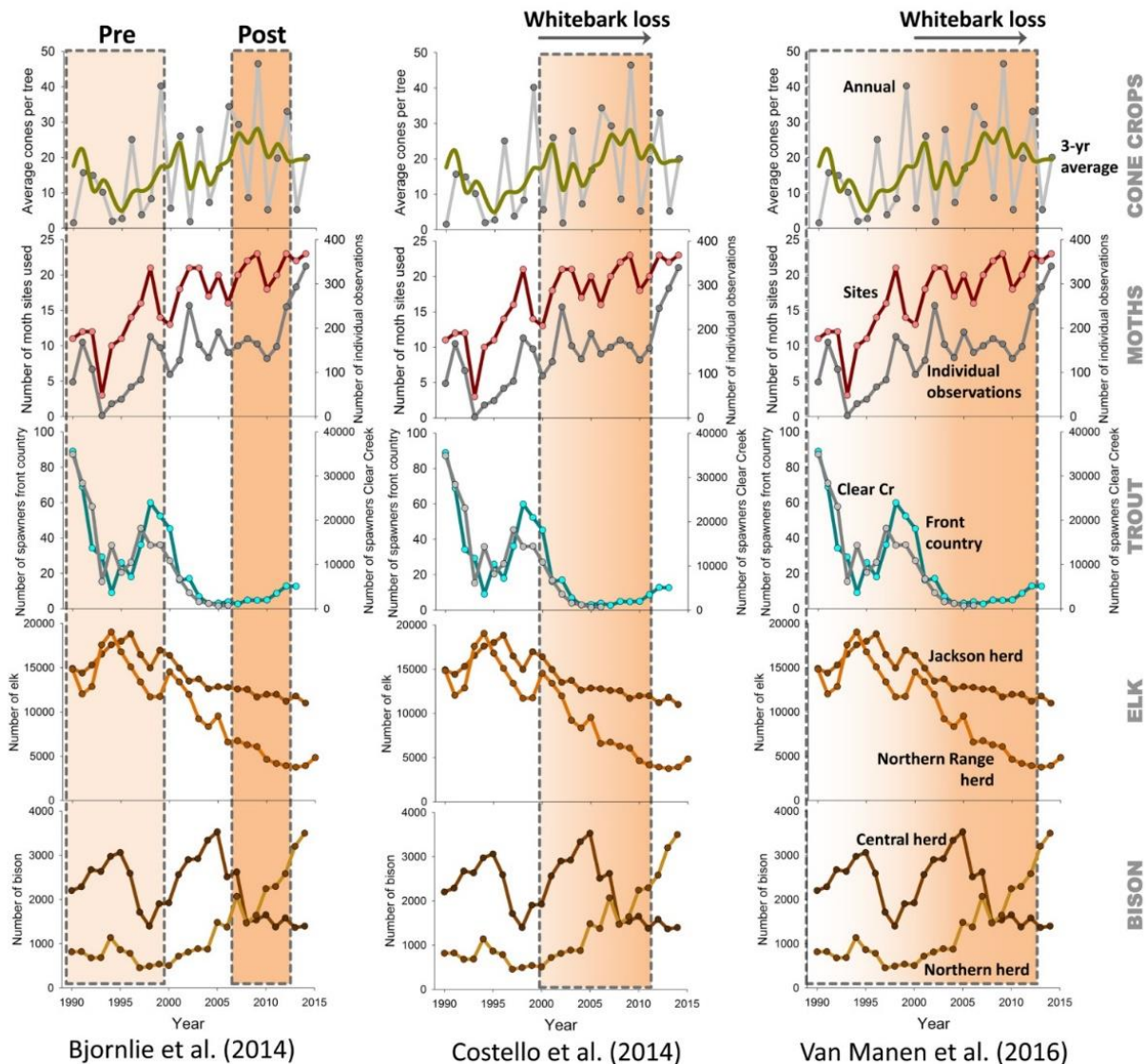
In other words, by failing to account for a number of plausibly important changes in Yellowstone's grizzly bear habitat, the IGBST—and Service—have no basis for making any claims about effects of density or whitebark pine on grizzly bear birth and death rates, and this aside from the fatal flaws in how they putatively addressed the factors they did consider.

Figures 10.1 and 10.2, below, provides some specifics. I show trends in known important foods over time, encompassing the span of relevance to the various analysis undertaken by the IGBST. These foods, top to bottom, include size of whitebark pine cone crops (not extent of whitebark pine forests), bear use of army cutworm moth sites, numbers of spawning cutthroat trout, numbers of elk in the ecosystem's two largest herds, and, finally, at bottom, numbers of bison in Yellowstone's two herds.

These figures also show how time period was treated in the three seminal IGBST papers, denoted by the vertical bars shaded different colors of orange. Bjornlie et al. (2014) assumed two time periods, one before (pre) and one after (post) major losses of whitebark pine to beetles, assuming that the only changes in the Yellowstone environment between these two periods were extent of whitebark pine forests and bear density.

The vertical shading in the graph farther right shows how Van Manen et al. (2015) approximated the presumed decrease in whitebark pine forests with ever-darker hues of orange—and again, without considering any other

environmental trends. Finally, the center graph shows the time period addressed by Costello et al. (2014) as a shaded vertical box, and, again, this researcher assumed that the only change afoot pertained to whitebark pine.



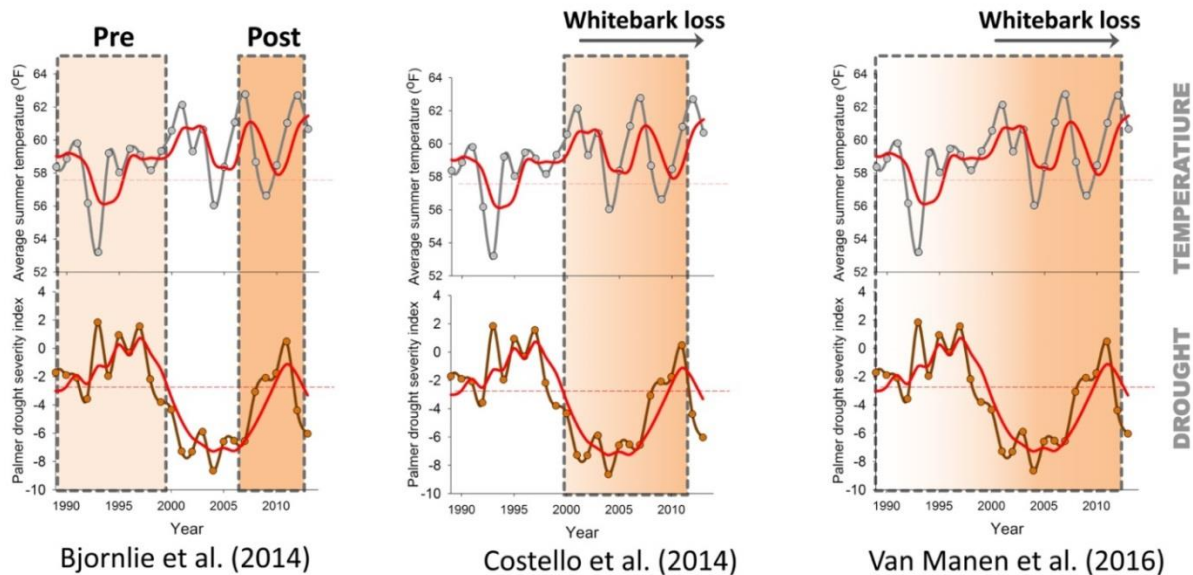
**Figure 10.1.** Trends in indicators of abundance for key Yellowstone grizzly bear foods are shown by rows, from top to bottom, intersected with rows denoting how three different analyses reported by the IGBST treated time periods, show as vertical boxes shaded various hues of orange. Progressively darker hues of orange denote less versus more whitebark pine, at least as treated in the IGBST analyses.

The takeaway from figure 10.1 is pretty straight-forward. The IGBST failed to account for major unfolding trends in food abundance. Bjornlie et al. (2014) failed to account for the fact that elk and cutthroat trout had declined and moth site use and whitebark pine cone crop sizes had increased between the 'pre' and 'post' periods. Likewise, Van Manen et al. (2015) neglected to account for these

very same trends as continuous temporal (and spatial) phenomena. Costello et al. (2014) failed to account for trends towards increasing sizes of whitebark pine seed crops, increasing levels of moth site use, and decreasing numbers of elk. All of these failures fatally compromise these analyses.

Figure 10.2, below, makes the added point that these three IGBST papers not only failed to account for trends in abundance of important foods, but also neglected to account for some longer-term trends in weather, with near certain effects, in turn, on other vegetal and animal foods. More specifically, Bjornlie et al. (2014) failed to account for a higher average summer temperatures

during their 'post' period; Van Manen et al. (2015) for an epic drought and for a trend towards progressively higher summer temperatures; and Costello et al. (2014) for the gradual recovery from deep drought. All of these patterns plausibly affected grizzly bear movements and diet.



**Figure 10.2.** The basic configuraiton here is the same as in figure x.1, but featuring trends in summer temperature (top row) and drought severity (bottom). The red lines are 3-year moving averages and the gray dots, annual values. Drought is indexed by the Palmer Drought Severity Index. All data are publicly available from NOAA.

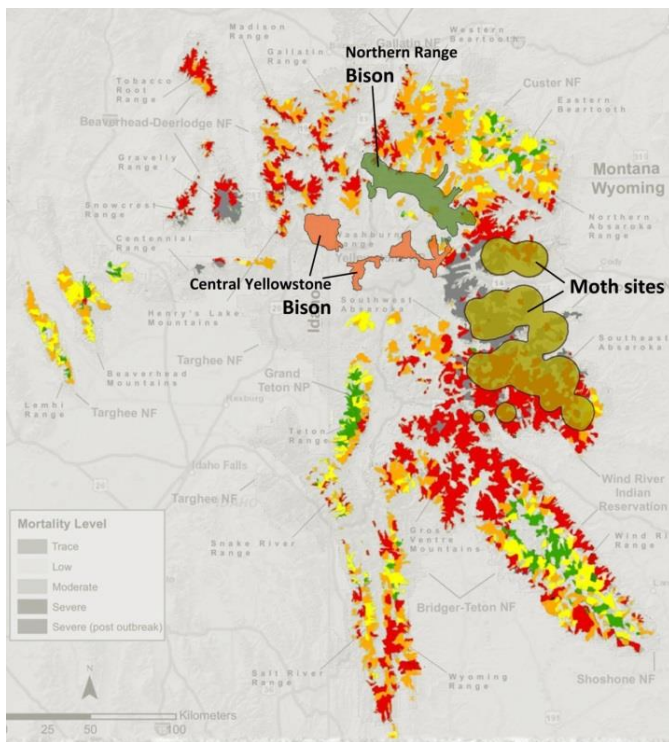
Finally, in addition to fatal neglect of temporal trends, the IGBST's science—and Service's derivative claims—fail to account for potential interactions between spatial distributions of and temporal trends in key food resources. This specific critique is relevant both because the IGBST pretends to deal with spatial aspects of food availability (albeit limited to whitebark pine) and because interactions among environmental factors in space and time are a very real consideration in any analysis of complex ecological systems. And, in fact, there are many potential interactions that were altogether neglected in analyses by the IGBST and Service.

Figure 10.3 illustrates a subset of potential interactions (the legend for this figure explains the various map features). For one, moth sites (the grayish-green blobs) correspond almost exactly with where we have seen the greatest losses of whitebark pine (in gray). In other words, availability of moths has very likely partially compensated for the severe losses of whitebark pine that

occurred in this area. For another, as per trends for Yellowstone's two bison herds shown in figure 10.3, bison have declined in precisely the same areas (the Central herd) where near extirpation of cutthroat trout also occurred, resulting in an amplification of the effects of trout losses. By contrast, the Northern Range bison herd (in green) has increased, with some likely compensation for losses of whitebark pine and declines in elk numbers in the northern part of the ecosystem.

As a bottom line: by failing to account for both the temporal and spatial aspects of major changes in the environment of Yellowstone's grizzly bears the Service fatally compromises its assessment of past and prospective future changes in demography and behavior of Yellowstone's grizzly bears. A prudent course of action would be for the Service to withdraw this draft Rule and remedy the profound deficiencies in its analysis and the science it has so far relied upon.





**Figure 10.3. Distributions of whitebark pine forests, moth sites, and core bison ranges in the Yellowstone ecosystem. Whitebark pine forests are shown in various colors corresponding to the magnitude of mortality from bark beetles as of 2009; gray indicates near total mortality, red, high levels, green, healthy forests, and yellow and orange somewhere in between (Macfarlane et al. 2013). All known moth sites are encompassed by buffers denoted by yellowish-green shading. The Northern Range bison herd range is shown in green and the Central bison herd in off-orange.**

**10.** The Service’s assumption that maintenance of a simplistic version of the 1998 human footprint will insure sustainable future human impacts is flawed for a number of reasons, including failure to account for changes in bear behavior in response to habitat conditions, changes in human lethality, and changes in edge effects attributable to development on lands adjacent to the PCA.

In multiple places the Service asserts that maintenance of certain GIS-delineated human features within the PCA will insure conservation of the Yellowstone grizzly bears into the indefinite future by maintaining demographic characteristics that ostensibly prevailed during a period of sustained population growth. The spatial attributes that presumably govern grizzly bear demography include road densities, the extent of areas >500m away from human infrastructure (so-called “secure” habitat), and numbers of livestock allotments.

This all-critical assumption that a static few GIS-delineated landscape features will insure anything into the indefinite future fails for numerous reasons, including (1) over-stated population growth during the invoked benchmark period of 1988-1998; (2) failure to account for a critical sources of human-caused mortality that can vary independently of the chosen few landscape

features; (3) failure to account for changes in bear behavior driven by changes in diet and food availability that will affect how often bears encounter the mapped lethal human features—independent of any change in these features; (4) changes in the lethality and behavior of people both in relation to and independent of mapped and monitored features; (5) changes in numbers of people on, off, and nearby to the mapped features, with resulting effects on encounter rates between bears and people; and (6) related edge effects associated with human population growth and residential and recreational developments on private lands near and inside the PCA. Taking each one of these in turn:

1. As I describe in my critique of the currently-adopted Chao2 method for monitoring trend of Yellowstone’s grizzly bear population (point 19.1), this method has almost certainly overstated growth, including for the

period 1988-1998. Which means that, although some growth was very likely happening, it was of a lesser magnitude than being asserted—and relied upon—by the Service in the Rule. As a practical matter, this translates into less of a buffer on this basis alone than the Service would have us believe (but see all my following points).

Perhaps more importantly, the 1998 footprint has, in fact, been associated with a range of demographic conditions, including (according to the Service) a decline in population growth rate to the point where the population has not changed in size for roughly 15 years. In fact, as I argue elsewhere (point 5.3), the population has likely declined during the last decade and has perhaps passed a tipping point. The entire premise of the Service's argument is rendered implausible by the fact that a wide range of human-caused grizzly bear mortality rates has been encompassed by a set of landscape conditions presumably designed to guard against such amplitude (see 19.4).

2. Currently, the primary human-related causes of grizzly bear mortality in the Yellowstone ecosystem are: availability of attractants at residences and recreational developments; conflicts over livestock; and conflicts with big game hunters. Additional minor causes include collisions with vehicles and removals because of more direct human-safety concerns. *As a spatial phenomenon*, most of these causes are covered by the Service's monitored features, but with the important exception of big game hunters. Hunters are particularly lethal to grizzly bears and, more importantly, often distributed in a way that is poorly correlated with roads, "secure" habitat, and livestock allotments. The upshot is that the monitoring spatial features provide a poor basis for monitoring what's happening with numbers and distributions of a certain class of human that is a major cause of grizzly bear mortality.

3. As I describe at length elsewhere in this critique (and as the Service also avers), the diet of Yellowstone's grizzly bears has changed substantially, with prospects of even more change to come. These changes organize around loss of cutthroat trout and whitebark pine seeds in some of the most secure habitats in the ecosystem, along with prospective losses of army cutworm moths, also in remote secure areas. There is little doubt that,

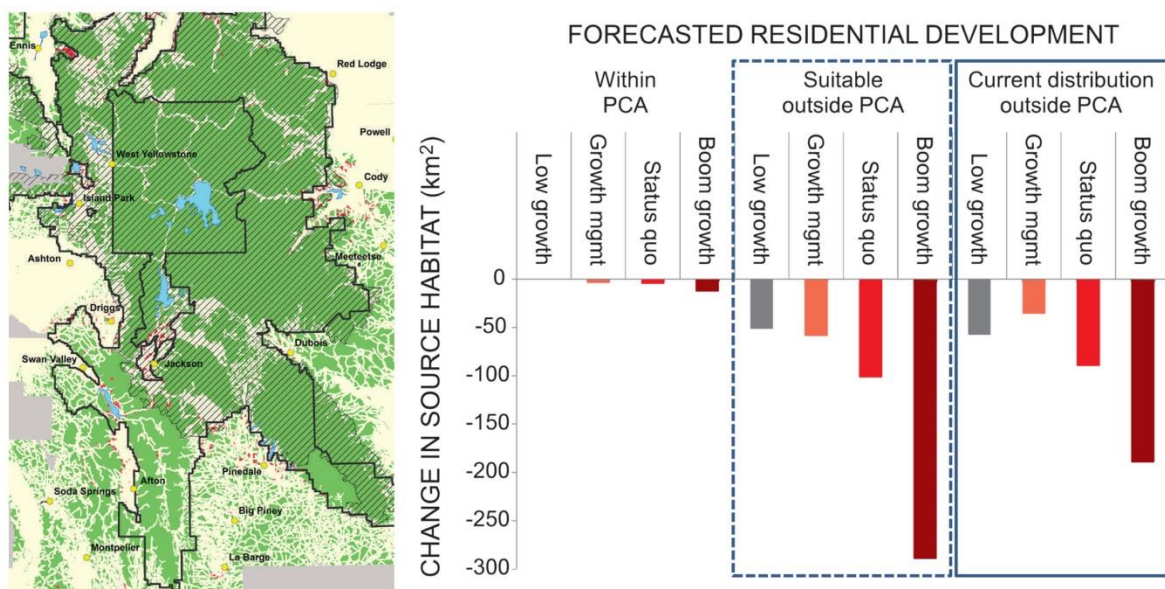
among other things, grizzly bears are turning to eating more meat, including livestock and scavenged offal left by hunters. As a consequence, grizzly bears are spending more time in highly lethal environments typified by grazing allotments and areas used by big game hunters (e.g., my points below; Haroldson et al. 2004). Use of alternate foods also seems to draw bears more often into less secure habitat nearer roads and other human facilities (Haroldson & Gunther 2013, Costello et al. 2014), as has been the case since the 1980s (Mattson et al. 1992). Even farther back in time, closure of garbage dumps in and around Yellowstone National Park during 1959-1962 had profound impacts on how grizzly bears distributed themselves relative to a comparatively static human infrastructure, but with catastrophic consequences for the bear population (Craighead et al. 1994). The main point here is that grizzly bears can end up being exposed much more often to lethal human-associated features as a result of habitat and diet changes and without any spatial change in the extent of human facilities or livestock grazing allotments—as per the 1998 human footprint.

4. Augmenting issue 3, a given number of people can change how they orient to mapped and monitored spatial features and, perhaps more important, can become more or less per capita lethal to bears. This point is historically emphasized by the fact that grizzly bears would have probably come closer to near-total extirpation in the Yellowstone ecosystem during the early to mid-1900s but for the fact that aggregate human lethality changed, and in spite of increasing human numbers (Mattson & Merrill 2002). More recently, as the Rule describes, human lethality has been reduced by instituting measures that reduce availability of human-associated foods around human facilities, thus reducing human lethality—all without any explicit correlation with roads and grazing allotments. We can only hope that humans continue to become ever less lethal, ever more assiduous in managing attractants, and continue to concentrate as much on roads, but simply monitoring roads and livestock grazing allotments will not provide any information on this critical dimension of the human footprint.

5. As the IGBST recognizes through its monitoring of big game hunters afield on national forest lands, and human recreational activity in Yellowstone and Grand Teton

National Parks, numbers of people matter to grizzly bear conservation, even given a fixed human infrastructure. It is thus probably relevant that numbers of visitors to Yellowstone Park increased by roughly 400,000 between the 1990s and 2010s, although remaining nearer the same in Grand Teton (IGBST 2015). But of perhaps even greater relevance is that visitation to these parks has trended ever upward from 2005 to the present (2,868,317 to 4,097,710 in Yellowstone; 2,463,442 to 3,149,921 in Grand Teton), meaning ever more people on roads and at recreational facilities, which no doubt creates mounting challenges for managers attempting to control attractants and risky human behaviors—but with no change in the physical infrastructure. Here, again, numbers alone matter. More directly, the management challenges that sheer numbers pose matter, with prospects of affecting grizzly bears that are exposed to areas near the human infrastructure.

6. It perhaps goes without saying (and as the Rule describes), population growth and associated development on private lands in the Yellowstone ecosystem continues at a rapid but, more recently, accelerating pace, with development disproportionately concentrated near protected areas and in productive riparian habitats (e.g., Gude et al. 2006). Strangely, the Service fails to feature research by Schwartz et al (2012) that explicitly estimates the impacts of projected exurban development on Yellowstone’s grizzly bears, differentiating impacts by whether they will occur in the PCA or outside in occupied grizzly bear habitat. “Boom” or even status quo growth could bring major loss of source habitats, contributing to even more habitat fragmentation than exists now (see my comments under point 14). These results are summarized in figure 10.1 immediately below.



**Figure 10.1. Figures extracted from Schwartz et al. (2012) pertaining to projected effects of exurban development on Yellowstone’s grizzly bear habitat. The beige in the map at left corresponds to projected human-impaired habitat. The bar graph to the right shows loss of source grizzly bear habitat in and out of the PCA under four different scenarios for growth of the human footprint.**

The Service liberally employs the notion of ‘edge effects’ as a basis for excluding habitat near sheep allotments in the Wind River Range from its classification as “suitable” habitat. The Service’s usage in that circumstance is problematic. However, edge effects are a very real consideration in relation to on-going and foreseeable exurban development adjacent to the PCA, with the possibility of transboundary effects plausibly attributable to the boundary-spanning movements of both bears and

people. The map at left in figure 10.1 shows this potential in graphic form, with projections of lethal habitat shown in beige. The point of this being that effects of mounting human activity on private lands in and near the PCA will engender largely negative effects that will not be accounted for in the 1998 benchmark pegged to federally-managed lands. The Service engages in what largely amounts to a bunch of hand-waving on pages 13199-13200 of the Rule about how extra-

jurisdictional activities on the part of state and federal managers will somehow mitigate for this. Such claims are unsubstantiated. Moreover, there is precedent for federal managers undertaking mitigation on public lands for harm arising from activities on nearby private holdings (e.g., the 1997 Swan Valley Grizzly Bear Conservation Agreement). In other words, the Rule's current arm-waving is not good enough in light of prospective trends in private land development in the Yellowstone ecosystem.

---

Parenthetically, the Service will probably assert in response to my critique of their 1998 benchmark that, even if valid, there are other safeguards in place in the form of methods for monitoring and managing mortality. As I hope is clear from the remainder of my critique, there are, in fact, critical failings and short-comings affecting all of these safeguards that debar them from providing a reliable backstop.

**11.** The Service fails to meaningfully account for past changes in major Yellowstone grizzly bears foods; this on top of the problems with its analysis regarding whitebark pine. Among key foods that the Service essentially dismisses out of hand are elk, bison, cutthroat trout, army cutworm moths and all of the vegetal foods that are affected by growing season drought. In short, not only does the Service fail to provide any useful basis for assessing past and prospective future changes in natural foods, but, even more problematic, fails to acknowledge and address clear scientific evidence that the Yellowstone grizzly bear population is in trouble and threatened by further deterioration of habitat conditions.

**11.1.** The Service fails to use or even acknowledge scientific evidence showing that there is *prima facie* reason to expect that availability of ungulates, army cutworm moths, cutthroat trout, and drought have affected grizzly bear death rates, with prospects of leading to elevated death rates over the next decade to century.

On page 13212 of the Rule the Service references a single research paper of only peripheral relevance (Schwartz et al. 2010) as a basis for asserting that “...only whitebark pine seeds are known to have an influence on grizzly bear mortality risk and reproduction. There is no known relationship between grizzly bear mortality risk or reproduction and any other individual food.” The Service then uses this assertion to dismiss out-of-hand any serious consideration of demographic consequences arising from past and likely future trends in any food source other than whitebark pine. In rushing through these bemusing leaps of logic the Service altogether ignores a trove of scientific information relevant to judging whether other foods might—or even do—have an effect on birth and death rates of Yellowstone’s grizzly bears. When taken seriously, this body of science paints a fundamentally different picture—which is the picture I paint here in my following points as well as throughout the rest of my comments.

It is first worth noting that the Service fails to explain how “...some of the highest calorie food sources available to grizzly bears in the GYE”—and of enough importance to be monitored by the IGBST (page 13212)—can be dismissed essentially out of hand. Or, related, why the ample trend data from foods important enough to be monitored year-after-year by multiple state and federal agencies is not worth the Service’s consideration (as with army cutworm moths, cutthroat trout, and ungulate carrion). Even without pursuing this issue any further, these twists of logic suggest an up-front disinterest by the Service in seriously engaging with the effects of foods

such as elk, bison, army cutworm moths, and cutthroat trout—or all of the other foods that might be affected by drought.

Moreover, it takes convoluted logic to conclude that “there is no known relationship” simply because the Service chooses to rely solely on fatally flawed science that failed to consider the possibility of such relationships in the first place (see my points 2.2 & 10 above). Failure on the part of a few scientists to exercise adequate scientific rigor does not constitute a thorough and sufficient examination of the science relevant to judging why birth and death rates of Yellowstone’s grizzly bears might have changed in the past, and how these rates might be affected in the future.

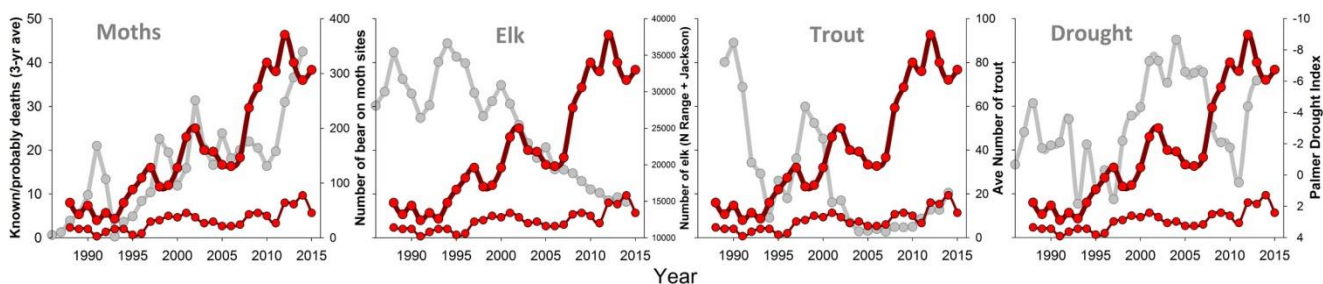
Beyond these logical problems, one important point to reiterate (see my point 7) is one that the Service itself makes in several places, including on page 13212. There are, in fact, only a handful of foods from which Yellowstone’s grizzly bears historically obtained perhaps as much as 80% of their energy and nutrients: meat from elk and bison; meat from cutthroat trout; seeds from whitebark pine; and army cutworm moths. As the Service notes in its (far from adequate) review of nutritional ecology, other foods the bears ate aplenty, but none came even close to providing the same amount of energy, protein, or fat as the four dominant foods. On this basis alone there is ample reason to expect that all of the four key foods—not just whitebark pine seeds--affected birth and death rates of Yellowstone’s grizzly bears in some measure. Certainly, on the basis of energetics and nutritional considerations alone, such a conclusion is more defensible than any other, including the conclusion hastily reached by the Service.

And, as I point out in numerous other places, it is fundamentally problematic that ALL but one of the analyses relating food abundance to grizzly bear



demography in the Yellowstone ecosystem failed to even consider the effects of moths, trout, elk, or bison—or any other food for that matter (Mattson et al. 1992, Pease & Mattson 1999, Schwartz et al. 2006, Van Manen et al. 2015). The only food effect that was entertained by these researchers was that of whitebark pine seeds. It is no wonder that if you don't look for or otherwise even consider additional effects, you probably won't document any. And, importantly, such a failure of scientific rationality does not equate to the absence of such effects—such as potentially those of trout or moths or elk or bison on grizzly bear birth and death rates. In fact, the single more replete analysis (Mattson 2000), detected effects of meat-eating on cub survival and root consumption on litter size.

More positively, though, there is evidence that death rates of Yellowstone's grizzly bears have varied in reflection of moth, elk, and trout abundance—also perhaps as a function of drought—especially between 1990 and 2005. Elsewhere I present definitive evidence that an increase in consumption of meat by Yellowstone's grizzlies as compensation for losses of whitebark pine seeds led to the sharp increases in natural and human-caused mortality since 2006 (see my points 9, 17, & 18). But here I focus on 1990–2005 using publicly available data from the IGBST, the National Park Service, the states of Wyoming and Montana, and NOAA, realizing that a rigorous analysis of all data currently sequestered by the Service would also entail spatial and temporal interactions.



**Figure 11.1.1.** These four panels superimpose trends in total known-probable grizzly bear mortality on trends in abundance of four foods plus drought for the period 1986–2015. Mortality is shown in red as a 3-year running average, with natural mortality (lower red line) differentiated from total mortality (top red line). The gray lines show trends, left to right, in number of bears seen on moth sites; numbers of elk in the Northern Range and Greater Jackson herds; average per stream numbers of trout counted in spawning streams around Yellowstone Lake; and an inverted representation of the Palmer Drought Index for the highest-elevation drainages of the Yellowstone ecosystem (i.e., peaks in the trend line indicate greater drought severity).

Figure 11.1.1 shows trends in total known and probable grizzly bear deaths in red as a 3-year running average superimposed on trends in foods, or food proxies, all of which are currently neglected by the Service.

Put simply, trends in human-caused and total grizzly bear deaths can be largely explained in terms of trends in availability of key foods. For example, a simple regression model containing trends in elk populations and availability of whitebark pine seeds (see my point 8.2) explains 74% of total and 76% of human-caused mortality (with P-values <0.0001)—with both food effects negative, as one would expect. A similar model including elk, trout (also negative), and drought (positive) explains 70% of human-caused mortality (also with P<0.0001). Another model yet, in which I used latent variables to deal with the high degree of temporal

correlation among covariates (i.e., principal components), explains 70% of total deaths and 72% of human-caused mortality, with elk, trout, and whitebark pine all having negative effects, and moths and drought, positive effects.

Parenthetically, I suspect that the anomalous *positive* relationship between grizzly bear death rates and use of moth sites is related to geography. As shown in Figure 11.1.2., all of the moth sites are on the east side and towards the periphery of the ecosystem, in areas where we have seen expansion of the grizzly bear population, and a burgeoning of livestock-related conflicts and resulting grizzly bears deaths (see my point 9). Emblematic of this, the cow skulls in figure 11.1.2 each represent a grizzly bear-livestock conflict for one representative year, of which a disproportionate number

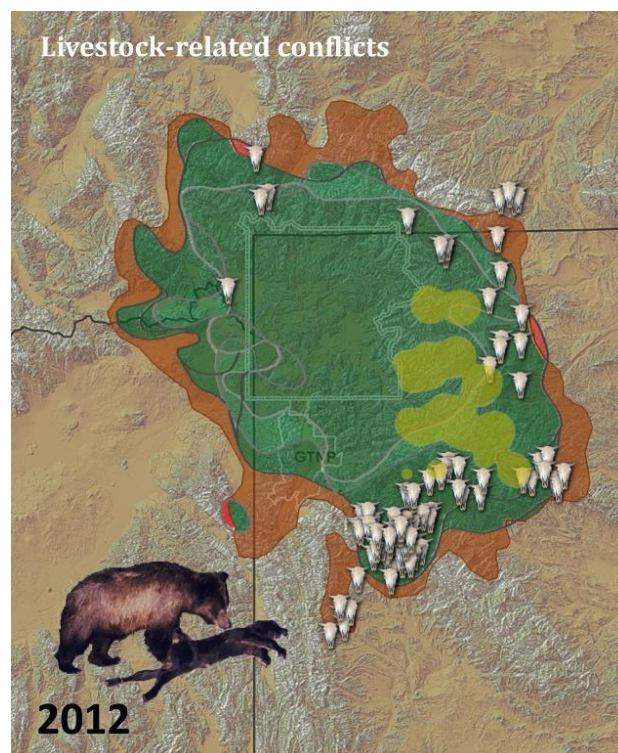
are figuratively just downslope from a moth site. The point of this being that moth sites are spatially correlated with an emerging major cause of grizzly bear deaths, and thus probably positively correlated with temporal trends in deaths largely as an artifact of this geography.

As a bottom line, there is strong evidence that all of the key grizzly bear foods have had a strong if not dominant effect on death rates, enough so that essentially all of the trends in total and human-caused grizzly bear deaths since roughly 1990 can be explained by availability of elk, cutthroat trout, whitebark pine seeds, army cutworm moths, and drought (as a proxy for other vegetal foods). On the basis of straight-forward nutritional considerations, there is also good cause to expect that these same foods have had, and will continue to have, strong effects on grizzly bear birth rates.

Quite simply, there is no excuse other than perhaps prejudice, laziness, and limited imagination for the Service's failure to consider the effects of all nutritionally important foods on birth and death rates of Yellowstone's grizzly bears. The Service needs to remedy its currently deficient analysis and seriously address past effects and future prospects for army cutworm moths, cutthroat trout, elk, and bison—as I outline in more detail in my following points.

**11.2.** The Service fails to meaningfully account for declines in elk populations and foreseeable threats to this source of bear food in its assessment of current and prospective threats to Yellowstone's grizzly bear population. This failure further compromises the Service's attempt to disentangle drivers of recent and prospective near-future changes in demography of the bear population.

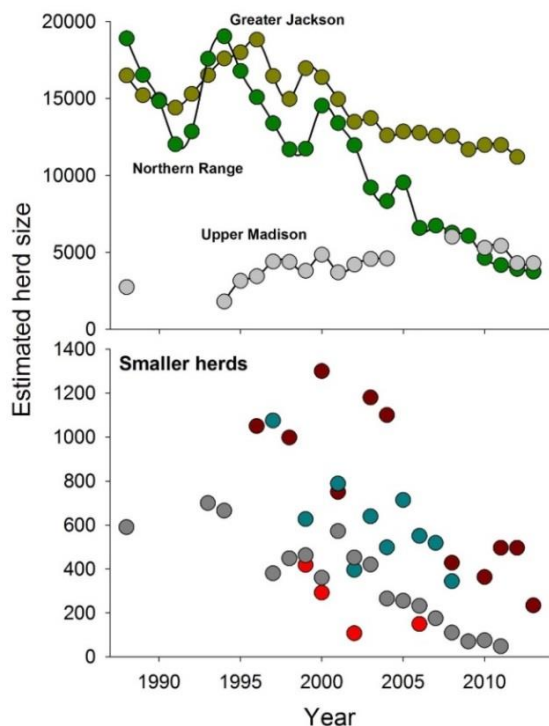
Meat from terrestrial sources has contributed between 25% and >60% of the energy and nutrients obtained by Yellowstone's grizzly bears from their environment, the range depending on the sex and age cohort and time period (Mattson 1997, Jacoby et al. 1999, Fortin et al. 2013, Schwartz et al. 2014). During the 1970s-early 1990s, elk were the source of the majority (c. 53%) of this meat (Mattson 1997). Moreover, terrestrial meat has been invoked as an important compensatory substitute



**Figure 11.1.2.** All of known sites where grizzly bears feed on moths in the Yellowstone ecosystem are shown here encompassed by the yellowish-green blobs. The cattle skulls each represent a location of a grizzly bear-livestock conflict during the emblematic year of 2012. The greenish shaded area represents the distribution of grizzly bears as of circa 2000 and, the orange, areas newly colonized by grizzlies during the last decade or so.

for losses of cutthroat trout and whitebark pine seeds (Fortin et al. 2013, Middleton et al. 2013, Ebinger et al. 2016; the Rule). For all of these reasons—in addition to the *prima facie* evidence I present under 11.1.1 above for strong effects of elk availability on death rates—past and prospective future trends in elk populations necessarily factor into any assessment of current and future prospects for Yellowstone's grizzly bear population. Negative trends would axiomatically constitute a threat.

Despite this, the Service fails to address the past, present, and future prospects for Yellowstone's elk populations in any meaningful way. Its analysis amounts to nothing more than a patently superficial and rushed treatment on page 13212 of the Rule. Moreover, this failing is non-trivial given unfolding trends and foreseeable threats.



**Figure 11.2.1. Trends in size of elk populations in Yellowstone's occupied grizzly bear habitat. Trends for larger herds are shown at top and for smaller herds at bottom. Because estimates are made only irregularly for the smaller herds, annual estimates are shown at dots with each color corresponding to a different herd.**

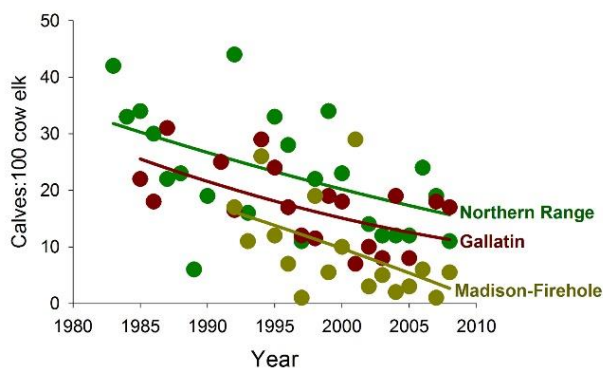
Figure 11.2.1 shows trends in size of all of the elk populations in Yellowstone's occupied grizzly bear habitat (parenthetically, all of these data are publicly available from the National Park Service and the states of Wyoming, Montana, and Idaho). The point is obvious: all of the herds but one (the Upper Madison) have declined, some dramatically—even catastrophically—resulting in probable substantial increases in human-caused grizzly bear mortality (see my point 11.1. above). These herd declines closely track declines in cow:calf ratios, shown in figure 11.2.2. This latter correlation substantiates results presented by Middleton et al. (2013) strongly suggesting that declines in elk numbers are being driven partly by deteriorating summer-range conditions and related diminishment of fat reserves among female elk. Declines have also been linked to a near-tripling of mortality rates among elk calves due largely to increasing levels of bear predation (Middleton et al. 2013). Regardless of the cause, the numeric declines are dramatic and unambiguous, at the same that Yellowstone's grizzly bears have apparently become increasingly dependent

on meat from terrestrial sources, while dying in increasing numbers (see my points 17 & 18 below).

Moreover, declining elk populations have almost certainly driven a decline in availability of spring carrion (figure 11.2.3), which historically has been a disproportionately important food for Yellowstone's female grizzly bears (Mattson 1997, 2000). The Service fails altogether to even recognize its own trend data regarding this phenomenon, and instead merely speculates that a reduction in spring carrion could happen, citing two papers that don't directly address these well-documented trends in carrion availability. All of this in service of rush to its ill-substantiated conclusion that "fluctuations" (euphemistically) in ungulate populations are not a threat to GYE grizzly bears.

Looking to the future, prospects are not good for Yellowstone's elk populations. If declines have indeed been driven partly by lower-quality summer forage and increased bear predation, the future can only hold worse to come. Bears are a classic case of subsidized predators when it comes to predation on ungulates calves, best documented in the case of moose and elk (e.g., Gasaway et al. 1992, Ballenberghe & Ballard 1994, Testa 2004, Zager & Beecham 2006). Which means that bear predation can persist at unsustainably high levels even as elk populations continue to decline. Climate change also promises to bring ever worse summer drought (Chang & Hansen 2015)—with predictably negative effects on the quality of elk summer forage. Moreover, despite being dismissed out of hand by the Service on page 13212, Chronic Wasting Disease looms as a potentially major catastrophe for elk and elk scavengers in Yellowstone's ecosystem (e.g., Jennelle et al. 2009; Wyoming Game & Fish Department 2015, 2016). Future prospects for Yellowstone's elk populations are not bright.





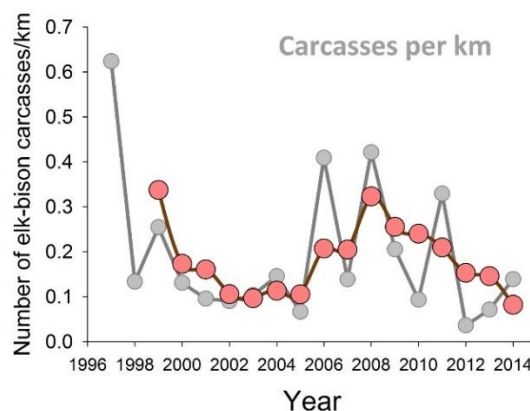
**Figure 11.2.2. Cow:calf ratios for three of Yellowstone's elk herds, with each herd denoted by a different color.**

That being said, my brief assessment here of status and trends for Yellowstone's elk populations is merely a preview of what is incumbent on the Service in support of this proposed Rule. The Service needs to critically assess past effects of and future prospects for this important grizzly bear food rather than breeze through a

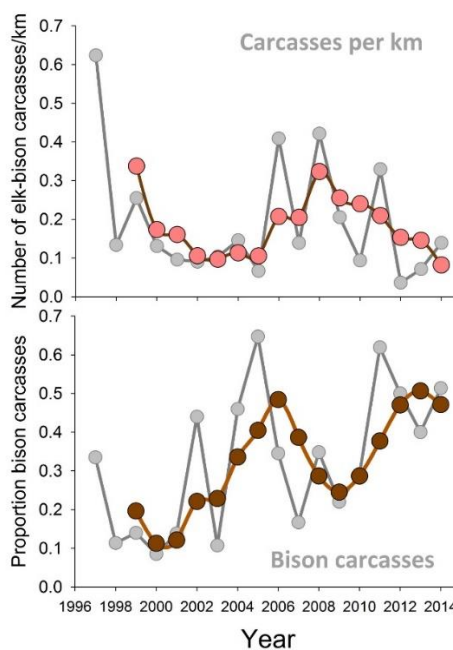
**11.3.** The Service fails to meaningfully account for changes in bison populations and foreseeable threats to this source of bear food in its assessment of current and prospective threats to Yellowstone's grizzly bear population. This failure further compromises the Service's attempts to disentangle drivers of recent and prospective near-future changes in demography of the bear population.

Mattson (1997) and Green et al. (1997) documented the disproportional importance of bison as a source of meat for Yellowstone's grizzly bears primarily owing to the large mass of and related abundance of meat on bison carcasses. Mattson (1997) estimated that bears obtained nearly a quarter of all ungulate meat from bison. Given the increasing importance of terrestrial meat in the Yellowstone grizzly bear diet (Schwartz et al. 2014, Ebinger et al. 2016), bison have very likely become more rather than less important to this bear population. In fact, even as total number of carcasses from winter-killed elk and bison has decreased on Yellowstone's ungulate winter ranges, bison have comprised an ever-larger percentage of the total (Figure 11.3.1).

superficial analysis apparently on its way to a foregone conclusion.

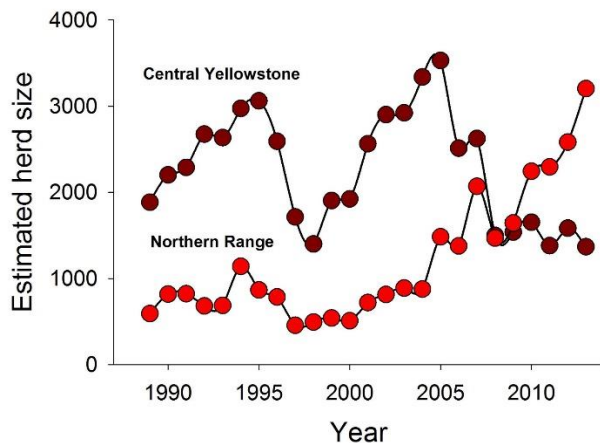


**Figure 11.2.3. Ungulates carcasses counted per km of transects surveyed during spring on Yellowstone ungulate winter ranges. Gray dots are annual values and pink dots represent a 3-year running average..**



**Figure 11.3.1. Results from annual spring surveys of carcasses on Yellowstone National Park winter ranges. The top graph shows number of carcasses detected per km of survey, with annual values in gray and a 3-year running average in pink. The bottom graph shows the proportion of all elk and bison carcasses that were of bison.**

As with elk, because bison are such an important bear food, the Service needs to critically assess past, present, and future likely trends for bison as part of its risk assessment for Yellowstone's grizzly bear population. Yet the Service fails to present such an analysis anywhere in the Rule other than its superficial treatment on page 13212, primarily in reference to management of brucellosis in bison.



**Figure 11.3.2. Trends in size of Yellowstone's two bison herds, the Northern Range herd in red and the Central Yellowstone herd in burgundy.**

Elsewhere, the Service offers some offhand claims substantiated only by a distorted reading of the scientific literature, most notably its reference to Fortin et al. (2013) page 13192. Fortin et al. (2013) documented radio-marked bears feeding on bison at 9% of all investigated feeding sites in a study area restricted to the environs of Yellowstone Lake—a figure the Service then

uses to dismiss bison as an important grizzly bear food. The Service's logical fallacies are emblematic of its fallacies throughout the Rule and include, first, conflating a small percentage of sites with what is, in fact, a huge amount of high-quality food, second, extrapolating results from a spatially restricted study area to an entire ecosystem, and, third, failing to note that the results of Fortin et al. (2013) pertain to the Central Yellowstone bison herd, which has declined, while altogether missing areas that coincide with the Northern Range bison herd, which has increased (see Figure 11.3.2).

Given the extent to which state and federal management of Yellowstone's bison has been driven by concerns about brucellosis, any assessment of future prospects for bison necessarily needs to meaningfully consider prospective future management regimes for control of brucellosis. The Service's encapsulation of this issue in a blithe and meaningless reference to the objective of the current brucellosis management plan ("maintain a wild, free-ranging population of bison" [US National Park Service & USDA Animal and Plant Health Inspection Service 2000]), is grossly insufficient to the Service's analytic task. In fact, the dramatically negative recent trend of the Central Yellowstone bison herd no doubt reflects the current brucellosis management regime, more than factors such as decreasing winter severity (Geremia et al. 2011, White et al. 2011). The Service has no basis for its flip dismissal of brucellosis management as a factor in bison abundance and as a potential threat to Yellowstone's grizzly bears.

**11.4.** The Service fails to meaningfully assess past (and future) threats posed by major declines in populations of Yellowstone Lake cutthroat trout by its use of convoluted logic organized around a distorted and selective representation of the best available science. The Service's distortions and omissions are so strikingly egregious that I devote a considerable amount of space here to rectifying these deficiencies.

present, and prospective future threat posed to Yellowstone's grizzly bears by the functional extirpation of cutthroat trout in Yellowstone Lake. All of this is based on a selective and distorted reading of essentially two scientific references. In fact, an adequately thorough and less distorted review of relevant scientific information reveals a fundamentally different picture in which trout constituted an important bear food; loss of trout resulted in harm to Yellowstone's grizzly bears; with prospects for harm continuing.

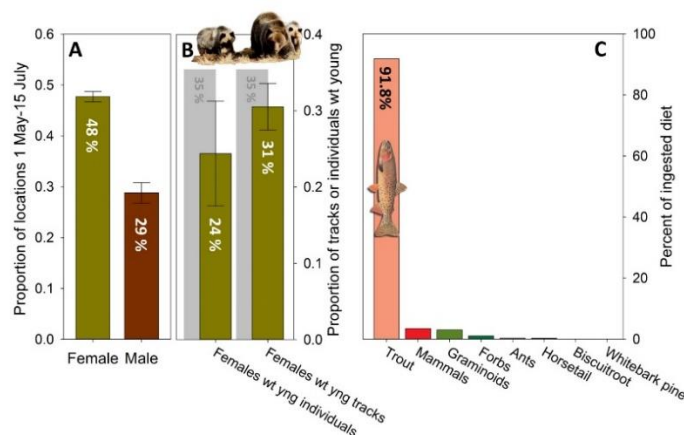
On Pages 13212 and 13213 of the Rule the Service devotes 1 paragraph to summarily dismissing the past,

Put succinctly, spawning cutthroat trout were a major source of energy and nutrients for grizzly bears living within range of Yellowstone Lake between the mid-1970s and late 1990s (see below). Roughly 15% of the bear population exploited this resource between mid-May and late July (Reinhart & Mattson 1990, Haroldson et al. 2005), although few grizzlies still consume trout. These percentages are based on estimates from the two referenced studies of 45 and 70 trout-consuming bears, and estimates of roughly 325 and 500 total bears in the population for the two corresponding time periods (Eberhardt & Knight 1995, IGBST 2003). Or put another way, the Service's bald assertion that "only a small portion of the GYE grizzly bear population uses cutthroat trout" is mystifying and unsubstantiated, especially given that the Service references the somewhat dated work by Haroldson et al. (2005) as its authority.

Figure 7.1., under Point 7 above, summarizes the estimated monthly contribution of cutthroat trout to dietary energy and nutrients of the Yellowstone grizzly bears between the late 1970s and early 1990s. These estimates are based on an analysis of fecal material ("scats") deposited by grizzly bears throughout the Yellowstone ecosystem during 1977-1993, weighted by average nutrient and energy contents, adjusted for digestibilities, and corrected for differences between ingested and fecal volumes (as per Mattson et al. 2004, Lopez-Alfaro et al. 2015; see my comments under point 7). Monthly variation in total amounts varies substantially because of seasonal differences in overall levels of feeding activity (low in the spring, high in the fall and late summer; Mattson et al. 1991a), as well as differences in numbers of bears out of their dens early and late in the active season (Haroldson et al. 2002).

Figure 7.1 shows that trout were an especially important source of energy and protein, provided in pulses that peaked during June and July. There is little doubt that the functional extirpation of trout in a number of spawning streams has left a major nutritional hole during these months that bears have needed to fill, apparently by preying more heavily on elk calves (which are particularly vulnerable this time of year) and by more heavily consuming lower-quality vegetal foods (Fortin et al. 2013, Middleton et al. 2013, Ebinger et al. 2016).

Nonetheless, it is not altogether clear to what extent cutthroat trout were an important source of energy and nutrients for female versus male grizzlies. The main contradictions arise from the results of Mattson & Reinhart (1995) and that of Felicetti et al. (2004). Felicetti's results suggest that male grizzlies made roughly five times more use of trout compared to female grizzlies (135g/kg versus 26g/kg), whereas Mattson & Reinhart (1995) suggest otherwise. A critically important contextual distinction pertains to the status of trout populations when the research supporting each result happened. The research reported in Mattson & Reinhart (1995) occurred during the peak of Yellowstone's cutthroat trout population (1985-1987); Felicetti's when the population was at low ebb, albeit during a minor resurgence (1997-2000; see my discussion of trends below).



**Figure 11.4.1. (A) Proportion of adult female and adult male telemetry locations concentrated within 2-km of Yellowstone during cutthroat trout spawning season, only considering bears with ranges overlapping spawning streams; (B) Proportion of all individuals and tracks documented along spawning streams during spawning season (in green) relative to the proportion of each expected by the total in the population; and (C) percent contribution of various foods to the ingested diet of bears concentrated along spawning streams during spawning season.**

Some key results from the mid-1980s are summarized in figure 11.4.1. Of the bears strongly suspected of consuming cutthroat trout, females spent nearly 1.6 as much time near spawning streams as did males (during the spawning season; left above, Panel A), although females with dependent young were present in proportions less than one might expect (indicated by the discrepancy between the gray and green bars in panel B).

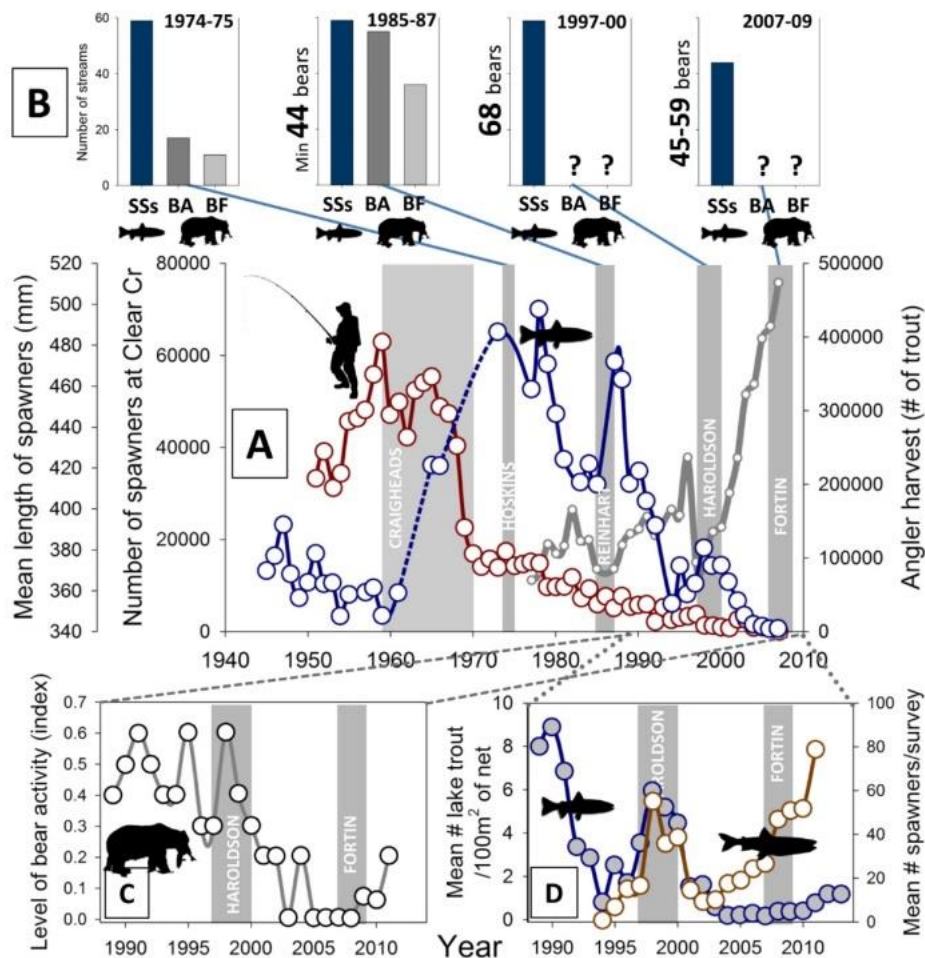
Moreover, analysis of scats collected within 500 m of spawning streams suggests that the bears that were present had a diet comprised of 90%+ cutthroat trout (corrected to reflect ingestion; Panel C). Although scats dropped by females couldn't be distinguished from scats dropped by males, the overwhelming conclusion is that any bear near a spawning stream during the spawning season was eating almost wholly cutthroat trout. The logical conclusion is that females were eating more trout than were males, at least during the mid-1980s. The only way this could not be the case is if females were concentrating near spawning streams, but not eating trout, which seems implausible in light of everything we know about what motivates the foraging behavior of animals.

Another interesting paradox arises from the fact that Felcetti et al. (2004) estimated the median consumption of trout by bears during 1997-2000 to be around 0.024-1.09 kg per individual, at the same time that Haroldson et al. (2005; from whom she obtained her samples) estimated that bear activity around spawning streams--including fishing--had not dramatically diminished from highs during the mid-1980s (see my discussion of trends below). But the claims by Felcetti and Haroldson find little support in independent observations. For one, trout populations had declined substantially--if not catastrophically--between the 1980s and late 1990s (see below). Given the strong relationship between trout densities and bear fish activity (Reinhart & Mattson 1987), it seems implausible that such a decline in trout populations would have had a minor effect on bear activity. The claim by Felcetti that trout were roughly 5-times more important a source of energy for males

compared to females is also in stark contradiction of the results described immediately above. Finally, the fact that grizzly bears have been documented to consume roughly 6 kg of trout in a single 41-minute bout of fishing suggests that any bear spending any amount of time fishing streams under favorable circumstances would have consumed many kg of trout during a single season--not something less than 1 kg.

An explanation for contradictions between the results of the mid-1980s and late-1990s studies potentially takes two forms. One is that the differences are simply a result of starkly different numbers of spawning cutthroat trout (see below), with related changes in relative access to streams by females versus males. There is ample evidence that adult male grizzlies can dominate concentrated food resources such as spawning trout, especially to the exclusion of security-conscious animals such as females with dependent young (the case two years out of three for Yellowstone females). Thus, if prime fishing opportunities had become increasingly spatially restricted, males would have become the primary winners, and females the losers. The result would have been a shift from disproportional use of the trout resource by females to disproportional use by males--leaving females bearing most of the harm arising from losses of cutthroat trout.

And, indeed, Yellowstone Lake's cutthroat trout population has exhibited huge ups and downs since the 1940s, when the Park Service first began to track trout numbers. Consumption of trout by bears has correspondingly varied. The composite figure below (figure 11.4.2) summarizes these key trends.



**Figure 11.4.2. Trends in numbers of Yellowstone Lake cutthroat trout and related trends in related levels of bear fishing and other activity, with reference to the various studies that I reference here.**

Panel A shows trends in numbers of spawning trout censused in Clear Creek, a major spawning stream on the east side of Yellowstone Lake (the blue line); the average length of trout captured in trawl nets (gray line); and numbers of fish killed by human anglers (all of these data can be found in Kaeding 2010 and other public archives). Key trends in numbers of spawning trout have been: a major increase during the 1960s, a substantial dip in the early 1980s, a resurgence in the late 80s, and a subsequent sustained decline to the present. Average size of trout has consistently varied inversely to population trends, indicating lack of recruitment of fish into smaller size classes during periods of decline.

Panel C shows levels of bear activity along spawning streams since 1989 (transects are located on streams concentrated on the west and northwest shores of the Lake; from IGBST Annual Reports). During 1989-1998

bear activity was substantial but varied. However, beginning in 1999, activity declined to the point where, now, bears rarely fish for spawning trout. This decline in bear activity is self-evidently related to the decline in numbers of spawning trout shown in blue in Panel D. Panel D also shows, in brown, numbers of lake trout captured in gill nets, standardized to reflect level of effort. Non-native lake trout were first documented in Yellowstone Lake in 1994, after which their numbers increased, then declined, and then increased again to the present. Lake trout prey on cutthroat trout and are implicated in the decline of cutthroat numbers.

One important feature of Panels A, C, and D is the denotation, as gray vertical bars, of different grizzly bear studies of relevance to documenting consumption of trout around Yellowstone Lake; each study is labeled with the name of the lead investigator(s). The Hoskins,



Reinhart, Haroldson, and Fortin (Fortin et al. 2013) studies surveyed tributary streams specifically to document bear activity along with size and duration of spawning runs. Panel B at the very top summarizes the results of each of these studies in terms of: number of streams with spawning runs (SSs, dark blue bar), with bear activity of any sort (BA, dark gray bars), and with sign of bear fishing (BF, light gray bars). As Fortin et al. (2013) and Middleton et al. (2013) document, although there has been a decline in numbers of bears active around Yellowstone Lake, the decline has not been catastrophic.

But, as I point out above, the brunt of declines in trout has probably been born by female grizzly bears, resulting in a turn to eating more terrestrial meat, especially in the form of predated calves, resulting in a probable increase in cub and yearling death rates (see my point 17) and a related overall increase in total grizzly bear mortality, especially during 1993-1997 and again during 2000-2003 (see my point 11.1 above).

**11.5. The Service fails to adequately address the effect of army cutworm moths on birth and death rates of Yellowstone's grizzly bears, and thereby fails to account for the past effects of dramatic increases in consumption of moths by bears and prospective future effects of losses of this food on Yellowstone's grizzly bear population.**

Army cutworm moths are amongst the highest-quality of grizzly bear foods in the Yellowstone ecosystem (Erlenbach et al. 2014). By summer's end, over-summering moths can consist of 50-80% fat (Kevan & Kendall 1997, White et al. 1998b). This high concentration of fats predictably accelerates accumulation of body fat amongst female grizzly bears that eat them (Robbins et al. 2007, Robbins et al. 2012, Erlenbach et al. 2014) and, with that, the odds that these females will achieve the substantial body fat—in excess of 20%—needed to produce and sustain cubs (Farley & Robbins 1995, Hilderbrand et al. 2000, Robbins et al. 2012).

Perhaps more importantly, it would stretch the bounds of plausibility to conclude that carrying capacity *has not* declined in areas around Yellowstone Lake occupied by bears that had made heavy use of cutthroat trout—which is what the Service strongly implies. Carrying capacity has almost certainly declined and, more importantly, this decline has occurred in the most protected core of the ecosystem centered on the southern part of Yellowstone National Park. Combined with the effects of increasing moth site use on the eastern periphery of the ecosystem (see below), this geographic redistribution in carrying capacity will predictably draw grizzly bears into more lethal environments outside of the National Parks, in comparatively less protected parts of Wyoming.

Given the picture that I present here based on the preponderance of evidence and associated logical deductions, the Service needs to undertake a more rigorous and less patently biased assessment of the threats posed directly and indirectly by losses of cutthroat trout.

Moreover, the sites where grizzly bears consume moths are located in areas that are amongst the most remote from people of any in the Yellowstone ecosystem (Mattson et al. 1991b, French et al. 1994, Gunther et al. 2014). And remoteness from people has repeatedly been shown by researchers to be one of the most important spatial factors affecting survival of adult grizzly bears in and near the Yellowstone ecosystem (Mattson et al. 1996; Merrill et al. 1999; Carroll et al. 2001, 2003; Merrill & Mattson 2003; Johnson et al. 2004; Schwartz et al. 2010).

Consumption of moths by grizzly bears, which occurs primarily between mid-July and mid-September, has increased dramatically from essentially nil during the mid-1980s to high levels that have been sustained since the late 1990s (Mattson et al. 1991b, IGBST 2015:42-43). Individual sightings of grizzly bears on moth sites have numbered between 240 and 350 during the last three years (IGBST 2015:42-43), which strongly suggests that a substantial number of individual bears use this food resource—perhaps the majority of those living in eastern

portions of the ecosystem. All of the 31 known sites where grizzlies consume moths are located on US Forest Service lands in the Absaroka Mountains east and southeast of Yellowstone National Park (Gunther et al. 2014). Six of these sites are located outside of the Primary Conservation Area (Van Manen, F.; personal communication).

Nowhere in the proposed Rule or CS does the Service address the prospective effects of past increases and future losses of army cutworm moths on grizzly bear demography, other than through patently convoluted logic transparently designed to sidestep this issue. None of the demographic analyses relied upon and referenced by the Service (e.g., Schwartz et al. 2006, Van Manen et al. 2015) have in any way explicitly incorporated the effects of army cutworm moth consumption in their analyses of grizzly bear birth or death rates. Lacking this foundation in analysis of prospective past effects, the Service has no basis for representing or judging what those effects have been or might be in the future. Nor do they have any basis for differentiating effects that they attribute to “density,” as such, from effects of increasing

consumption of cutworm moths given that both are highly correlated in time, as well as correlated in space (Gunther et al. 2014, IGBST 2015:42-43, Van Manen et al. 2015)

Lack of attention to this issue by Schwartz et al. (2006) and Van Manen et al. (2015) does not obviate the burden on the Service to consider the available relevant science, which is summarized here. Using this available science, and in the absence of anything more definitive, the preponderance of evidence supports concluding that increased availability and consumption of moths has very likely led to increased birth rates and decreased late-summer deaths rates amongst bears with access to this food, and that future loss of moths would lead to the opposite. Certainly, this conclusion is better supported than either of the two alternatives: that availability and consumption of moths has resulted in either no effect or negative effects, and that past and future abundance of this food is of little or no consequence to long-term conservation—which is essentially what the Service has claimed.

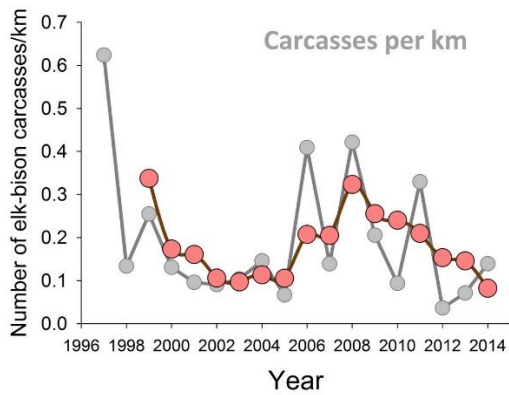
**12.** The Service disregards and misrepresents the best available scientific information in its assessment of the impact of wolves on Yellowstone’s grizzly bears on page 13212 of the Rule—in fact, the Service essentially disregards wolves altogether as a factor to be considered in their own right.

On page 13212 of the Rule the Service presents a superficial and otherwise inadequate mini-assessment of the past and prospective future impacts of wolves on Yellowstone’s grizzly bears in an apparent rush to reach its hasty conclusion that “fluctuations” in ungulate populations have not nor will ever threaten grizzly bears in this ecosystem. In fact, a clear-eyed reading of the best available science shows that wolves have very likely harmed Yellowstone’s grizzly bears, albeit to an unknown extent.

Female grizzly bears historically consumed a disproportionate amount of the terrestrial meat that they ate by scavenging carrion during the spring, in contrast to adult male bears that ate disproportionately more meat during summer and fall and, of that, more by outright predation (Mattson 1997, 2000). Since the

reintroduction of wolves, amounts of spring carrion have declined (figure 12.1), primarily as a result of declining elk populations (see my point 11.2 above). These declines in elk have probably been driven by a combination of unsustainable sport harvest, adverse weather, grizzly bear predation on calves, and wolf predation on elk of all sex and age classes (Vucetich et al. 2005, Evans et al. 2006, Eberhardt et al. 2007, Barber-Meyer et al. 2008, Griffin et al. 2011, Brodie et al. 2013, Proffitt et al. 2014). The point being that wolf predation has very likely played a part in very real declines in spring carrion, especially because of selection by wolves for the older and weaker elk that almost certainly would have otherwise died overwinter and been available to female grizzlies as carrion (Evans et al. 2006, Wright et al. 2006).





**Figure 12.1. Ungulate carcasses counted per km of transects surveyed during spring on Yellowstone ungulate winter ranges. Gray dots are annual values and pink dots represent a 3-year running average.**

The Service ignores this probable indirect role of wolf predation on female grizzly bears, along with an effect that is more direct. Specifically, wolves have been known to kill grizzly bear cubs (see page 13205 of the Rule), a phenomenon that is notoriously difficult to detect and thus almost certainly under-documented (see my point 17). There is no way that this predation by wolves on grizzly bear cubs can be construed as a neutral much less positive effect.

The Service concludes its putative mini-assessment of wolves by asserting that grizzly bears have probably benefitted from the extent to which they have been able to appropriate wolf kills for their own consumption, citing research conducted in Alaska (Ballard et al. 2003), while entirely overlooking highly relevant research undertaken in Yellowstone (Gunther & Smith 2004). These Yellowstone researchers found that females very rarely if ever usurped wolf kills. In fact, adult male grizzlies—which are of little relevance to population-level productivity—were essentially the sole beneficiaries of wolf kills. In other words, whatever meat wolves were directly provisioning for bears was going almost entirely into the bellies of adult males.

In short, wolves have been and will probably continue to be a detrimental feature of Yellowstone’s grizzly bear habitat, thereby constituting a threat; and the Service utterly fails, first, to give this issue due regard and, second, to sufficiently and accurately represent the relevant best available science. If considered properly, wolves will probably threaten grizzly bears directly through predation on young bears and indirectly through effects on ungulate populations, now and for the foreseeable future.

**13.** The Service fails throughout the Rule to account for the effects of climate change on past, present, and prospective future changes in habitat and demography of Yellowstone’s grizzly bears. The Service neglects most of the relevant best available science; distorts what little it does cite; deploys otherwise faulty logic; and relies, instead, largely on a single workshop publication and related assertions regarding the opinions of an amorphous “majority” of bear scientists.

The Service is remarkably obtuse in its assessments of how climate change has, is, and will foreseeably affect Yellowstone’s grizzly bear population. Much of its argument is presented on pages 13197, 13216, 13217 of the Rule, from which I have extracted the following synoptic quotes:

On page 13197, the Service cursorily states its central conclusion: “Most grizzly bear biologists in the United States and Canada do not expect habitat changes predicted under climate change scenarios to directly threaten grizzly bears (Servheen and Cross 2010, p. 4). These effects may even make habitat more suitable and food sources more abundant.”

On page 13216 and 13217 the Service marches through several paragraphs in which it acknowledges the obvious fact that unprecedented climate change is happening; that the western United States will be warmer; and that hydrologic regimes will change. After this pro forma recitation, the Service then leaps to again conclude: “Most grizzly bear biologists in the United States and Canada do not expect habitat changes predicted under climate change scenarios to directly threaten grizzly bears (Servheen and Cross 2010, p. 4). These changes may even make habitat more suitable and food sources more abundant.”

On page 13217 the Service perambulates through another pro forma acknowledgment that climate change will, indeed, affect the abundance and distribution of plant and animal species only to repeat a variant of its emerging mantra: “While the extent and rate to which individual plant species will be impacted is difficult to foresee with any level of confidence (in their entirety: Walther et al. 2002; Fagre et al. 2003), there is general consensus that grizzly bears are flexible enough in their dietary needs that they will not be impacted directly by ecological constraints such as shifts in food distributions and abundance (Servheen and Cross 2010, p. 4; IGBST 2013, p. 35).

Finally, on page 13217 the Service again marches through yet another pro forma discussion of prospective changes in fire regimes to reach its master conclusion regarding prospective effects of climate change on Yellowstone’s grizzly bears: “Because grizzly bears have shown resiliency to changes in vegetation resulting from fires, we do not anticipate altered fire regimes predicted under most climate change scenarios will have significant negative impacts on grizzly bear survival or reproduction, despite its potential effects on vegetation. Therefore, we conclude that the effects of climate change do not constitute a threat to the GYE grizzly bear DPS now, nor are they anticipated to in the future.”

The short-comings of the Service’s treatment of climate change are striking—and consistent with a track record of disregard recently highlighted by the US Montana District Court’s ruling on the Service’s failure to list wolverines under the ESA.

**13.1.** The Service fails to adequately represent the best available science of direct relevance to projecting environmental change in the Yellowstone ecosystem.

The Service’s at times lengthy recitation of literature that forecasts generic effects of climate change is clearly *pro forma*, as evidenced by the fact that the Service doesn’t even pretend to explicitly link such effects to the particulars of Yellowstone’s bears and bear habitat.

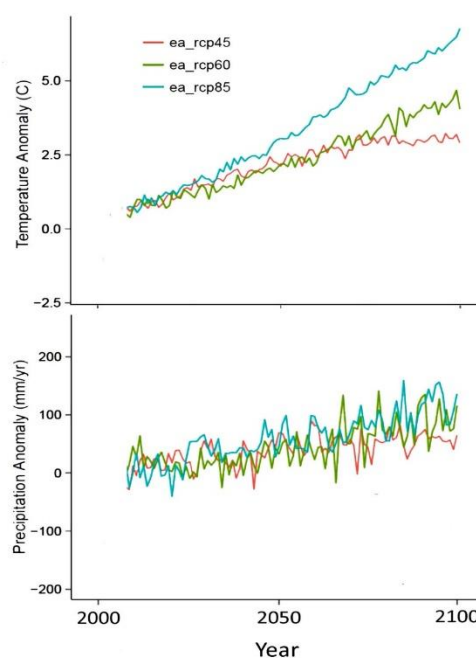
Emblematic of its failure to address Yellowstone’s specific conditions, the Service (barring once) almost totally ignores the large body of research that directly addresses climate change in Yellowstone, including projections for climate, vegetation, and wildfire. In the one instance where the Service does cite regionally-specific research (i.e., Romme & Turner 1991), the results are misrepresented in an apparent attempt to dismiss the threat posed by climate change to army cutworm moths (for more on this, see my comments specific to moths). But perhaps most problematic, the Service fails to address what we do know about grizzly bear behavior, diet, and habitat in the Yellowstone ecosystem and instead substitutes platitudes such as “most grizzly bear biologists” and “general consensus.”

Briefly, climate has warmed and will continue to warm substantially in the Yellowstone ecosystem, with a net projected increase in growing season drought, albeit mitigated by some projected increase in precipitation. Without being exhaustive, Pedersen et al. (2010), Rice et al. (2012), Chang & Hansen (2015), and Tercek et al. (2015) provide what is probably the most relevant and up-to-date information on past and prospective future changes in climate of the Yellowstone ecosystem. Temperatures have already increased substantially, especially since the late 1940s, and will continue to increase at a rapid rate under all plausible forecast scenarios (Figure 13.1.1). Total precipitation has been stable during the last 60 years or so, but is projected to increase modestly with climate change, with offsets by warming resulting in a net projected increase in droughty conditions, especially late in the growing season. For various reasons, snowpack has declined significantly since 1980, but in large measure due to warmer winter and spring conditions—consistent with broad-scale west-wide trends (Clow 2010, Pederson et al. 2013). The resulting hydrologic changes have been detrimental to cold-water fish such as cutthroat trout (Williams et al. 2009; Isaak et al. 2010, 2012, 2015; Wenger et al. 2011). The magnitude of these historical and forecasted changes is non-trivial and potentially even catastrophic—and at variance with implications made by the Service in the Rule that uncertainty is perhaps a defining feature. It is not. The forecasts are thematically unambiguous, convergent, and consistent with recent historical trends.

Numerous researchers have projected climate-driven changes in the distributions of either vegetation formations or individual plants species at a resolution meaningful to regional assessments for the Yellowstone ecosystem (e.g., Romme & Turner 1991; Bartlien et al. 1997; Shafer et al. 2001; Schrag et al. 2007; Crookston et al. 2010; Coops & Waring 2011; Diaz & Eischeid 2007; Westerling et al. 2011; Bell et al. 2013, 2014; Gray & Hamann 2013; Chang et al. 2014; Hansen & Phillips 2015; Rehfeldt et al. 2006, 2012). Again, unlike some of the Service's innuendo in the Rule, the projections are unambiguous and consistent. We can expect massive changes in the distributions and abundance of plant species, including the prospective loss of most (90% plus) alpine and high subalpine environments. Among the species expected to experience major declines are subalpine fir, Engelmann spruce, and whitebark pine,

with invasion of higher elevations by Douglas-fir and lodgepole pine—continuing trends that have been underway for the last 13,000 years (Iglesias et al. 2015).

Fire regimes are expected to change substantially. Westerling et al. (2011), Luo et al. (2013), Stavros et al. (2014), Barbero et al. (2015), and others project an increase in fire frequency and/or extent perhaps sufficient to essentially eliminate forest conditions from most of the Yellowstone ecosystem—albeit with a potentially progressive lessening of fire intensity (Parks et al. 2016). These future fire regimes will likely amplify the rote effects of climate change in driving an increase in the extent of non-forest conditions (Rice et al. 2012, Chang & Hansen 2015), but with an additional likely CO<sub>2</sub>-driven trend towards increasing concentration of biomass on shrubs such as *Artemisia* sp. (e.g., Harte & Shaw 1995, Polley et al. 1997, Morgan et al. 2007).



**Figure 13.1.1. Projected increases in temperature and precipitation specific to the Yellowstone ecosystem (Chang & Hansen 2014).**

This very brief review emphasizes the extent to which the Rule neglects high-relevant regionally-specific research, provides a backdrop of prospective change, and provides an opportunity to actually examine (in brief) what climate change might bring—and has already brought—for Yellowstone's grizzly bears; and with reference to the particulars of grizzly bear research in

this ecosystem instead of resort to platitudes and figurative arm-waving.

**13.2. The Service fails to adequately account for the prospective terminal loss of whitebark pine as a functional part of Yellowstone's grizzly bear habitat.**

There is little doubt that climate warming has been a major driver of devastating—even catastrophic—losses of mature whitebark pine to bark beetles, especially since the early 2000s (Logan et al. 2010, Macfarlane et al. 2013). In fact, these losses are the very premise of the IGBST research that the Service cites so extensively (e.g., Bjornlie et al. 2014, Van Manen et al. 2015; but see my other comments regarding the fatal flaws of this work). Looking to the future, virtually every study that has been done projects terminal losses of virtually all whitebark pine in the Yellowstone ecoregion from a combination of climate warming, increased fires, insidious spread of white pine blister rust, continued outbreaks of bark beetles, and competition from lower-elevation species such as lodgepole pine and Douglas-fir (e.g., Romme & Turner 1991, Bartlein et al. 1997, Warwell et al. 2006, Schrag et al. 2007, Coops & Waring 2011, Coops et al. 2011, Hatala et al. 2011, Jewett et al. 2011, Simard et al. 2012, Gray & Hamann 2013, Weed et al. 2013, Chang et al. 2014, Miller et al. 2015). The preponderance of evidence unambiguously supports the conclusion that whitebark pine will continue to be lost and will not return as a functional part of Yellowstone's grizzly bear habitat. This conclusion holds, the apologia of Mahalovich (2013) notwithstanding, especially given that this author would have us believe that something never before achieved is possible: i.e., the artificial selection (or engineering) of a new species that is simultaneously highly resistant to blister rust and beetles, a better competitor under warmer drier conditions, with continued production of ample nutritious seeds, and, as a practical matter, able to be propagated in sufficient numbers to make any functional difference. Unlikely at best.

And recent, on-going, and foreseeable losses of whitebark pine have had and will almost certainly continue to have major negative impacts on Yellowstone's grizzly bears. As I point out elsewhere, bear mortality, in general, and in relation to use of human-associated meat, has sky-rocketed coincident

with terminal declines in whitebark pine seed availability beginning 2006-2007. Moreover, whitebark pine seeds were unambiguously an important source of dietary fat—a critical diet nutrient—and, historically, of roughly twice the importance to females as to males (Mattson 2000, Felicetti et al. 2003).

**13.3. The Service fails to adequately account for the prospective terminal loss of army cutworm moths as a functional part of Yellowstone's grizzly bear habitat.**

On page 13213 of the Rule, the Service invokes a single publication to claim that, because “vegetation types in Yellowstone have a wide elevational range,” alpine tundra and other alpine communities will not be adversely affected by climate warming. They then go on to claim, based on an additional single citation, that army cutworm moths will not be adversely by climate warming, not only because alpine environments will somehow survive intact, but also because moths will somehow otherwise adapt. These claims are not substantiated nor are they logical.

For one, alpine environments are, in fact, defined by a very specific climatic envelope, as is the corresponding domain of the plants that comprise alpine tundra (Lütz 2011, Körner 2013). Moreover, every single scientific projection for alpine environments under different plausible scenarios of climate change predicts (or projects) major if not catastrophic losses (e.g., Grace et al. 2002, Pauli et al. 2003, Walther et al. 2005, Grabherr et al. 2010, Dullinger et al. 2012, Elmendorf et al. 2012, Gottfried et al. 2012). Projections specific to the alpine zone in the western United States are no exception (Romme & Turner 1991, Diaz & Eischeid 2007). These projections are consistent with the climatic and physiological factors that sustain alpine plants in the face of competition from other species better adapted to less harsh lower-elevation environments (for example, see a rich scientific literature dating back to Tranquillini [1964] and Billings & Mooney [1968]).

On top of this, every instance where bears have been documented to feed on aggregations of army cutworm moths in the northern Rocky Mountains has been restricted to alpine fellfields near alpine tundra: the Mission Mountains, Scapegoat Mountains, Glacier

National Park, and the Absaroka Mountains (Chapman et al. 1955, Craighead et al. 1982, Mattson et al. 1991b, French et al. 1994, O'Brien & Lindzey 1998, White et al. 1998a). As a corollary, every study of summer cutworm moth ecology has demonstrated that the moths subsist on the nectar of tundra flowers (French et al. 1994, O'Brien & Lindzey 1994, Kevan & Kendall 1997, White et al. 1998b). It is somewhat mysterious, then, as to how and why grizzly bears would shift to feeding on moths in an environment where feeding on moths has never before been documented and where moths have never before been documented to thrive. The Service not only fails to reference any of the highly relevant literature listed here, but also convolutes and contradicts all available evidence.

Whereas it is true that no one can say for sure how over-summering army cutworm will respond to loss of alpine environments, this does not in any way substantiate the assertions made by the Service that alpine environments will somehow be unaffected by climate warming, that moths will somehow adapt, and that grizzly bear foraging will be minimally affected. Such claims, in fact, defy not only the weight of evidence, but also everything we do know about grizzly bears, cutworm moths, and prospective effects of climate change on the habitats that over-summering moths currently depend on.

**13.4. The Service fails to adequately account for the prospective terminal loss of cutthroat trout as a functional part of Yellowstone's grizzly bear habitat.**

Yellowstone cutthroat trout are a cold-water-adapted species that is, together with bull trout, amongst the most vulnerable of any fish to prospective warming of aquatic habitats (Bear et al. 2007, Kaeding 2012). Although cutthroat trout will grow more quickly in warmer waters (Bear et al. 2007, Kaeding 2012, Al-Chokhachy et al. 2013), this advantage is offset by elevated competition, incidence of disease, spread of non-native species, and worsening flow regimes that typically accompany warming—which is also often coincident with drying (Koel et al. 2006, Gresswell 2009). In Yellowstone Lake, the primary threats from non-natives species are in the form of whirling disease (at a 20% plus infection rate among native cutthroat trout), New Zealand mud snail (as near as the Madison River), and Lake trout—a highly piscivorous predator on

cutthroat trout first detected in Yellowstone Lake during 1994.

There is no doubt that Yellowstone Lake cutthroat trout populations have declined catastrophically since the late 1970s, to the point where this species has been functionally extirpated as a source of food for Yellowstone's grizzly bears (see my comments under above). There is likewise no doubt that predation by Lake trout played a major role in this decline (Ruzycki et al. 2003, Koel et al. 2005). However the role of worsening hydrologic conditions is under-appreciated. Kaeding (2010) presents convincing evidence that hydrologic conditions (indexed by total annual air degree-days) drove declines in cutthroat trout populations perhaps even more than Lake trout predation, explaining the fact that the beginning of substantial declines in the cutthroat trout population predated detection of Lake trout by roughly 15 years.

Looking to the future, there is also little doubt that climate change will bring worsening rather than improving conditions for Yellowstone Lake cutthroat trout, including elevated water temperatures, early peak flows in spawning streams, worsening late-summer low flows, increasing blockage of spawning stream outlet channels, and less thermal buffering because of more prevalent wildfires (e.g., Williams et al. 2009; Isaak et al. 2010, 2012, 2015; Wenger et al. 2011; Tercek et al. 2015). The basis for this prognosis is consistent and strong. Insofar as threats from non-native species are concerned, even though there is evidence for the efficacies of recent efforts to control Lake trout in Yellowstone Lake (Syslo et al. 2011, Koel et al. 2015), such efforts will likely need to be sustained indefinitely, with virtually no prospect of ever completely eliminating Lake trout (Koel et al. 2006, 2015; Gresswell 2009). Moreover, there is no plan in place with prospects of ever controlling whirling disease or preventing the eventual introduction of New Zealand mud snails. In other words, the long-term prospects for Yellowstone Lake cutthroat trout are bleak, albeit with the possibility of modest positive trends in the next several decades. More certainly, cutthroat trout will not return as a major grizzly bear food in the most protected core of the ecosystem.

**13.5. The Service fails to adequately account for the prospective effects of climate change on populations of elk and bison in the Yellowstone ecosystem.**

Belying the cursory treatment of elk and bison by the Service on page 13212 of the Rule, an assessment of how climate change might affect these ungulates, along with consequent effects on grizzly bears, is perhaps the most complicated of any for foods of recent importance to bears. Certainly, the Service's hasty conclusion that "fluctuations in the availability of ungulates are not a threat to the GYE grizzly bear population now, or in future" is irresponsible and simple-minded.

Elk populations in the northern Rocky Mountains, including the Yellowstone ecosystem, are limited and regulated by a combination of factors, most notably sport hunting, winter severity, summer forage, and predation. The Service would claim that sport hunting is discretionary and therefore entirely under the control of managers. Without questioning any assertions about control over sport harvest, climate *is not* controllable by wildlife managers.

Not surprisingly, a number of publications have implicated winter severity as a limiter of elk populations, primarily through effects on survival of short-yearling and senescent animals (Garrott et al. 2003, Lubow & Smith 2004, Vucetich et al. 2005, Brodie et al. 2013, Proffitt et al. 2014)—something that the Service acknowledges in the Rule. But an even larger body of research implicates summer forage conditions, primarily through effects on female pregnancy and early calf survival (Merrill & Boyce 1991, Coughenour & Singer 1996, Cook et al. 2004, Lubow & Smith 2004, Vucetich et al. 2005, Parker et al. 2009, Griffin et al. 2011, Middleton et al. 2013, Proffitt et al. 2014) —something the Service does *not* acknowledge. And calf survival is increasingly recognized to be a driver of elk population growth (Raithel et al. 2007).

Compared to elk, much less is known about the limitation or regulation of bison populations, especially in Yellowstone's unique environment. Perhaps the best synopses of this information can be found in the Elsevier Press book "The Ecology of Large Mammals in Central Yellowstone," specifically in Bruggeman et al. (2009),

Fuller et al. (2009), Geremia et al. (2009). All of these researchers found that winter severity reduced bison survival rates, but in a way that entailed complex interactions with anthropogenic factors and bison population densities.

In short, winter severity (e.g., Snow-Water-Content [SWE]) and summer weather (e.g., late-season forage conditions) have strong effects on elk populations, whereas winter severity seems to be the dominant climate/weather effect on bison. With those themes in mind, it is relevant to look at projections for SWE on Yellowstone's elk and bison winter ranges, drought (i.e., summer precipitation and temperature) effects on summer ranges, and the likely extent and nature of non-forest conditions—which, on the face of it, would be tied to the extent of favorable forage conditions for both ungulates.

As it turns out, the amount and extent of severe winter conditions, at least as indexed by SWE, are not projected to change much, if at all, on Yellowstone's winter ranges for the next 75 years or so (Marcus et al. 2012: 126-127)—this because most nearer-term effects of winter warming will be experienced at lower elevations below the rising elevational threshold of the rain-snow transition (Klos et al. 2014). Thus, at least for the foreseeable future, there is not likely to be much mitigation of limiting effects attributable to winter severity—and, thus, no related positive population responses.

The forecast for summer drought and related decreases in forage quality is less certain for the Yellowstone ecoregion (Rice et al. 2012, Chang & Hansen 2015). But, to the extent that drought effects manifest later in the growing season, and are driven by an offset of less certain precipitation forecasts by more certain temperature ones (Marcus et al. 2012: 126-127), odds are better that incidence and severity of drought will increase rather than decrease. In fact, such a prognosis is consistent with West-wide spatially-explicit forecasts of drought (Guzler & Robbins 2011, Gai 2012), especially the incidence of severe episodes (Strzepek et al. 2010).

This weight-of-evidence prognosis needs to be considered in the balance with likely increases in non-forest conditions. As I note earlier, this increase probably



will not be of a simple nature, with the prospect of more biomass being concentrated on woody shrubs compared to forbs and grasses, to the detriment of both elk and bison.

All of this constitutes a basis for reaching some provisional conclusions regarding climate-driven prospects for elk and bison in the Yellowstone ecoregion. Carrying capacity for bison will probably not increase in the foreseeable future simply because winter severity will not likely diminish. By contrast, carrying capacity for elk will likely increase, primarily as a function of an

**13.6.** The Service fails to adequately account for nature, quality, and potential effects of alternate foods that may be used more heavily by Yellowstone's grizzly bears in response to losses of currently-important foods.

All of this begs the question whether Yellowstone's grizzly bears will find alternative foods to eat that are of sufficient quality and quantity to offset past and prospective future losses of foods that were (and are) known to be important sources of energy and nutrients: whitebark pine seeds, cutthroat trout, army cutworm moths, elk, and bison. Perhaps as important, will bears likely end up eating these alternative foods under circumstances where risk of death is elevated? Answering these questions requires more than what the

increase in non-forest conditions, but to an extent strongly conditioned on the prevalence of growing-season drought. As a bottom line, there is no simple prognosis for elk and bison, especially given that populations of both are strongly affected by anthropogenic forces such as sport hunting (elk) and, increasingly, incidence and management of disease (elk and bison). In other words, there is no basis here for the Service's blithe conclusion.

Service currently offers in the Rule, which amounts to assertions and platitudes based on invocations of "omnivory," "resilience," and the ill-framed opinions of bear researchers who probably know little about climate change and even less about the Yellowstone ecosystem (for more on this see my comments related to nutritional ecology, point 7).

So, what evidence is there to draw on? Perhaps the most comprehensive evidenced-based forecast of climate-driven dietary changes for Yellowstone's grizzly bears was done by Mattson (2000). Because this is the sole example of such an effort, I quote extensively from it as follows, noting that some citations are dated simply because of this dissertation's 2000 publication date:

"There is evidence from this study that grizzly bear foraging is temperature and moisture sensitive. The abundance and related use of ants by grizzly bears clearly seem to be dependent on ambient warmth [see also Mattson 2001] as, to a lesser extent, do growth and use of dandelions and thistles. It is likely that use of these foods by bears will increase with climate warming, assuming that moisture relations remain unchanged. However, use of many vegetal foods was sensitive to amounts of precipitation. The likelihood that bears would excavate a food declined during dry months, as did the likelihood that they would graze many of the forbs and grasses. All else equal, it is likely that grazing and root grubbing would be less common if climate warming caused drier soils during the growing season. In addition, the sensitivities of grubbing for biscuitroots and rodents to total winter precipitation suggest that use of biscuitroots would decline and use of rodents would increase if winters became drier.

Currently, it is strictly a matter of speculation whether total amounts of vegetal foods would change in bear range, aside from whether these foods would be used by bears or not as a function of proximal conditions. Compared to use of biscuitroots, use of yampa is conceivably more sensitive to widespread drying because yampa is restricted to moist sites (Mueggler & Stewart, 1980; Mattson, 1984) and is typically more difficult to extract (Mattson et. al. 1999 [2004]). It also is likely that consumption of clover by Yellowstone's grizzly bears will be more sensitive to changes in ambient conditions than many other bear activities because use of this food is so strongly associated with dense swards on moist soils. Otherwise, use of mushrooms and *Shepherdia* may increase because bear use of these foods is strongly linked to low-elevation lodgepole pine-dominated types (LPICO and LPIEN; Table 3; [see also Mattson 1997]). These types will likely become more extensive under warmer conditions (Romme & Turner, 1991).



Fire had a number of effects on the behavior of Yellowstone's grizzly bears that would likely ramify if climate warming induced more frequent and extensive burns. Grizzly bears were more likely to graze dandelions and early-season graminoids after the 1988 wildfires compared to before. On the other hand, the likelihood that they would excavate osmorrhiza roots or whitebark pine seeds declined substantially along with the intensity of excavations for pine seeds. The former activities were more likely to occur in recent burns, while the latter were not (Blanchard & Knight, 1990; Mattson, 1997a; Table 3). All of these consequences are logically related to fire-caused increases or declines in these foods (Blanchard & Knight, 1990; Singer & Harter, 1996; Mattson, 1997a). The post-1988 decline in bear use of rodents and rodent food caches during Spring and Estrus could have been a consequence either of fire-caused pocket gopher mortality or bears choosing to graze instead. Unfortunately, there is little research on the consequences of fires to pocket gophers that might provide insight into which was a greater effect. Even so, the increase in post-fire use of rodents during Hyperphagia suggests that pocket gopher mortality was not a factor and that the explanation lies in trade-offs with opportunities to graze graminoids, year-round."

As a bottom line, though, any invocation of ants, hornets, foliage, rodents, or roots as substitutes for foods that have been lost—and will prospectively continue to be lost—has no *prima facie* merit simply on the basis of nutritional and energetic considerations (e.g., Mattson et al. 2004). I cover this in more detail under my comments related to nutritional ecology. In other words, contrary to assertions (or innuendo) by both the Service and Gunther et al. (2014), dandelions or roots of various types quite simply will not provide compensation, especially at a population level. Likewise, remarks such as those by Fortin et al. (2012) suggesting that fungi have, and will, compensate for on-going losses of foods such as cutthroat trout and whitebark pine seeds has little merit. Fungi offer little fat (a critical nutrient for bears), and consumption of false truffles (and other mushrooms) has largely been confined to a limited portion of the ecosystem concentrated in lodgepole pine forests on the rhyolite plateaus of Yellowstone National Park (Mattson 1997, 2000; Mattson et al. 2002, 2004; Fortin et al. 2013). And, when fungi in the feces collected by Fortin et al. (2012) are corrected for the differential passage and digestibilities of various foods, the overall dietary contribution of false truffles and other fungi is trivial (Lopez-Alfaro et al. 2015).

There is a chance that high-quality foods from warmer climes could migrate to the Yellowstone ecosystem with time. The most obvious candidate is Gambel's oak—a source of acorns and a high-quality bear food in areas where it does occur, the nearest of which is roughly 130 miles south of Yellowstone's occupied grizzly bear habitat. In fact, several projections suggest that suitable climatic environments will emerge for Gambel's oak in the Yellowstone ecosystem over the next 100 years (e.g., Rehfeldt et al. 2006). That still begs the question of how

long it would take oaks to colonize newly opened environments over a 100 miles distant, especially given that migration rates have emerged as a major prospective consideration amongst those projecting changes in plant distributions (e.g., Pearson 2006). Perhaps more to the point of these deliberations: we can be more certain of what will happen with *in situ* foods compared to speculative foods relocating from a considerable distance.

### 13.7. The bottom line when it comes to the prospective effects of climate change:

The Service does a grotesquely inadequate job of assessing the prospective effects of climate change on Yellowstone's grizzly bears and, to the extent that it does attend to this task, the Service's intent seems to be out-of-hand dismissal of such effects in service of rushing to a preordained/pre-decisional conclusion. When given due regard, the net assessment is one of continued major losses of known high-quality foods, dietary shifts among surviving bears to greater reliance on lower-quality foods, and a substantial decline in unit area carrying capacity of the Yellowstone ecosystem. Moreover, grizzly bears will likely be spending more time foraging in high-risk environments, especially to the extent that they eat more foods at lower elevations nearer people—or foods such as livestock that bring them into greater conflict with people. It is certainly the case that past, on-going, and prospective future losses of whitebark pine and moth foraging sites will deprive grizzly bears of foods in some of the most remote and secure parts of the Yellowstone ecosystem. By contrast, essentially all prospective replacement foods (including Gambel's oak, should it ever arrive) tend to occur in more hazardous lower-elevation habitats. The preponderance of evidence

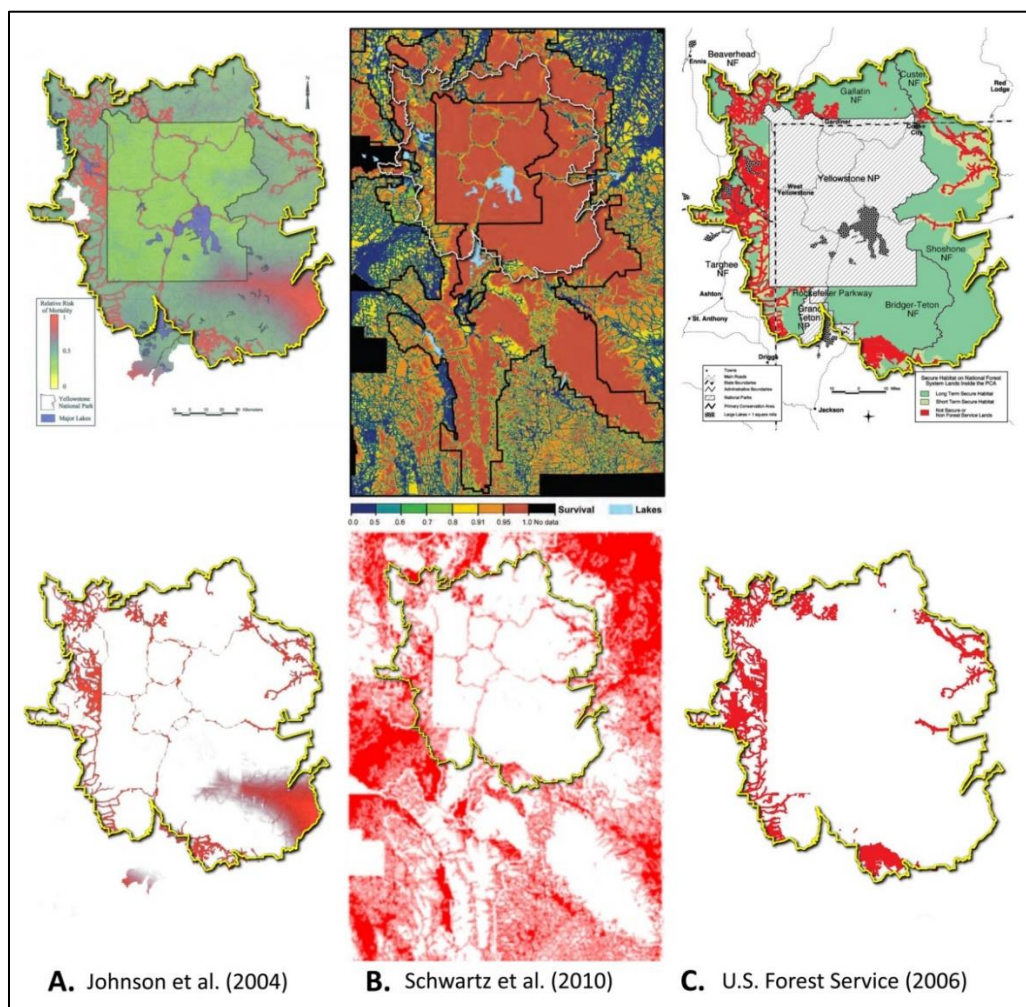
clearly supports a different conclusion from that reached by the Service. Climate change has had and will continue

to have devastating impacts on Yellowstone's grizzly bears.

**14.** The Service's assertion on page 13197 of the Rule that "there are no data to indicate habitat fragmentation within this population is occurring [sic]" is wrong because it contradicts the totality of best available science. There is, in fact, ample evidence of habitat fragmentation within the current distribution of Yellowstone's grizzly bears, which renders the Service's assertion both wrong and arbitrary.

On Page 13197 of the Rule the Service asserts that "The GYE grizzly bear population is currently a contiguous population across its range, and there are no data to indicate habitat fragmentation within this population is occurring [sic]." Realizing that fragmentation and

contiguity often come in degrees rather than as absolutes, this statement by the Service flatly contradicts the best available science as well as its own representations of "secure" habitat. In other words, this assertion is unsubstantiated and wrong.



**Figure 14.1.** This figure presents three maps extracted from the most recent assessments of habitat fragmentation and impairment in the Yellowstone ecosystem (top), with the areas of fragmented and impaired habitat extracted and uniformly shown in red in the bottom array (e.g., Schwartz et al. [2010] invert their color scheme and show the most impaired habitat in blue and the least impaired in red). The PCA boundary is shown in yellow in the three bottom maps.

Figure 14.1, immediately above, shows the mapped results of three out of the total of six studies that have explicitly looked at contiguity and fragmentation of grizzly bear habitat in the Yellowstone ecosystem. The six include Merrill et al. (1999), Carroll et al. (2001), Merrill & Mattson (2003), Johnson et al. (2004), U.S. Forest Service (2006), and Schwartz et al. (2010). The results above are from the three latest studies, with areas of fragmentation or contiguous impaired habitat extracted and shown in red in the three images arrayed left to right at the bottom. Parenthetically, the map produced by Schwartz et al. (2010) purports to represent odds of survival for grizzly bears, with the red denoting all of the areas where modeled survival rates are well below what is considered to be sustainable. The map produced by the U.S. Forest Service is based explicitly on delineations of “secure” habitat as defined by the Service. The PCA is delineated in yellow in the three bottom images.

The results of all of these studies constitute a remarkable consensus, including the three not explicitly represented

in figure 14.1. All show high degrees of fragmentation and substantial areas of impaired or otherwise deficient habitat. Within the PCA, these areas are concentrated in the west on the Targhee and Gallatin National Forests (NFs), in the far south on the Bridger-Teton NF, and in the northeast on the Shoshone and Gallatin NFs. Immediately adjacent to the PCA, there is a substantial zone of fragmented habitat separating the PCA from a sizable chunk of suitable habitat in the Wind River Range. Not coincidentally, a large fraction of conflicts between livestock and grizzly bears are currently concentrated in this fracture.

Even allowing for different and shaded definitions of fragmentation, the Service is egregiously deficient in its representation of this substantial body of convergent scientific results. The Service needs to acknowledge and adequately represent this literature, provide a functional and justified definition of “fragmentation,” and then reconcile that definition with the scientific results referenced here.

**15.** The Service’s assertion that “we do not expect such development [of mining claims] inside the PCA will constitute a threat to the GYE grizzly bear DPS now, or in the future” is unsubstantiated, counter to the primacy of the 1872 General Mining Law, and thus arbitrary.

The Service asserts on page 13196 of the Rule that the CS ensures that habitat security will not be compromised or “threatened” by the development of mining claims. The rule goes on to state that there are 28 mining claims with operating plans in the PCA. The Rule then asserts that federal land and minerals managers (primarily the U.S. Forest Service) will somehow allow for operation of only one new mine at a time, forestalling the operations of any others—and thus “ensuring” no net loss of habitat security. At the end of the section devoted to Mineral and Energy Development, the Service concludes “we do not expect such development [of mining claims] inside the PCA will constitute a threat to the GYE grizzly bear DPS now, or in the future.”

These claims and assertions are unsubstantiated and belie the history of mining claim development, including the impacts on grizzly bears that were anticipated and

documented by regulatory agencies during previous evaluations of proposed mining operations. For one, the CS will not trump provisions of the 1872 General Mining Law. As the U.S. Forest Service states in its 2006 EIS covering Forest Plan revisions for management of Yellowstone’s grizzly bear habitat: “Projects would be permitted according to the requirements of the 1872 Mining Law” (p. 208) and “Processing of mineral operations under the 1872 General Mining Law is not discretionary” (p. 271). Barring major political intervention, any proposed mining operations will proceed. And there are currently two mining operations in the process of development in and near the PCA (the Crevice Mine and the Emigrant Mine). The New World Mine dating from the early 1990s was deemed to have major potential impacts on grizzly bears (e.g., Mattson 1995) and did not pass regulatory review only because of

Presidential intervention and a special Congressional allocation to purchase the entailed mineral claims.

In short, a long history of legal precedent, together with realities on the ground, cannot be over-turned or otherwise magically transformed simply by the Service's

unsubstantiated assertion. The Service needs to recognize the primacy of the 1982 Mining Law, the implications of this primacy, the fact that mining claims are being and will continue being developed, and that these realities will likely constitute some degree of threat to the Yellowstone grizzly bear population.

**16.** The definition of "secure" habitat adopted by the Service is unsubstantiated by any referenced scientific research, roughly 72-times smaller than the compilation of best available science would recommend, and thus arbitrary. This gross underestimation of the dimensions of a secure area leads to inflated estimates of total secure habitat in Yellowstone's Bear Management Units. Moreover, the Service argues against its own definition of secure habitat in excluding certain areas from being deemed "suitable."

The Service defines "secure habitat" on page 13194 of the Rule as "those areas with no motorized access that are at least 4 ha (10 ac) in size and more than 500 m (1,650 ft) from a motorized access route or recurring helicopter flight line..." The cited authority for this definition is the U.S. Forest Service's 2006 EIS for revision of Forest Plans in the Greater Yellowstone Ecosystem.

Yet this document contains no justification for the adopted definition of secure habitat other than a reiteration of the dimensions given in the Rule. As a result, the Service does not provide nor reference any justification grounded in the best available science for this key facet of current and prospective habitat management under terms of the CS. Moreover, the asserted definition of secure habitat is ill-conceived and substantially at odds with the best available science, and thus amounts to an arbitrary determination.

By contrast, a compilation of the best available science by Mattson (1993), referenced to a thoroughly articulated justification, recommends that "microscale" security areas contain a core roughly 290 ha (716 ac) in size, roughly 2-4 km from the nearest road or other human facility. The resulting area, including core and buffer, would be 28.3 km<sup>2</sup> (c. 7000 ac) in size. The recommended core would be roughly 72-times larger than the 4 ha used by the Service and roughly 4-8 times farther from the nearest significant human facility. The secure core recommended by Mattson (1993) corresponds to the size of 24-48 hr foraging areas documented for Yellowstone's grizzly bears, whereas the buffering distance from human facilities attends to not

only to the extent of characteristic habitat alienation, but also the characteristic zone within which human-caused mortality has been documented to concentrate. There has been essentially no science since 1993 that would support a change in the recommendations made by Mattson (1993).

Perhaps as important, the standards developed by Mattson (1993) have been codified through litigation and through a US Fish & Wildlife Service Biological Opinion on the 1997 Revised Forest Plan for the Targhee National Forest. The Service fails to address this discrepancy between its past and present deliberations.

Interestingly, the Service tacitly refutes its own definition of secure habitat in its argument on page 13185 of the Rule for excluding fragments of habitat adjoining sheep allotments in the Wind River Range from "suitable" habitat. The Service's argument rests on an ill-defined invocation of "edge effects"; i.e., that edges of an unspecified dimension are somehow unsecure enough to warrant exclusion from "suitable" habitat. Without being privy to the exact dimensions of these "edges," they are almost certainly larger, each, than the 4 ha (plus 500 m buffer) threshold that the Service argues elsewhere is sufficient to ensure "security." The Service thus presents us with a prospective logical contradiction that needs to be reconciled.

In short, given the importance of habitat security to grizzly bear conservation, the Service needs to provide a readily-accessible and coherent justification for its

definition that is grounded in the best available science rather than bald assertion. If such a justification is not forthcoming, the Service needs to revise its standard for

secure habitat to reflect the best available science and then uniformly apply that definition in its delineations and deliberations.

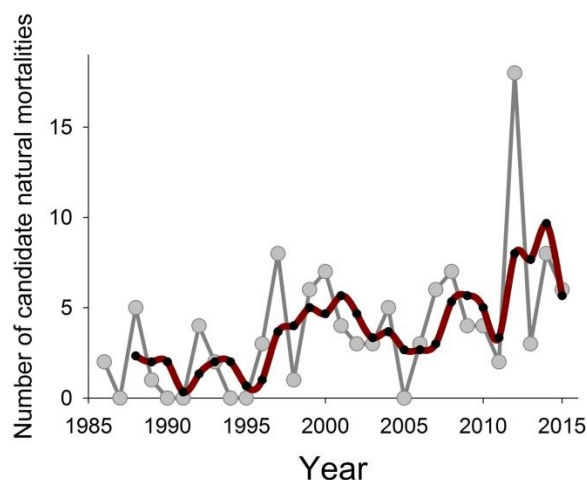
**17. The Service disregards and misrepresents the best available scientific information in its dismissal of natural predation as a threat to Yellowstone’s grizzly bears on page 13205 of the Rule.**

The Service claims that natural predation of grizzly bears is rare and then recites the number of bears known to have been killed by other bears (28 between 1986-2012, roughly 1 per year) and by wolves (a total of 8 during an unspecified period of time) in the Yellowstone ecosystem as a basis for then concluding “...this source of mortality does not constitute a threat to the GYE grizzly bear DPS now, or in the future.” These statements constitute a selective and distorted representation of the best available science which would, in fact, support a different conclusion.

Most of the grizzly bears that die because of natural predation are cubs and yearlings (for substantiation, see the Service’s own referenced literature). Most of these deaths are not documented because of the very nature of natural predation, which is very opaque to researchers. In the large majority of cases, young bears are noted to have disappeared between one sighting of the mother and the next, without any clue as to the cause. Only rarely do investigators get on the ground in a timely enough way to “document” the natural cause of death, which is almost invariably predation—rarely senescence or a natural accident. Nonetheless, a large number of cubs and yearlings disappear, almost all likely because of predation.

When all potential natural deaths are considered—again, most likely attributable to predation—a different picture emerges compared to the one painted by the Service. Drawing on IGBST data, the median number of bears that likely or almost certainly died from predation is actually nearer 3 per year rather than 1 per year for the period 1986-2015. Perhaps of more relevance to the Rule, these numbers have increased substantially over time, as shown by figure 17.1. Whereas the per annum median was 1 between 1986 and 1996, the median since 2010 has been 6. Throughout the period 1986-2015, 66% were

cubs and yearlings. The dramatic and non-trivial jump in deaths potentially attributable to predation corresponds with loss of foods such as whitebark pine and cutthroat trout (see my point under 11.1) and a probable shift by many of the affected bears to eating more meat from ungulates—which is likely to be particularly hazardous for the offspring of involved adult females (see my comments elsewhere, including the inadequate conceptual frame used by the Service to assess hazards associated with bear consumption of different foods [X]).



**Figure 17.1. Number of known and probable mortalities likely to have been caused by natural predation, 1986-2015. Annual numbers are shown by the gray dots, a running three-average by the thicker red line. Data were provided by the IGBST and the Service.**

In fact, this jump in known and probable deaths, likely attributable to predation, coincides almost exactly with the dramatic decline in cub and yearling survival rates documented by Van Manen et al. (2015), which they also attribute to bear predation (but under the rubric of “density-dependence,” a causal claim that is unsubstantiated for reasons that I articulate elsewhere). Regardless of the cause, Van Manen et al. (2015)



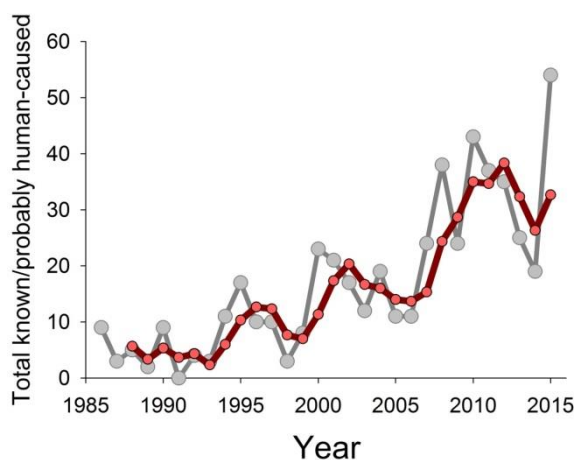
attribute the stalling of population growth beginning in the early 2000s in large part to this jump in deaths of young bears. In other words, this increase in deaths has had non-trivial effects on population trajectory.

As a bottom line, weight of evidence supports concluding that natural predation on especially cubs and yearlings has increased at the same time that survival rates of these younger bears has substantially declined, all with

demonstrable effects on population growth rate. As such, weight of evidence would support concluding that natural predation does, in fact, pose a “threat” to the population, especially given that weight of evidence further supports concluding that increases in natural predation are due primarily to a deteriorating environment—shifts in diet driven by losses of key foods such as whitebark pine seeds.

**18.** The claim by the Service on page 13207 of the Rule that “Because human-caused mortality has been reduced...this source of mortality does not constitute a threat to the GYE grizzly bear DPS now, or in the future” is a completely arbitrary unempirical assertion.

The Service deploys a number of bald assertions together with varying degrees of tortured logic on page 13206 and 13207 of the Rule in an effort to dismiss the threat posed by human-caused mortality to Yellowstone’s grizzly bear population as a basis for then concluding that ““Because human-caused mortality has been reduced...this source of mortality does not constitute a threat to the GYE grizzly bear DPS now, or in the future.” This conclusion and its supporting arguments are not only unsubstantiated by any empirical evidence, but also contradict the best available scientific information.



**Figure 18.1.** Total known and probable human-caused mortalities, by year, for the proposed Yellowstone grizzly bear DPS. The gray line and dots shown annual counts and the red line a 3-year running average. All data were obtained from the IGBST and the Service.

My claim is illustrated by a simple graph and derivative calculation using publicly-available scientific information obtained from the IGBST and the Service. Figure 18.1. shows the number of human-caused grizzly bear deaths in the Yellowstone ecosystem (i.e., the PCA, DMA, and proposed DPS) for each year, 1986-2015. The gray dots represent tallies for each year and the red line a 3-year running average of the same to emphasize trend. The result is unambiguous and in stark contrast to claims made by the Service in the Rule.

Total human-caused mortality has risen steadily since roughly 1994, and risen dramatically since 2007. More succinctly, human-caused mortality rose by 8.9% per year 1986-2015 and, even more remarkably, by 7.0% per year 2002-2015. This most recent period is especially relevant because the Service states in multiple places that “the population stabilized” during this approximate 15-year period. In other words, at the same time that the Service claims that the population did not increase, human-caused mortality was increasing by 7% per annum. If true, then human-caused mortality rates axiomatically substantially increased between 2002 and the present.

Parenthetically, if mortality rates were increasing during this 15-year period, one would expect the beginnings of a population decline. Elsewhere I present evidence that such a decline is, in fact, evident. But my point here takes the Service’s assertions regarding population growth and the data pertaining to human-caused mortality at face value. The inescapable conclusion is that all of the

management actions referenced by the Service on pages 13206 and 13207 of the Rule at best kept increases in human-caused mortality from being worse than they already were, but not enough to prevent the major observed increases.

As a bottom line, the only defensible conclusion to be drawn from the best available scientific information is that past (and prospective future) management actions were not sufficient to curb increases in human-caused mortality and, for that reason, human-caused mortality constitutes a threat to the GYE grizzly bear DPS now and in the future.

**19.** The Service employs methods for monitoring population trend and mortality rates that are unreliable, optimistically biased, insensitive to unfolding conditions, and prone to producing nonsensical results. These methods do not provide dependable information regarding status and trend of Yellowstone's grizzly bear population now or when prospectively applied after proposed removal of ESA protections. Moreover, the Service's methods are likely to allow for over-killing.

**19.1.** The Chao2 method adopted by the Service for monitoring population trend does not represent the best available science and is, moreover, beset by biases that have introduced systematically inflated and overly-optimistic estimates of trend for the Yellowstone grizzly bear population.

The Service repeatedly asserts throughout the Rule, CS, and Recovery Plan Appendix that the so-called Chao2 method is "the best available science" for estimating population size and, from that, population trend. These assertions are unsubstantiated and contradicted by what is, in fact, the best available science. Even more mystifying and problematic, the Service fails to acknowledge ample of evidence of bias affecting the Chao2 method, which results in systematically inflated estimates of trend for the Yellowstone grizzly bear population.

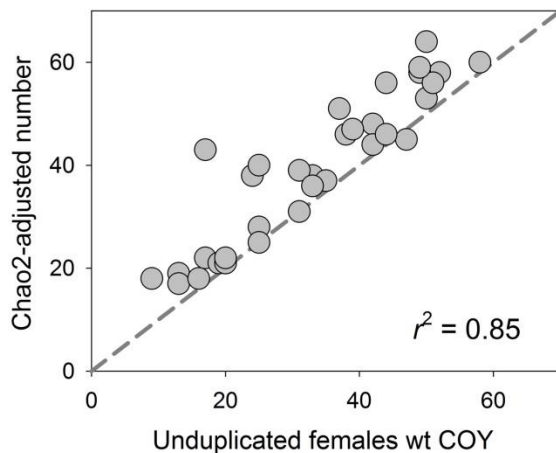
The Chao2 method is driven by counts of unduplicated females with cubs-of-the-years (Females with COY). Once these counts are ascertained, the Chao2 calculation presumes to account for all of the females with COY that were not detected (unknown, unrecorded). Once the known and unknown females with COY are added together and summed over a three-year period, this presumed estimate of total numbers of reproductive females in the population (given a 3-year reproductive interval) is multiplied by various factors to account for other sex- and age-classes of grizzly bears, thereby yielding a purported estimate of total population size.

Doak and Cutler (2014a, 2014b) present a compelling critique of the Service's approach to estimating population trend based on counts of females with COY, adjusted by the Chao2 method. Doak and Cutler show that essentially all of the positive population trend presumably exhibited by Yellowstone's grizzly bear population between the early 1990s and the present is likely to have been an artifact of biases introduced by increased search effort and increased intrinsic sightability of bears. Van Manen et al. (2014) attempted to refute Doak and Cutler's original critique, but were refuted, in turn, by Doak and Cutler's more recently published paper (2014b), which constitutes the last word insofar as the best available science is concerned. Interestingly, the IGBST itself admits to the very bias identified by Doak and Cutler in Table 2.1 of the Workshop Report (IGBST 2012) that the Service invokes throughout the Rule.

The figures below are illustrative of the major problems besetting the Service's Chao2 method. For one, the Chao2 calculation introduces an implausibly small adjustment to presumably account for unseen undocumented females with COY—on average, only an additional 6, or 19% more, per year. In other words, the Service is essentially claiming that roughly 81% of all females with COY are seen and documented, which is *prima facie*, unlikely. Similarly, as figure 19.1.1 illustrates, adjusted and underlying counts are 0.92 correlated, which means, not only that underlying counts of females with COY explain 84% of the total variation in resulting



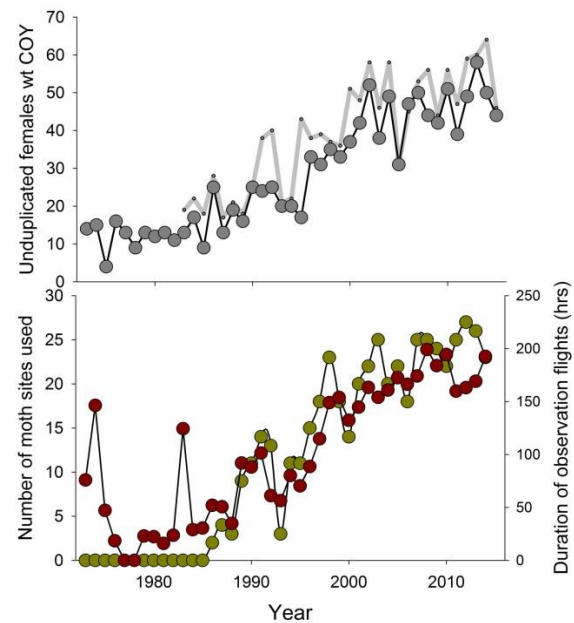
estimates of the cohort total, but also that the Chao2-adjustment introduces essentially no additional information. As a bottom line, it is highly unlikely that the Chao2-adjustment corrects for much of anything, meaning that the resulting estimates of total population size are driven almost entirely by counts of females with COY alone. Importantly, these underlying counts are based on all sightings from all sources, without accounting for any factors that might influence such sightings.



**Figure 19.1.1.** The relationship between annual numbers of unduplicated females with COY (x-axis) and the total number of females with COY after adjustments introduced by the Chao2 estimator (y-axis). Each gray dot represents one year's data; the dashed line represents a perfect 1:1 relationship.

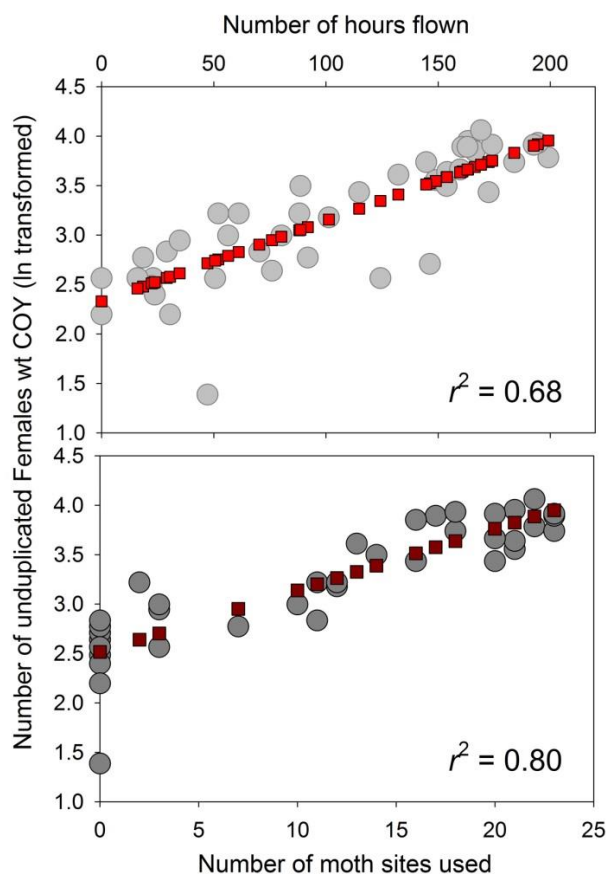
Figure 19.1.2., to the right, illustrates perhaps the central problem with the Chao2/females with COY method. The top graphic in this figure shows long-term trends in numbers of females with COY (dark gray dots) along with the minor adjustments introduced by the Chao2 calculation (the light gray line above). This trend is the primary (but not sole; see my comments below) basis for the Service's claims regarding increases in Yellowstone's grizzly bear population. Then notice the trend lines in the graphic at bottom. The burgundy dots show the numbers of hours flown by researchers and managers in efforts explicitly designed to sight females with COY, which matters because roughly 66% of all sightings of females with COY are made from the air. The yellowish-green dots show the number of sites known to be used by bears feeding on army cutworm moths, which matters because, unlike any other feeding activity, essentially all of the bears engaged in this activity are seen by aerial

observers (O'Brien & Lindzey 1998). In other words, levels of feeding on moth sites are indicative of intrinsic sightability of the bears being sought out by researchers and managers.



**Figure 19.1.2.** The top graphic shows annual counts of females with COY (gray dots) and presumed adjustments by the Chao2 method to account for unseen undocumented females. The bottom graphic shows aerial search effort by managers and researchers as part of observation flights (burgundy dots) and number of moth sites used by grizzly bears (yellow-green dots).

The parallels are striking. Presumed trends in counts of females with COY almost perfectly mirror search effort and moth site use, the latter (as I point out immediately above) an indicator of overall sightability. Figure 19.1.3 puts this in more literal terms by relating annual counts of females with COY to aerial effort (top) and number of exploited moth sites (bottom). The take-away here is that, depending on which relationship you want to consider, search effort could explain 70% and moth site use 80% of the total variation in annual counts of females with COY—which leaves little residual variation to reflect much of anything happening with underlying true population trend. These relationships simply reiterate in graphic form the main critique of the Chao2 method made by Doak and Cutler (2014a, 2014b).

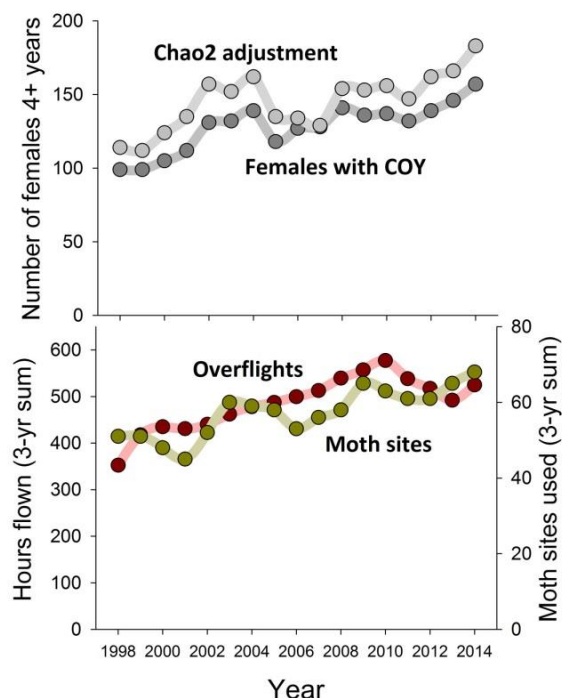


**Figure 19.1.3.** The figure at left shows relations between annual counts of females with COY (natural-log transformed) and aerial search effort (top) and number of moth sites used by grizzly bears (bottom). The gray dots correspond to data for a given year and the red squares to the predicted value given the modeled relationship.

Unfortunately, Chao2 estimates and underlying counts of females with COY have continued to be contaminated with bias during the last 20 years from increases in search effort and sightability—despite claims by the Service and IGBST that search effort has more-or-less stabilized. Illustrative of my point, figure 19.1.4. shows trends in aerial search effort, moth site use, counts of females with COY, and Chao2 adjustments for this period.

Parenthetically, the IGBST has argued that aerial search effort increased simply as a function of the increased distribution of Yellowstone’s grizzly bear population. As it turns out, even when standardized to distribution of the

population at any given point in time, aerial search effort per unit area doubled between the mid-1990s and late 2000s.



**Figure 19.1.4.** Three-year sums of females with COY and related Chao2 adjustments (top) and 3-year sums of aerial search effort and moth site use by grizzly bears (bottom) for the period 1995-2014.

In short, if you have a compelling argument showing that most variation in annual estimates produced by the Chao2 method is an artifact of bias—as I have demonstrated here—any assertion that the method produces reliable and useful indicators of trend is essentially arbitrary, if not capricious—as with the Service’s assertions that this method is reliable and “the best available science.”

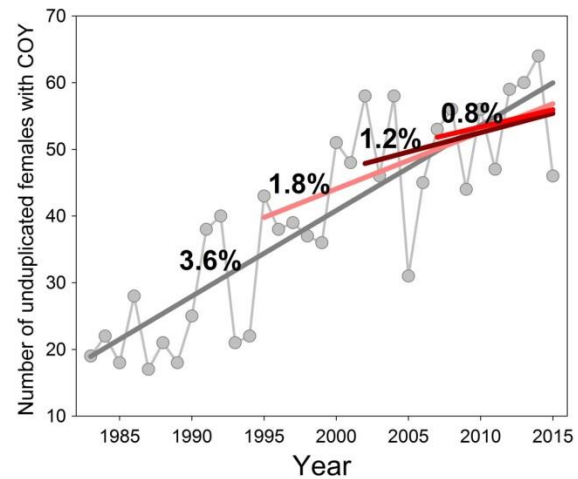
Having made this point, deficiencies in the Chao2-based approach could be partly remedied by having the Service insure that search effort and search distribution remain constant in the future, while at the same time relinquishing any claims to being able to estimate past trend in population size using this method (see my comments 20.4 and 20.5).

**19.2.** The so-called “model-averaged” approach adopted by the Service to produce estimates of population size and, from that, estimates of population trend, is insensitive to unfolding problematic conditions. Estimates of trend from this approach are also vulnerable to manipulation depending on the time period adopted for model specification.

Even taking the egregiously deficient Chao2 method at face value, the so-called “model-averaged” approach adopted by the Service contributes to an overall method that is remarkably insensitive to rapidly unfolding conditions in the Yellowstone ecosystem. This matters because, as I document extensively in my comments, environmental conditions are, at best, rapidly changing and, much more likely, substantially deteriorating.

The model-averaged approach basically fits a regression model to Chao2-adjusted annual estimates of total females with COY, and then uses the intercept and slope from the model to, in turn, estimate the current year’s total. This approach presumably “smooths” short-term trends. Moreover, the regression model is fitted to data going back to 1983, presumably to produce a “reliable” estimate of trend with narrower confidence intervals, this as a consequence of employing a larger  $n$ .

The logic behind this approach is inane. The Service is basically substituting statistical precision for ecological relevance by inflating sample size through inclusion of annual data that have long since become irrelevant to judging status of the population. Why include annual counts of females with COY from 1983-1995, or even from 1995-2000, given the dramatic changes that have occurred and continue to occur in the Yellowstone ecosystem since the mid-1990s and early 2000s (see my comments elsewhere)? This conflation of precision with ecological importance is an error that most textbooks on biostatistics warn against—but apparently to no avail with the Service. More specifically, for the regression methods employed by the Service (and IGBST) to be valid, the distributional relationship of females with COY to time is assumed to be “stationary”—in essence meaning that underlying system dynamics are not changing. This assumption clearly does not hold here.



**Figure 19.2.1.** This graph shows trend lines fit to data for numbers of females with COY in the Yellowstone ecosystem, with each line representing a fit to a different span of years. The percent change per annum is shown for each trend line, emphasizing that estimates of trend change and become progressively approach zero as the time interval is truncated closer to the present.

Moreover, results of the “model-averaged” approach depend substantially on the time period being modeled—not only in generating an estimate of trend, but also in producing an estimate of population size (as a function of the  $\beta$  coefficient indicating trend). This matters because, the farther back you go in time with Yellowstone’s grizzly bear data, the more optimistically you bias your results. So the Service (or whomever) can more-or-less arbitrarily generate different results by basing estimates on different periods of time.

Figure 19.2.1 illustrates this problem. I show annual Chao2-adjusted estimates of females with COY as gray dots in the background. I also show trend lines fit by regression to natural-log transformed values, with each line corresponding to results using different relevant periods of time: 1983-2015 (the Service’s default); 1995-2015 (when we began to see major declines in trout and elk as per my comments elsewhere); 2000-2015 (when we first started to see major beetle-caused whitebark pine mortality); and 2007-2015 (when we saw the terminal decline in availability of whitebark pine seeds, also as per my earlier comments). The numbers above each line are the trends estimated for each period, represented as annual percent change. The point is pretty basic: population trend declines as you

progressively truncate the included years, which, in turn, yields a lower estimate of current total population size.

Finally, the Service's use of a model-averaged approach is flawed because it makes a further nonsensical assumption: that there is some theoretically-justified intrinsic relationship between counts of females with COY and time that can be specified mathematically and statistically in terms of an underlying model. A relationship between numbers and density? Perhaps. A relationship between numbers and food abundance? Yes. But not a relationship between numbers and the mere passage of time.

Even if one were to buy off on this unsupported assumption, one then needs to justify the form of the model adopted for estimating trend as a basis, in turn,

**19.3.** The mortality rates presented by the Service in Tables 1 and 3 of the Rule as benchmarks for managing mortality are liberal and thereby allow for over-killing of grizzly bears relative to objectives keyed to different population sizes.

The basis for this concern arises from the recent critique of IGBST estimates of population trend by Doak & Cutler (2014a, 2014b). They showed that there was good reason to think that population growth rate had been over-estimated by the IGBST using both the Chao2-based method and more complex calculations using death and birth rates estimated from known fates of radio-marked grizzly bears. More specifically, Doak & Cutler found that Schwartz et al. (2006) and IGBST estimations thereafter had not accounted for senescence in both birth and death rates of female grizzly bears, and that when accounted for, female survival rates and population growth rate (as estimated by Harris et al. 2006) dropped significantly.

Van Manen et al. (2014) claimed to have rebutted the original Doak & Culer (2014a) analysis. Aptly enough, the response of Doak & Cutler (2014b) to this presumed rebuttal was entitled "Doth Protest too Much." More specifically, Doak & Cutler found that the Van Manen et al. response was larger confirmatory of their original critiques. To quote Doak & Cutler: "[the Van Manen et al.] results show that incorporating senescence sharply reduces previously estimated population growth from

for estimating total numbers of females with COY. Linear? Quadratic? Cubic? Asymptotic? Logistic? A different choice will yield a different model-based estimate of current population size. And yet the Service employs linear and quadratic models, without statistical or theoretical justification. In short, this aspect of the method, like choice of time frame, entails arbitrary and capricious decisions on the part of the Service.

The Service needs to abandon its "model-based average" approach given the insensitivity of this method to rapidly changing environmental conditions in Yellowstone and because it does not constitute the best available science. An approach based on a running average of annual growth rate over a sensible number of preceding years—say six—would probably service the purpose instead.

1983 to 2001"; and "[the Van Manen et al.] study shows that there is so much uncertainty in population estimates that inferences about population trends are extremely weak." In other words, the collective results presented, not only by Doak & Cutler (2014a, 2014b), but also by Van Manen et al. (2014) show that population growth rate from 1983-2001 was over-estimated by the IGBST, and that all of the methods used by the IGBST for monitoring the Yellowstone grizzly bear population provide an "extremely weak" basis for inference.

Insofar as the Rule is concerned, the best available science shows that the mortality benchmarks in Tables 1 and 3 are too liberal by virtue of being linked to inflated estimates of population growth—which means that purported management objectives will not be achieved by employing these rates. More specifically, a 7.6% and 15% mortality rate for females and males, respectively, will not maintain a stable population, but rather yield unintended declines. And given all of the other problems with methods for monitoring and responding to mortality rates that I describe in my comments 19 and 20, there is a good chance that such declines will not be detected nor addressed in a timely manner, and certainly not in a way that would allow a meaningful response to prospective lags between environmental degradation and demographic responses (my point 5).

Given these considerations, the Service needs to: (1) acknowledge rather than glibly dismiss the unreliability

of all its current indicators of mortality and population growth rates; (2) revise all of the benchmark mortality rates in Tables 1 and 3 downward by several percentage points to acknowledge and account for the liberal bias of the rates they currently use—for example, from 7.6%

**19.4.** The Service employs a method for indexing annual mortality rates that has no known or unbiased relationship to the mortality standards/thresholds presented in Tables 1 and 3 of the Rule. As a result, allowable levels of mortality calculated using the Service's proposed methods for post-delisting management entail a non-trivial risk of over-killing Yellowstone's grizzly bears, and thereby pose a threat.

The mortality rates codified in tables 1 and 3 of the Rule are presented by the Service as if they were reliable guidelines for managing grizzly bear mortality to achieve either population stability, increase, or even declines. The rates associated with maintaining a stable population (for example, 7.6% per annum for independent-aged females) are assumed to be sufficient for the purpose because they are associated with presumed population increases. But there are major problems with this approach sufficient to nullify it as a reliable guide for management.

The Service proposes to manage grizzly bear mortality so as to achieve various population goals by comparing the ratio for a given year of estimated total dead to total live bears against a benchmark rate calculated from the known fates of radio-marked bears. In other words, an estimated total number of dead bears ( $D$ ) is divided by an estimated total population size ( $N$ ) for a given year to yield a purported estimate of death rate (i.e., a ratio of dead to live bears)—this for each of the monitored sex-age classes of grizzly bears. Total dead bears are estimated using methods described in Cherry et al. (2002) and total live bears using the Chao2-based estimation of total reproductive females, coupled with multipliers to account for dependent young, pre-reproductive females, and independent males. This purported rate is then compared against a benchmark rate billed as being selected so as to achieve the

down to 5.6% for females at a population size of  $\leq 674$ ; and (3) put its move to delist Yellowstone's grizzly bear population on hold until it has a better basis for managing mortality.

management purposes attached to a given population size: e.g.,  $\leq 675$ , 675-747, or  $>747$ .

The benchmark rate was calculated as (essentially) the probability that a given radio-marked bear would have died during a given year at a given age—in other words, based on known fates of bears that had been captured and ratio-tracked. Any given rate based on known fates is related to a prospective population objective (growth, stasis, or reduction) based on simulations of population growth using a range of birth and death rates. In other words, if the population was estimated to be growing or stable, then the death rates computed from fates of radio-marked bears are estimated to be those compatible with any future population growth or stasis.

One key assumption in the management approach described in the Rule and MOA is that there is equivalence between population growth rate and death rates. This assumption is tenuous at best because it does not deal with variation in birth rates: population growth is, axiomatically, the difference between birth and death rates. In other words, one half of the equation is left out of any explicit consideration. The only presumed corrective is allowances made in both the Rule and MOA for a reevaluation of demographic rates by the IGBST should the grizzly bear population be declining for reasons that don't comport with applied death rate guidelines. And this is to happen only if prescribed death rates are exceeded 3 years in a row (for problems with that provision see my comments under 20.3).

But the other important assumption is that the calculation used to estimate annual death rates ( $\hat{D} / \hat{N}$ ) correlates perfectly with the benchmarks estimated from known fates of radio-marked bears—and with a 1:1 slope. As it turns out, the exact relationship between the benchmarks and the index being used to monitor death rates is unknown. Certainly—emphatically—there is no equivalence between the methods underlying each. Put another way, even if we calculate a putative death rate

of 7.6% for adult females in the population during a given year, we don't know whether that 7.6% is either "real" or unambiguously equivalent to the rate being proffered as a standard and a guideline.

This is a case where apples are being compared to oranges and where, moreover, the Service is either not identifying this discrepancy or even cognizant of it in the first place. But, again, as with lack of attention to birth rates, the presumed corrective will be some sort of management review if and when a mysterious population decline were to occur—but then almost certainly much delayed because of the current provision for review only if mortality standards are violated three years in a row (and, again, see my point below).

What makes this situation all the more risk-ridden is the *fact that the methods by which total deaths and total live bears are calculated are prone to substantial bias* ( $\hat{D}$  and  $\hat{N}$  are merely biased estimators)—of a nature that can both amplify or dampen bias in a relationship with benchmarks that is already unknown. Hence, the nature and magnitude of change in bias from one year to the next is, and will continue to be, unknown, with the distinct possibility of unintentionally over-killing bears.

More specifically, as the IGBST (2012) notes in table 2.1 of a recent review of population monitoring, the method for estimating total mortality is "Slightly Low (slightly more deaths may have occurred than estimated because heterogeneity in data greater than accounted for in estimator; effect would lead to underestimating total mortality)" (see my comment immediately below). And, if "Low" is approximately of the same magnitude as "Low" (in the same report) for the Chao2 estimator, then there are major problems. Likewise, the Chao2-based estimator of total population size is likely to vary with search effort (as I document in my point 19.1). In other words, if there is little effort invested by managers in finding bears, then estimates of population size will probably be increasingly biased low, in ways that could partially offset or mitigate for underestimates of total mortality. But—importantly—the Service doesn't know exactly how these biases interplay. And search effort to document females with COY has increased dramatically, so the bias towards a low estimate of population size is lessening at the same time that our estimates of total mortality are varying in unknown ways relative to biases

introduced by "heterogeneity" (Cherry et al. 2002, USGS 2012). In other words, bias is varying all over the place in unknown and undocumented ways, with potentially major effects on a metric central to monitoring the Yellowstone grizzly bear population, now, and in the future.

Finally, estimates of total population size are substantially affected by the multipliers used to account for dependent young, pre-reproductive independent females, and independent males, all with the potential for introducing yet more bias. As I point out below (my point 19.4), the multiplier used to account for independent males was increased substantially during and after 2012, according to the IGBST because death rates for independent males had decreased—substantially. Yet, as I point out below (point 19.4), survival rates of independent males very likely did not increase, but rather decreased—the opposite. Which is to say that a bogus multiplier was applied resulting in an artificial inflation of total population size by around 100 bears, with this biased estimate of total population size then used as the denominator for indexing death rate—with predictably yields a lower "rate." And this on top of the systematic inflation of total population estimates introduced by continuing increases in search effort and sightability of bears (see my point 19.1).

As a bottom line, the method being billed by the Service as insurance against over-"harvest" of grizzly bears is beset by a substantial amount of uncorrectable bias that introduces non-trivial risk of over-killing bears. This arises from multiple causes, including (1) using a method for estimating death rates that has no known relationship to the standards being used to guide management (the apples and oranges problem); (2) substantial biases affecting methods for estimating both total numbers of annual deaths (the death rate numerator) and females with COY during a given year (the root of the death rate denominator); and (3) bias and outright error affecting multipliers used to derive estimates of total population size. The chain of potentially compounding errors debars any confidence in the Service's method for monitoring grizzly bear death rates.

If there is a corrective, it entails, at a minimum: (1) standardizing search effort for females with COY (as per my points 19.1 & 20.5); (2) further developing the



method for estimating total numbers of deaths so as to account for biasing “heterogeneity”; (3) rigorously account for variation in birth rates as part of an on-going (versus discretionary and episodic) analytic process; and (4) employing a precautionary (rather than incautious)

**19.5.** The Service produces inflated estimates of population size and trend that are largely an artifact of implausibly high estimates of survival rates for male and female bears 2+ years old. Moreover, these survival rates are also insensitive to rapidly changing conditions. Together, these short-comings constitute a methodological threat to the Yellowstone grizzly bear population.

As I preview in my comments above under point 19.3., the Service uses estimates of death rates derived from fates of radio-marked bears at several critical junctures in its proposed and current methods for monitoring and managing mortality of Yellowstone’s grizzly bears. For one, these rates are the basis for the seminal benchmarks presented in Tables 1 and 3 of the Rule for achieving either population increase, stasis, or decline—depending on estimated population size. The mortality rates are also directly used to determine the proportions of different sex-age classes in the population, in turn, the basis for multipliers used to arrive at total population estimates. The estimated proportions of independent males, pre-reproductive independent females, and dependent offspring are essentially inverted and each used to multiply annual Chao2-based estimates of total reproductive females.

These multipliers obviously can have major effects on total population estimates. For example, beginning in 2012 the IGBST began using a larger multiplier to account for number of independent males, this because they claimed that the most recent estimate of death rates for males, using data from 2002-2011, had decreased. Hence there were presumably more males in the population than had been thought. In fact, the difference between population estimates using the old and new multipliers averaged 107 for 2012-2014, which amounted to an instantaneous 17% increase in total population size. Axiomatically, this substantial increase in the denominator for calculating the index of mortality rate translated into decrease in this rate—by roughly 15%. In

approach to developing multipliers to account for sex-age cohorts other than reproductive females. Meanwhile, the Service needs to remove the inflated claims that it makes in the Rule for the efficacies of its current approach to managing mortality.

other words, depending on the multipliers, you can be either substantially over or under a given mortality rate threshold such as those presented in Tables 1 and 3 of the Rule.

For these reasons the estimates of death rates derived from fates of radio-marked bears need to be unimpeachable. But there are two major problems with these rates, one of which is chronic, and the other particularly evident during the last 15 years.

The chronic problem has to do with the inherent extent to which death (and birth) rates calculated from fates of radio-marked bears are insensitive to rapidly changing conditions. This arises from the fact that reliable estimates depend on large sample sizes, and the only way one can come up with a large sample size is to include data that span a number of years—a decade or so. In other words, these death rates (or, inversely, survival rates) are slaved to the past and, in an environment such as Yellowstone’s, 10 years can rapidly become irrelevant to the present and near future. In fact, this problem holds for all estimates obtained from fates of radio-marked bears, including birth rates. As a result, episodic future reviews of demography by the IGBST, through the lens of data from ratio-marked bears, will stand little chance of offering critical insights needed to remedy deteriorating population-level conditions—contrary to assertions in both the Rule and the MOA.

But the more important problem is the extent to which death rates derived from fates of radio-marked bears are not only discrepant from, but also fundamentally at odds with, straight-forward and unambiguous trends in numbers of grizzly bears dying in the Yellowstone ecosystem.

Figure 19.4.1 illustrates this problem. The red lines show three-year running averages for numbers of known-probably deaths of female (top) and male (bottom) grizzly bears >2 years old. The black dashed line towards the top

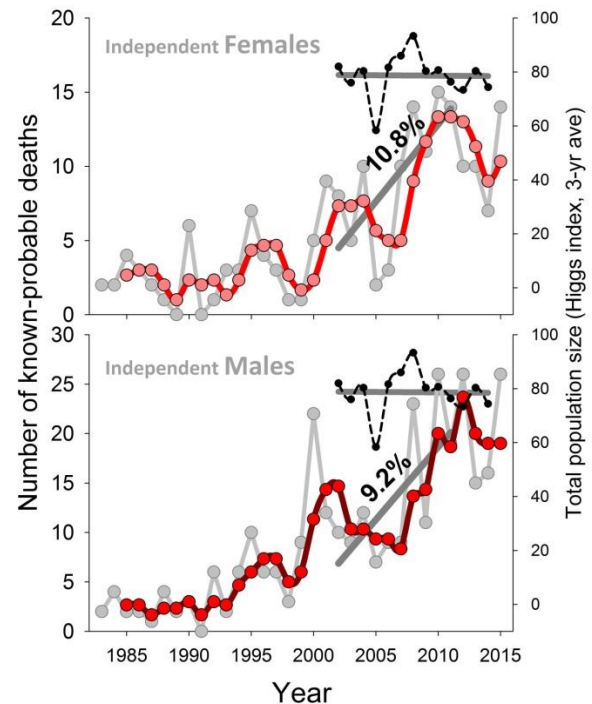


of each graph shows what is probably our most reliable annual estimates of total population size derived from the Mark-Resight method (a less biased although less precise estimator compared to Chao2). I show the two trends in juxtapose for good reason given that death rate (as above) is essentially the number of bears dying as a fraction of the number of bears alive. In other words, if the number of live bears is static or declining at the same time numbers of dead bears are increasing dramatically, then death rates *must* be increasing. And, in fact, numbers of male and female deaths were increasing at an astounding rate of 9-10% per annum for the period 2002-2011, at the same time that total population size was essentially static. In other words, death rate *must* have been increasing dramatically during this period of time for both sexes.

Yet, as I noted above, the IGBST claims (in its 2012-2014 Annual Reports), not only that death rates of male bears were *decreasing* during 2002-2011, but also that death rates of female bears *remained unchanged*. It is as if the data I present in figure 19.4.1 and the data the IGBST used to calculate revised death rates were drawn from two different universes. Which are to be believed? I would argue that the data I present here (all from IGBST databases and Annual Reports) are straight-forward and virtually impossible to refute, whereas the death rates estimated by the IGBST from fates of radio-collared bears derive from assumption-ridden, complex, and refutable models. There is good reason to believe the unambiguous trend data.

**19.6.** The method adopted by the Service for estimating total numbers of grizzly bear mortalities during a given year tends to under-estimate this total and is insensitive to unfolding trends that have likely increased rather than decreased the magnitude of this under-estimation.

The Service repeatedly invokes the method developed by Cherry et al. (2002) as its basis for estimating total



**Figure 19.4.1.** Trends in annual numbers of known-probable grizzly bear deaths for females (top) and males (bottom) juxtaposed with trends in annual estimates of total population size using the Higgs et al. (2013) Mark-Resight method. The red lines are 3-yr running averages of deaths and the light gray lines behind the annual numbers. Total population size is shown by the dashed black line. I've also included trends lines and associated estimates for deaths, 2002-2011.

In short, the death rates that the Service draws on so heavily in the Rule and that the states employ so centrally in the MOA stand impeached. At the very least the Service needs to adequately explain the contradictions that I high-light here. Moreover, the Service's frequent assertions that current mortality rates do not threaten Yellowstone's grizzly bear population are unsubstantiated and, in fact, contradicted by the best available science.

number of grizzly bear deaths, a value which is then used in the numerator of the calculation used to annually index death rates in the Yellowstone ecosystem. This rate index is compared to the benchmarks in Tables 1 and 3 of the Rule to determine whether numbers of deaths were compatible with different management objectives. I describe other problems with the Service's overall method for monitoring and managing mortality under

other points but focus here on problems with its adopted method for estimating total numbers of dead bears.

There are two basic and relatively well-recognized problems with the Cherry et al. (2002) method. First is a tendency to under-estimate total mortality. Second is a related vulnerability to systematic bias interjected over time as a result of changes in cause of death as well as capture and radio-collaring efforts.

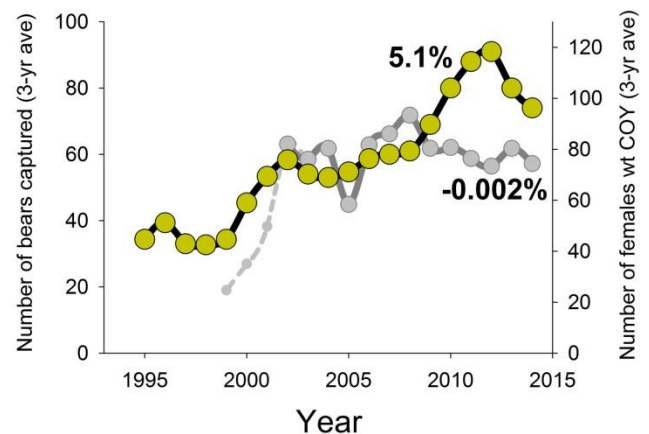
The risk-inflating tendency of this method to under-estimate mortality is noted in Table 2.1 of the seminal 2012 IGBST Workshop Report: “Slightly Low (slightly more deaths may have occurred than estimated because heterogeneity in data greater than accounted for in estimator; effect would lead to underestimating total mortality).” This is a chronic problem that is exacerbated or mitigated by changes in bias affecting estimates of total population size—which is the denominator in calculations of annual indices of death rate.

But there is a second problem, prominently noted by Cherry et al. (2002): “The assumption of a constant reporting rate for radio-collared bears over time was important in our specification of the prior and in application of the method to the count data. This assumption could be violated if, for example, the probability of a death being reported depended on the cause of death and these causes changed over time. Mattson (1998) argued that this has in fact occurred...there is some evidence that reporting rates have declined in recent years.” In other words, if causes of death are trending towards those that are less likely to be reported, then the Cherry et al. (2002) method will be prey to an ever-increasing under-estimation of total deaths.

Moreover, estimates of total deaths will be further biased by level of effort to capture and radio-collar grizzly bears in the Yellowstone ecosystem. This bias arises from the fact that deaths of radio-collared bears are not subject to the multiplier introduced by Cherry et al. (2002) to presumably account for unreported-unknown mortalities. In other words, if ever more effort is being exerted to capture bears, resulting in ever-more radio-marked bears, you are likely to end up with a larger number of deaths each year attributable to marked bears and thus not subject to any adjustment to account for

unknown mortalities—this simply as a function of effort on the part of researchers and managers and without any intrinsic relationship to numbers of bears dying.

Figure 19.5.1. shows that grizzly bear captures have in fact increased at a far more rapid rate than any probable change in total population size, which is consistent with capture effort alone magnifying the extent to which total grizzly bear mortality is being under-estimated. As shown by the yellowish-green dots, numbers of bears captured and then monitored have increased at 5% per annum since 2002, at the same time that estimates of total population size based on the Mark-Resight method have essentially not changed (the gray dots). Ergo, a larger fraction of the population is being marked, predictably yielding a larger number of dead bears that were radio-collared—which is, in fact, the case, at a rate of roughly 4% per year since 2002.



**Figure 19.5.1. Trends in numbers of bears captured each year (yellowish-green dots) and estimated total population size (gray dots, based on Mark-Resight). Both values are presented as 3-year running averages, along with estimates of annual change in each time series by the numbers shown for each.**

In short, the Service fails to acknowledge the several problematic biases affecting its promoted method for estimating total numbers of dead bears in the Yellowstone grizzly bear population. On top of this, the Service fails to acknowledge that these biases amplify risk and, perhaps more importantly, that these biases have probably increased over time resulting in an ever more pronounced under-estimation of total mortality. As a result, death rate is probably being increasingly under-estimated, leading to increased errors by managers regarding the sustainability of current levels of mortality.

The Service needs to acknowledge these biases affecting estimation of total grizzly bear deaths and the risks that they bring. Related, the Service needs to surrender any of its claims regarding past trends in mortality rates and focus, instead, on efforts to improve methods so as to

reduce bias. At a minimum these include upgrading the current Cherry et al. (2002) method to account for changes in cause of death for unmarked bears, and standardizing capture efforts so as to not introduce bias arising simply from increased exertions on the part of managers and researchers.

---

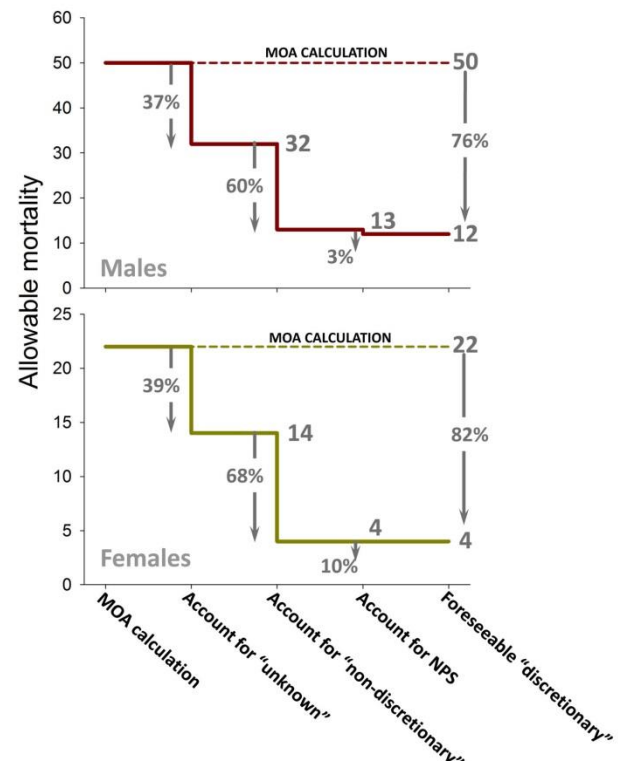
**20.** The Rule and the accompanying Memorandum of Agreement (MOA) developed by the states for managing Yellowstone’s grizzly bears post-delisting are inadequate in provisions for calculating and managing total allowable mortality. Moreover, both the MOA and the Rule are deficient in terminology and provisions for managing grizzly bear distribution.

**20.1.** The methods described in the Rule to account for ‘background’ mortality are not only discrepant with methods described in the MOA, but also fail to account for unknown-unreported grizzly bear deaths, thus constituting a major methodological threat to the Yellowstone grizzly bear population.

On page 13203 of the Rule the Service walks the reader through an example of how ‘discretionary’ mortality will be calculated—of which presumably all could be provisionally allocated by the states at the beginning of a given year for sport hunting. The example calculations purport to account for ‘background’ mortality, which is defined in the previous paragraph as including various causes, including “unknown/unreported calculations.” Yet the example given by the Service, fails, in fact to account for “unknown/unreported” mortalities, leading to an inflated estimate of the number of bears candidate for ‘discretionary’ mortality. This is a major error given that discretionary mortality for independent females and males ends up being over-estimated by approximately 75% and 200%, respectively. In other words, this is a non-trivial even fatal mistake on the part of the Service.

The Service needs to account for unknown-unreported mortalities in its calculations. Given the current IGBST method used to estimate unknown-unreported deaths, this foreseeable cause needs to be subtracted before other foreseeable ‘non-discretionary’ deaths are deducted. Given that the unknown-unreported fraction during 2010-2014 has averaged 39% of the total known-probable deaths for independent females and 37% of the same for independent males, these fractions need to be the first to be subtracted from the initial calculation of allowable mortality. After that, other ‘non-discretionary’ causes can be deducted.

The other major missing piece in the Service’s proposed method for estimating and allocating ‘discretionary’ mortality is its lack of provision for the National Park Service. This is especially glaring in the MOA, which presumably further codifies methods described in the Rule. In other words, all of the ‘discretionary’ mortality is



**Figure 20.1.1.** An illustration of reductions in allowable mortality that need to happen if unknown-unreported and other ‘non-discretionary’ deaths are to accounted for, in addition to ‘discretionary’ deaths foreseeably occurring on NPS jurisdictions—prior to any determinations regarding bears available for ‘discretionary’ management on non-NPS lands.

assumed to go to jurisdictions managed by the states of Wyoming, Montana, and Idaho, and none to National Park Service-managed lands. Recent history would suggest that this NPS fraction is roughly 10% of the ‘discretionary’ total. In other words, explicit provision needs to be made for this foreseeable mortality occurring on NPS jurisdictions, with corresponding

deductions from the states' share of 'discretionary' up for grabs as a prospective sport hunt.

By way of clarification, figure 20.1.1, illustrates the nature of the stepdown that needs to occur in the Service's calculations; first accounting for unknown-unreported, then other 'non-discretionary', then the NPS share—this for a population of roughly 717. The percentages I use are approximations. Exact percentages

**20.2.** A guideline for total mortality rate, with the intent of producing population growth, is needed in both the Rule and the MOA for an estimated population size of  $\leq 600$  bears.

The rationale for this recommendation is pretty straightforward. Managers should set a goal, expressed in terms of total mortality rates, that will likely produce growth in the Yellowstone grizzly bear population should it drop below the basement number of 600. Even taken at face value, the mortality guidelines currently set for any population less than or equal to 674 are, by the Service's own admission, rates associated with a stable population at best.

The agencies may argue that they already have a provision for eliminating virtually all 'Discretionary'

**20.3.** Review of current management approaches should be mandated whenever mortality guidelines are exceeded during any two consecutive years, for any of the three specified cohorts of bears, rather than the standard of three consecutive years specified in the current Rule and MOA.

Both the Rule and the MOA specify that a review of management leading to potential changes in harvest would occur only if recommended mortality rates were exceeded in 3 consecutive years. If the sequencing was right (e.g., 2 years of excess followed by one year within bounds, followed by two more sequences of this nature), this protocol would allow the states to kill bears in excess of recommended guidelines for 7 out of 10 years, which,

(or at least transparent methods for calculating exact percentages) for each stepdown need to be calculated and presented by the Service

Finally, the methods described in the MOA for calculating 'discretionary' mortality are considerably discrepant from those described in the Rule. This discrepancy needs to be corrected, along with other corrections that I have outlined here.

mortality once 600 is reached—tantamount to a drop in total mortality rate. This is not enough. An explicitly named target rate would provide incentive to reduce what the agencies are currently calling 'Non-discretionary' mortality once the population is at or near 600; and this mortality rate should be several percentage points below the 7.6% and 15% caps applied to males and females when the population is  $< 675$ . Given that there are a 1.4% and 5% drops in the benchmark mortality rates for females and males, respectively, once the population drops below 675, it would be logical to apply a commensurate drop in benchmark rates once the population drops below 600, to around 6% for females and 10% for males. (Also, see my 20.6, below, for more on the problems of using 'Discretionary' and 'Non-discretionary').

taking all of the other elements of the MOA at face value, would be a recipe for producing a declining population—and without provision for introducing a timely change in management. Under the current approach, a check would only be introduced if estimated population size dropped below 600, at which point, options for reversing course would be intrinsically limited.

With the change recommended here (review after 2 rather than 3 successive years of violated mortality rate targets), timely review would be triggered much more often and with the prospect of actually reversing course prior to excessive declines in the bear population. Certainly, the current proposed approach is not precautionary nor in any other way conservative.

**20.4.** Both the Rule and the MOA need to commit to resetting or recalibrating all aspects of the methods used to monitor trend, calculate allowable total mortality, and trigger various outside reviews if and when new methods are adopted for estimating total population size. Without this provision, the existing approach constitutes a methodological threat to the population

The Rule and MOA describe methods for calculating total allowable mortality ('Discretionary' plus 'Non-discretionary') that are highly sensitive to estimates of total population size. Given that different estimators of total population size can yield numbers that vary by as much as 40%—even using the same inputs (e.g., Mark-Resight versus Chao2; Higgs et al. [2013] and IGBST [2015])—the Service needs to include language in the Rule that explicitly guards against state agencies introducing a new method that dramatically increases estimates of total population size without any commensurate adjustments in reckonings of trend, methods for estimating total allowable mortality, or thresholds that trigger outside reviews—all of which is currently allowed in both the Rule and the MOA.

As is, state management agencies could (for example) adopt the existing Mark-Resight method for estimating total population size as soon as Yellowstone's grizzly bears are delisted, and produce a dramatic purported "increase" in the population. This would instantaneously translate into a markedly positive increase in putative population trend along with numbers of bears available for 'discretionary' mortality—without any change whatsoever in the underlying population or on-the-ground conditions.

**20.5.** The MOA and the Rule need to explicitly specify that population monitoring will continue indefinitely at the same intensity (neither more nor less) and according to the same design as occurred during the 5 years prior to delisting.

Given vulnerabilities of the Chao2 method—or any other foreseeable method—to bias introduced by search effort and intrinsic sightability of bears (see my comments

Allowance for such a scenario not only introduces substantial risk, but also, even more importantly, emasculates and otherwise renders immaterial all of the presumed safeguards against over-exploitation described by the Service in the current Rule. A population that the Service currently represents as numbering around 675 could suddenly be inflated to over 925, thereby allowing for a potential sport harvest of, not 15, but rather nearer 25, a 67% increase. Likewise, a population at a threshold of 600 that would debar all sport harvest could be inflated to over 800, with instantaneous allowance for harvest of 15 or so bears. And, even more problematic, a population at the threshold of 500, that the Rule claims might trigger a status review by the Service, could be suddenly increased to 700, well above such a trigger.

Whether such scenarios came to pass intentionally or unintentionally, they would unambiguously pose a serious threat to the population embedded in methods currently contained in the Rule. The Service needs to remedy this unacceptable risk. There are several options, amongst which the least ambiguous and straight-forward would be to commit to continued use of the Chao2 method for estimating total population size, but with an accompanying commitment to rigorously standardize search effort and distribution (see my comment 20.5 below). This would help control for the bias that besets the Chao2 method. Another option would be to commit in the Rule and MOA to use the lower bound of uncertainty intervals for estimates of total population size generated by the Mark-Resight method, should it be adopted. This would presumably mitigate for the major short-coming of this method identified by IGBST (2015), which is the large uncertainty in annual estimates.

under 19.1), the Rule and MOA both need to contain a commitment to maintaining the current exact intensity and distribution of search effort devoted to documenting the presence of females with COY. Such a commitment would help curb any tendencies on the part of management agencies to temporarily inflate population estimates through increased search effort, especially if such an increase were coupled with greater orientation towards areas where grizzly bears are most easily seen.



**20.6. Terminology for referring to bear mortality should be changed in the Rule and MOA from 'Discretionary' versus 'Non-discretionary' to 'Management' versus 'Other'.**

The semantics of the current distinction between 'Discretionary' and 'Non-discretionary' mortality in the Rule and the MOA lead to confusion. Moreover, the distinction is disingenuous. By using these terms, the Service and state managers lead both themselves and their readers to assume that they have no control or influence over so-called 'Non-discretionary' mortalities—that this category of mortalities “needs” to happen or is the result of some act of God. This is not the case. History has shown (as the current Rule would claim) that managers do, in fact, have substantial influence over the so-called 'Non-discretionary' mortalities through activities such as law enforcement, education, and sanitation. The Rule even strongly implies that managers have influence over “natural” mortalities to the extent that sport harvest of specific cohorts of bears can amplify or dampen levels of mortality caused by conspecifics—especially infanticide (e.g., Swenson et al. 2001a, 2001b; Bellemain et al. 2006; Bischof et al. 2009; Gardner et al. 2014). In other words, 'Non-discretionary' mortalities can, in fact, be 'Discretionary'.

When you look at the more concrete categories of bear deaths that the Rule and MOA are allocating to 'Discretionary' versus 'Non-discretionary', it turns out that the distinction is fairly straight-forward distinction. 'Discretionary' deaths are simply those that will be directly sanctioned by managers and meted out by either uniformed employees of a state agency, by Wildlife Services, or by those licensed to act on a state agency's behalf (e.g., licensed hunters). 'Non-discretionary' deaths are simply all others resulting from the actions of those (including other animals) who are not explicitly and directly authorized, in any immediate sense, to kill grizzly bears.

In fact, the current category of 'Discretionary' correlates closely with historical deaths of grizzly bears caused by managers responding to conflict situations, including threats to human safety—in other words, 'management' removals. 'Non-discretionary' correlates with all of the other historical categories. For the sake of clarity and in service of reducing ambiguity, I recommend that the Service revise the Rule so as to refer to 'Discretionary' kills as 'Management' kills and 'Non-discretionary kills' as simply 'Other'.

**21. Occupancy provisions for adult females need to apply to all portions of the DMA, not just the PCA, stratified on the basis of what are currently called 'Flight areas'.**

The current approach outlined in the Rule and the MOA essentially loads all of the 'Discretionary' mortality allotted for independent females on those without dependent young (lone females) outside of National Parks. Under current provisions, no sport harvest of females accompanied by dependent young would be allowed. This amounts to the brunt of 'discretionary' human-caused deaths among females being borne by lone bears on the periphery of the DMA.

On average, only 1 of 3 adult females will be without young during a given year. Moreover, some percentage of these lone females will be inside National Parks where they will not be subject to hunting. As a result, something

less than 33% of the adult females in the population (say, 25%), all concentrated on the ecosystem periphery, will be subject to most of the planned killing each year. And, importantly, the current approach essentially uses females inside National Parks to subsidize calculations of allowable sport harvest outside.

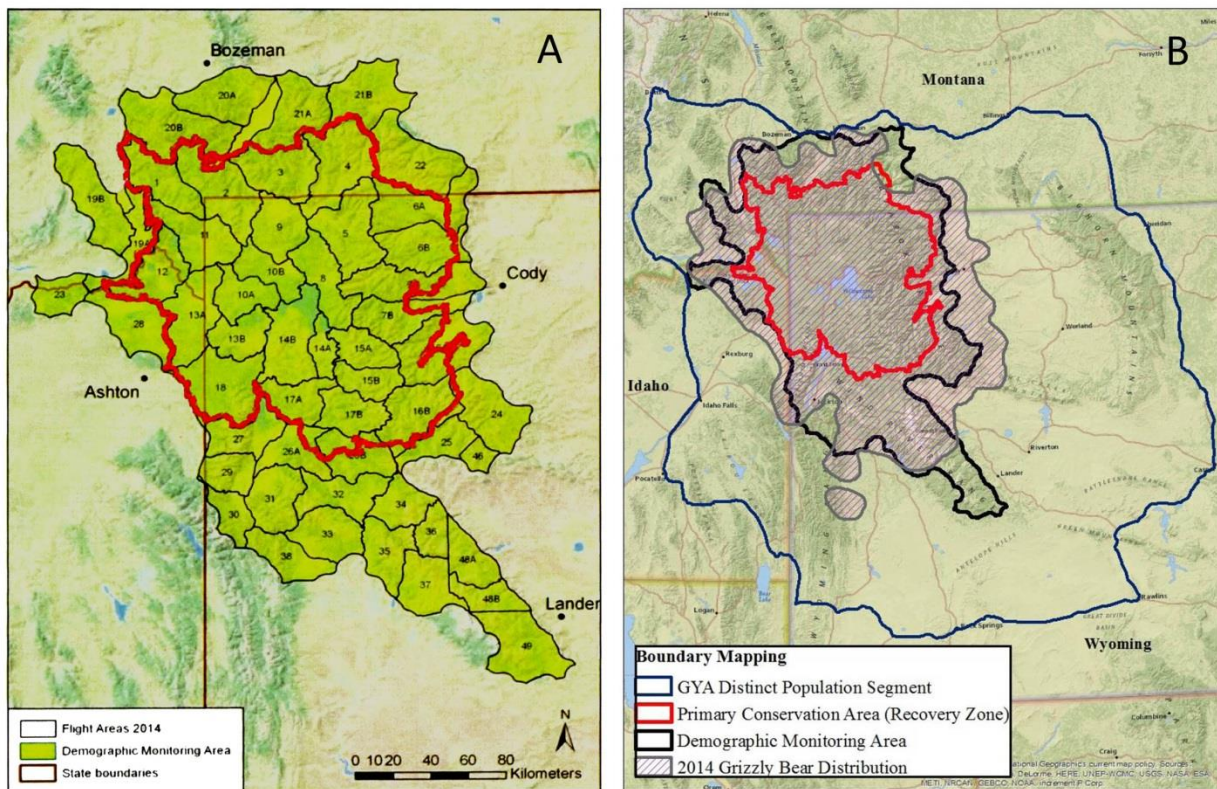
The end result will be patently unsustainable killing of females on the periphery. Source-sink population dynamics would also certainly be amplified which, according to Doak (1995), could lead to increased vulnerability of the population to unintended and long-lagged declines.



Preferentially killing females that would otherwise have given birth to cubs the following year could introduce yet other unpredictable amplifications of population trends. On the face of it, amplified oscillations might be curbed by the fact that, with fewer females giving birth to cubs any following year, estimates of total population size based on observations of females with COY would be smaller, which might then lead to a lower 'Discretionary' kill the year after. But there would then be a pulse of cubs from females that were subsequently subject to a light harvest, which would lead to an inflated estimate of population size and a resulting inflated sport harvest the year after...and so on. In short, the approach described in the Rule and the MOA will lead to fewer females living on

the ecosystem periphery and less predictability regarding the consequences of management actions.

A requirement by the Service for occupancy of all management units by reproductive females, including 'flight areas' outside the DMA (see figure 21.1 below), would introduce a curb on excesses built into the Rule and MOA, which currently have punitive implications for females outside National Parks. Alleviating these current excesses would result in proportionately greater numbers of females on the periphery, which would foster eventual connectivity between Yellowstone and the NCDE.



**Figure 21.1.** Map A, above, shows the PCA (delineated by red, as shown in map B) relative to the full extent and partitioning of the DMA (in yellow). The Rule and current MOA only provide for insurance of occupancy by adult females within the units contained by the PCA and leaves occupancy of all the other units ('Flight Areas') in the DMA up in the air when it comes to presence of reproductive females.