

Chapter 3 Habitat Standards and Monitoring

Background

Habitat standards and monitoring protocol in this Conservation Strategy identify provisions that Federal and State land managers throughout the Greater Yellowstone Ecosystem ([GYE](#)) are committed to for habitat preservation of a recovered Yellowstone grizzly bear population. Between 1986 and the initial 2007 delisting of the Yellowstone grizzly bear population, grizzly bear habitat in the GYE was managed under standards and guidelines established by the Interagency Grizzly Bear Committee (IGBC 1986) and specified in national forest and national park management plans. Acknowledging that humans are the primary agent of grizzly bear mortalities, a principal objective of the IGBC was to improve survival rates by implementing management strategies that minimized anthropogenic influences and grizzly bear-human conflicts. IGBC measures implemented inside the Grizzly Bear Recovery Zone (GBRZ) led to improved management of garbage and food attractants, reduced sheep grazing, and restrictions on motorized access and human development. These standards and guidelines that were imposed upon public lands were instrumental in the recovery of the grizzly bear in the GYE throughout the mid-1980s and into the 1990s.

The subsequent 1993 *Grizzly Bear Recovery Plan* (USFWS 1993) required the preservation and monitoring of habitat necessary to support a recovered population. This led to the ~~to the~~ development of more explicit and measureable habitat criteria to be applied inside the GBRZ, as per the *Recovery Plan Supplement: Habitat-based Recovery Criteria for the Greater Yellowstone Ecosystem* (USFWS 2007c). To satisfy this requirement, measureable habitat criteria were established that called for no net loss of secure habitat with respect to 1998 conditions. These criteria were embraced and incorporated into the draft Conservation Strategy and released for public comment in 2000. Analysis of public comments and new information was used to establish the final habitat standards for a recovered ~~Yellowstone~~ [GYE](#) population as identified in the 2007 Conservation Strategy (USFWS 2007a) and

appended in a supplement to the Recovery Plan (USFWS 2007b). This 2016 revision of the Conservation Strategy includes some changes to the 2007 document that help clarify habitat standards as they pertain to the 1998 baseline.

Clarifying language to the application rules has been inserted where necessary to provide better direction for application of these standards on a local project level. No substantive [FJK1] changes in the content of habitat standards have been made under this revision. However, some modifications in habitat monitoring protocols have been made and are documented in this chapter. Upon delisting of the Yellowstone population, the GBRZ will be referred to as the Primary Conservation Area (PCA) to reflect the shift from managing for recovery to one of conservation.

Introduction

Habitat standards apply to Federal lands inside the PCA and identify three factors that must be maintained at, or improved upon with respect to conditions existing in 1998: 1) secure habitat, 2) number and capacity of developed sites [FJK2], and 3) number and acreage of active commercial livestock grazing allotments. All three of these factors are linked to human activities that affect grizzly bear mortality and displacement. These three standards apply to public lands within the PCA [FJK3], the area where past recovery efforts and present habitat conservation measures are primarily focused. The PCA serves as a relatively safe haven located at the core of the ecosystem and accounts for approximately 41% of the Yellowstone grizzly bear's occupied range as estimated from methods of Bjornlie *et al.* 2014 (Figure 6). The 1998 baseline for habitat standards was selected because studies showed (and recently affirmed) that the ~~Yellowstone~~-GYE grizzly bear population was increasing annually at a robust rate of 4 to 7 percent between 1983 and 2001 (Boyce *et al.* 2001b, Harris *et al.* 2006, 2007, IGBST 2012). Habitat conditions in 1998 were considered representative of this time period since levels of secure habitat and developed sites inside the PCA had remained relatively constant in the 10 years preceding 1998 and beyond (USDA 2004). Hence,

FINAL DRAFT

conditions in 1998 are believed to have supported and contributed to the population growth observed during 1983–2001. Habitat standards, as they apply to the 1998 baseline, impose measurable side boards on allowed levels of human activity inside the PCA and establish a clear benchmark against which future improvements and impacts of habitat can be measured.

To facilitate management of habitat throughout the PCA, the area inside the PCA is divided into 18 distinct bear management units (BMUs) and 40 subunits (Figure 2). BMU boundaries were delineated to approximate the average *lifetime* range of an adult female grizzly bear in the GYE. Each BMU was further subdivided into one or more subunits comparable in size to the average *annual* home range of an adult female grizzly bear. Monitoring habitat at a subunit scale provides greater spatial resolution and proved to be better suited for analyzing habitat use patterns and ensuring good distribution of bear habitat throughout the PCA (USDA 1985).

Hence, conditions pertaining to secure habitat and developed site standards are measured and compared against 1998 levels for each of the 40 bear management subunits within the PCA. To date, habitat-based criteria throughout the PCA have been successfully maintained at, or improved upon, 1998 levels for all 40 subunits. Adherence to these standards ensures that sufficient habitat for the Yellowstone grizzly bear will continue to be available into the foreseeable future. Habitat standards in this document are subject to revision based on the best available science and will be reviewed and updated as necessary.

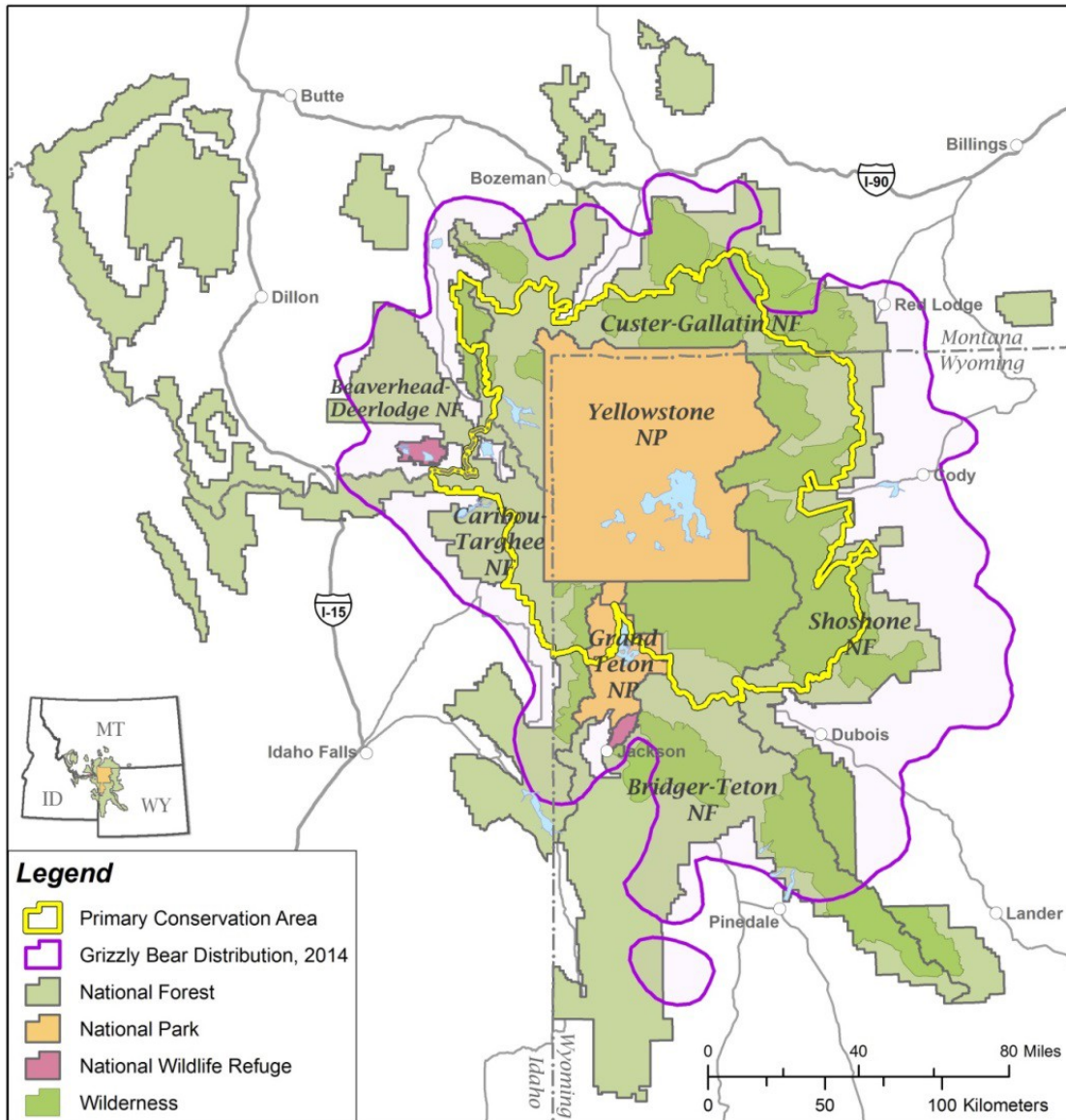
In addition to mandatory habitat standards, several other habitat parameters will be monitored and evaluated to determine the overall condition of habitat for grizzly bears in the PCA. These additional monitoring items include ~~habitat connectivity~~ transportation planning, ~~hunter numbers~~, and productivity or grizzly bear use of the following ~~four high-calorie~~ foods: 1) ~~winter-killed~~ ungulates, 2) cutthroat trout, 3) army cutworm moths, and 4) whitebark pine seeds. Information on monitoring protocols for these items is found in subsequent sections of this chapter.

FINAL DRAFT

Agencies responsible for management of grizzly bear habitat in the GYE are committed to continue collecting the necessary information to evaluate adherence to habitat standards and monitoring protocols throughout the PCA. The overall objective for habitat management inside the PCA is to ~~reduce human-caused grizzly bear mortalities~~^[FJK4] by maintaining or improving habitat with respect to 1998 conditions while maintaining options for resource management activities at approximately the same level as existed in 1998. The habitat standards and monitoring requirements in this Conservation Strategy will be incorporated into National Forest [plans](#), National Park [compendiums](#), and BLM plans.

Figure 6. Federal lands comprising the Greater Yellowstone Ecosystem (GYE), the Primary Conservation Area (PCA), and estimated Grizzly Bear Occupied Range as of 2014.

FINAL DRAFT



FINAL DRAFT

Outside the PCA, grizzly bears ~~are allowed to expand~~have expanded into adjacent areas considered biologically suitable and socially acceptable, as per direction in the State and Tribal management plans (Appendices I, J, ~~and K, and O~~). The key to successful management of grizzly bears outside the PCA is a sustainable balance that accommodates the needs of grizzly bears along with the competing demands of human use. As such, an important management objective for areas outside the PCA is to maintain existing resource management and recreational uses and allow agencies to respond to demonstrated problems with appropriate management actions. Approximately 83 percent of suitable habitat outside the PCA occurs on federally owned land and about 82.6 percent of that suitable habitat is occupied by grizzly bears (Figure 6). A flexible management strategy is crucial for promoting acceptance and tolerance for grizzly bears as they continue to expand into suitable habitat outside the PCA. Standards and guidelines for other wildlife species identified in National Forest and Park management plans indirectly provide additional habitat management direction for bears outside the PCA.

State grizzly bear management plans for Idaho, Montana, and Wyoming recommend and encourage land management agencies to maintain or improve habitats important to grizzly bears and to monitor habitat conditions outside the PCA. These three states acknowledge the importance of secure habitat (see secure habitat definition below), motorized access management, and road density issues related to the survival of grizzly bears and other wildlife. Consequently, levels of secure habitat ~~and motorized route density~~ are monitored on federal lands outside the PCA ~~to identify and prevent potential habitat threats from negatively impacting the long-term viability of the Yellowstone grizzly bear population.~~ Land management agencies work cooperatively with state wildlife agencies to meet identified population and habitat goals for grizzly bears in the GYE. The process of implementing -state and federal grizzly bear management is coordinated by the Yellowstone Grizzly Bear Coordinating Committee (YGCC) representing all respective land management agencies in the GYE (see Chapter 6 Implementation and Evaluation).

Immediately upon ESA delisting of the species, regional foresters in Regions 1, 2, and 4 of the

FINAL DRAFT

U.S. Forest Service agree to add the grizzly bear to their Sensitive Species lists for the five National Forests in the GYE. Forest Service sensitive species direction requires that any project “*must not result in loss of species viability or create significant trends toward federal listing*” (USDA 2005). Sensitive species direction also requires the Forest Service to “*assist states in achieving their goals for conservation of endemic species*” (USDA 2005). A biological evaluation will be completed for all Forest Service projects potentially affecting the GYE grizzly bear. These evaluations will be completed for all Forest Service projects potentially affecting the grizzly bear. These evaluations will determine whether projects do or do not meet the habitat standards in this Conservation Strategy. If the biological evaluation demonstrates that a project does not meet the habitat standards as well as other relevant habitat and population criteria, the project will be modified as necessary to ensure complete adherence with all required measures.

Habitat Standards Inside the Primary Conservation Area

Human activity is the primary factor negatively impacting availability and security of grizzly bear habitat in the GYE. The relationship between bears and habitat is extremely complex and difficult to quantify. However, unfettered human activity is known to result in displacement and mortality of grizzly bears and was a significant contributing factor leading to listing the grizzly bear in the conterminous U.S. as a Threatened species in 1975. Restrictions in human activities due to management practices implemented by the IGBC in the mid-1980s correlate strongly with the steady increase in the Yellowstone grizzly bear population that was observed between 1983 and 2001. Habitat standards formalized in this document impose measurable sideboards on levels of human activity allowed on **Federal lands** [FJK5] inside the PCA, thereby reducing opportunities for grizzly bear-human conflicts, habitat disturbance, and displacement of grizzly bears from valuable habitat.

Habitat standards identified in this document address three key factors related to human activity (motorized access, site development, and commercial livestock grazing) and specifically call for no net loss in secure habitat inside the PCA from what existed in 1998 (Appendix E). Adequate

secure habitat is essential to the survival and reproductive success of grizzly bears, particularly adult females.

It is the goal of habitat management agencies to maintain or improve habitat conditions throughout the PCA at or above 1998 levels, as measured per bear management subunit. These levels of secure habitat have been maintained and will continue to be maintained, and improved on where possible, ~~long into the future~~ for the foreseeable future.

Potential impacts to grizzly bears and their habitat will be evaluated and mitigated using the criteria and standards in this Conservation Strategy in coordination with state wildlife agencies.

Omissions to the 1998 habitat measurements comprising the baseline (Appendix E) may be corrected for when based on new and well documented information substantiating the existence and status of anthropomorphic features (i.e., motorized routes, developed sites, or livestock allotments) that were not properly accounted for in the 1998 baseline. When verified, legitimate corrections to the baseline will be tracked and reported and will constitute new baseline habitat levels against which future change will be measured.

Application rules specific to each habitat standard provide additional direction on how these standards are to be implemented at a Federal project level. The following habitat standards and application rules apply to all Federal lands inside the PCA.

Secure Habitat Standard

The Secure Habitat Standard requires that inside the PCA, the percentage of secure habitat within each bear management subunit must be maintained at or above levels that existed in 1998^[FJK6] (Appendix E). The sole exception to the 1998 secure habitat baseline applies to the three subunits identified in the 2007 Conservation strategy as in need of improvement above 1998 levels (Gallatin #3, Henrys Lake #2, and Madison #2). These three subunits must be

maintained at or

above levels attained from the full implementation of the 2006 Gallatin National Forest Travel Management Plan (Appendix E). Authorized Federal projects that result in temporary or permanent changes to secure habitat must follow the Application Rules identified below.

Secure habitat [FJK7] is defined as any contiguous area ≥ 10 acres in size and more than 500 m from an open or gated motorized access route (road or trail) or recurring low level helicopter line during the non-denning period (March 1 – November 30). Gated routes that are closed year-round to public motorized use but remain accessible to administrative personnel are still considered motorized access routes, and hence, detract from secure grizzly bear habitat.

There are activities allowed in secure habitat (see below) that do not violate standards or count as motorized access routes. Decommissioned routes that are permanently and effectively closed to the public and administrative staff do not count against this standard. Lakes larger than 1.6 sq km (1 sq mi) in spatial extent are excluded from secure habitat calculations.

Application Rules for Permanent Changes in Secure Habitat

Permanent changes to secure habitat are allowed inside the PCA when associated with an authorized Federal project involving construction of new motorized routes (i.e., roads or trails), reconstruction of existing motorized routes, or opening of a previously decommissioned route if, and only if, the following conditions are met:

- Any loss in secure habitat below baseline levels is replaced by restoring secure habitat of equivalent quality and quantity (e.g., through decommissioning) in the same bear management subunit. Habitat quality must be assessed based on the best collective scientific understanding of grizzly bear habitat ecology and the rationale for all mitigation measures must be fully documented.
- Replacement habitat must be in place before project implementation or concurrent with project development as an integral part of the project plan. Replacement habitat must remain in place for a minimum of 10 years before it can be subsequently replaced and mitigated for per application rules (this duration is based upon the generation time for

FINAL DRAFT

of a female grizzly bear, or the time it takes to replace herself in the population).

- For those subunits identified as in need of improvement above 1998 levels (*Gallatin #3, Madison #2, and Henry's Lake #2*), secure habitat will be maintained at or above levels associated with full implementation of the 2006 Gallatin National Forest Travel Management Plan (see Appendix E).
- For activities based on statutory rights, such as access to private lands under the *Alaska National Interest Lands Conservation (ANILCA)* or the *1872 General Mining Law*, where permanent reductions in secure habitat cannot be replaced within the affected subunit, then secure habitat will be compensated at a commensurate level at or above the baseline in the nearest possible subunit. In these rare situations, subsequent changes to secure habitat in the two affected subunits constitute permanent changes to the baseline.
- Honor existing oil and gas or other mineral leases. Proposed *Applications for Permit to Drill (APDs)* and operating plans within those leases would strive to meet the application rules for changes to secure habitat. New leases, APDs, and operating plans must meet the secure habitat and developed site standards.
- Motorized routes on private land that post-date 1998 are not counted against this standard. However, for motorized roads or trails acquired through land exchanges or acquisition that are desirable to maintain for public use, mitigation is strongly recommended.

Application Rules for Temporary Changes in Secure Habitat

Temporary reductions in secure habitat below baseline levels inside the PCA are allowed when associated with authorized Federal projects. Project activities should be concentrated in space and time to minimize disturbance. The following conditions must be met for temporary projects:

- Only one project affecting secure habitat may be active within a given bear management subunit at any one time.

FINAL DRAFT

- Total acreage of secure habitat affected within a given BMU does not exceed 1 percent of the acreage in the largest subunit within that BMU. The acreage of a project that counts against the 1 percent limit (i.e., the amount of secure habitat affected) is measured as the acreage within the 500-meter buffer around any temporary motorized access route or low-level helicopter flight line that intrudes into existing secure habitat.
- Use of project roads will be limited to administrative purposes associated with project activities. Project implementation shall not reduce secure habitat below baseline levels for more than 4 consecutive years. The collective set of project roads that affect secure habitat below baseline levels shall be closed to all motorized travel after 3 years. Project roads shall be decommissioned such that secure habitat is restored within 1 year after road closure.

Activities Allowed in Secure Habitat

The following activities are allowed in secure habitat inside the PCA without violating the standard:

- Activities that do not require route construction or reconstruction, re-opening of a permanently closed road, or recurring low-level helicopter flight lines.
- Helicopter use for short term (no more than 2 days in the duration of a project), or at higher elevations (> 500 m above ground level with no landing). Aircraft used in emergency firefighting are allowed.
- Non-wheeled, over-the-snow use (i.e., snow machines) is allowed unless new research identifies a concern. Conflicts associated with winter-use activities that develop either during denning or after den emergence in the spring can be addressed with local area restrictions.
- Access to power lines and/or utility corridors for occasional and necessary maintenance service that does not require new route construction and is used only for administrative purposes related to power line/utility maintenance.

FINAL DRAFT

- Project activities (e.g., temporary road construction and maintenance, or use of recurring low-level helicopter flights) that occur during the grizzly bear denning season between December 1 and February 28.

Developed Site Standard

The Developed Site Standard requires that on Federal lands^[FJK8] inside the PCA, the number and capacity for human use of developed sites must be maintained at or below the 1998 levels (Appendix E). Projects that propose a change in the number or capacity of developed sites must follow the Application Rules specified below.

Developed sites refer to those sites or facilities on public land with features intended to accommodate administrative needs and public recreational use. Such sites typically are identified or advertised via visitor maps, information displays, or administrative personnel as discernable destination sites promoted by the agency. Developed sites are often associated with human activities that may disrupt grizzly bear use of habitat, or have attractants that potentially lead to increased human-bear conflicts. Examples of developed sites include, but are not limited to: campgrounds, picnic areas, trailheads, boat launches, rental cabins, summer homes, lodges, service stations, restaurants, visitor centers, and administrative sites.

Administrative sites are those sites or facilities constructed for use primarily by government employees to facilitate the administrations and management of public lands. Administrative sites are counted towards developed sites. Examples include: administrative headquarters, ranger stations, patrol cabins, park entrances, federal employee housing, and other facilities supporting government operations. **Dispersed sites**, in contrast to developed or administrative sites, are those not associated with a developed site, such as a front-country campground. These sites are typically characterized as having no permanent agency-constructed features, have minimal to no site modifications, and may include primitive road access. Dispersed sites are not counted toward developed sites.

Application Rules ~~for Developed Sites~~

On Federal [land](#)^[FJK9]s inside the PCA, changes to developed sites or construction of new developed sites are allowed if the following conditions are met:

- Construction of new sites will be [mitigated](#)^[FJK10] for within that subunit to offset any increase in the number of developed sites and/or capacity for human use, habitat loss, and increased access to surrounding habitats.
- Mitigation of detrimental impacts will occur within the affected subunit and adequately compensate for the type and extent of [impacts](#)^[FJK11]. Mitigation measures will be in place before implementation of the project or included as an integral part of completion of the project.
- Consolidation and/or elimination of dispersed campsites is considered adequate mitigation for increases in human capacity at developed campgrounds if the new campsite capacity is less than or equivalent to that of the dispersed camping eliminated and if future overnight use of the dispersed site(s) is definitively curtailed.
- Conversion of uncontrolled dispersed campsites to a minor day-use site is allowed if there is a net benefit to both human and bear safety and if the dispersed site(s) can be modified in such a way that future over-night use of the site is definitively curtailed. Such modification of site-use would not contribute to an increase in baseline developed sites.
- Expansion [\(in capacity and acreage\)](#) of existing administrative sites is exempt from mitigation if such developments are deemed necessary for enhancement of public land management and other viable alternatives are not available. Temporary construction of work camps for highway construction or other major maintenance projects are exempt from human capacity mitigation if other viable alternatives are not available. Food storage structures and management must be in place and all other factors resulting in potential detrimental impacts to grizzly bears will be mitigated as identified for other developed sites.
- [Modifications to existing developed sites that reduce resource damage, detrimental environmental impacts, and/or the potential for grizzly bear conflicts are allowed \(e.g.,](#)

FINAL DRAFT

installing a vaulted toilet to avoid damage to water resources or installing bear-resistant storage structures to reduce conflict).

- [Modifications to dispersed campsites that reduce resource damage, detrimental environmental impacts, and/or the potential for grizzly bear conflicts are allowed \(e.g., installing bear-resistant storage structures and limiting parking expansion\). Such modifications do not require mitigation as long as they are not permanent or irretrievable.](#)
- For activities based in statutory rights (e.g., *1872 General Mining Law*, *Americans with Disability Act*, *ANILCA*, etc.), if the number of developed sites exceeds the 1998 baseline, the Forest Service will, to the fullest extent of its regulatory authority, reduce developed sites to commensurate levels and mitigate to offset any increases in human capacity, habitat loss, and increased access to surrounding habitat within the affected subunit if possible. In those rare cases where mitigation cannot be accomplished within that subunit, commensurate compensation will be accomplished in the nearest subunit and changes in the two affected subunits become permanent changes to the baseline.
- Honor existing oil and gas and other mineral leases. For proposed *Applications for Permit to Drill* (APDs) and operating plans within those leases, the Forest Service should, to the fullest extent of their regulatory authority, strive to meet the developed site standard and satisfy application rules for changes in secure habitat. New leases, APDs, and operating plans must meet the developed site standard and satisfy application rules for changes in secure habitat.
- Developments on private land are not counted against this standard. However, for developed sites acquired through land exchanges or acquisitions that are desirable to maintain, mitigation is strongly encouraged but not required. The rationale behind this is to encourage acquisition and transformation of private land to public ownership since this negates the potential for future development and results in better management for grizzly bears.

Livestock Allotment Standard

The Livestock Allotment Standard requires that on Federal lands inside the PCA, there will be no increase in the number or acreage of active commercial livestock grazing allotments nor an increase in permitted sheep Animal Months (AMs) relative to that which existed in 1998 (see Appendix E). Existing sheep allotments will be monitored, evaluated, and phased out as the opportunity arises with willing permittees.

Application Rules

Grazing allotments tracked for purposes of grizzly bear conservation include both vacant and active commercial livestock units for sheep, cattle, and/or horses on Federal lands inside the PCA. **Active** allotments are livestock units with active grazing permits. **Vacant** allotments are those without an active permit, but which may be restocked or grazed periodically by other permittees at the discretion of the land management agency to resolve resource issues or other concerns. Changes in livestock allotments inside the PCA that satisfy the allotment standard may occur if the following conditions are met:

- A vacant allotment may be reissued an active permit resulting in an increase in the number of permitted cattle, but the number and net acreage of active allotments inside the PCA must not exceed the 1998 baseline. Appropriate analysis by the action agency must be conducted to evaluate impacts on grizzly bears.
- Combining or dividing existing allotments is allowed as long as the net acreage and number of active allotments does not exceed 1998 levels.
- Where chronic grizzly bear conflicts occur on livestock allotments inside the PCA, and an opportunity exists with a willing permittee, alternatives for resolving conflicts may include authorization of a non-use permit, moving livestock to a vacant allotment where there is less likelihood of conflict, or cattle grazing can be phased out on that allotment.

Habitat Monitoring

The primary objective of habitat monitoring is to track and assess the status of grizzly bear habitat throughout the ecosystem with an emphasis placed on habitat inside the PCA. Monitoring requirements presented in this section focus on evaluation of adherence to habitat standards identified such that secure habitat, developed sites, and commercial livestock grazing allotments are maintained at, or improved upon, 1998 levels. However, additional habitat parameters pertaining to four high-calorie foods of the grizzly bear diet are also monitored to assist in evaluating the status of grizzly bear habitat and its ability to support a recovered grizzly bear population.

Monitoring Secure Habitat and Motorized Access Route Density

Background

Humans are the primary agent influencing grizzly bear mortality and population trajectories in the GYE and elsewhere (McLellan and Shackleton 1988, Mattson and Knight 1991, Mace *et al.* 1996, Schwartz *et al.* 2010, Proctor *et al.* 2012). Motorized access has historically been used as a surrogate measure of human presence on the landscape, and consequently serves as the basis for differentiating secure and non-secure habitat throughout the ecosystem. Land managers throughout the GYE recognize that availability of secure habitat is crucial to the survival and long-term reproductive success of grizzly bears. Managing the landscape to reduce grizzly bear mortality risk requires that motorized roads and trails be considered when evaluating and maintaining secure habitat throughout the ecosystem.

Motorized access parameters, including: 1) percent secure habitat, 2) open motorized access route density (OMARD), and 3) total motorized access route density (TMARD)-, are measured and monitored against levels that existed in 1998. To date, no net decrease in secure habitat relative to 1998 levels has occurred on federal lands in any of the 40 bear management subunits within the PCA. Instead, reductions in motorized access implemented post-1998 have led to an

FINAL DRAFT

increase of 1.4 percent in secure habitat inside the PCA; a gain approximate in size to the area of Yellowstone Lake.

Subunits with potential for improvement

Several subunits, Gallatin #3, Henrys Lake #2, and Madison #2, were targeted in the 2007 Conservation Strategy as needing improvement in secure habitat with respect to 1998 levels. The specific areas with potential for improvement identified in these three subunits fall within the Gallatin National Forest boundary and consequently, the quantity and timing of improvements was to be determined by the Gallatin National Forest Travel Management Plan (TMP). With implementation of the 2006 Gallatin TMP, many roads inherited from these exchanges have been permanently decommissioned. Non-system routes that are not maintained by the Forest Service have subsequently been closed, with a high priority given to road decommissions in the three subunits identified as in need of improvement. With full implementation of the Gallatin Travel Plan near completion, measureable increases in secure habitat with respect to 1998 baseline levels (Appendix E) and reductions in motorized route density have been realized in the three targeted subunits. The Gallatin National forest determine, via a Travel Plan Amendment, that all gains in secure habitat resulting from full implementation of the TMP will effectively constitute new baseline levels for these three subunits. If and when approved, elevated secure levels for these three subunits will serve as a new measure against which future change will be made.

Monitoring Protocol

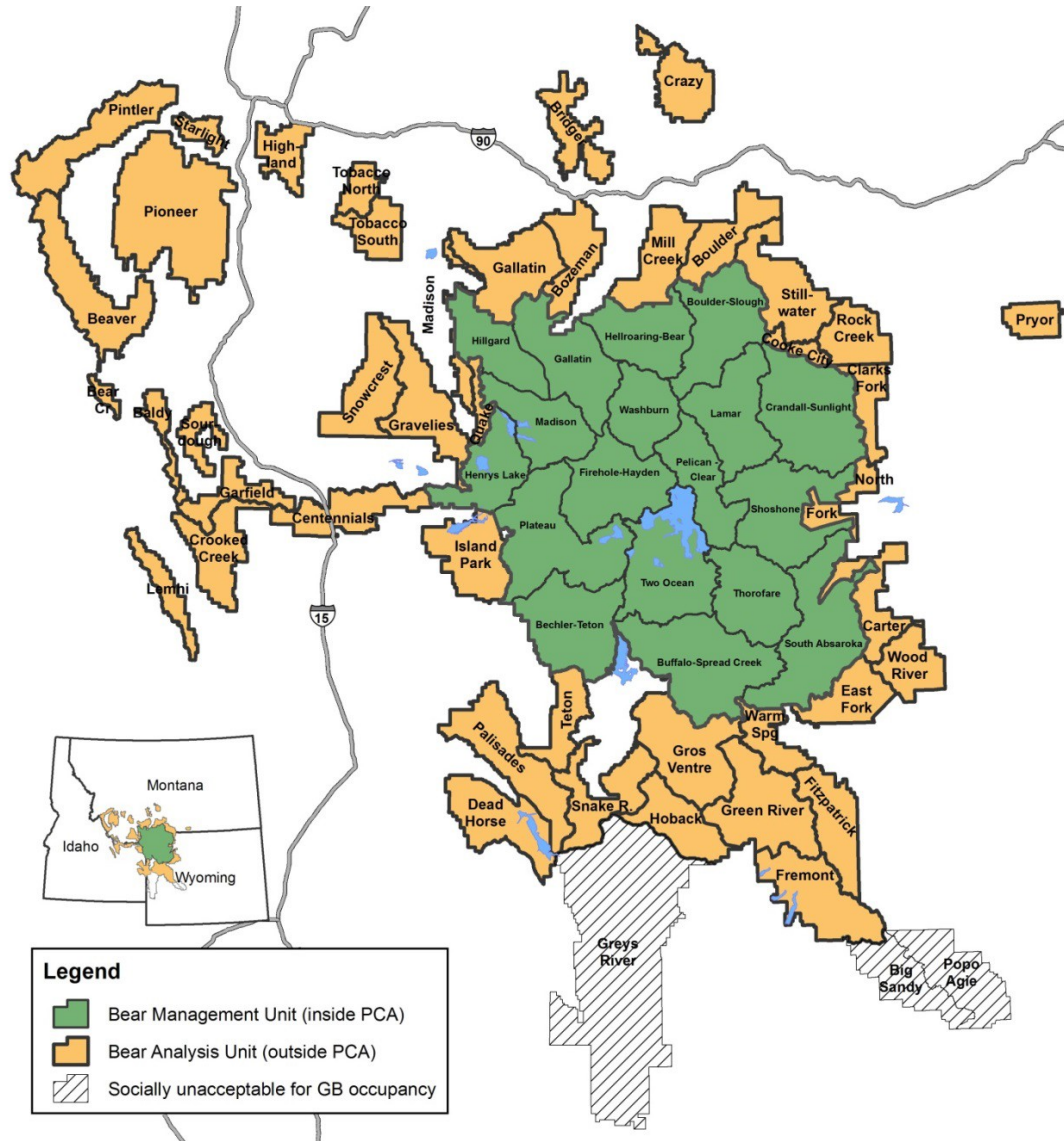
Secure habitat and motorized route density are monitored ~~inside the PCA and tracked throughout the ecosystem~~ to verify compliance with secure habitat standards ~~inside the PCA and to assist in balancing grizzly bear security and survival with human land use concerns outside the PCA~~. Motorized access parameters that are monitored and reported include levels of 1) secure habitat, 2) open motorized access route density (OMARD) greater than 1.6 km/sq

FINAL DRAFT

km (1 mi/sq mi)), and 3) total motorized access route density (TMARD) greater than 3.2 km/sq km (2 mi/sq mi). Inside the PCA, these three parameters are measured and reported annually for each bear management subunit. Outside the PCA, secure habitat is measured and reported biennially (even numbered years) for each bear analysis unit (BAU, see Figure 7). Changes in configuration and status of motorized routes are submitted each year to the Grizzly Bear Habitat Database Coordinator by representatives from each National Forest and National Park in the ecosystem. Status and configuration of motorized access routes are inventoried and tracked by the Database Coordinator. This insures that reported measurements are based on the most current available information. Percent secure habitat, OMARD, and TMARD are calculated using the Motorized Access Model as described in Appendix E.

Secure habitat, as defined earlier, refers to those areas ≥ 10 acres in size and more than 500 m from an open or gated motorized route. Lakes greater than 1.6 sq km (1 sq mi) are excluded from secure habitat calculations. **OMARD** is a measure of the density of motorized routes that are open to the public for one or more days during the non-denning portion of the year when grizzly bears are active (March 1-November 30). **TMARD** measure the density of all motorized routes open to the public and/or administrative personnel for one or more days during the non-denning season. Roads that are closed year-round to the public but open to administrative personnel detract from secure habitat and count toward TMARD, but do not contribute to OMARD. Motorized routes that have been permanently decommissioned such that there is no motorized use by either the public or administrative staff, do not contribute to OMARD or TMARD, and do not detract from secure habitat. For a more detailed discussion of OMARD and TMARD, as well as changes in monitoring protocol, please refer to Appendix E. Measurements are reported annually (inside the PCA) and biennially (outside the PCA) in the IGBST Annual Report, ~~Yellowstone Grizzly Bear Investigations~~ and are posted online for public access at the IGBST website (<http://nrmssc.usgs.gov/products/IGBST>).

Figure 7. Bear management units and subunits inside the Primary Conservation Area (PCA) and bear analysis units outside the PCA.



Monitoring Developed Sites

Background

Levels of human development on the landscape have been shown to be an important predictor of grizzly bear mortality in the GYE (Schwartz et al. 2010). Developed sites increase the spatial and temporal extent of human presence on the landscape and contribute to the displacement and mortality of grizzly bears. A significant concern related to developed sites is the increased potential for grizzly bear-human conflicts attributable to food conditioning and habituation. Past attempts at modeling grizzly bear mortality in the GYE have focused on levels of overnight human use as a primary factor related to grizzly bear mortality. Increased numbers of people using an area and potentially interacting with grizzly bears is an important issue in evaluating impacts of developed sites on grizzly bear survival.

Monitoring Protocol

Changes in developed sites^[FJK12] on public lands inside the PCA are measured, tracked, and evaluated against 1998 levels (Appendix E). Information pertaining to changes in the number of developed sites inside the PCA is submitted annually to the Grizzly Bear Habitat Database Coordinator by representatives from each National Forest and National Park Ecosystem. Current and baseline numbers of developed sites are inventoried in a GIS database and reported annually in the IGBST Annual Report [Yellowstone Grizzly Bear Investigations](#).

Monitoring Livestock Grazing

Background

Conflicts between livestock and grizzly bears have historically led to the relocation or removal of grizzly bears in the GYE. Grizzly bears tend to prey on cattle and sheep regardless of the

FINAL DRAFT

abundance of natural foods because livestock in occupied grizzly bear territory represent one of many foraging opportunities (Gunther *et al.* 2004). Most grizzly bear-livestock conflicts tend to occur outside the PCA since all commercial allotments on National Park lands and many allotments on National Forest lands inside the PCA have been permanently closed.

Consequently, monitoring grizzly bear-livestock conflicts on public lands is not limited to inside the PCA, but is conducted annually throughout the entire ecosystem. Currently, approximately 59 percent of the Yellowstone grizzly bear's occupied range falls outside the PCA. As commercial livestock grazing persists in areas where grizzly bears live, the number of conflicts will most likely continue to pose a challenge to grizzly bear managers. This is particularly true on domestic sheep allotments. Financial incentives offered through non-governmental organizations (NGOs) have proven to be a successful mechanism for retiring sheep grazing allotments on public land when willing participants were available (Gunther *et al.* 2004). These types of opportunistic partnerships between federal agencies, NGOs, and willing permittees may be considered an alternative for resolving chronic conflicts on grazing allotments within prime grizzly bear habitat[FJK13].

Monitoring Protocol

On federal lands inside the PCA, the number and acreage of commercial livestock grazing allotments and the number of sheep animal months (AMs) is monitored and reported annually relative to 1998 levels. Inside and outside the PCA, grizzly bear conflicts associated with grazing of commercial livestock on federal lands is monitored and reported annually.

Commercial livestock grazing and conflict information is submitted for publication in the IGBST [Annual Report, Yellowstone Grizzly Bear Investigations](#).

Monitoring ~~High-Calorie~~ Grizzly Bear Foods

Background

FINAL DRAFT

Grizzly bears are opportunistic omnivores who have evolved highly versatile foraging strategies allowing them to shift diets among numerous food sources, depending on what is available spatially and temporally (Schwartz *et al.* 2003, 2013). [The IGBST will continue to monitor four high-calorie foods. Long-term management and conservation of grizzly bears in the GYE call for monitoring of four high-calorie foods. These four food types](#)—listed by dry weight kilocalories per gram (kcal/g) include: 1) army cutworm moths (7.91 kcal/g), 2) ~~winter-killed~~ ungulates (6.80 kcal/g), 3) cutthroat trout (6.10 kcal/g), and 4) whitebark pine seeds (3.99 kcal/g). These four foods have varying distributions in the ecosystem and are subject to annual fluctuations and therefore do not necessarily serve as a major dietary component of every grizzly bear in the GYE. Natural annual fluctuations in abundance and distribution of these four calorie-rich foods make it very challenging to establish reliable thresholds. However, these four high-calorie foods are known to exert a positive influence on grizzly bear fecundity [FJK14] and survival and constitute some of the highest sources of digestible energy available to grizzly bears in the GYE (Mealey 1975, Servheen *et al.* 1986, Pritchard and Robbins 1990, Mattson *et al.* 1992, Haroldson *et al.* 2006, Schwartz *et al.* 2006).

Gunther *et al.* (2014a) exhaustively documented the diet of the GYE grizzly bears to include over 266 distinct plant and animal species ranging from grasses, fungi, berries and seeds, to fish and carrion. The trophic flexibility of grizzly bears, as documented by the variety of foods they consume, allow them to opportunistically forage across diverse habitats spanning the entire GYE. Their highly varied diet serves as an adaptive mechanism that enhances their ability to persist when faced with rapid and long-term changes in availability and abundance of any one food source. Compositional analysis of scats collected over a 37-year period (1943 to 2009) showed that grizzly bears within the GYE most frequently feed on foods that are consistently available and widely distributed, such as grasses, sedges, and ants (Gunther *et al.* 2014a). However, when opportunity arises, grizzly bears will shift their diet to maximize body mass gain by selecting calorie-rich foods such as ungulates, fish, whitebark pine seeds, clover, moths, and small mammals.

FINAL DRAFT

Human-induced environmental change, such as introduced organisms, habitat loss, climate change, and other anthropogenic factors, ~~have~~has the potential to affect availability and distribution of these calorie-rich foods in the future. However, despite a substantial decline of whitebark pine and natural stochasticity of other food resources within the GYE, grizzly bears have shown notable resilience by adjusting habitat use (Costello *et al.* 2014) and shifting diets to maintain body mass and condition (Schwartz *et al.* 2014, Ebinger et al. 2016). In a comprehensive synthesis study conducted by the IGBST, findings did not indicate a strong dependence of GYE grizzly bears on whitebark pine seeds but rather, where and when available, the inclusion of this food as a component of a diverse and dynamic diet (IGBST 2013). Monitoring foods comprising such a diverse diet is challenging, which is why efforts have focused on four foods with relatively high energetic value and for which abundance (or use by bears) is relatively easy to measure: ~~Because of their high-caloric value and use by grizzly bears,~~ whitebark pine, ungulates, cutthroat trout, and army cutworm moths ~~are currently monitored either directly or indirectly on an annual basis.~~

Monitoring Protocol

To monitor these four high-caloric foods and their importance to grizzly bears, the IGBST will survey and report on ~~each of these foods~~ and their availability (or use by bears) groups annually ~~d~~ per detailed ~~food~~ monitoring protocols identified in Appendix D, as budgetary constraints allow. IGBST scientists will analyze the relationship between abundance and availability of these four food types with the number of grizzly bear-human conflicts, grizzly bear management actions, known and probable grizzly bear mortalities, and changes in the distribution and trend of the GYE grizzly bear population. Results of these analysis-analyses will be presented, when available, in the annual reports prepared by the IGBST and relevant peer-reviewed publications. If detectable declines in certain foods occur and the IGBST concludes these declines are related to biologically significant changes in demographic parameters, the IGBST shall report these findings for consideration by the GYCC (see Chapter 6, Implementation and Evaluation, for details on this process). Annually monitoring results of

FINAL DRAFT

whitebark pine, ungulates, cutthroat trout, and army cutworm moths, when available, are to be reported in the IGBST Annual Report.

~~Monitoring protocols of high-calorie foods identified in this Conservation Strategy will continue as long as budgets allow.~~ Monitoring and surveying methods may be modified when necessary to incorporate new technological advances in monitoring techniques or new knowledge of bear foraging and habitat use within the GYE. For example, variation in body condition among bears is strongly associated with available food and provides insight into seasonal nutrition of individual bears, as well as different sex and age classes. Body condition may be derived through bioelectrical impedance analysis (BIA), which allows for direct estimation of fat content of captured grizzly bears (Farley and Robbins 1994). The IGBST collects this information on captured bears when feasible, but sample sizes are small and inference for some analyses (e.g., fall season analyses) is limited. An alternative method to BIA to measure body condition is the estimation of storage energy using measurements of mass and body length. Results of any investigations of alternative approaches will be reported by the IGBST in annual reports and peer-reviewed publications. Existing monitoring programs may be expanded, as—
~~budget allows, to include occupied habitat beyond the PCA and areas predicted for future use by bears. Monitoring results of whitebark pine, winter-killed ungulates, cutthroat trout, and army cutworm moths, when available, are to be reported in the annual IGBST publication *Yellowstone Grizzly Bear Investigations*.~~

~~Winter-killed~~ Ungulates

Background—The GYE harbors one of the most carnivorous grizzly bear populations inhabiting the North American interior (Jacoby et al. 1999, Mowat and Heard 2006). Isotopic nitrogen ($\delta^{15}\text{N}$) levels measured in 221 grizzly bear hair samples collected between 2000 and 2010 indicate that on average, terrestrial meat accounted for 44.4% of the assimilated diet of Yellowstone grizzly bears (Schwartz



FINAL DRAFT

et al. 2014). In contrast, in Glacier National Park and adjacent national forest lands, meat accounts for a smaller proportion of the grizzly bear diet; using stable isotope analysis for a small sample of grizzly bears, Jacoby et al. (1999) found that meat accounted for only 33%, 0%, and 6% of adult male, adult female and subadult diets, respectively. ~~Protein and fat from ungulate carcasses ranks as the second highest food source of gross caloric value available to grizzly bears in the GYE (Gunther et al. 2014a, b).~~ Winter-killed ungulates, primarily elk and bison, historically provided an important source of protein to bears, especially during early spring before most plant foods become available. Transects were historically surveyed each spring to estimate availability of winter-killed ungulates. However, the survey design does not allow estimation of the amount of biomass available (Cherry 2006). Additionally, ungulate herd distribution has shifted as a result of the reintroduction of wolves, and it is unclear how much of the biomass was consumed by wolves before bears emerge from their dens. As an alternative to carcasses as a spring food, grizzly bears also consume earthworms, ants, and pocket gophers. Grizzly bears continue to opportunistically forage for animal matter and scavenge carrion throughout the active season and will seek out gut piles and other remains left by ungulate hunters in the fall (Haroldson et al. 2004).

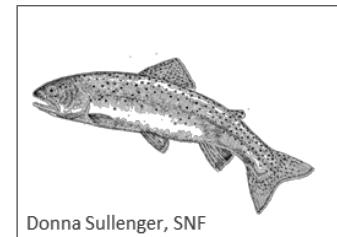
Monitoring Protocol—~~Relative abundance of ungulate carrion is often monitored by correlating the number of carcasses available to grizzly bears and other scavengers during the spring with measures of snow water equivalency (depth, density, and moisture content) in snowpack (Podruzny et al. 2012). Availability of carrion for grizzly bears is potentially affected by increased competition from recently reintroduced wolves and changes in elk and bison management practices. For these and other reasons historic carcass transects will continue to be surveyed as long as budgetary allocations permit. There are currently 30 spring ungulate carcass survey routes in Yellowstone National Park (YNP) and 12 transect routes on Yellowstone's Northern Range in the Gallatin National Forest. Current survey methods and ungulate carcass survey routes may be redesigned or modified when appropriate. Annual estimates of ungulate herds, both bison and elk, have been made since XXXX by the National Park Service and the States of Idaho, Montana, and Wyoming and will continue into the foreseeable future. These~~

FINAL DRAFT

estimates occur by unit and provide a measure of availability and distribution across the landscape occupied by grizzly bears. When available, ~~monitoring results of winter killed ungulate carcass availability~~ ungulate herd estimates will be summarized and reported annually in the IGBST ~~Annual Report~~ publication Yellowstone Grizzly Bear Investigations.

Cutthroat Trout

Background—Due to their high digestibility and protein and lipid content, spawning cutthroat trout are one of the highest sources of digestible energy available to bears ~~in~~ with home ranges in close proximity of Yellowstone Lake and its tributaries (Mealey 1975, Pritchard and Robbins 1990, Gunther et al. 2014a). Grizzly bears were once known to prey on cutthroat trout in at least 36 different streams tributary to Yellowstone Lake (Hoskins 1975, Reinhart and Mattson 1990). Haroldson et al. (2005) estimated that approximately 68 grizzly bears per year frequented and likely fished ten Yellowstone Lake spawning streams tributaries monitored during 1997-2000. Introduction of non-native lake trout (*Salvelinus namaycush*) and effects of drought and whirling disease (*Myxobolus cerebralis*) has led to a decline in native cutthroat trout populations and an associated decline in number of bears visiting spawning streams (Teisberg et al. 2014).

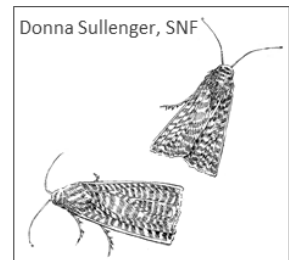


Monitoring Protocol—The Yellowstone Lake cutthroat trout population is monitored most years in the spring, depending on weather and spring snow melt, using stream surveys, ~~large mesh gillnets,~~ weirs with fish traps, and occasionally electronic fish counters. An electronic sonar fish counter was installed and calibrated in 2013 along Clear Creek on the east side of Yellowstone Lake to facilitate annual counting of spawning cutthroat trout ascending Clear Creek. Visual stream surveys are also conducted most years to identify trends in the number of cutthroat trout spawning Yellowstone Lake tributaries. ~~Visual surveys to measure the presence of cutthroat trout and rainbow hybrids are also typically conducted at the Trout Lake inlet creek.~~ Yellowstone NP biologists provide an annual summary of cutthroat trout monitoring results ~~to~~

the IGBST for publication in [the IGBST Annual Report](#)~~the Yellowstone Grizzly Bear Investigations~~. Current survey methods may be modified or redesigned as appropriate.

Moth Aggregation Sites

Background—Alpine moth aggregations are a calorie-dense and nutrient-rich food source found at remote, high-elevation alpine sites dominated by talus and scree slopes in the eastern half of the ecosystem. Knowledge regarding the intricate relationship between army cutworm moths and grizzly bears has improved substantially since the late 1980s when grizzly bear use of moth aggregation sites was first discovered and such sites were included in observation flights (Bjornlie and Haroldson 2014). When available, moths are a valuable source of nutrition for grizzly bears because they have the highest reported gross caloric content per gram of any food available to grizzly bears in the GYE (7.91 kcal/g; Gunther et al. 2014a). Some bears may feed almost exclusively on moths for a period of over one month (French et al. 1994). A grizzly bear feeding extensively on moths over a 30-day period can consume 47%, or close to half, of its annual energy budget of 960,000 calories (White 1996). Grizzly bears whose home ranges include moth aggregation sites often visit these talus slopes during mid-to-late summer and early fall to accumulate fat reserves in preparation for the winter denning season. Although grizzly bear use of moth sites does not vary widely over time (1993 is one notable exception; low bear use due to late, extensive snow cover), annual monitoring provides important data regarding this high-calorie resource.

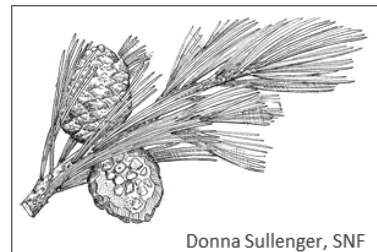


Monitoring Protocol—As of 2013, 37 confirmed and 16 possible moth sites have been identified in the GYE. However, size, location and moth abundance of sites fluctuate from year to year due to natural variation in environmental factors, such as snow cover (Bjornlie and Haroldson 2014). Aerial observations of bears feeding at moth sites are made from fixed-wing aircraft as part of on-going radio tracking and observation flights conducted by the IGBST. Although this monitoring protocol does not provide direct information regarding the abundance of moths,

grizzly bear use of aggregation sites can provide an indirect measure of the relative abundance of this resource in a given year. Aerial surveys of all confirmed moth sites will be conducted annually and results will be summarized and presented in the ~~annual~~ IGBST Annual Report Yellowstone Grizzly Bear Investigations.

Whitebark Pine Cone Production

Background—Due to their high fat content and potential abundance, whitebark pine seeds are an important fall food for bears in the GYE (Mattson and Jonkel 1990). Yellowstone grizzly bears consume whitebark pine seeds extensively when whitebark cones are available. Bears may feed almost



exclusively on whitebark pine seeds when production exceeds 22 cones per tree (Mattson et al. 1992). Because whitebark pine is a masting species, availability varies substantially from year to year. ~~During fall seasons of low whitebark pine seed availability, grizzly bears often seek~~

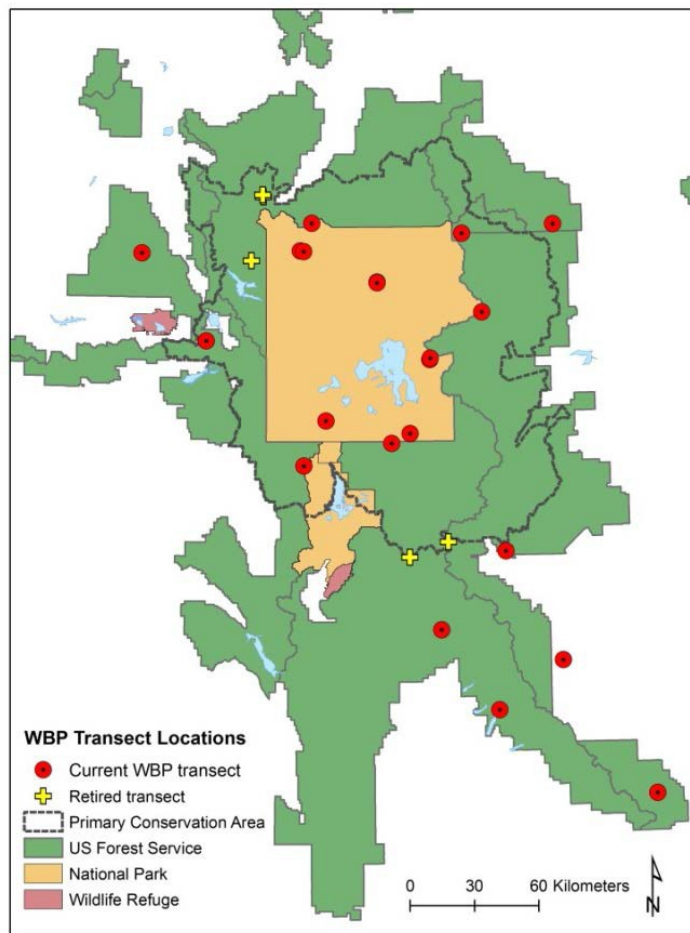
~~alternate foods at lower elevations, leading to more frequent bear conflicts and human-caused grizzly bear mortalities (Mattson et al. 1992, Knight and Blanchard 1994, Gunther et al. 1997, Haroldson et al. 2006). Conversely, when whitebark pine nuts are abundant, there are generally very few grizzly bear human conflicts during the fall season (Mattson et al. 1992, Gunther et al. 1997).~~ [FJK15] Studies have shown that during poor whitebark pine years grizzly bears selected less

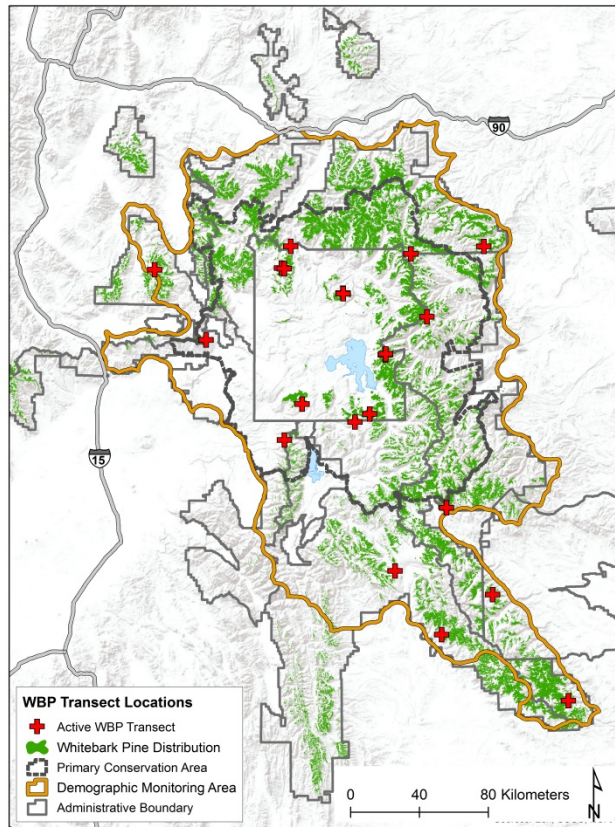
for whitebark pine stands (Costello et al. 2014) and consumed more animal matter, boosting their fat levels to match those measured in years of high cone production (Schwartz et al. 2014). Although whitebark pine has experienced widespread declines in the GYE (see subsequent section), extensive studies by the IGBST showed no profound negative effects on grizzly bears at the individual or population level (IGBST 2013). In addition, Costello et al. (2014) reported that approximately one-third of Yellowstone grizzly bears in their study included little or no whitebark pine stands within their fall range.

Monitoring Protocol—Currently there are 21 whitebark pine cone production transects^[FJK16] (Figure

8) within the GYE. [Transects will maintain a representative sample of whitebark pine cone production and distribution \(Figure 8\).](#) Annual transect surveys are typically conducted between July 15 and August 15 to count cones after maturation but before cones and seeds have been collected by red squirrels (*Tamiasciurus hudsonicus*) and Clark's nutcrackers (*Nucifraga columbiana*). The presence or absence of blister rust and beetle infestations as well as activity levels of grizzly bear, black bear, red squirrel, and Clark's nutcracker are also recorded during transect surveys. Monitoring of whitebark pine cone production using current or modified methods will continue under this Conservation Strategy and results will be summarized and reported in the IGBST [Annual Report—publication Yellowstone Grizzly Bear Investigations](#).

Figure 8. [Distribution of whitebark pine and ~~L~~location of whitebark pine cone production transect sites in the GYE, 2014.](#)





~~Monitoring~~ Mountain Pine Beetle Infestation and White Pine Blister Rust Infection

Background—Since the early 2000s, whitebark pine has declined significantly throughout much of the species' historic range in the Northern Rockies due to the spread of mountain pine beetle (*Dendroctonus ponderosae*) and white pine blister rust (*Cronartium ribicola*). The greatest levels of whitebark mortality resulted from mountain pine beetle, a native insect that typically attacks large, mature trees with inner bark thick enough to support larvae (Larson 2011). Beetle infestations tend to occur episodically every 20-40 years resulting in high, widespread mortality across coniferous forests. The most recent outbreak began in the early 2000s and impacted millions of hectares in the Rocky Mountains (Raffa *et al.* 2008). The infestation was exacerbated by warmer winters at higher elevations allowing for increased brood development and survival of adult beetles, and greater opportunity for reproduction (Bentz *et al.* 1991, Perkins and Roberts 2003, Larson 2011, Dooley 2012).

White pine blister rust, an exotic invasive pathogen introduced to North America in 1910, affects whitebark pines of all age classes, although seedlings and saplings are especially susceptible to infection. This exotic fungal pathogen infects the cambium of whitebark pine and other five-needle pines, causing reproductive failure and tree mortality (McKinney *et al.* 2009, Bockino and Tinker 2012). However, some individual whitebark pines carry genetic traits that make them more resistant to the disease. Restoration programs launched by the Forest Service use a technique described by Mahalovich *et al.* (2006) to breed and plant rust-resistant whitebark pines as part of an on-going effort to restore and maintain the species in the GYE.

In 2000, under the auspices of the Greater Yellowstone Coordinating Committee (GYCC), the Whitebark Pine Subcommittee (WPBSC) was created and tasked with forging a comprehensive long-term strategy for monitoring whitebark pine throughout the ecosystem. Recognizing the persistent and pervasive threat that blister rust and pine beetle posed to the health of whitebark pine, the subcommittee reached out to other agency and non-governmental partners to avoid

FINAL DRAFT

duplication of efforts. The result of these alliances is the Greater Yellowstone Whitebark Pine Monitoring Working Group (GYWPMWG), which consists of partners from the National Park Service (NPS), U.S. Forest Service (USFS), U.S. Geological Survey (USGS), and Montana State University (MSU). Led by the NPS Greater Yellowstone Inventory and Monitoring Network (GRYN), a strategic and peer-reviewed monitoring protocol was established for detecting, tracking, assessing, and reporting the health, status, and trends of whitebark pine throughout the GYE (GYWPMWG 2011). This ground-based monitoring program was initiated in 2004 and will continue to assess the current status and long-term trends of whitebark pine into the foreseeable future.

Monitoring Protocol—Spearheaded by the GRYN, an interagency collaborative monitoring effort involving NPS, USFS, and USGS partners will measure the status and trends of whitebark pine throughout the GYE. Monitoring efforts will focus on collecting critical baseline information for assessing 1) infection rates and severity of white pine blister rust; 2) survival of whitebark pine, taking into account synergistic interactions of blister rust, mountain pine beetle, wildland fire, and other agents of change; and 3) recruitment of whitebark pine trees into cone-bearing age classes. Monitoring protocols will follow methods and procedures established in the *Interagency Whitebark Pine Monitoring Protocol for the Greater Yellowstone Ecosystem* (GYWPMWG 2011). Results of current whitebark pine status and trends will be made available at the [GRYN Inventory and Monitoring website](#) and referenced in the ~~annual~~-IGBST [Annual Report monitoring report Yellowstone Grizzly Bear Investigations](#).

Hunter Numbers |

[FJK17]

Background

~~The number of elk hunters in Wyoming, Idaho, and Montana who recreate in the PCA (Table 5) were estimated and compared with known and probable grizzly bear mortalities from 2005 to 2014 to determine if bear mortality is correlated with hunter numbers. Although total hunter~~

numbers have declined over this time period, the data showed little evidence of a relationship between hunter numbers and hunting-related human-caused grizzly bear mortality (van Manen 2015, *in litt.*).

The greatest source of grizzly bear (≥ 2 years old) mortality during 2004–2014 in the GYE has been due to interactions with hunters. Nearly all known and probable bear mortalities occur as surprise encounters, at big game carcasses, or at hunter camps. The number of mistaken identity kills (i.e., mistaken for black bear) are small. Although the number of hunters using the PCA have decreased, the number of grizzly bear known and probable mortalities due to interactions with hunters increased in the last decade, primarily outside the PCA (Figure 5, Chapter 2). Potential explanations for why this occurred include bears learning to seek hunter-killed game, an increase in population size and concurrent expansion of occupied range, and greater use of ungulate resources (Haroldson *et al.* 2004, Schwartz *et al.* 2010, IGBST 2013).

Table 5. Estimated numbers of elk hunters within the GYE grizzly bear recovery zone plus a 10-mile perimeter in Idaho, Montana, and Wyoming, 2005–2014.

State	Year									
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Idaho ^a	3,619	3,016	2,592	1,763	1,819	1,904	1,860	1,803	1,937	2,771
Montana ^c	12,365	12,211	12,635	12,470	12,382	12,334	12,269	10,936	NA ^b	11,925
Wyoming ^{a,d}	9,888	9,346	8,716	8,792	8,440	6,712	6,413	7,566	7,818	8,109
Total	25,872	24,573	23,943	23,025	22,641	20,950	20,542	20,305	NA	22,805

^a Idaho and Wyoming numbers include archery and gun hunters.

^b NA = hunter number estimates not currently available.

^c Gun-only season.

^d A percentage of total hunter numbers was used in hunt areas 61 to 63, 67, 68, 73, and 83 because a portion of the hunt area falls outside the designated area.

FINAL DRAFT

~~State and federal wildlife agencies have attempted to reduce the loss of bears to hunters by expanding information and education programs. “Living in Bear Country” workshops are conducted regularly in many GYE communities, and licensed outfitters and guides have increased training for their members and clients.~~

Monitoring Protocol

~~Data from state wildlife agencies on big game herd units or hunting districts will be used as an index to backcountry use during the hunting season. Hunter use levels combined with numbers of grizzly bear human conflicts will be used to identify when and where to increase public education efforts and develop appropriate management actions to minimize grizzly bear human conflicts that result in bear mortality.~~

Transportation PlanningMonitoring Habitat Connectivity

Background

Habitat connectivity is the degree to which the landscape promotes natural movement of wildlife as they seek important resources for survival and successful procreation. Potential effects of highway improvements, such as increased motorized access, higher traffic volume, and higher speed limits, are known to increase grizzly bear mortality, reduce habitat connectivity, and potentially inhibit gene flow among nearby populations (Mace 2004, Summerfield *et al.* 2004, Proctor *et al.* 2012). Certain road designs and road improvements potentially discourage bear crossings, may lead to increased mortality from vehicle collisions, and may cause habitat fragmentation. The potential impact of highways on demographic and genetic connectivity of grizzly bears in the GYE is a key consideration in the transportation planning process.

Monitoring Protocol

To prevent habitat fragmentation and loss of connectivity within the GYE, existing road survey information [FJK18] will be compiled and evaluated by the appropriate land management agency as an integral part of the planning stage of any proposed road improvement and/or construction project in suitable grizzly bear habitat within the GYE (both inside and outside the PCA). During the NEPA analysis stage of such projects, analyses of road survey information will be conducted to evaluate potential impacts of the project on grizzly bear habitat connectivity. More specifically, federal agencies [FJK19] will identify important crossing areas by collecting and/or assessing existing information about known grizzly bear sightings, ungulate road mortalities, locations of game trails, and bear home ranges and habitat use within and near the road corridor. By identifying crossing areas used by grizzly bears, federal officials [FJK20] can recommend mitigation measures to reduce potential impacts from road construction both during and after a project. For example, during construction, work camps should be placed in areas with lower risk of displacing grizzly bears and use of bear-proof food and garbage storage containers should be implemented. Highway planners are encouraged to place warning signs at points of high mortality risk and implement wildlife crossing infrastructure such as culverts or underpasses to enhance safe passage. Road construction in areas of relatively high value for potential grizzly bear habitat linkage should be designed to mitigate potential negative impacts on habitat connectivity, including the consideration of installing crossing structures.

Literature Cited

- Bentz, B., J. Logan, and G. Amman. 1991. Temperature-dependent development of the mountain pine beetle (Coleoptera: Scolytidae) and simulation of its phenology. *Canadian Entomologist* 123: 1083–1094.
- Bjornlie, D., and M.A. Haroldson. 2002. Grizzly bear use of insect aggregation sites documented from aerial telemetry and observations. Pages 33–37 in C. Schwartz and M. Haroldson, editors. *Yellowstone grizzly bear investigations: annual report of the Interagency Study Team, 2001*. U.S. Geological Survey, Bozeman, Montana, USA.
- Bjornlie, D.D., and M.A. Haroldson. 2014. Grizzly bear use of insect aggregation sites documented from aerial telemetry and observations. Pages 40–43 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, 2013*. U.S. Geological Survey, Bozeman, Montana, USA.
- Bjornlie, D.D., D.J. Thompson, M.A. Haroldson, C.C. Schartz, K.A. Gunther, S.L. Cain, D.B. Tyers, K.L. Frey, and B.C. Aber. 2014. Methods to estimate distribution and range extent of grizzly bears in the Greater Yellowstone Ecosystem. *Wildlife Society Bulletin* 38: 182–187. Doi: 10.1002/wsb.368.
- Blanchard, B. 1978. Grizzly bear distribution in relation to habitat areas and recreational use: cabin Creek-Hilgard Mountains. M.S. Thesis, Montana State University, Bozeman, Montana, USA. 75 pp.
- Blanchard, B., and R.R. Knight. 1996. Effects of wildfire on grizzly bear movements and food habits. Pages 117–122 in J.M. Greenlee, editor. *The ecological implications of fire in Greater Yellowstone*. Proceedings of the 2nd biennial conference on the Greater Yellowstone Ecosystem. 1993. Yellowstone National Park, Wyoming. International Association of Wildland Fire. Fairfield, Washington, USA.
- Blanchard, B.M., R.R. Knight, and D.J. Mattson. 1992. Distribution of Yellowstone grizzly bears during the 1980s. *American Midland Naturalist* 128: 332–338.

- Bockino, N.K., and D.B. Tinker. 2012. Interactions of white pine blister rust and mountain pine beetle in whitebark pine ecosystems in the souther Greater Yellowstone Ecosystem. *Natural Areas Journal* 32: 31–40.
- Boyce, M.S. 1992. Population viability analysis. *Annual Reviews of Ecology and Systematics* 23: 481–506.
- Boyce, M.S. 1993. Population viability analysis: Adaptive management for threatened and endangered species. *Transactions North American Wildlife Natural Resource Conference* 58: 520–527.
- Boyce, M.S. 1995. Population viability analysis for grizzly bears (*Ursus arctos horribilis*): a critical review. Report to the Interagency Grizzly Bear Commmittee, Missoula, Montana, USA. 79 pp.
- Boyce, M.S., B.M. Blanchard, R.R. Knight, and C. Servheen. 2001a. Population viability for grizzly bear: a critical review. *Interagency Association of Bear Research and Management Monograph Series* 4. 45 pp.
- Boyce, M.S., D. MacKenzie, B.J.J. Manly, M.A. Haroldson, and D. Moody. 2001b. Negative binomial models for abundance estimation of multiple closed populations. *Journal of Wildlife Mangagement* 65: 498–509.
- Caughley, G. 1994. Directions in conservation biology. *Journal of Animal Ecology* 63: 215–244.
- [Cherry, S. 2007. Monitoring ungulate carcasses and spawning cutthroat trout. Pages 55–62 in C.C. Schwartz, M.A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2006. U.S. Geological Survey, Bozeman, Montana, USA.](#)
- Costello, C.M., F.T. van Manen, M.A. Haroldson, M.R. Ebinger, S. Cain, K. Gunther, and D.D. Bjornlie. 2014. Influence of whitebark pine decline on fall habitat use and movements of grizzly bears in the Greater Yellowstone Ecosystem. *Ecology and Evolution* 4: 2004–2018.
- Craighead, J.J., J.R. Varney, and F.C. Craighead, Jr. 1974. A population analysis of the Yellowstone grizzly bears. Montana Forest and Conservation Experiment Station and Montana Cooperative Wildlife Research Unit, University of Montana, Missoula, Montana,

FINAL DRAFT

USA. 20 pp.

- Dooley, E.M. 2012. Mountain pine beetle outbreaks in high elevation whitebark pine forests: the effects of tree host species and blister rust infection severity on beetle productivity. Thesis. University of Montana, Missoula, Montana, USA. 123 pp.
- Eberhardt, L.L. 1995. Population trend estimates from reproductive and survival data. Pages 13–19 in R. R. Knight and B. M. Blanchard. Yellowstone grizzly bear investigations: report of the Interagency Study Team, 1994. National Biological Service, Bozeman, Montana, USA.
- Eberhardt, L.L., B. Blanchard, and R. Knight. 1994. Population trend of the Yellowstone grizzly bear as estimated from reproductive and survival rates. *Canadian Journal of Zoology* 72: 360–363.
- Eberhardt, L.L., and R.R. Knight. 1996. How many grizzlies in Yellowstone? *Journal of Wildlife Management* 60: 416–421.
- [Farley, S.D., and C.T. Robbins. 1994. Development of two methods to estimate body composition of bears. *Canadian Journal of Zoology* 72: 220–226.](#)
- French, S.P., M.G. French, and R.R. Knight. 1994. Grizzly bear use of army cutworm moths in the Yellowstone ecosystem. *International Conference on Bear Research and Management* 9: 389–399.
- Greater Yellowstone Whitebark Pine Monitoring Working Group. 2011. Interagency Whitebark Pine Monitoring Protocol for the Greater Yellowstone Ecosystem, Version 1.1. Greater Yellowstone Coordinating Committee, Bozeman, Montana, USA.
- Green, G.I., D.J. Mattson, and J.M. Peek. 1997. Spring feeding on ungulate carcasses by grizzly bears in Yellowstone National Park. *Journal of Wildlife Management* 61: 1040–1055.
- Gunther, K.A., M.T. Bruscino, S. Cain, K. Frey, and R.R. Knight. 1997. Grizzly bear-human conflicts, confrontations, and management actions in the Yellowstone Ecosystem Subcommittee report. National Park Service. Unpublished report. 43 pp.
- 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: 10–22.
- Gunther, K.A., R. Shoemaker, K. Frey, M.A. Haroldson, S.L. Cain, F.T. van Manen, and J.K. Fortin. 2014a. Dietary breadth of grizzly bears in the Greater Yellowstone Ecosystem. *Ursus*

25: 60–72.

- Gunther, K.A., T. Wyman, and E. Reinertson. 2014b. Spring ungulate availability and use by grizzly bears in Yellowstone National Park. Pages 32–35 in F.T. van Manen and M.A. Haroldson, editors. Yellowstone grizzly bear investigations: Annual report of the Interagency Grizzly Bear Study Team, 2013. U.S. Geological Survey, Bozeman, Montana, USA.
- Haroldson, M.A., K.A. Gunther, D.P. Reinhart, S.R. Podrutzny, C. Cegelski, L. Waits, T. Wyman, and J. Smith. 2005. Changing numbers of spawning cutthroat trout in tributary streams in Yellowstone Lake and estimates of grizzly bears visiting streams from DNA. *Ursus* 16: 167–480.
- Haroldson, M.A., C.C. Schwartz, S. Cherry, and D. Moody. 2004. Possible effects of elk hunting on the fall distribution of grizzly bears in the Greater Yellowstone Ecosystem. *Journal of Wildlife Management* 68: 129–137.
- Haroldson, M.A., C.C. Schwartz, K.C. Kendall, K.A. Gunther, D.S. Moody, K. Frey, and D. Paetkau. 2010. Genetic analysis of individual origins supports isolation of grizzly bears in the Greater Yellowstone Ecosystem. *Ursus* 21: 1–13.
- Haroldson, M.A., C.C. Schwartz, and G.C. White. 2006. Survival of independent grizzly bears in the Greater Yellowstone Ecosystem, 1983–2001. Pages 33–42 in C.C. Schwartz, M.A. Haroldson, G.C. White, R.B. Harris, S. Cheery, K.A. Keating, D. Moody, and C. Servheen, authors. Temporal, spatial, and environmental influences on the demographics of grizzly bears in the Greater Yellowstone Ecosystem. *Wildlife Monographs* 161.
- Haroldson, M.A., F.T. van Manen, and D.D. Bjornlie. 2014. Estimating number of females with cubs-of-the-year. Pages 12–21 in F.T. van Manen, M.A. Haroldson, K. West, and S.C. Soileau, editors. Yellowstone grizzly bear investigations: Annual report of the Interagency Grizzly Bear Study Team, 2013. U.S. Geological Survey, Bozeman, Montana, USA.
- Haroldson, M.A., F.T. van Manen, and D.D. Bjornlie. 2015. Estimating number of females with cubs-of-the-year. Pages 11–20 in F.T. van Manen, M.A. Haroldson, K. West, and S.C. Soileau, editors. Yellowstone grizzly bear investigations: Annual report of the Interagency Grizzly Bear Study Team, 2014. U.S. Geological Survey, Bozeman, Montana, USA.

FINAL DRAFT

- Harris, R. 1986. Modeling sustainable harvest rates for grizzly bear populations. Pages 268–279 in A. Dood, B. Brannon, and R. Mace. Final programmatic EIS: the grizzly bear in northwest Montana. Montana Fish, Wildlife & Parks, Helena, Montana, USA.
- Harris, R.B., C.C. Schwartz, M.A. Haroldson, and G.C. White. 2006. Trajectory of the Yellowstone grizzly bear population under alternative survival rates. Pages 44–55 in C.C. Schwartz, M.A. Haroldson, G.C. White, R.B. Harris, S. Cherry, K.A. Keating, D. Moody, and C. Servheen, eds. Temporal, spatial, and environmental influences on the demographics of grizzly bears in the Greater Yellowstone Ecosystem. Wildlife Monographs 161.
- Harris, R.B., G.C. White, C.C. Schwartz, and M.A. Haroldson. 2007. Population growth of Yellowstone grizzly bears: uncertainty and future monitoring. *Ursus* 18: 168–178.
- Hoskins, W.P. 1975. Yellowstone Lake tributary study. Interagency Grizzly Bear Study Team. Unpublished report. 31 pp.
- Interagency Grizzly Bear Committee. 1986. Interagency grizzly bear guidelines. Missoula, Montana, USA. 100 pp.
- Interagency Grizzly Bear Committee. 1998. Interagency Grizzly Bear Committee Taskforce Report: Grizzly bear/motorized access management. Missoula, Montana, USA. 8 pp.
- 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, 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, Bozeman, Montana, USA.
- Jacoby, M.E., G.V. Hilderbrand, C. Servheen, C.C. Schwartz, S.M. Arthur, T.A. Hanley, C.T. Robbins, and R. Michener. 1999. Trophic relations of brown and black bears in several western North American ecosystems. *Journal of Wildlife Management* 63: 921–929.

- Kamath, P.L., M. A. Haroldson, G. Luikart, D. Paetkau, C. Whitman, and F.T. van Manen. 2015. Multiple estimates of effective population size for monitoring a long-lived vertebrate: an application to Yellowstone grizzly bears. *Molecular Ecology*. Doi: 10.1111/mec.13398.
- Keating, K.A., C.C. Schwartz, M.A. Haroldson, and D. Moody. 2002. Estimating number of females with cubs-of-the-year in the Yellowstone grizzly bear population. *Ursus* 13: 161–174.
- Knight, R.R., and B.M. Blanchard. 1994. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 1993. National Biological Service, Bozeman, Montana, USA.. 26 pp.
- Knight, R.R., and B.M. Blanchard. 1995. Yellowstone grizzly bear investigations: annual report of the Interagency Study Team, 1994. National Biological Service, Bozeman, Montana, USA. 27 pp.
- Knight, R.R., B.M. Blanchard, and L.L. Eberhardt. 1995. Appraising status of the Yellowstone grizzly population by counting females with cubs of the year. *Wildlife Society Bulletin* 23: 245–248.
- [Kooijman, S.A.L.M. 2000. Dynamic energy and mass budgets in biological systems, 2nd edition. Cambridge: Cambridge University Press.](#)
- Larson, E.R. 2011. Influences of the biophysical environment on blister rust and mountain pine beetle, and their interactions, in whitebark pine forests. *Journal of Biogeography* 38: 453–470.
- Mace, R.D. 2004. Integrating science and road access management lessons from the Northern Continental Divide Ecosystem. *Ursus* 15: 129–136.
- Mace, R., J.S. Waller, T. Manley, L.J. Lyon, and H. Zuuring. 1996. Relationships among grizzly bears, roads, and habitat in the Swan Mountains, Montana. *Journal of Applied Ecology* 33: 1305–1404.
- Mahalovich, M.F., K.E. Burr, and D.L. Foushee. 2006. Whitebark pine germination, rust resistance and cold hardiness among seed sources in the Inland Northwest: planting strategies for restoration. Pages 91–101 in L.E. Riley, R.K. Dumroese, and T.D. Landis, technical coordinators. *Nationl Proceedings: Forest and Conservation Nursery Associations*; 2005.

FINAL DRAFT

Proceedings RMRS-P-43. USDA Forest Service, Fort Collins, Colorado, USA.

FINAL DRAFT

- Mattson, D.J., B.M. Blanchard, and R.R. Knight. 1992. Yellowstone grizzly bear mortality, human habituation, and whitebark pine seed crops. *Journal of Wildlife Management* 56: 432–442.
- Mattson, D.J., and C. Jonkel. 1990. Stone pines and bears. Pages 223–236 in W.C. Schmidt and K.J. McDonald, compilers. *Proceedings-symposium on whitebark pine ecosystems: ecology and management of a high-mountain resource*. U.S. Forest Service. General Technical Report INT-270.
- Mattson, D.J., and R.R. Knight. 1991. Effects of access on human-caused mortality of Yellowstone grizzly bears. *USDOI National Park Service Interagency Grizzly Bear Study Team Report 1991B*. Bozeman, Montana, USA.
- McKinney, S.T., C.E. Fiedler, and D.F. Tomback. 2009. Invasive pathogen threatens bird-pine mutualism: implications for sustaining high-elevation ecosystem. *Ecological Applications* 19: 597–607.
- McLellan, B.N., and D.M. Shackleton. 1988. Grizzly bears and resource-extraction industries: effects of roads on behavior, habitat use and demography. *Journal of Applied Ecology* 25: 451–460.
- Mealey, S.P. 1975. The natural food habits of free-ranging grizzly bears in Yellowstone National Park, 1973–1974. M.S. Thesis, Montana State University, Bozeman, Montana, USA. 158 pp.
- Miller, C.R. and L.P. Waits. 2003. The history of effective population size and genetic diversity in the Yellowstone grizzly (*Ursos arctos*): Implications for conservation. *Proceedings of the National Academy of Sciences* 100: 4334–4339.
- [Molnar, P.K., T. Klanjscek, A.E. Derocher, M.E. Obbard, and M.A. Lewis. 2009. A body composition model to estimate mammalian energy stores and metabolic rates from body mass and body length, with application to polar bears. *The Journal of Experimental Biology* 212: 2313–2323.](#)
- Mowat, G., and D.C. Heard. 2006. Major components of grizzly bear diet across North America. *Canadian Journal of Zoology* 84: 473–489.
- Perkins, D.L., and D.W. Roberts. 2003. Predictive models of whitebark pine mortality from mountain pine beetle. *Forest Ecology and Management* 174: 495–510.

FINAL DRAFT

Podruzny, S.R., and K.A. Gunther. 2002. Spring ungulate availability and use by grizzly bears in Yellowstone National Park. Pages 29–33 *in* C. Schwartz and M. Haroldson editors.

Yellowstone grizzly bear investigations: annual report of the Interagency Study Team, 2001.

U.S. Geological Survey, Bozeman, Montana, USA.

FINAL DRAFT

- Podruzny, S.R., K.A. Gunther, and T. Wyman. 2012. Spring ungulate availability and use by grizzly bears in Yellowstone National Park. Pages 29–31 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.
- Pritchard, G.T., and C.T. Robbins. 1990. Digestive and metabolic efficiencies of grizzly and black bears. *Canadian Journal of Zoology* 69: 1645–1651.
- Proctor, M.F., D. Paetkau, B.N. McLellan, G.B. Stenhouse, K.C. Kendall, R.D. Mace, W.F. Kasworm, C. Servheen, C.L. Lausen, M.L. Gibeau, W.L. Wakkinen, M.A. Haroldson, G. Mowat, C.D. Apps, L.M. Ciarniello, R.M.R. Barclay, M.S. Boyce, C.C. Schwartz, and C. Strobeck. 2012. Population fragmentation and inter-ecosystem movements of grizzly bears in western Canada and the northern United States. *Wildlife Monographs* 180: 1–46. Doi: 10.1002/wmon.6.
- Reinhart, D.P., and D.J. Mattson. 1990. Bear use of cutthroat trout spawning streams in Yellowstone National Park. *International Conference on Bear Research and Management* 8: 343–350.
- Schwartz, C.C., J.K. Fortin, J.E. Teisberg, M.A. Haroldson, C. Servheen, C.T. Robbins, and F.T. van Manen. 2014. Body and diet composition of sympatric black and grizzly bears in the Greater Yellowstone Ecosystem. *Journal of Wildlife Management* 78: 68–78.
- Schwartz, C.C., M.A. Haroldson, and S. Cherry. 2006. Reproductive performance of grizzly bears in the Greater Yellowstone Ecosystem, 1983–2002. Pages 18–23 in C.C. Schwartz, M.A. Haroldson, G.C. White, R.B. Harris, S. Cherry, K.A. Keating, D. Moody, and C. Servheen, authors. Temporal, spatial, and environmental influences on the demographics of grizzly bears in the Greater Yellowstone Ecosystem. *Wildlife Monographs* 161.
- Schwartz, C. C., M. A. Haroldson, K.A. Gunther, and D. Moody. 2002. Current distribution of grizzly bears in the greater Yellowstone ecosystem, 1990-2000. *Ursus* 13:156–162.
- Schwartz, C.C., M.A. Haroldson, K.A. Gunther, and C.T. Robbins. 2013. Omnivory and the terrestrial food web: Yellowstone grizzly bear diets. Pages 109–124 in P.J. White, R.A.

FINAL DRAFT

- Garrot, and G.E. Plumb, editors. Yellowstone's wildlife in transition. Harvard University Press, Cambridge, Massachusetts, USA.
- Schwartz, C.C., M.A. Haroldson, and G.C. White. 2010. Hazards affecting grizzly bear survival in the Greater Yellowstone Ecosystem. *Journal of Wildlife Management* 74: 654–667.
- Schwartz, C.C., S.D. Miller, and M.A. Haroldson. 2003. Grizzly bear. Pages 556–586 in G.A. Feldhamer, B.C. Thompson, and J.A. Chapman, editors. *Wild mammals of North America: biology, management, and conservation*. Second edition. John Hopkins University Press, Baltimore, Maryland, U.S.A.
- Servheen, C.R., R. Knight, D. Mattson, S. Mealey, D. Strickland, J. Varley, and J. Weaver. 1986. Report to the IGBC on the availability of foods for grizzly bears in the Yellowstone ecosystem. 21 pp.
- Summerfield, B., W. Johnson, and D. Roberts. 2004. Trends in road development and access management in the Cabinet-Yaak and Selkirk grizzly bear recovery zones. *Ursus* 15: 115–122.
- Teisberg, J.E., M.A. Haroldson, C.C. Schwartz, K.A. Gunther, J.K. Fortin, and C.T. Robbins. 2014. Contrasting past and current numbers of bears visiting Yellowstone cutthroat trout streams. *Journal of Wildlife Management* 78: 369–378. Doi: 10.1002/jwmg.667
- USDA Forest Service. 1985. Cumulative effects analysis process for the Yellowstone Ecosystem. Unpublished report 40 pp.
- USDA Forest Service. 2004. Forest plan amendments for grizzly bear conservation for the Greater Yellowstone Area National Forests draft environmental impact statement. Idaho, Montana, and Wyoming, USA. 303 pp.
- USDA Forest Service. 2005. Forest Service Manual 2600 – Wildlife, Fish, and Sensitive Plant Habitat Management. Amendment no. 2600-2005-1. National Headquarters (WO), Washington, D.C. 22 pp.
- U.S. Fish and Wildlife Service. 1993. Grizzly bear recovery plan. Missoula, Montana, USA. 181 pp.

FINAL DRAFT

- U.S. Fish and Wildlife Service. 2003. Draft Final Conservation Strategy for the Grizzly Bear in the Greater Yellowstone Area. U.S. Fish and Wildlife Service, Missoula, Montana, USA. 397 pp.
- U.S. Fish and Wildlife Service. 2007a. Final Conservation Strategy for the Grizzly Bear in the Greater Yellowstone Area. U.S. Fish and Wildlife Service, Missoula, Montana, USA. 88 pp.
- U.S. Fish and Wildlife Service. 2007b. Recovery Plan Supplement: Revised demographic criteria for the Greater Yellowstone Ecosystem. Missoula, Montana, USA. 35 pp.
- U.S. Fish and Wildlife Service. 2007c. Recovery Plan Supplement: Habitat-based recovery criteria for the Greater Yellowstone Ecosystem. Missoula, Montana, USA. 52 pp.
- Walters, C.J., and C.S. Holling. 1990. Large-scale management experiments and learning by doing. *Ecology* 71: 2060–2068.
- U.S. Fish and Wildlife Service. 2016. Recovery Plan Supplement: Revised demographic criteria for the Greater Yellowstone Ecosystem. Missoula, Montana, USA.
- Walters, C.J., and C.S. Holling. 1990. Large-scale management experiments and learning by doing. *Ecology* 71: 2060–2068.
- White, G.C. 1996. Two grizzly bear studies: moth feeding ecology and male reproductive biology. Ph.D. Dissertation, Montana State University, Bozeman, USA. 79 pp.