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Please accept the attached comments on the forest plan revision.

I have reviewed the draft plan and the draft environmental impact statement and feel strongly that Alternative D, or some similar alternative, which contains even more wilderness or strongly protected lands than Alternative D, should be selected. This conclusion is based primarily on 2 factors: the history (especially the management history) of the Hyalite-Porcupine Buffalo Horn Wilderness Study Area (HPBH WSA), and the ecology of the species that currently rely upon the HPBH WSA and will depend upon it in the future as the climate changes.

History

The HPBH WSA is the largest single block of intact habitat remaining in the Custer-Gallatin NF that has not been formally classified as wilderness. It was identified as having extremely valuable wilderness character since the Wilderness Act was established. The Wilderness Act (78 Stat. 890; 16 U.S.S. 1132), co-sponsored by Senator Lee Metcalf of Montana, was passed by the US Congress in 1964. It mandates the preservation of wilderness character in congressionally designated wilderness. The Lee Metcalf Wilderness was not one of the 54 original wilderness areas set aside by the Wilderness Act. This wilderness was designated in 1983 by its own act; the Lee Metcalf Wilderness and Management Act of 1983 (P.L. 98-140). The Congressional Record for the Lee Metcalf Wilderness and Management Act reinforces this mandate, stating, "The overriding principle guiding management of all wilderness areas, regardless of which agency administers them, is the Wilderness Act (section 4(b)) mandate to preserve their wilderness character.[rdquo]

In its original form, the Lee Metcalf Wilderness and Management Act would have included what is now the Hyalite-Porcupine-Buffalo Horn Wilderness Study Area in a contiguous 600,000 acre Wilderness. By the time the Lee Metcalf Wilderness and Management Act was passed however in 1983, Senator John Melcher and others had split this larger area into 4 separate wilderness areas totaling 259,000 acres, and removed the HPBH WSA from the bill. Before that time though, the 1977 Montana Wilderness Study Act (MWSA: P.L. 95-150) was passed by the U.S. Congress in November and set aside the Hyalite-Porcupine-Buffalo Horn Wilderness Study Area (HPBH WSA: often called the Gallatin Crest WSA), along with eight other wilderness study areas. The Act stated that [ldquo]In furtherance of the purposes of the Wilderness Act, the Secretary of Agriculture shall, within five years after the date of enactment of this Act, review certain lands designated by this section, as to their suitability for preservation as wilderness, and report his findings to the President[hellip].. and that [ldquo]certain lands in the Gallatin National Forest, Montana, which are generally depicted on a map entitled [lsquo]Hyalite-Porcupine-Buffalo Horn Wilderness Study Area[rsquo] and dated April 1976, comprising approximately one hundred and fifty-one thousand acres, which shall be known as the Hyalite-Porcupine-Buffalo Horn Wilderness Study Area.[rdquo]

The Act further stated that these WSAs shall be administered by the Secretary of Agriculture to maintain their presently existing wilderness character and potential for inclusion in the National Wilderness Preservation System until Congress determines otherwise. The term [ldquo]maintain their presently existing wilderness character[rdquo] has been interpreted by some to mean that the managing agency, the U.S. Forest Service, was obligated to administer the area as de facto wilderness (ie. closing the area to all mechanized and motorized uses) until such time as a determination could be made. However, some mechanized and motorized uses were later allowed in some areas of the HPBH WSA

The Hyalite-Porcupine-Buffalo Horn area was also included in the RARE II study process which was initiated in June of 1977. All of the nine Montana Wilderness Study Act (MWSA) areas were included in the RARE II inventory. The purpose of RARE II was to study all roadless and undeveloped areas in the National Forest System and recommend them as either wilderness or nonwilderness. The RARE II process did not meet all the requirements of the MWSA legislation. For instance, RARE II did not provide for public notice and hearings and the incorporation of the hearing record in the report to Congress. Even so, the Forest Service decided to begin the evaluation of the MWSA areas by including them in the RARE II process to the extent possible. Through the RARE II process, all MWSA areas were placed in a "further planning" category until the remaining requirements of the MWSA legislation were completed.

A series of reports have been prepared relating to the HPBH WSA. Ten public workshops were conducted in Montana in September 1979 to identify issues relating to the MWSA areas. A separate effort was made to identify public issues and management concerns for the Gallatin National Forest as part of the Forest planning process. This resulted in the Hyalite Porcupine Buffalo Horn Wilderness Study Report EIS prepared by the Forest Service for the Gallatin National Forest Plan in 1958 (USDA 1985). The initial Wilderness Study Report (USDA 1985) was a legislative environmental impact statement required by Congress.

The purpose of the 1985 Study Report was to evaluate the area for its wilderness suitability and make a recommendation for its future management following the requirements of the National Environmental Policy Act (NEPA) and the National Forest Management Act (NFMA). The Study Report analyzed seven different alternatives. Alternative 5 allocated the entire study area, which had not been encumbered by roads and timber harvest, to wilderness. Alternative 7, the Proposed Action, included designation of a special scenic area in the Hyalite Peaks area (23,102 acres) to be reserved for public recreation. A national recreation trail along the Gallatin Crest was also proposed. No wilderness was recommended in alternative 7, with 42,803 acres allocated for [lsquo]Wildlife and Recreation[rsquo], 23,102 acres allocated as [lsquo]Scenic Area[rsquo], 13,103 acres as [lsquo]Dispersed Recreation (nonroaded), 12,785 acres as [lsquo]Timber Management[rsquo], 8,503 acres as [lsquo]Near Natural[rsquo] and 1,774 acres as [lsquo]Big Game with Timber Management[rsquo]. No Record of Decision (ROD) was completed from this report; normally this would have been done by the Forest Supervisor and the ROD would form the basis of a Bill before Congress to pass an Act that would determine the status of the lands in the HPBH WSA. It is at this point in the process that the science-based NEPA and NFMA processes have created recommendations that can be acted upon by Congress. Depending upon the political climate in Congress, such a Bill could either be supported or opposed and perhaps alternative Bills could be written: science gives way to politics and there are no guarantees about the outcome. Such Bills can also be attached as riders to other [lsquo]must pass[rsquo] legislation, such as defense funding, to ensure their passage; in general all legislators from the state in question need to support such strategies for them to be successful.

The conclusion of the 1985 Study Report was to adopt Alternative 7 and not recommend the HPBH study area for inclusion in the natural wilderness preservation system despite the finding within the report that: [ldquo]Most of the area is suitable for wilderness consideration. Impacts to the area[rsquo]s natural integrity and appearance tend to be on the area[rsquo]s periphery. Natural appearance of the area will be affected in a few places by sight or sounds from outside the boundaries, but these disturbances would probably affect less than 5 percent of the area.[rdquo].

Wilderness was not included in the Proposed Action primarily because of fragmented land ownership: "The chief impediment to [Wilderness] manageability of the area is the private checkerboard inholdings." (USDA 1985, p III-8). However, since 1985 the privately owned inholding lands have been largely consolidated through land exchanges and purchases, thus removing this [lsquo]impediment[rsquo] to wilderness consideration. The findings of the 1985 report thus remain valid: most of the area is suitable for wilderness consideration. The HPBH WSA lands currently make up about 40% of all NF lands within the Gallatin Range, and about 73% of the total inventoried NF roadless lands within the Gallatin Range.

In 1996, the Montana Wilderness Association initiated legislation over Forest Service Management of WSA's across Montana, citing loss of historic wilderness character due to increased motorized recreation and lack of appropriate management actions by the Agency. This lawsuit specifically cited the HPBH WSA and concerns about Gallatin National Forest management actions. The litigation was settled in 2001 and resulted in the Forest Service's agreement to conduct travel management planning for all WSAs. Travel Planning and Forest Planning decisions have subsequently superseded the mandate for Wilderness consideration in determining the status of the lands within the HPBH WSA.

In 2003, the Gallatin National Forest completed the [ldquo]Hyalite Porcupine Buffalo Horn Wilderness Study Area Character Assessment[rdquo] authored by Kimberly Schlenker (Schlenker 2003). This report summarized the current physical and social conditions of the HPBH study area in 2003 as compared to existing wilderness characteristics in 1977. Changes since 1977 were documented,

and their effects on four principal characteristics of wilderness: natural integrity, remoteness, opportunities for solitude, and apparent naturalness were described. By 2003, the Forest Service had acquired over 37,000 acres of the private land checkerboarded with Forest lands, most of these previously owned by Burlington Northern Railroad and its timber subsidiary, Plum Creek Timber, Inc. (Clark et. al 2012). However, many activities took place on these lands from road construction and timber harvest to camp improvements on private lands leased by outfitters. By the time of the 2003 report the Forest Service did not have complete data on all the activities that may have had an effect on wilderness characteristics. The acquisition of these lands increased the number of public access points from 9 to 16 trailheads (Schlenker 2003).

In 2012 The Gallatin National Forest, in cooperation with the University of Montana, completed the [ldquo]Wilderness Character Monitoring Report Hyalite Porcupine Buffalo Horn Wilderness Study Area[rdquo] authored by Erin Clark, Kimberly Schlenker, and Catherine Filardi (Clark et al. 2012).

The report draws heavily from the University of Montana Wilderness Institute's 2011 efforts collecting field data relevant to wilderness character. This effort stemmed from a 2009 collaboration between the Wilderness Institute, the Aldo Leopold Wilderness Research Institute, the Forest Service, and several local, non-governmental organizations to develop measurable field Indicators for the four qualities of wilderness character Identified in the Wilderness Act of 1964. In 2009 and 2010. These indicators were 1) untrammeled quality, 2) natural quality, 3) undeveloped quality, and 4) Opportunities for solitude or a primitive and unconfined type of recreation. Wilderness Institute crews implemented these field protocols across four of Montana's congressionally designated Wilderness Study Areas. During summer 2011, Wilderness Institute crews and community volunteers hiked every trail in the HPBH WSA and made detailed observations along 218 miles of system trails and 44 miles of non-system trails (Clark et al. 2012). This report was designed to establish a baseline for each of these measures of wilderness so that trends could be evaluated over time. At this time the total area of the WSA was estimated at approximately of about 155,000 acres of land.

The history of the HPBH WSA thus strongly supports wilderness designation; this was the original intent when areas in Montana were first considered for wilderness designation. Although politics and development interests reduced the area considered for wilderness, the HPBH WSA was set aside for further consideration. It has not become less valuable for wilderness in the intervening years; in fact, it is much more valuable as wilderness as we have come to understand the importance of intact ecosystems in this time of accelerating climate change and human population growth. The history of maintaining the HPBH WSA is strongly supported by its ecology.

Ecology

Wilderness character is not explicitly defined in The Wilderness Act of 1964, but congressional intent is expressed in the Definition of Wilderness, Section 2c of the Wilderness Act:

[ldquo]A wilderness, in contrast with those areas where man and his works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. An area of wilderness is further defined to mean in this Act an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man[rsquo]s work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation;

(3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, education, scenic, or historical value.[rdquo]

The primary definitions of the act (1 and 2) have been characterized as the [lsquo]anthropocentric[rsquo] wilderness concept while the other attributes listed (3 and 4) represent the [lsquo]biocentric[rsquo] concept (Leslie and Taylor 1985); both are important components of wilderness. Leslie and Taylor (1985) argue that [ldquo]anthropocentric wilderness inventories can only establish a wilderness threshold by an essentially arbitrary decision because the perception of wilderness quality by recreationists differs widely among individuals and is influenced by such a variety of personal factors as to defy logical analysis (Ittelson et al., 1974)[rdquo]. This appears to be the approach being taken currently by the community collaborative techniques being used to evaluate uses of roadless areas and Wilderness Study Areas such as the Gallatin Forest Partnership. In contrast, Leslie and Taylor (19850 assert that [ldquo]biocentric wilderness inventories can establish an objective wilderness threshold by reference to ecological principles, particularly those embodied in island biogeography theory (Diamond, 1975).[rdquo] In that regard, the report that I submitted to the Custer Gallatin Forest Plan Revision planning process (Craighead, 2015) in 2016 and 2018 can be considered a biocentric approach to evaluate wilderness values (of the HPBH WSA) from an ecological, wildlife-centered, perspective. The following observations are primarily drawn from that report. I was greatly disappointed that it was not referenced in any of the planning documents or included in the bibliography of relevant literature to the Forest Plan Revision.

I understand that forest management is a balancing act to try to 1) protect the resources of the forest, with the need to 2) provide goods and services and opportunities for user groups. In the case of the HPBH WSA I contend that protection of the resource (an intact ecosystem) outweighs the needs of human user groups and should be the guiding principle in management of this area. The impacts of extractive uses are well known and lead to degradation of most habitats and ecosystem services over time. Also, all forms of recreation contribute to trail erosion and cause disturbance to non-habituated wildlife. There is a large body of scientific research on the effects of various forms of recreation on wildlife, habitat, and other environmental components. Most of the literature has focused on the effects of paved roads, but there is a growing body of research on the effects of different types of trails and different activities on those trails. A 1975 survey of land managers reported substantial erosion on mountain trails during the previous decade that was attributed to dramatic increases in horse and foot travel on trails not designed to accommodate higher volumes of traffic (Godin and Leonard, 1979). Since 1975, the use of mountain bikes, motorcycles, all-terrain vehicles ATV[rsquo]s), off-road vehicles (ORVs), and snowmobiles has also increased dramatically.

The first review of the recreation impacts literature was done in 1985 by Boyle and Samson (1985) who found 536 references concerning effects of nonconsumptive outdoor recreation on wildlife (Boyle and Samson 1985). The variety and magnitude of recreational impacts has increased greatly since then. In 1997 a review of scientific literature on effects of linear developments on wildlife included thousands of documents (Jalkotzy et al. 1997). A subsequent review by the Montana Chapter of the Wildlife Society in 1999 summarized 403 papers related to effects on carnivores alone (Claar et al. 1999). A bibliography compiled for the Bridger-Teton National Forest in 2002 included 607 scientific papers, reports, articles and documents written with respect to the effects of roads on wildlife and the montane ecosystem (Nietvelt 2002).

In a literature review for Mount Spokane State Park by Pacific Biodiversity Institute (Snetsinger and White 2009) impacts were summarized: outdoor recreation was found to be the 2nd leading cause of decline of U.S. threatened and endangered species on public lands (Losos et al. 1995) and 4th leading cause across all ownerships (Czech et al. 2000). As recreational use of public lands continues to grow, there is increasing concern over the trade-offs that may exist between recreation and protection of wildlife (Reed and Merenlender 2008).

A [ldquo]Synthesis of the Literature and State of the Practice[rdquo] about conflicts on multiple-use trails was compiled by the Federal Highway Administration at the request of The National Recreational Trails Advisory Committee (FHWA 1994). This document looked at the challenges faced by trail managers to protect natural resources while maintaining user safety and providing high-quality user experiences. As might be expected from a highway agency, the document focuses primarily on trail construction types, and users, and avoiding conflicts among users. It does however state that: [ldquo]All trail use, regardless of travel mode, impacts natural resources[rdquo].

Resource damage depends on many factors including the type of ecosystem, type of wildlife, elevation, type of vehicle, and level of use among others (FHWA 1994).

Another thorough review of relevant research was done by Kuss, et al. (1990). They concluded that generally hiking and backpacking cause greater changes to trails than walking; backpacking causes more damage to trails than hiking without a pack; horses and packstock cause greater damage than hiking; trail biking causes more damage than hiking; and track-driven vehicles cause more damage than wheel-driven vehicles. Impacts on wildlife and the environment were not well addressed. Cole and Knight (1990) did an assessment of recreational impacts on biodiversity in wilderness areas. Their review did not include wheeled vehicles and found that fishing, hunting, and associated management practices had the greatest impact on diversity at a regional scale.

The effects of recreation on the environment and on other recreationists vary greatly even among members of the same user-group. It can be summed up in one sense by Sprung (1990) who noted that people who view the environment as an integral part of the experience are more susceptible to feeling conflict than those who see the environment as just a setting for their activity. (Low Impact Mountain Bicyclists of Missoula (LIMB), for example, encourages riders "to use mountain bikes to enjoy the environment, rather than use the environment to enjoy mountain bikes". Since the FHWA review in 1994 the type of vehicles (ATV[rsquo]s, ORV[rsquo]s, mountain bikes, and snowmobiles) have changed greatly and the demand for areas of use has intensified. This same author conducted a review comparing mountain biking to other forms of travel (Sprung 2004) and concluded that studies did not show that mountain bikes cause more natural resource impact. Sprung based his conclusion on several studies that did not show any significant difference in soil erosion or wildlife displacement between hikers and mountain bikers; including Taylor and Knight (1993), Wisdom et al. (2004), and Thurston and Reader (2001). Aside from some poor study designs, the factor that is ignored in reaching this conclusion is the fact that mountain bikers travel a lot farther than hikers in the same time period and thus create a disturbance over a much larger area; even if the disturbance is equivalent to hiking at any given point. This point is made by Vandeman (Vandeman 2004) who represents the opposite side of the mountain bike spectrum from Sprung; each has a website promoting their views. In one study by Wisdom et al. (2004) the same 20 mile (32 km) study area was covered by one pair of users on ATV[rsquo]s, 2 pairs of mountain bikers, and 3 pairs of hikers to traverse the distance in the time allotted.

In 2000 a review focusing on ATV[rsquo]s and ORV[rsquo]s and snowmobiles was published (Stokowski and LaPointe 2000). Their key findings were that the impacts were similar for all types of motorized vehicles; the main differences were due to more intensity of use or the level of fragility of the affected environment. In western habitats wildlife are negatively impacted by the presence and noise of ATVs, ORVs, and snowmobiles, although some mammals (deer, for example) may become, over time, habituated to these vehicles. Snowmobiles compact insulating layers of snow and thus compromise the habitat of mammals living below the snow layer. Since snowmobiles share the same noise characteristics as ATVs and ORVs, they may put undue stress on large ungulates, including moose and deer. ATV use has been found to widen and rut forest roads, and to increase the sediment load to streams which may threaten fisheries (Stokowski and LaPointe 2000). The U.S. Forest Service published a review of recreation impacts and their management in wilderness (Leung and Marion 2000) based upon Leung[rsquo]s Doctoral dissertation in the Great Smoky Mountains and Marion[rsquo]s research as Unit Leader and Scientist at the USGS Patuxent Wildlife Research Center. This paper summarizes the impacts of direct effects of recreation on soil, vegetation, wildlife, and water, as well as indirect/derivative effects. Direct effects on wildlife include habitat alteration; loss of habitats; introduction of exotic species, wildlife harassment; modification of wildlife behavior; and displacement from food, water and shelter. Indirect effects include reduced health and fitness; reduced reproduction rates; increased mortality; and community composition changes (Leung and Marion 2000).

A literature review in 2009 reviewed impacts on 21 wildlife species in Mount Spokane State Park in Washington and documented studies that found impacts on elk and wolverine among other species. (Snetsinger and White 2009). The mere presence of trails negatively impacts 14 of the 21 species, and areas of concentrated recreation/recreational development negatively impacted an additional 7 species. Just human presence/wildlife observation was documented to impact 9 of the 21 focal species. Snowmobiles were the only motorized form of recreation included in the review; they ranked highest of recreation types in terms of the number of focal species impacted (7 of 21 species). Noise, speed, and ability of snowmobiles to go off-trail likely contribute to their relatively high level of impact. Horseback riding and biking were documented to affect notably fewer of the focal species (1 and 2, respectively), but very few studies in this review included these forms of recreation (Snetsinger and White 2009).

Another review in 2009 compared impacts of hiking, mountain biking, and horse riding on vegetation and soils (Pickering et al. 2009). Overall they found that there had been little research

at that time related to horses and biking compared with hiking. They did conclude that there are specific impacts of horses such as those associated with manure and urine, grazing and the construction and use of tethering yards and fences. Mountain bike specific impacts include soil and vegetation damage from skidding and the construction of unauthorised trails, jumps, bridges and other trail technical features (Pickering et al. 2009).

A review in 2010 by the Miistakis Institute in Canada (Quinn and Chernoff 2010) found that all trail use has environmental effects. The most detrimental environmental effects (especially to soils and vegetation) occur when a trail is first constructed. Effects on soil and vegetation are difficult to evaluate regarding hiking versus horseback versus wheels. Effects on wildlife are generally more pronounced with mountain bikes than with either hiking or horseback, generally due to the [lsquo]sudden encounter[rsquo] effect (Quinn and Chernoff 2010).

In addition to the fact that human uses can displace wildlife from valuable habitat and make that habitat unavailable to them, thus effectively reducing the carrying capacity of the environment for those species, human uses can act as a barrier to wildlife movement. The HPBH WSA is a critical landscape for wildlife connectivity both locally and regionally between Yellowstone National Park and protected areas to the north and northwest. Connectivity for wildlife is an increasingly important concept to be addressed in management decisions for maintaining long term persistence of wildlife populations by helping ensure the resilience (ability to adapt to change) of those populations. A connectivity strategy is a key element in Forest Plan Revisions mandated by the 2012 Planning Rule.

The very definition of an animal implies movement. Animals move across landscapes to meet daily, seasonal, and lifetime needs. Such movements are necessary for survival of individuals and the persistence of the population and species. Movements occur across a wide range of scales from daily movements (meters to kilometers) to seasonal migrations (tens to hundreds of kilometers) to lifetime movements (thousands of kilometers in sum). A male grizzly bear in Yellowstone, for example, requires about 900 km2 of habitat during his lifetime and will disperse, on average, about 200 km when he is weaned and leaves his natal area. The longest recorded dispersal of a brown/grizzly bear is 800 km. To allow dispersal of wide-ranging species such as grizzlies and wolverines, and to allow seasonal migrations for species such as elk and deer, connectivity (or habitat connection) is needed between secure habitat like the HPBH WSA and other habitat cores within the region.

Grizzly bears, like wolverines, require large areas of habitat to persist. Male grizzlies also disperse long distances and can genetically maintain a metapopulation structure if there is sufficient habitat for connectivity between core populations. Female grizzlies, unlike wolverines, do not disperse long distances; female offspring invariably establish home ranges adjacent to, or overlapping with, their mother[rsquo]s home range.

In general, a metapopulation can have a greater probability of persistence than isolated single populations. At a metapopulation level, dispersal between population centers is important for population persistence (Levins 1970, Hanski and Gilpin 1997). Providing for dispersal between local populations helps ensure genetic exchange, as well as allowing for immigration and emigration in response to epidemic disease, insect outbreaks, climate change or large scale fire that might extirpate one or several local populations (Breitenmoser et al. 2001, Hedrick 1996, Hedrick and Gilpin 1996). Historic evidence supports the existence of a true metapopulation structure for grizzly bears in the contiguous United States and habitat modeling indicates that the potential remains for a metapopulation structure to be re-established (Craighead and Vyse 1996).

The first connectivity model for grizzly bears was published by Walker and Craighead in the Proceedings of the ESRI Users Conference [ldquo]Analyzing Wildlife Movement Corridors in Montana Using GIS[rdquo] (Walker and Craighead 1997). The primary movement route, using a least-cost-path, between the GYE and the NCDE includes the HPBH WSA. (Figure 1). Red denotes the highest value corridor habitat followed by green and then blue. This model has been refined, and other modeling approaches have been developed since 1997, but all of them include this corridor.

https://www.researchgate.net/publication/297734026_Analyzing_Wildlife_Movement_Corridors_in_Montana_Using_GIS). Each of successive analyses have refined the approach and incorporated additional data. More recently the Interagency Grizzly Bear Study Team (IGBST) published [ldquo]Potential paths for male-mediated gene flow to and from an isolated grizzly bear population[rdquo] (Peck et. al 2017) (http://onlinelibrary.wiley.com/doi/10.1002/ecs2.1969/full). These model results corroborate our earlier results but in finer detail.

Figure 1. Least Cost Path Corridors for Grizzlies Between GYE and NCDE.

Credit: American Wildlands, Richard Walker and Lance Craighead

Connectivity for grizzly bear metapopulations can occur at two levels; 1) Genetic connectivity can be established over fairly long distances (average dispersal distance 200 km) by male bears moving between population centers. Habitat between populations needs only to be adequate for travel and survival of a male bear over a period of weeks. 2) Demographic connectivity can be established in nature only by female bears gradually occupying habitat between larger, more secure, habitat blocks. For female movement to colonize uninhabited areas such as the central Idaho wilderness from the GYE, this could take decades or centuries but will only happen if there is sufficient habitat in between for females with families to live and persist. However, besides natural dispersal, female and male bears can be transplanted by wildlife management agencies into empty habitat.

Evidence for historic grizzly bear connectivity suggests that the GYE population was connected to the west and north through the Centennial Mountains to the Selway-Bitterroot ecosystem, to the Cabinet-Yaak ecosystem, and ultimately to Canadian populations (Mattson and Merrill 2002, Merrill et al. 2005). Other evidence indicates historic connectivity to the Northern Continental Divide Ecosystem (NCDE) through the Tobacco Root, Highland, Champion-Thunderbolt and/or Elkhorn mountains (Picton 1986, Merriam 1922). It is also likely that grizzlies had connectivity to the NCDE through the HPBH WSA area, the Bridger and Little Belt Mountains. Grizzlies inhabited the Little Belts as recently as the 1960[rsquo]s (Aune, Pers. Comm. 1996)

Maintaining all options for grizzly bear connectivity to other population centers such as the NCDE is critical for the long-term persistence of the GYE grizzly bear population. Even large and protected reserves such as the GYE are too small to maintain viable populations of large mammals if they are isolated (Soule 1980; Belovsky, 1987; Allendorf et al. 1990). An isolated population of 600-800 bears requires gene flow from other populations to maintain and increase genetic variability. The retained genetic heterozygosity has been estimated at from 55% (Paetkau et al. 1997, Craighead et al. 1999) to 75% which is less than zoos manage for, and the inbreeding coefficient of grizzly bears in the Yellowstone population is estimated at 0.125: this is what one would get from a marriage of first cousins (Gilpin, pers. comm. 2006). The main factor affecting levels of genetic diversity appears to be connectedness to larger populations (Paetkau et al. 1997)

From a genetic standpoint, maintaining a corridor for connectivity through the HPBH WSA to the NCDE, will be very important for the persistence of grizzly bears in the GYE, particularly as climate change and land use change alter current grizzly bear habitat. In 2007 grizzly bear habitat and connectivity was modeled by the Craighead Institute for the entire northern Rockies region of the U.S. (Figures 2 and 3). The study found that the HPBH WSA is important living habitat as well as part of a key movement corridor for grizzlies. The HPBH WSA is virtually all critical grizzly bear habitat as kernel density modeling by the Interagency Grizzly Bear Study Team (IGBST) has demonstrated. It is available on the IGBST website as well:
https://www.usgs.gov/media/images/animated-image-showing-grizzly-bear-range-expansion-gye-1990-2016

Described in: https://pubs.er.usgs.gov/publication/70131504

Figure 2. Combined grizzly living and connectivity habitat.

Figure 3. Regional Connectivity for Grizzly Bears.

Weaver (2014) used a quantitative approach to assign conservation values to lands in the Flathead National Forest. He assigned a [lsquo]Very High[rsquo] conservation value for grizzly bears to lands that contained primary habitat components in a secure setting (more than 500 m from an open road. These same criteria can be found in about 99% of the HPBH WSA (the sole exception being in the SW end of the WSA along Highway 89 near Teepee Creek where the WSA boundary is about 300m from the highway for a distance of about 3 km).

Grizzly bears are useful as a focal species whose presence indicates a healthy, functioning ecosystem. Intact ecosystems which are not fragmented by human developments or degraded by human activities are important for many reasons. These include the provision of ecosystems services such as clean air and clean water, climate regulation, soil formation, nutrient cycling, and harvesting of food, fuel, fibers, and pharmaceuticals. Ecosystems also provide spiritual and psychological benefits whose values are not yet well understood. In a recent analysis of the economic benefits accrued from wild nature (Balmford et al. 2002), benefits from intact ecosystems were estimated to greatly exceed those from continued habitat conversion with an overall cost:benefit ratio of 100:1. Protected areas are now seen as a means to conserve ecosystem services which support society (McNeely 2015) and they are highly cost-effective in protecting biodiversity (Balmford et al. 2002, Rodrigues et al. 2015).

Because of the negative effects of human-related activities and developments on many wildlife populations and individuals there is a critical need for secure areas of refuge where animals are able to meet their life history needs of survival and reproduction with a minimum of disturbance. Such areas need to contain high quality habitats and need to be as permanent as possible so that wildlife have a certainty that they can find what they need at the same location over time.

Climate change can gradually affect that certainty as habitats change, but those changes are beyond our control to a large degree; management of public lands and human use restrictions can also affect that certainty, and those changes can be controlled, but are also unpredictable to a degree. Land use on unprotected public lands in the future may depend upon upper-level agency decision-making and often political and economic pressures. Land use on private lands can change at any time; areas with little hunting pressure can become heavily hunted in the future causing wildlife such as elk to try to find new areas of refuge.

Altering the last remaining roadless areas to accommodate human uses that are not essential to our survival is actually not [ldquo]pragmatic[rdquo]: those intact ecosystems may in fact be essential to our survival in the future as climate change progresses. Based on the data and information contained in the Craighead report (Craighead 2015), the HPBH WSA can be considered an intact [lsquo]ecosystem[rsquo] or critical component of a larger ecosystem, the GYE, and as such should be protected from further human alteration and disturbance. This protection should be as restrictive of human uses as possible and should be as permanent as possible.

To ensure that wildlife have sufficient habitat for population persistence into the future, and to confer resilience in the face of climate change and land use change, there must be an adequate amount of protected habitat available among the spectrum of lands that are accessible to those wildlife. The more permanent that protected habitat is, and the larger the area is, the more certainty there is that wildlife populations can persist. Fragmenting the HPBH WSA into smaller pieces of protected habitat would greatly diminish its value for wildlife habitat and the provision of ecosystems services, and could nullify its ability to function as a refuge from climate change. I feel that all of the HPBH WSA should be retained as wilderness as well as all other inventoried roadless areas within the Custer Gallatin National Forest.

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