

Scientific assessments needed to inform land-use planning in the Gallatin and Madison ranges

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Summary

The Greater Yellowstone is the last, large, intact ecosystem in the temperate latitudes of the planet and thus an area of unquestionable global conservation importance. The proposed Greater Yellowstone Conservation and Recreation Act (GYCRA) would take about 40% of the lands currently in Wilderness Study Area status in the Custer Gallatin National Forest and convert them to a new land designation—Watershed, Wildlife and Recreation Areas—that would allow motorized and nonmotorized trail use in the backcountry. Studies indicate that increased outdoor recreation irreparably harms wildlife, critical habitat, and the ecological integrity of a region. The impact of intensified motorized and nonmotorized recreation in areas occupied by grizzly bears, wolverines, wolves, and other native species with large ranges has not been fully analyzed in the Greater Yellowstone Ecosystem (GYE) but likely will be significant.

The consequences of unprecedented climate change in the region, including increasing temperature, reduced snowpack, and earlier snowmelt, are already being felt and will continue in the coming decades. The ecological impacts include changes in wildlife distribution and behavior, tree mortality and habitat change, weeds, wildfire and other disturbances. Climate change is also contributing to more people visiting and settling in this mountainous region, and this influx of people, in turn, will continue to increase demand to recreate in the backcountry. Intensifying motorized and nonmotorized use will occur in an ecosystem that is already stressed from climate change.

Forest management in proposed Wildlife and Recreation areas will add to disturbance and disruption of ecological processes in regions currently off-limits to logging and fuel treatments. Management impacts on wildlife and habitat are not considered in the GYCRA. In summary, any piece of legislation that allows increased motorized and nonmotorized recreation in the backcountry needs careful scientific analysis to understand the consequences and likelihood of long-term ecological damage. Current

studies suggest no positive ecological outcome to an expansion of motorized/nonmotorized recreational use of wildlands.

The report makes several recommendations, including the need for:

- a rigorous, peer-reviewed scientific assessment of the ecological consequences of motorized/nonmotorized recreational use, now and in the future, in the area addressed in the GYCRA. This assessment should identify critical knowledge gaps that need to be addressed before WSA status is changed.
- an evaluation of the legality of current levels of recreational usage in light of the Montana Wilderness Study Area Act of 1977;
- an expansion of the area designated as Wilderness in the GYE to achieve maximum protection of wildlife and habitat in the face of growing climate and human pressures;
- adequate resources for monitoring use and impact of backcountry recreation, a robust education program for gateway communities and motorized and nonmotorized users of backcountry areas, and funds to repair damaged areas in a timely fashion;
- an evaluation of all WSAs and Inventoried Roadless Areas in the GYE to develop an ecosystem-wide strategy to protect ecological health. This analysis would be requested by the Greater Yellowstone Coordinating Committee.

Introduction

The purpose of this document is to provide information on what is known and to identify the types of scientific analyses that are needed to inform large landscape planning for the Gallatin and Madison Range components of the Custer Gallatin National Forest (CGNF). The issue is timely because various legislation has been drafted or is proposed that could lead to a change in the status of currently protected lands in this region. By way of introduction, we summarize the legislation with a focus on the Greater Yellowstone Conservation and Recreation Act (GYCRA), describe the significance of the issue for the long-term sustainability of the Greater Yellowstone Ecosystem (GYE), and comment on an earlier assessment written in 2019 that was provided by the Gallatin Forest Partnership in support of the GYRCA. The second section presents scientific information that is relevant for the key conservation issues in the region. In the third section, we make recommendations on next steps for additional study and effective landscape planning in the region.

Competing legislation

Two groups have drafted legislation on land use for the Gallatin and Madison Ranges. The first comes from traditional wilderness advocates who introduced the Northern Rockies Ecosystem Protection Act and the Gallatin-Yellowstone Wilderness Act in 2021. If approved by Congress, the act would convert the WSAs and Inventoried

Roadless Areas to formal Designated Wilderness. The second bill, offered by the Gallatin Forest Partnership (GFP) in 2024, is the Gallatin Yellowstone Conservation and Recreation Act (GYCRA), a proposed legislation to “conserve areas for wildlife migration, protect the headwaters of the Gallatin and Yellowstone rivers, maintain existing recreation uses, and designate ...new wilderness”. The GFP is composed of traditional wilderness advocates including Wild Montana (formerly called the Montana Wilderness Association), The Wilderness Society, and the Greater Yellowstone Coalition. Also included are recreation user groups such as the Southwest Montana Mountain Bike Association, the Montana Chapter of Backcountry Hunters and Anglers, and the Gallatin Valley Back Country Horsemen. The proposed act would designate about 60% of the Hyalite-Porcupine-Buffalo Horn Wilderness Study Area (HPBH WSA) as formal Wilderness (as defined by the Act) and the remainder as the Porcupine-Buffalo Horn Wildlife & Recreation Area, the West Pine Wildlife & Recreation Area, and the Hyalite Watershed Protection & Recreation Area. The stated purpose of the three proposed recreation areas is “the protection of wildlife and watershed health and providing recreation for motorized, mechanized, equestrian, and foot access for the enjoyment of users”. The act would allow within some or all of these areas: motorized and mechanized uses on CGNF designated trails; vegetation management including fuels treatment, prescribed fire, thinning, and planting; and commercial logging. An outcome of the GYCRA would be that the Secretary of Agriculture would no longer be required to review the lands for future wilderness or manage these lands for future inclusion in the wilderness preservation system.

Significance for the Greater Yellowstone Ecosystem

Decisions about the Gallatin and Madison ranges have large consequences for the health of the GYE. It is widely acknowledged that human pressure on the GYE has been rapidly increasing in the last few decades. Private lands are being fragmented by roads, housing, and other infrastructure. Public lands have experienced increased recreation on roads by record numbers of visitors and on trails by motorized, mechanized, and human-powered users. All lands of the GYE face the spread of invasive plants (weeds), non-native fish, plant and animal diseases, as well as the impact of changes in climate. A leading question is how to keep the GYE intact, whole and healthy in the face of land and water development on its periphery, climate change, and intensifying human visitation.

The large size of the GYE wildlands is owed to the existence of Yellowstone and Grand Teton National parks at the core, the designation of Wilderness Areas, Wilderness Study Areas (WSAs), and the protection of Inventoried Roadless Areas around the parks. The size of the wildlands defines GYE’s ecological integrity and creates a vast area where native species and natural processes can play out with little influence of modern humans. The diversity of intact communities is partially a result of the region’s rugged topography, seasonal snow-dominated climate, and diverse geology and soils. From mountain tops to deep valley bottoms, soil fertility and climate vary spatially creating an array of microhabitats. This variability allows species to find suitable

habitats under changing climate and human pressures, thus conferring resilience to native populations. Climate, snow cover, soil moisture, and plant growth also vary seasonally. Consequently, many of the native fish and wildlife species move across large areas over the course of a year to meet food, habitat, and microclimate needs. Additionally, species such as grizzly bear, wolves, and wolverine have extensive home ranges, and viable populations require large areas.

Fragmentation of natural habitats and construction of fences, roads, and buildings reduce the area of suitable habitat and can block the movement of wildlife across the landscape. Motorized, mechanized, horse, and foot-based recreation can disrupt wildlife, spread invasive species, and cause soil erosion. Most other natural areas in the contiguous US have been reduced in size by human pressures, such that their native species and natural functioning have been compromised or lost. This reduction is generally accelerated by the direct and indirect effects of climate change. Preventing the shrinking wildland portion of the GYE is critical to maintaining its ecological integrity.

Motorized and mechanized uses in the Hyalite-Porcupine-Buffalo Horn WSA have been contested since the 1980s. The Montana Wilderness Study Act of 1977 specified that WSAs are to be administered to maintain their wilderness character at the time of legislation and their potential for inclusion in the National Wilderness Preservation System. The act allowed levels of motorized recreation consistent with historic use but that did not reduce the primitive condition in place in 1977. Mountain bikes were not yet available at that time. Usage increased rapidly in the 1980s and 1990s, and in 2001, a Federal District Court ruled that the US Forest Service could not establish that the pre-existing Wilderness character was being maintained. Consequently, the Gallatin National Forest developed a travel plan that allowed winter and summer motorized and mechanized (mountain bike) use on a reduced network of designated trails and areas. Lawsuits during 2007-2011 led to the courts requiring that the travel plan be further restricted in the WSA.

Since 2011, intensity of use of the trails in the WSA has increased dramatically and several non-system trails have been created by users. However, no groups have challenged in court whether the current recreational usage is consistent with the Montana Wilderness Study Area Act of 1977. An important consequence of passage of the GYCRA is that the US Forest Service would no longer be required to evaluate the Wildlife, Watershed and Recreation portions of the WSA for inclusion in the Wilderness Preservation System. Thus, any legal recourse for reducing motorized and mechanized usage in the WSA would no longer be subject to the Montana Wilderness Study Area Act of 1977. Furthermore, the GYCRA would functionally “codify” existing recreational uses on designated trails in the portions of the WSA that are outside of the newly designated wilderness area, and it would not limit the intensity of use (numbers of users) on those trails.

Previous Scientific Assessment of the GYCRA

In support of the GYCRA, Belote and Talty (2019) evaluated four conservation metrics (naturalness, grizzly bear connectivity, under-represented ecosystem types, and trail density) in the region. This unpublished report, cited by the GFP as scientific support for designating the GYCRA land units, indicates that all five land units of the GYCRA had relatively high naturalness, grizzly bear connectivity, and under-represented ecosystem types relative to other portions of the CGNF and the contiguous US. The five land units, which we refer to in total as the planning area, were judged to have high conservation value and merit some level of protection. Portions of the planning area were found to have high trail densities at the time of writing. The report emphasized potential conflicts between ecological integrity and trail-based recreation, “The tensions between maintaining wildlife and wilderness character while providing people recreational access is a universal challenge for federal land management and conservation”. The main conclusion was, “Recreation is expected to increase, and a key conservation challenge in the next several decades will be to sustain the wildland values while providing recreation opportunities for growing resident populations and visitors”.

Belote and Talty (2019) recommended additional analysis on these topics:

- Analysis of the impact of recreation on intact mammal communities including occupancy of large and meso-carnivores and particularly grizzly bear occurrence and density
- Assessment of the social, economic, and ecological values that might reveal opportunities for sustainably managing a landscape for multiple values
- Better understanding of the conflicts among values and the role of adaptive management programs to bring data to bear on future decisions. (It was suggested that such an analysis could be revised to include other values that may conflict with high recreation use.)

Not discussed in Belote and Talty (2019) but critical for the protection of wildlands are the impacts of (1) increased motorized and mechanized recreational usage on wildlife; (2) current and projected climate impacts on wildlife, habitat, and recreation; (3) rapidly increasing visitation, recreational use, and development in region and their impact on wildlands; (4) proposed forest management activities in and around proposed wilderness areas. These four topics are outlined in detail below.

Scientific Assessments Needed to Inform Large Landscape Planning

(1) Increased motorized and mechanized recreational usage on wildlife

The Hyalite-Porcupine-Buffalo Horn Wilderness WSA is among the most important wildlife habitats in the contiguous US (Craighead 2015), and it deserves special note. It

is unique in the planning area because it supports all the native vertebrate species within the GYE, with the exception of bison. This WSA hosts some 5,000-6,000 elk that summer in the high country and winter in lower elevations. It has experienced positive population growth for grizzly bears. The area also provides habitat for wolverine, gray wolf, bighorn sheep, and Yellowstone cutthroat trout and it contains critical bird-species richness hotspots. Moreover, the location of the Hyalite-Porcupine-Buffalo Horn Wilderness WSA in the northwest portion of the GYE is a critical wildlife corridor between Yellowstone and the Northern Continental Divide Ecosystem Crown of the Continent ecosystems. Outdoor recreation has the potential to strongly disrupt these wildlife populations, their movement, and their habitats.

Scientific studies are increasingly finding that outdoor recreation can have negative impacts on wildlife. Recent meta-analyses (Larson et al. 2016, 2019) revealed that 93% of the studies surveyed found at least one significant effect of recreation on wildlife, most of which were negative. Vertebrate richness and abundance were lower in association with higher levels of recreation in 70% of cases. The negative effects were stronger for carnivores and herbivores than for omnivores, and stronger for small-bodied and ground-nesting birds than larger and tree- and shrub-nesting birds. Recreation is a leading factor in the endangerment of plant and animal species on US federal lands and is listed as a threat to 189 at-risk bird species globally. Documented effects of recreation on animals include altered behavioral responses, such as increased flight and vigilance; changes in spatial or temporal habitat use; declines in abundance, occupancy, or density; physiological stress; reduced reproductive success; and modified species richness and community composition (Larson et al. 2019).

Various types of comparisons and methods have been used in studies on the effects of recreation on animals. In one study, comparison was made of wildlife occupancy in locations in Glacier National Park in a year with and one without COVID-19 restrictions on visitation (Anderson et al. 2023). The authors found evidence that even low-impact human recreation (non-motorized, trail-based hiking) in a strictly protected national park affected the spatiotemporal ecology of a large variety of mid- to large-sized mammal species. Although the influence of human presence on species was not strong in all cases, the authors found consistent negative responses across all groups of mammals, with fewer detections, reduced occupancy and detection probabilities, and generally decreased daytime activity.

Camera traps have been used to assess relative effects of various recreational activities on terrestrial wildlife. Naidoo and Burton (2020) found in the Chilcotin Mountains of southwestern British Columbia that all 13 species studied avoided humans on trails, with avoidance strongest for mountain biking and motorized vehicles compared with hikers and horseback riders. The high temporal avoidance by wildlife of motorized vehicles and mountain biking is consistent with other studies documenting greater levels of wildlife disturbance associated with the noise and speed of motorized vehicles. The authors also suggest that wildlife in the study area may perceive mountain bikes to be more similar to motorized vehicles than nonmotorized recreationists.

The velocity at which mountain bikes travel along trails, as well as the tremendous growth of the activity, has also led to concerns about their impact on wildlife in other places. Lewis et al. (2021) found in the Colorado Front Range that some species (e.g., fox squirrel, red fox, and striped skunk) did not demonstrate a response to recreationalists, primarily hikers and a small proportion of bikers and equestrians. Other species (e.g., black bear, coyote, and mule deer), however, altered their activity patterns on recreation trails to be more active at night. Still other species (e.g., Abert's squirrel, bobcat, and mountain lion) exhibited reduced occupancy and/or habitat use in response to human recreation.

A review of several similar studies of winter recreation effects on northern ungulates by Harris et al. (2014) drew the following conclusions: recreation impacts on ungulates increase when it occurs over long periods and across large areas, with disturbances unpredictable in location and time; because motorized use covers greater area, the numbers of disturbance events increase; these disturbances have less effect than disturbances generated by nonmotorized users; and lastly, the presence of alternative habitats for animals to relocate reduces the impacts of disturbances from winter recreation.

The distance at which wildlife respond to recreation has been the subject of a few studies. Taylor and Knight (2003) quantified the effects of mountain biking and hiking on bison, mule deer and pronghorn antelope in a state park in Utah. They found no statistical difference in wildlife response to these two forms of recreation. For both types, the authors found that bison and pronghorn antelope exhibited a 70% probability of flushing from on-trail recreationists when the animals were within 100 m of trails; mule deer had a 70% probability of flushing when 390 m from trails. A broader review of this topic by Dertien et al. (2021) found that threshold response distances for wading and passerine birds were generally less than 100 m, whereas distances were greater than 400 m for hawks and eagles. Mammal threshold distances varied widely from 50 m for small rodents to 1,000 m for large ungulates. Motorized recreation had the highest median threshold distance (average distance that animals moved away) for birds (111.5 m), whereas multi-use nonmotorized recreation had the highest median value for mammals (100 m). Hiking-only recreation had the lowest median threshold distance for both.

Species of high concern with the Gallatin/Madison planning area include wolverine, grizzly bear, and elk. Heinemeyer et al. (2019) examined in Idaho, Wyoming, and Montana the responses of wolverines to backcountry winter recreation. They found that motorized recreation occurred at higher intensity across a larger footprint than nonmotorized recreation in most wolverine home ranges. Wolverines avoided areas of both motorized and nonmotorized winter recreation. Within home ranges, wolverines avoided all forms of winter recreation and showed increasing avoidance of areas as the amount of off-road winter recreation increased, resulting in indirect habitat loss or degradation of moderate- or high-quality habitats.

The potential effects of human recreation on grizzly bears are particularly concerning. Research in Yellowstone National Park has demonstrated that grizzlies are twice as likely to use an area when human presence is prohibited as when human access is not restricted (Coleman et al. 2013). Research in the central Canadian Rocky Mountains, found a 50% decrease in grizzly bear detection rates within 267 m of trails (Thompson et al. 2025).

Moreover, extensive research on grizzly bears has concluded that human activities that increase interactions between bears and people also increase the potential for bear mortality and can convert population source areas to population sinks (Schwartz et al. 2012). This finding is particularly concerning because the Hyalite-Porcupine-Buffalo Horn WSA is at the edge of the bear population source area centered in Yellowstone National Park. Encounters between backcountry recreationists and grizzly bears in the past have resulted in human fatalities and subsequent euthanasia of bears (e.g., Servheen et al 2017). It is clear that recreation has potential to displace bears from suitable habitats and increase mortality rates.

Elk are also sensitive to outdoor recreation. A study in the Cascade Range of Washington State (Procko et al. 2024) found that detection rate of elk by camera traps was relatively constant at low levels of recreation (0–11 people/day) but decreased by over 41% when recreation increased to 12 to 22 people/day. The authors also found the animals shifted toward increased evening activity with higher-than-average recreation. Naylor et al. (2009) experimentally subjected elk in northeast Oregon to encounters with all-terrain vehicles (ATV) riding, mountain biking, hiking, and horseback riding. They found that elk travel time increased in response to all four disturbances. Elk travel time was highest during ATV exposure, followed by exposure to mountain biking, hiking, and horseback riding. Feeding time decreased during ATV exposure and resting decreased when elk were subjected to mountain biking and hiking disturbance. Relatedly, Wisdom et al. (2018) found that elk avoided recreationists in real time, with mean minimum separation distances from humans that varied from 558 to 879 m among the four treatments. Distances between elk and recreationists were highest during ATV riding, lowest and similar during hiking and horseback riding, and intermediate during mountain biking.

A few studies have done surveys of recreationists' perceptions of their impacts on wildlife. A systematic review of 47 articles published between 1992 and 2018 (Gruas et al. 2020) revealed that in 43% of the surveys, most respondents were not aware of their impact on wildlife. A survey of 640 backcountry trail users on Antelope Island, Utah, (Taylor and Knight 2003) discovered that approximately 50% of recreationists felt that their activities were not having a negative effect on wildlife. In general, survey respondents perceived that it was acceptable to approach wildlife more closely than empirical data indicated wildlife would allow. Recreationists also tended to blame other user groups for stress to wildlife rather than holding themselves responsible.

In summary, current knowledge on recreational effects on wildlife indicate that current and increasing backcountry recreation of all forms in the Hyalite-Porcupine-Buffalo Horn WSA are likely to be having strong negative effects on several species and that research is needed to quantify these effects. These effects may not be well recognized or understood by recreationists, and education on the topic may help reduce conflicts. would be beneficial.

(2) Current and projected climate impacts on wildlife, habitat, and recreation

Current trends and projected climate change in the Greater Yellowstone Area are discussed in detail in the Greater Yellowstone Climate Assessment (Hostetler et al. 2021). This assessment is based on the best-available scientific information at the time of publication, was written by regional and national climate experts, and underwent extensive peer review before its release. The major findings are as follows.

Since 1950, the GYE has warmed on average by 2.3°F (1.3°C) since 1950. This warming has resulted in a growing season that is now two weeks longer than it was in the 1950s and below 8000 ft, annual snowfall has declined by 25% (nearly 24 inches), including by 96% in September. The rapid warming that marks the end of winter now occurs in February to March, instead of March to April as it did in 1950. Melting of snowpack is also occurring earlier in the year and peak annual stream run-off now occurs on average 8 days earlier than it did in 1950.

Through the 21st century, temperatures will likely increase from 5-6°F (2.8-3.3°C) above the base period of 1986-2005, and possibly as much as 10-11°F (6.5-6.1°C). These increases will bring warmer days and nights, warmer winters, and hotter summers in the coming decades and will affect ecosystems, economies, and human and community health in the GYE. More winter precipitation will fall as rain instead of snow and the amount of water stored annually in snowpack will decline. Snowmelt and runoff will occur earlier in the spring, and higher evapotranspiration and reduced runoff will create water shortages and more fires in summer.

Associated with climate change is an increase in extreme, climate-driven weather events that are often difficult to predict. The state's most costly climate disasters in recent years are from short-term or sudden events, including late-summer drought, severe storms, and wildfire (NOAA, nd). Spring rain-on-snow events, such as the 1-in-500-year flood of June 2022 in northern Yellowstone, are more likely with warmer temperatures and changing storm patterns (including atmospheric rivers). An increase in severe convectional storms with lightning, hail, and downbursts is also projected in this part of the US. Increasing vapor-pressure deficit (i.e. the "thirstiness of the air" from warming temperatures) creates weather conditions for larger, more frequent fires (Westering et al. 2011; Turner et al. 2022). Projected warmer, drier conditions will also lead to higher stream temperatures and lower flows during the summer recreation season.

As discussed in the previous section, the wildlands of GYE offer vital habitat for wildlife and plants that is unmatched in the western US. Beyond that, they are also a critical climate refuge in the Rocky Mountain region, maintaining habitable conditions as other areas become climatically unsuitable, fragmented, or disturbed by humans. Plans to shrink climate refugia within the WSAs by opening large tracts to recreational use and potential logging impact wildlife beyond the direct threat of human encounters. Wolverines have been listed as endangered under the Endangered Species Act as rising temperatures are expected to reduce the amount of snowpack needed for denning and hunting. The duration of snow accumulation and seasonal food availability also influence the denning behavior of grizzlies and black bears (Fowler et al. 2019). In the face of climate change, habitat connectivity between the GYE and the Crown of the Continent and the Bitterroot ecosystem will also become ever more essential to support migration and maintain the long-term viability of grizzly bears, wolves, and wolverines. Belote and Talty (2019) note areas of grizzly bear connectivity in the three land units recommended for GYCRA wilderness designation, but climate-driven changes in habitat and food resources, animal behavior, trail use and density, and development were not considered in that study.

Climate change is and will continue to alter vegetation composition and habitat distribution in the GYE in complex ways (Harsch and Hille Ris Lambers 2016), with some species moving upslope and others downslope to find suitable conditions. Drought and warming are projected to increase tree mortality, wildfire size and severity, and the likelihood of tree disease and insect infestation. Douglas-fir, an important conifer in GYE middle-elevation forests, requires a certain number of days of freezing temperatures for seedling growth; such conditions may no longer occur at those elevations (Harrington et al. 2010). At higher elevations, dramatic loss in high-elevation whitebark pine from the combined climate effects of mountain pine beetle outbreaks, drought, and wildfire is leading to subalpine forest decline at GYE high elevations (Buotte et al. 2016, 2017). Climate change is accelerating the spread of flammable cheatgrass across the western US, including the GYE, where it establishes in areas disturbed from humans, recreational vehicles, and livestock (Molvar et al. 2024).

In summary, climate change is putting the wildlands of GYE and other natural ecosystems in a continual state of flux, one that alters animal populations, behavior, distributions, and habitat. It also influences recreational decision-making, expectations, and the intensity and footprint of backcountry use (Monz et al. 2021). Wildlands will be under ever-greater pressure by recreationalists in the future as areas of snow-dominant precipitation shrink to higher elevations, dry dusty conditions and high temperatures characterize the valleys, and wildfire smoke and fire risk make areas inhospitable or dangerous (Hostetler et al. 2021). Increased motorized and nonmotorized use in the backcountry will accelerate these negative impacts of climate change, through the introduction and spread of weeds, increased likelihood of wildfire ignition, and increased trail erosion during extreme weather events. Probably, the most vulnerable area is the Hyalite-Porcupine-Buffalo Horn Wilderness WSA where the loss of snowpack, late-summer water, and high fire risk are shared with dramatic increases in backcountry

recreational demand from the Big Sky community. Better understanding of the amplifying and synergistic impacts of climate change and nature-based recreation is needed in the three WSAs of the GYCRA and throughout the GYE.

(3) Increasing visitation and development in region

The GYE has experienced a transition to a “New West economy,” a multidecadal shift away from agriculture, timber, and mining and toward nonlabor industries and natural amenity uses (Haggerty et al. 2018). Coinciding with this economic transition, the human population within the GYE has doubled and housing density has tripled since 1970, and both are predicted to double again by the year 2050 (Hansen and Phillips 2018). Currently, 31% of the area of GYE is human modified. Among the major watersheds of the GYE, the Gallatin watershed has the highest level of development of private lands. Natural habitats cover only 58% of private lands, 27% is in agriculture, and 15% is in residential and urban development (Hansen et al. 2024). This watershed had the highest rate of conversion of natural habitats to agriculture and development during 2000-2019 at 6.1%) and the human population grew by 73%.

Outdoor recreation has increased in the GYE commensurate with population growth (Hansen and Phillips 2016). Visitation to Yellowstone National Park has increased by 85% during 1970–2016. More than 4 million people entered the park during 2015 and 2016 and 5 million in recent years. Skier days have risen by 69%, 57%, and 5% per year in each of the three commercial ski areas for which trend data are available. The growth in the GYE human population suggests increases in fishing, hunting, hiking, backcountry skiing, mountain biking, and off-road vehicle use; however, data on these forms of outdoor recreation are currently unavailable at spatial resolutions relevant to the GYE. In the upper Madison River, for example, angler days increased from 51,000 in 1984 to 178,000 in 2016, an increase of 250%, and Montana Fish Wildlife and Parks has proposed restricting use to protect the fishery (MFWP 2018). Trail use in the Bridger Mountains in 2021 was about 1400 people on weekdays and 2400 on weekends (Headwaters Economics, 2021). Hyalite Canyon in 2021 had an overall summer monthly visitation increase of 20% with an average of 29,500 vehicles traveling into the canyon each summer month (US Forest Service 2021). In December 2020, the number of vehicles traveling into Hyalite increased by 32% from the previous December. In January 2021, vehicle traffic jumped 67% from January 2020, with a count of 17,297 vehicles traveling into the canyon. A survey of trail users in Gallatin County in 2021 (Craighead 2022) found that equal numbers of people consider themselves bikers or hikers and that most people use the trails for recreation purposes (41%) followed by health and fitness (36%) and connecting with nature (21%). Many people want to see more trails everywhere within the county (44%) and would like more amenities added to trailheads, especially dog waste receptacles. These survey results testify to the growing number of recreationalists in the Hyalite-Porcupine-Buffalo Horn Wilderness WSA and their expectations for augmented services.

There is a clear relationship between trail and road density and the occurrence of weedy invasive species (Pollnac et al. 2012; Alexander et al. 2016). In addition, recreational vehicles have been shown to spread weed seeds (Taylor et al. 2012). Ecosystem impacts of weeds have been studied extensively around the world and in many cases have detrimental impacts on species from microbes to wildlife disrupting ecological functioning.

Research is needed to quantify rates of change in trail use by each form of recreation within the Gallatin/Madison planning area.

(4) Proposed forest management activities in watershed and wildlife recreation areas

The Hyalite-Porcupine-Buffalo Horn Wilderness WSA is protected from all forest management activities except limited hazard tree removal and measures necessary to control fire, insects, and diseases. In the areas that would be removed from the HPBH WSA by the GYCRA the following forest management would be allowed:

- Commercial logging in the portion of the HPBH WSA that is in the West Pine Creek Wildlife and Recreation Area.
- Vegetation management including fuels treatment, prescribed fire, thinning, and planting in the Porcupine-Buffalo Horn Wildlife & Recreation Area, the Hyalite Watershed & Recreation Area, and the West Pine Wildlife & Recreation Area.

Allowing commercial logging and/or vegetation management in portions of the former HPBH WSA has the potential to substantially erode the wilderness character and wildlife habitat quality that were protected under the Montana Wilderness Study Area Act of 1977. Commercial logging is not allowed in Wilderness areas because it can harm wildlife by destroying and fragmenting habitats, removing mature and old-growth trees that some species need to survive, reducing food sources, and increasing human-wildlife conflict (Pallardy et al. 1997). Changes in fuel structure, road construction for management activities, and introduction of weeds alter natural disturbance regimes that are already impacted by climate change. Vegetation management can also have negative effects on wildlife (Block et al. 2016). Removing dense vegetation can temporarily reduce protective cover for animals, making them more vulnerable to predators. Burning or thinning may destroy active nests, impacting nesting birds and other animals depending on dense vegetation. Some species with highly specialized habitat requirements may be negatively affected by any significant alteration to their environment. Improperly timed or too intense prescribed burns can negatively impact wildlife by burning key food sources or important habitat features.

Recommendations

The following recommendations emerge from the assessment above.

- Conduct rigorous scientific research on the individual and compounding consequences of increased backcountry use, climate change, and forest management in the planning area.
- Assess the legality relative to the Montana Wilderness Study Area Act of 1977 of current and potential future levels of motorized and mechanized uses in the Hyalite-Porcupine-Buffalo Horn WSA.
- Consider expanding the area to be designated as wilderness in the GYCRA to include all eligible areas in the WSAs, such as the upper West Pine Creek, upper Hyalite Basin, and portions of the WSA area south of Porcupine.
- Provide adequate resources to monitor and address recreational use and changes to wildlife and habitat condition in the proposed Wildlife and Recreation Areas and also resources to restore impaired places in a timely manner.
- Develop programs to educate backcountry recreation users on best practices for limiting negative ecological impacts, as is mentioned in the GYCRA.
- Encourage the Greater Yellowstone Coordinating Committee to evaluate the WSAs and Inventoried Roadless Areas of the GYE and recommend strategies to favor ecological health.

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