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Supplemental Assessment Information for the Bridger-Teton National Forest



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Supplemental Assessment Information for the Bridger-Teton National Forest

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Abstract: The Bridger-Teton National Forest developed this Supplemental Assessment Information for the Bridger-Teton National Forest in accordance with the National Forest System land management planning rule (planning rule) adopted by the U.S. Department of Agriculture. As stated in the planning rule at 36 Code of Federal Regulations (CFR) 219.6, an assessment must be completed for the development of a new forest plan or for a forest plan revision. This assessment evaluates existing information and trends about relevant ecological, economic, and social conditions, with emphasis on sustainability and the relationship to the land management plan. In this assessment for plan revision, the responsible official identified and evaluated existing information relevant to the plan area for 15 topic areas.

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Chapter 1. Overview and Assessment Background

The National Forest Management Act of 1976 requires every forest and grassland to develop, maintain, and periodically revise an effective land management plan (or forest plan). The forest plan serves as the primary document guiding decisions made about resource activities on the ground, for instance, much like a county comprehensive plan. The current planning rule, the process for developing and revising plans and required content, was adopted in 2012 (36 CFR 219).[1] The Bridger-Teton National Forest (Bridger-Teton) has initiated the process to revise its 1990 Land and Resource Management Plan (forest plan) under the 2012 Planning Rule with this draft assessment (Assessment).

As stated in the planning rule at 36 CFR 219.5(a), planning for a national forest is an iterative process that includes an assessment; developing, amending, or revising a plan; and monitoring. These three phases are complementary and may overlap. The intent of the planning framework is to create an adaptive process that informs integrated resources management; adapts to changing conditions, such as climate change; and improves management based on new information and monitoring. The Bridger-Teton is currently in the assessment phase of the planning process. A description of the three phases of the planning process follows:

1. Assessment Phase: Evaluation of existing information, such as relevant ecological, economic, and social conditions, trends, and sustainability, and the relationship to the land management plan within the context of the broader landscape.
2. Plan Development Phase: Updating information, including the following: identification for the need to change the forest plan based on the assessment, development of a proposed plan and alternatives, consideration of the environmental effects of the proposed plan and alternatives, provision for public review and comment of the proposed plans, provision to object before a proposed plan is chosen, and, finally, approval of the selected plan.
3. Monitoring Phase: The continuous observation and collection of feedback for the planning cycle used to test relevant assumptions, track relevant conditions over time, and measure management effectiveness.

Assessment Document Structure

This Assessment is organized into three chapters and two appendices. Chapter 1 is the introduction and includes the following: information about the forest plan revision planning process, best available science used in the assessment, forest setting, distinctive roles and contributions, the public participation process, and the tribal engagement process. Chapters 2 and 3 summarize the findings by the above-identified topic areas. These chapters identify and describe important information evaluated in this assessment phase. Finally, two appendices consist of information relevant to the air quality assessment including air quality visibility graphs and emissions inventory data.

Each topic section identifies the nature, extent, and role of existing conditions and reasonably foreseeable future trends within the plan area and in the broader landscape. Trends may imply a

[1]Access the Planning Rule at: https://www.fs.usda.gov/detail/planningrule/home/.

range of changes that are reasonably foreseeable in the future. Statistical analysis is not implied or necessary to identify and describe trends in the assessment phase. Trends may be described in broad terms such as increasing, decreasing, or remaining stable; describing the contribution that the plan area makes to ecological, social, or economic sustainability related to the topic; and identifying information gaps.

At the end of this document, there are References, a Glossary of Terms, and list of Acronyms.

Purpose of the Assessment

The Assessment presents an evaluation of existing information and trends about relevant ecological, economic, and social conditions. The focus is on the relationship of these conditions to the forest plan and the ability to care for the land and serve people long into the future. This Assessment is not a decision document, but it contributes to the planning process by:

- building a common understanding about current conditions and trends with the public and interested parties before starting the plan revision;
- providing information that helps identify the need to change current forest plan direction; and
- developing a more complete understanding of complex topics and the integration of ecological, social, and economic considerations across a large and diverse landscape.

The Assessment Process

The forest supervisor for the Bridger-Teton established an interdisciplinary team in March of 2023 to complete the draft Assessment. The Bridger-Teton issued a Notice of Intent to Prepare an Assessment and Initiate Plan Revision on May 29, 2024. Beginning in March 2023, revision team staff and forest leadership held an array of public engagement activities designed to inform, listen to, and learn from diverse perspectives (refer to the Public Engagement Section).

Best Available Scientific Information

The 2012 Planning Rule requires the responsible official to use the best available scientific information to inform the Responsible Official about the development of a revised plan (36 CFR 219.3). The Responsible Official shall also document how scientific information used to provide information for the Assessment was determined to be the best available scientific information, based on what is most relevant, accurate, and reliable (36 CFR 219.6(a)(3)). Plan components for the revised Bridger-Teton Assessment will therefore be developed based on the scientific information used – and references included – in this Assessment.

The 2012 Planning Rule acknowledges that the best available scientific information may include expert opinions, inventories, or observation data prepared and managed by the U.S. Forest Service (USFS) or other agencies, universities, reputable scientific organizations, and data from public, tribal and governmental participation. Specialists use many resources, including, but not limited to, peer-reviewed and technical literature; databases and data management systems; modeling tools and approaches; local and state plans; Indigenous knowledge; and information received from public engagement. This type of information was used to evaluate conditions, trends, and risks. The team relied on the definition of best available scientific information in the 2012 Planning Rule, including the primary criteria: accurate, reliable, and relevant. To be relevant, the information must pertain to the 15 topics under consideration at spatial and

temporal scales appropriate to the plan area and to a land management plan. Relevance in the assessment phase means scientific information that is relevant to the condition and trends of the 15 topics in 36 CFR 219(b) or to the sustainability of social, economic, or ecological systems (36 CFR 219.5(a)(1)).

Pre-assessment efforts included work with the Rocky Mountain Research Station, Northern Research Station, contractors, and university researchers. An internal team prepared databases and geographic information system (GIS) resources so that information would be readily available to address questions under the 2012 Planning Rule. For example, a regional contractor prepared a socioeconomic baseline report including interdisciplinary discussions to describe ecosystem services. The University of Utah and University of Wyoming produced a 2019 Situation Report that has informed public engagement planning. Forest monitoring reports were produced and published for the 2017-2018 and 2019-2020 biennial. This Assessment provides the update for the 2021-2022 biennial monitoring report, and it includes consideration of the 15 Planning Rule topics. Through plan revision, a new monitoring report will also be produced.

For this Assessment's foundational information on ecosystems, a wide-ranging interdisciplinary team reviewed several available datasets to determine how the various ecosystems within the Bridger-Teton could best be described and evaluated for "integrity" or healthy functioning, not just now but continuing into the future, with a focus on the anticipated duration of the revised forest plan. Then a series of interdisciplinary workshops helped the team illuminate the key characteristics of each identified ecosystem and consider existing information regarding current conditions and existing trends for those defining elements. (These workshop reports for both terrestrial and aquatic ecosystems are included as appendices, and integrity evaluation summaries are provided at the beginning of Chapter 2, Assessment Findings.)

Scope, Scale and Timing

The responsible official establishes the scope, scale, and timing of the Assessment process. The geographic scope of this Assessment includes all lands within the administrative boundary of the Bridger-Teton (the plan area), as well as consideration of conditions and the management situation on surrounding lands. Where relevant for individual resource topics, the information is presented at smaller scales, such as ranger districts, landscape areas, and watershed boundaries.

The Assessment provides the foundation for the plan revision process. The time frame considered in the Assessment includes the status and trends that occurred since the current 1990 forest plan. Where relevant, some resource areas are assessed using a much longer timescale into the past for reference (e.g., the natural range of variation analysis for ecosystems). In addition, the Assessment includes information related to likely future trends.

Assessment content includes the 15 topical areas as required in the planning rule at 36 CFR 219.6(b) and as presented in the land management planning handbook (FSH 1909.12.10 (11)(b)):

- terrestrial ecosystems, aquatic ecosystems, and watersheds;
- air, soil, and water resources and quality;
- areas of tribal importance;

- system drivers, including dominant ecological processes, disturbance regimes, and stressors, such as natural succession, wildland fire, invasive species, and climate change and the ability of terrestrial and aquatic ecosystems to adapt to change;
- baseline assessment of carbon stocks;
- threatened, endangered, proposed and candidate species, and potential species of conservation concern;
- social, cultural, and economic conditions;
- benefits people obtain from the National Forest System in the planning area (ecosystem services);
- multiple uses and their contributions to local, regional, and national economies;
- recreation settings, opportunities and access, and scenic character;
- renewable and nonrenewable energy and mineral resources;
- infrastructure, such as recreational facilities and transportation and utility corridors;
- cultural and historical resources and uses;
- land status and ownership, use, and access patterns; and
- existing designated areas located in the plan area and potential need and opportunity for additional designated areas.

Each topical area was considered and information relevant to the Bridger-Teton was compiled in this Assessment. In addition, information applicable to land management plans for surrounding landscapes was considered.

Wilderness inventory and evaluation and wild and scenic river eligibility findings are not addressed within this Assessment document, but they will be concurrently provided in separate, subsequent documents as part of the assessment process.

Next Steps

The Bridger-Teton will consider public comments from the Draft Assessment for the Final Assessment. Once the Assessment phase is complete, the Bridger-Teton will release a Need to Change document that summarizes findings in the Final Assessment and provides the roadmap for what needs to change or be considered during the Plan Revision phase. It is important to note that certain 1990 Plan components will not change and will be carried forward during the revision process.

Forest Setting: An Overview of the Bridger-Teton

Bridger-Teton staff manage 3.47 million acres of public land within five counties in western Wyoming. The Bridger-Teton is the largest, single administrative unit within the Greater Yellowstone Ecosystem (GYE), which is the largest intact ecosystem in the “Lower 48” or conterminous United States. The Bridger-Teton stretches from Wyoming’s western border with Idaho, adjoining Grand Teton National Park, the National Elk Refuge, and Yellowstone National Park on the west and north; abutting lands managed by the Caribou-Targhee National Forest to the west; continuing south to the open sage steppe lands of southwestern Wyoming, largely

managed by the Bureau of Land Management (BLM) and east along the ramparts of the Wind River Range bordering the Shoshone National Forest and the Wind River Indian Reservation, home to the Eastern Shoshone and the Northern Arapaho Tribes (See Figure 1).

In many cases, the Greater Yellowstone Area provides an appropriate context for considering ecosystem integrity and public services provided by the Bridger-Teton. In other instances, the context is the five Wyoming counties that encompass the Bridger-Teton (Lincoln, Sublette, Teton, Fremont, and Park).

The Bridger-Teton is one of a handful of national forests in the U.S. that are contiguous, meaning that it does not have a checkerboard ownership pattern and it is not divided into geographically separate areas. The Bridger-Teton's history (https://www.fs.usda.gov/main/btnf/learning/history-culture) – early land protections, distance from major railroads, and relatively late settlement – is largely responsible for this contiguous ownership. Yellowstone National Park was the nation's first national park, but part of the Bridger-Teton, along with the Shoshone Forest, became the nation's first national forest following its establishment in 1891 (Anderson 1927). Originally known as the Yellowstone Timberland Reserve, the forest's land area was later expanded in 1897 and grew to encompass three divisions by 1908: Teton, Shoshone, and Wind River (See Figure 2).

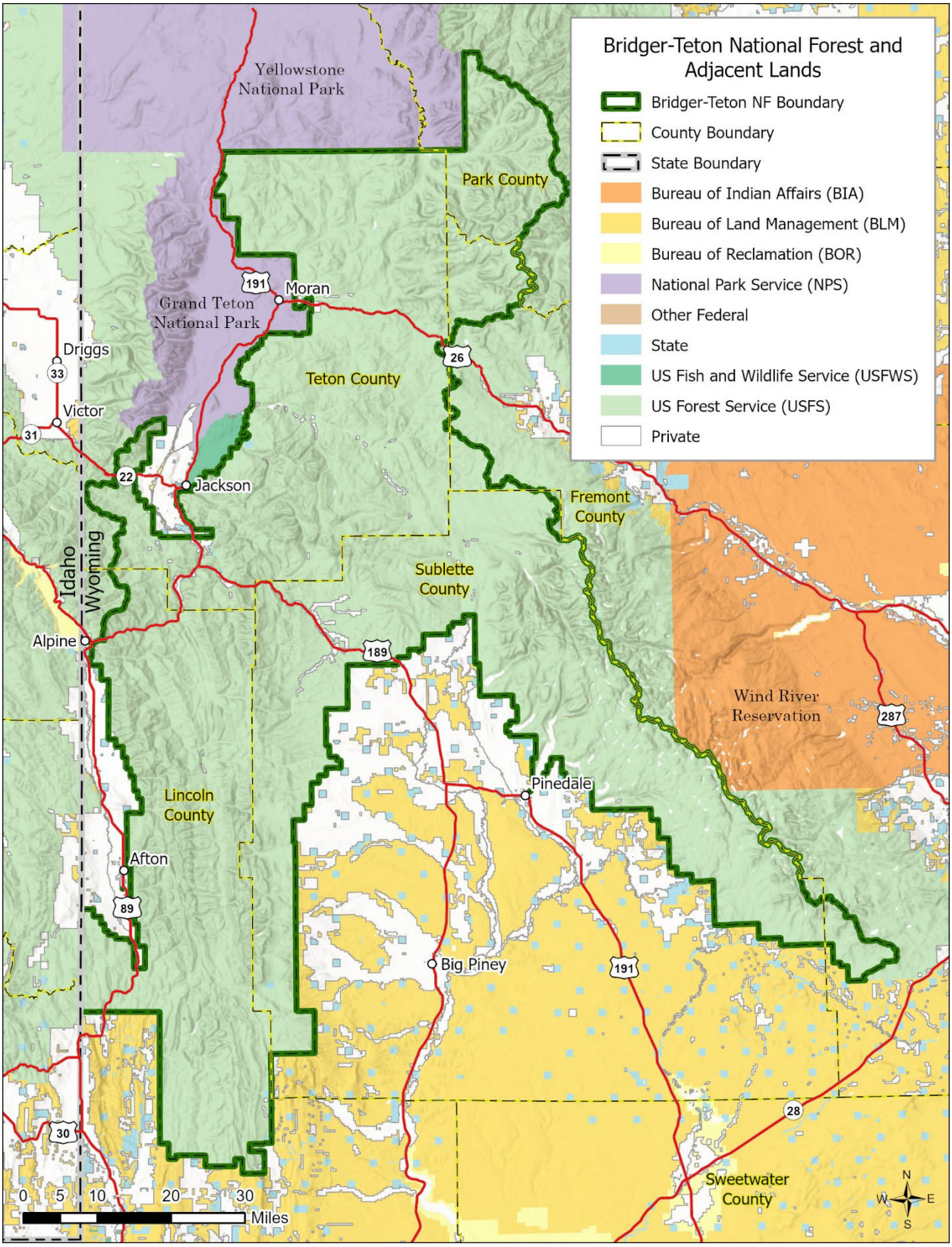


Figure 1. Bridger-Teton National Forest vicinity map

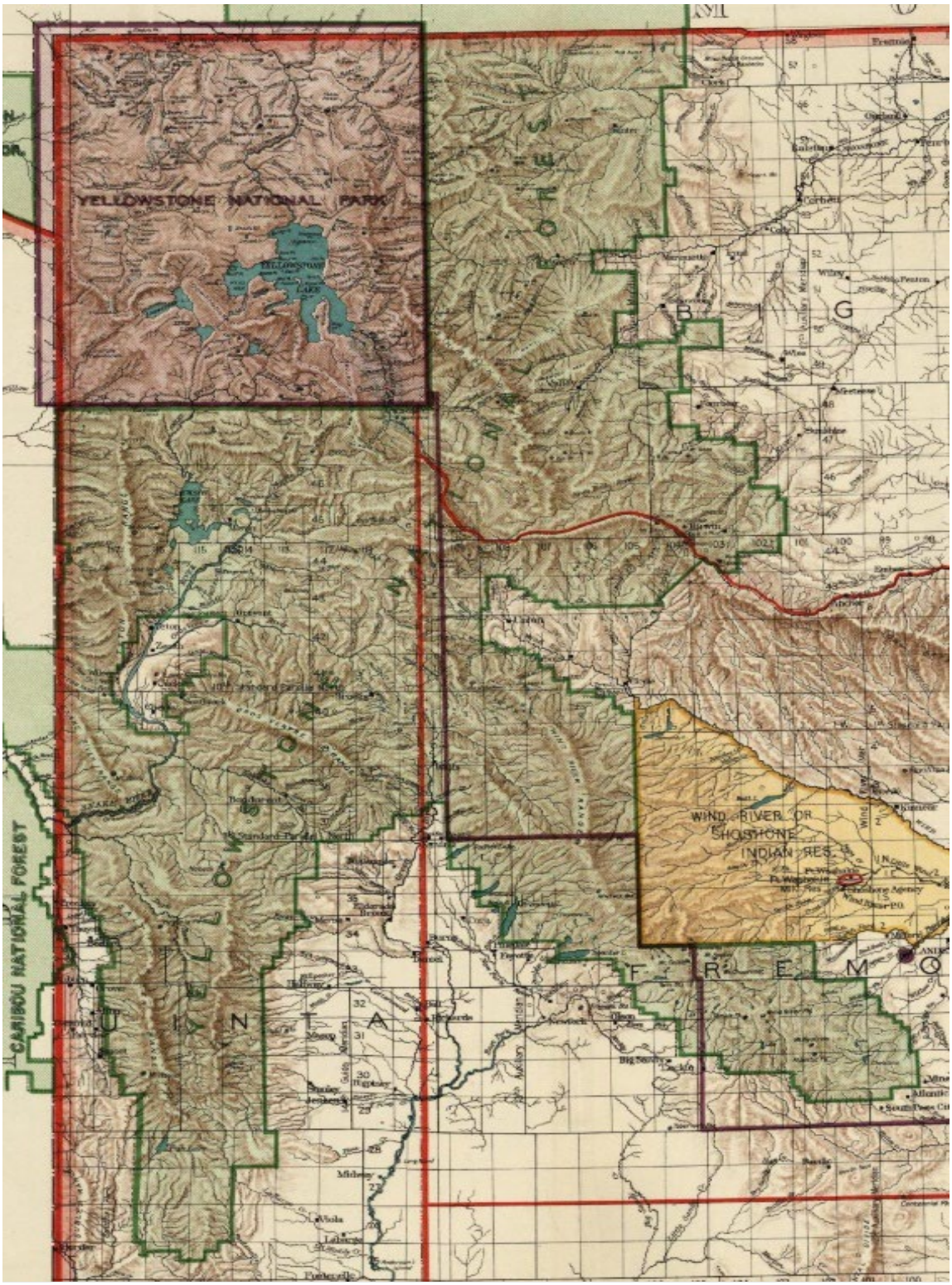


Figure 2. Yellowstone Forest Reserve 1904-1908

This 8.3-million-acre reserve was divided into various combinations of forests between 1908 and 1941 (Teton, Shoshone, Wyoming, and Bonneville/Bridger). Grand Teton National Park was carved out of the Bridger-Teton in 1929 and later expanded. In 1973, the Teton and Bridger

Forests were administratively combined into one unit and the Bridger-Teton took on administration of a portion of the Targhee National Forest (except for range management).

Overall, the Bridger-Teton is characterized by distinctive mountain ranges and major river corridors with interspersed basins. Different geologic formations and ecological assemblages combined with different administrative and human histories contribute to a forest that is very diverse, encompassing three major zones – Teton/Gros Ventre (north zone), Wyoming/Salt River Range (west zone) and Wind River/Green River (east zone).

Distinctive Roles and Contributions

The 2012 Planning Rule (36 CFR 219.7(f)(1)) and associated handbook (FSH 1909.12.22.32) require revised plans to describe the forest's distinctive roles and contributions within the broader landscape. This section describes roles for which the forest is valued and best suited, considering the Agency's mission, the forest's unique capabilities, and opportunities available on nearby lands. The distinctive roles and contributions provide focus and context for developing plan components; help provide an all-lands approach; and provide a foundation for desired conditions and objectives.

Water and Snow

While many Rocky Mountain national forests provide headwaters for important water uses, the Bridger-Teton is especially important, as it is located at the top of the watershed giving rise to the Snake River, which flows west to the Columbia River; Green River, which flows south to the Colorado River; and Yellowstone River, which flows east to the Missouri and Mississippi Rivers. The Bridger-Teton boasts thousands of named creeks and lakes providing habitats for fish and wildlife, memorable recreation opportunities, and essential community municipal and agricultural use (e.g., Big Springs, Star Valley Front, and Fremont Lake). Some water resources are nationally recognized through congressionally designated Wild and Scenic Snake Rivers. The unique "Parting of the Waters" at Two Ocean Pass is recognized as a National Natural Landmark; there, waters divide into Atlantic Creek flowing east and Pacific Creek flowing west. On the south end of the Bridger-Teton, the Tri Basin Divide splits the Columbia Basin, the Colorado River Basin, and the arid, no-outlet Great Basin—all three of which provide habitat for multiple cutthroat trout species. Finally, many scenic subalpine lakes, waterfalls, and springs are located on the Bridger-Teton, including Periodic Spring near Afton, a geological feature that is one of a handful of springs in the world that regularly cycle on and off.

Abundant snowfall and numerous glaciers sustain these rivers and lakes. Climate refugia on the Bridger-Teton are important to diverse species, including humans. Snow coverage in the Bridger-Teton is gaining increased attention, as climate projections suggest snow coverage will remain in the Bridger-Teton longer than elsewhere. At a large scale, habitat for boreal species is anticipated to shrink and become less connected, which heightens the value of existing areas of intact habitat. Compared to almost any other place in the lower 48 states, the Bridger-Teton is considered the most intact and probable refugium for boreal species and could contribute to their persistence (McKelvey, et.al. 2011). Climate refugees include fish species seeking cold water; wolverines that depend on deep snowpack; mountaintop plant and animal species seeking cold temperatures; and humans seeking respite from hot temperatures or simply a place to continue their favored water- or winter-recreation activities.

Wildlife and Fish

In multiple surveys of residents and visitors, wildlife emerges as a significant value and role of the Bridger-Teton. The GYE was initially defined by the movement of wildlife across jurisdictions. The GYE is a sanctuary for the largest concentration of wildlife in the coterminous U.S.; unique to the Lower 48, it continues to support most mammal and bird species that were present before the 1880s. Even within the GYE, the Bridger-Teton stands out as particularly important, largely due to its expansive, relatively undeveloped habitats, which support 74 species of mammals, 355 bird species, 12 reptile or amphibian species, and 25 species of fish. Notably, the Bridger-Teton has healthy populations of predator species—such as grizzly bears, wolves, and mountain lions—which are strong indicators of productive ecosystems. Gaining increased attention are the long-distance ungulate migrations for pronghorn, mule deer, and elk. In 2008, the “Path of the Pronghorn” through the Bridger-Teton became the first federally designated migration corridor; this 175–330-mile round-trip migration route is the longest corridor for terrestrial animal migration in the Lower 48 states. Additionally, the Wyoming Range mule deer herd, found on the Bridger-Teton, is coveted by hunters, both local and from afar. The Bridger-Teton also has four large core herds of bighorn sheep that have persisted without having to be re-established with transplants; these herds account for 85 percent of Wyoming’s bighorn sheep population, and they are the largest meta-populations in its range. The significance of wildlife on the Bridger-Teton is reflected in the large amount of research conducted there, focused on everything from insects to large mammals, including the seminal publication, “Elk of North America,” authored by Olaus Murie. Wildlife art galleries abound, including the National Museum of Wildlife Art and many filming projects are centered around wildlife and hunting on the Bridger-Teton.

A few specific places on the Bridger-Teton stand out as exceedingly rare and important to fish, notably a 984-foot-long stream formed by thermal seeps and springs, which is home to the only population of the endangered Kendall Warm Springs Dace. Historically, Wyoming was home to six sub-species of cutthroat trout. Today five remain, four of which occur in the Bridger-Teton – the Bonneville (Bear River) Cutthroat (*Oncorhynchus virginalis utah*), Colorado River Cutthroat (*Oncorhynchus virginalis pleuriticus)*, Snake River Fine-spotted Cutthroat (*Oncorhynchus virginalis behnkei)*, and Yellowstone Cutthroat (*Oncorhynchus virginalis bouvieri)*. The ability to fish for four native subspecies of Cutthroat in one area is a notable feature of the Bridger-Teton.

Wildlands and Dispersed Recreation

Wildlands are defined as natural areas that have not been significantly modified by human activity. Today, most of the U.S. is covered by a dense system of roads, with ecosystems that have been heavily modified by human activity (Pew 2001). Although no place on earth is truly “untouched” by human activity, the presence of a “blank spot on the map,” particularly areas of contiguous, undeveloped backcountry greater than 5,000 acres, are increasingly rare. The eastern U.S. is largely developed and even within the western U.S., only a few large undeveloped areas stand out. The GYE is one such area (See Figure 3). The Bridger-Teton is notable for its contribution to this wildland network, with 41 percent of the forest congressionally designated (e.g. Wilderness), small protected areas that contain unique geological or ecological features, and 41% that remains largely undeveloped (e.g. Inventoried Roadless Areas).

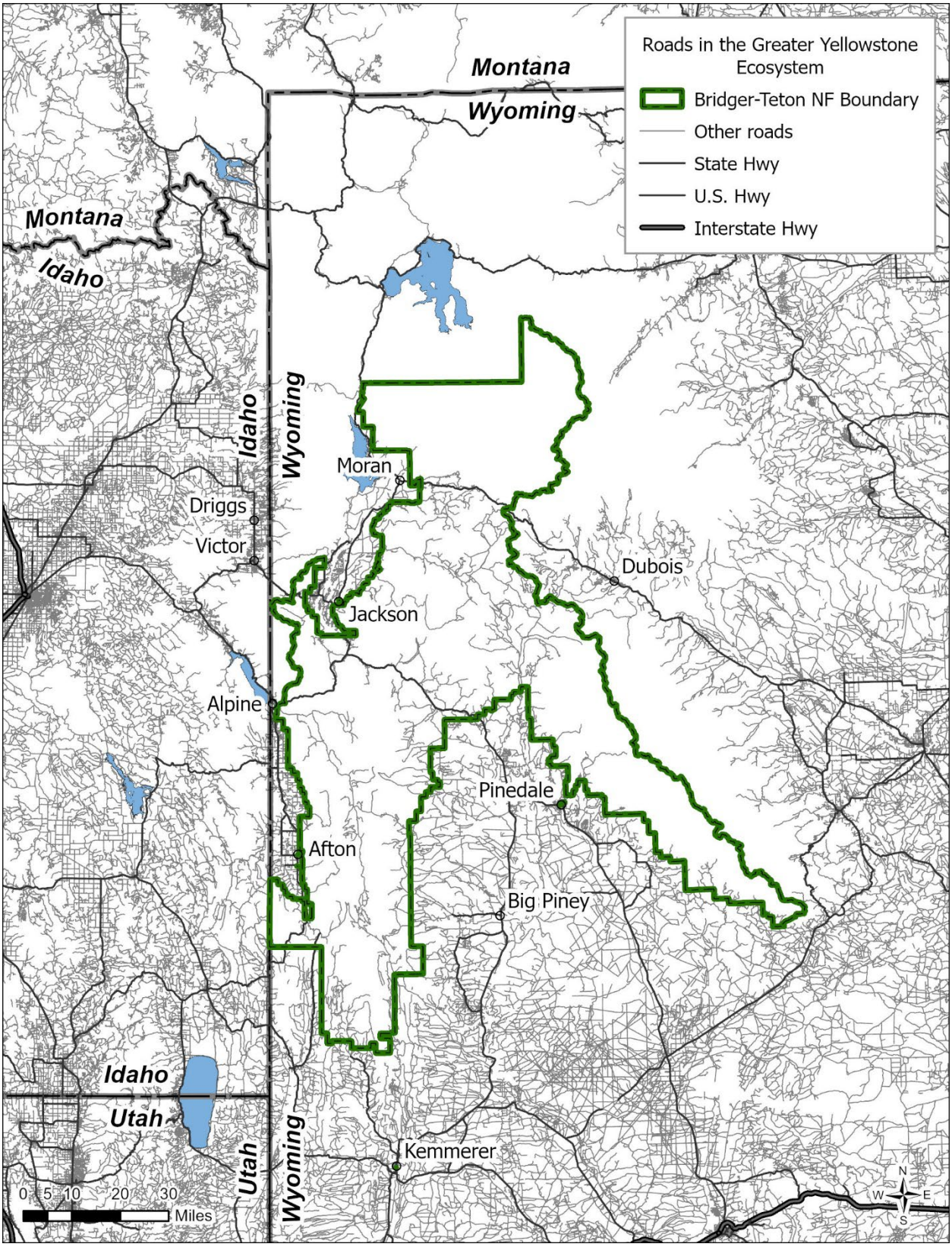


Figure 3. Roads in the Greater Yellowstone Ecosystem

The value of these relatively unmodified and unroaded natural areas is gaining recognition. Ecologically, these areas provide quality habitat and clean water that support the wildlife and fish species found on the Bridger-Teton. Socially and economically, the presence of large wildlands and 3,475 miles of trail is the reason why the Bridger-Teton supports the largest outfitting program in the Intermountain Region, offering everything from: pack-trips, hunting, fishing, hiking, day horse rides, climbing, rafting, snowmobiling, skiing, and more. The Bridger-Teton is known for its relatively undeveloped character, which provides the foundation for year-round dispersed recreation activities: dispersed camping, trail-based activities, boating, and fishing/hunting dominate the summer/fall season, while snowmobiling and backcountry or cross-country skiing dominate the winter season outside of mountain resorts. Roughly 94 percent of the Bridger-Teton offers a primitive or semi-primitive setting essential for these dispersed recreation activities. Of particular note, primitive recreation settings (i.e., those areas at least 3 miles away from roads) comprise 43 percent of the Bridger-Teton in the summer, offering more opportunity than any other forest in the Intermountain Region to experience natural sounds, star-lit dark sky and backcountry solitude or serenity.

Cultural Heritage: A Way of Life

With the nearest metropolitan area 200 miles away, the Bridger-Teton is considered a rural forest. Most of the nearby communities are small, with less than 2,500 residents, except for Jackson. All of the five counties encompassing the forest include large percentages of Federal public lands, and their history and community character are closely tied to public lands and natural resource use.



Figure 4. Green River Drift

For the southern and eastern portion of the Bridger-Teton, community character, human settlement, and economic activity are inextricably tied to fur-trapping and ranching. Of all the

communities around the Bridger-Teton, Big Piney holds the distinction of being the oldest permanent settlement founded in 1879. Fierce winter weather forced emigrants, travelling with a thousand cattle, to stop at South Piney Creek and wait for spring. When spring finally arrived, the lush grass and thriving cattle convinced them to stay put and establish a post office, store, and schoolhouse. Nowhere is the history and importance of grazing and the ranching lifestyle more evident than with the Green River Drift, a 58-mile-long cattle trail that has been continuously used since the 1890s to drive cattle with horses, cowboys, and dogs between spring pasture in the desert to summer pasture in the Bridger-Teton (Figure 4 and Figure 5). Individual herds from the various ranches are moved via trails to the Upper Green River cattle allotment, the largest allotment in the Bridger-Teton, where they intermingle until cold weather arrives, and cows begin to “drift” down to lower elevations, where cowboys spend weeks separating the cows into their home ranch herds. The significance of this trail was recognized in 2014 when the Green River Drift became the first ranching-related traditional cultural property listed on the National Register of Historic Places. Its unique history was featured both on the Wyoming Public Broadcasting Service (PBS) and on CBS 60 Minutes in 2022. With 94 active livestock allotments on the Bridger-Teton providing summer forage for cows and sheep, cowboy traditions remain strong through county fairs, 4H programs, and daily ranch life.

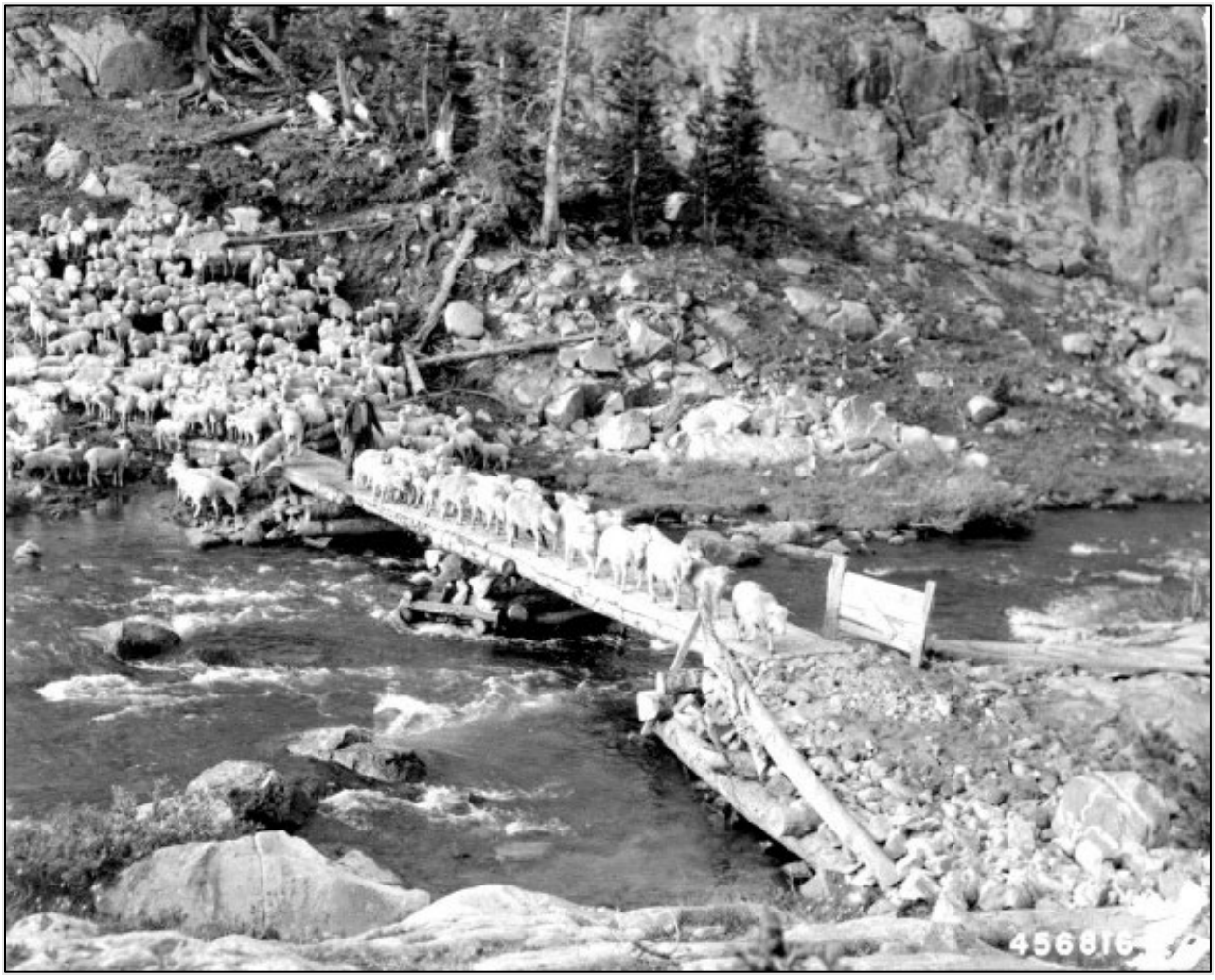


Figure 5. Fremont Crossing 1949

Before Euro-American settlers arrived in the 1880s, the Eastern Shoshone and Shoshone-Bannock people used prominent routes to traverse the Wind River Range into the Green River Valley and follow the Snake River into western Wyoming for various activities, including: tracking, gathering plants, fishing, and hunting. Some of these routes also became important corridors for settlers; the Lander Cut-off Trail is one example. This National Historic Trail allowed 13,000 emigrants to travel westward on a route that was less arid. It was the first federally funded road project west of the Mississippi River. And while settlement in the western U.S. initially occurred via wagon trails, it was ultimately most closely associated with development of the intercontinental railroad system. The Bridger-Teton played a role in this process by supplying timber for railroad ties and later mine props for the Kemmerer coal mines. Evidence of such “tie hack” activity, including the remains of villages, can still be found along the Green River, the Hams Fork River, and in the mountains west of LaBarge and Big Piney.

For the northern portion of the Bridger-Teton, abundant elk, beaver, and associated outfitting and hunting activity along with the scenery of the Teton Range strongly influenced community character and contributed to an early tourism economy in Jackson Hole, which continues to this day. Ranching also played a role in settlement, particularly west of the Snake River, with many historic cattle ranches still operational today, whereas ranches catering to tourists were prominent east of the Snake River (Daugherty 1999). Interestingly, sheep were banned from the original Bridger-Teton in 1905 based on the rationale that sheep ate the vegetation upon which elk herds depended for forage (Southworth and Polk 1999). Because of this early policy, the original Teton National Forest is likely the only national forest that was not affected by sheep grazing, offering ecological reference conditions not available elsewhere.

Major Drivers and Stressors

Stressors are factors that may directly or indirectly degrade or impair ecosystem composition, structure, or ecological processes in a manner that may impair its ecological integrity (36 CFR 219.19). Drivers may be considered synonymous with stressors, although drivers do not necessarily impair ecological integrity. In fact, some drivers are necessary to support ecosystem integrity. Some drivers may become stressors when they occur outside of the frequency, severity or extent than what is expected in the natural range of variation. Many drivers and stressors that impact ecosystem conditions are related to natural disturbances or influences, while others are anthropogenic in nature. Many drivers and stressors interact with each other to create complex effects and feedback loops and can impact social and economic sustainability as well as ecological sustainability.

Forest and rangeland ecosystems are inherently dynamic, as ecosystem structure, composition, and function shift in response to vegetation growth, succession, disturbance, and other drivers. Successional processes, environmental conditions, and disturbances such as: wildfire, insect outbreaks, drought, and forest disease are all naturally occurring and interact to influence the structure and composition of ecosystems. Over the last century, additional human-caused drivers such as: land uses, forest management, fire suppression, non-native invasive species, anthropogenic climate change, and deposition from air pollution have increasingly interacted with natural ecosystem drivers to shape ecosystem conditions and trends. Drivers and the subsequent ecosystem responses vary spatially, temporally, and by ecosystem type on the Bridger-Teton.

(Chapter 2 discusses drivers and stressors in detail and sections throughout the Assessment address driver and stressor impacts on the specific resources.)

Current Management Constraints and Opportunities

Just as ecological, social and economic conditions have changed, the managerial environment within the Forest Service has evolved. Since its establishment in 1905, the Forest Service has undergone at least four distinct eras in its effort to provide for the *"greatest good for the greatest number in the long run"*: a custodial era from 1905-1945, a timber development era from 1945-1960, an environmental era from 1960-1990 that saw Congress pass significant public land laws including the Multiple Use Sustained Yield Act and the National Environmental Policy Act; and an ecosystem management era emerging in 1990 that strived to incorporate new science and treat forests as a whole (MacCleery 2008). The agency continues to undergo change with current management characterized by a focus on sustainability, larger wildfires and rising fire costs that impinge on non-fire functions (USDA Forest Service 2015), shared leadership structures through collaboratives and partnerships, and centralized budget and administrative functions. This evolution is important because it sets the context under which forest plans are developed.

The current forest plan is a product of the science and societal interests of the 1980s. It was the Bridger-Teton's first effort to allocate its land base to different management-emphasis zones in accordance with the Multiple-Use Sustained Yield Act of 1960, as amended, and other, then-current congressional public lands laws. Since the forest plan's approval in 1990, it has been amended 12 times to accommodate changes such as new fire science and administrative designations like the Path of the Pronghorn. The most recent amendment was the 2015 sage grouse amendment (USDA 2015).

In the 1980s, forest plans focused on specifying resource outputs, a useful lens to provide a sense of possibilities for development or growth. However, output quantities proved often to be tied to external forces, such as congressional budget or worldwide markets, thus forests had little opportunity to meet the specified ambitions. Additionally, the emphasis on outputs was often based on limited understanding of ecosystem function. The 2012 Planning Rule seeks to learn from the past, beginning with understanding ecological conditions and functions so forests can provide services for present and future generations. For example, clean air was not mentioned in the 1990 forest plan, but scientific understanding around that topic has exponentially grown, enabling managers to advance actions that support air quality and, in turn, sustain human and other life.

Several topic areas required by the 2012 Planning Rule were not included in the 1990 Forest Plan, for example, non-timber forest products. Recent research has shown the importance of addressing other new topics, like migration corridors and climate change. At the same time, increasing residential development along Bridger-Teton boundaries has necessitated an increased emphasis on fire management, supported by advances in wildland fire science. Population growth, changing demographics, and major technology changes have transformed the recreation industry, resulting in completely new activities and changes in how and where people want to experience the outdoors. Interest in alternative energy sources is also growing and demand for communication infrastructure, supportive minerals extraction, or direct energy sources like hydropower, may influence future forest management.

Many people care deeply about the Bridger-Teton, as evidenced by the Bridger-Teton's many partners who contribute their time, expertise, labor, and funding to help expand the capacity for resource stewardship. The USFS Northern Research Station created a Stewardship Map web application that illuminates the extensive nature of the Bridger-Teton's partner network. As an

example, the number of formal partnership agreements increased more than six-fold between 2000 and 2020, with 11 partnership agreements executed in 2000 and 71 partnership agreements executed in 2020. Annually, contributions have risen from $748,000 to $7.5 million in that same time. Agreements range from forest and weed management efforts to trail work; ambassadors dedicated to responsible recreation, wildfire prevention, road maintenance, avalanche education, wildlife, and fish habitat improvement, and more. County-specific partnerships, such as Schedule A road agreements, Sheriff's Office patrols, and fire department collaborations, all provide assistance and benefits to the Bridger-Teton. The economic ripple effect of these efforts is enormous. As a stewardship model, the Bridger-Teton is well-positioned for a more regenerative approach to land management, where people interact with land and water in reciprocal relationships that begin to create the kind of caring kinship long advocated by indigenous peoples.

Much work has been accomplished on the Bridger-Teton since the 1990 Forest Plan was initiated. Electronic project records show that 483 projects were completed between September 2004 and March 2025. Of those projects, 31 were appealed and 28 were litigated. Table 1 below outlines the emphasis areas and total numbers of the completed projects within that timeframe.

Table 1. Number of projects completed on the Bridger-Teton since 2004

Project Emphasis Area	Number of Projects	% of Total Projects
Special use management	208	42%
Recreation management	73	15%
Fuels management	44	9%
Wildlife, fish, rare plants	33	7%
Grazing management	27	6%
Vegetation management (non-forest products)	25	5%
Water management	17	4%
Forest products	16	3%
Road management	14	3%
Minerals and geology	10	2%
Land ownership management	7	1%
Facility management	4	1%
Land management planning	3	1%
Special area management	2	1%

Desired Future Conditions (DFCs) are described in detail in the 1990 Forest Plan. They are goals that guide the plan and provide themes for certain areas of the Bridger-Teton. Table 2 below outlines the DFCs and provides information on how the Bridger-Teton made progress towards achieving those goals since 1990.

Table 2. 1990 Forest Plan DFCs and progress made by the Bridger-Teton

Desired Future Condition (DFC)	Theme	Acreage	% of Forest	Did we make progress towards achievement of DFC? What has changed since 1990?
1B: Substantial Commodity Resource Development with Moderate Accommodation of Other Resources	An area managed for timber harvest, oil and gas, and other commercial activities with many roads and moderate to occasionally substantial emphasis on other resources.	182,993	5.3%	Nine oil and gas wells have been drilled since 1990. 48% of all timber harvest units on the forest have occurred in this DFC.
2A: Non-motorized Recreation Areas	An unroaded area managed to give a quiet, almost primitive recreation experience.	164,469	4.8%	Most of this DFC retains a primitive or semi-primitive, non-motorized recreation setting according to current ROS mapping and is managed for non-motorized recreation in the summer.
2B: Motorized Recreation Areas	An area managed to give a motorized recreation experience.	34,610	1.0%	Most of this DFC is managed for motorized recreation in the winter. Approximately half of the area retains a semi-primitive, motorized recreation setting in the summer.
3: River Recreation	An area managed to give river- and scenic-recreation experiences.	74,258	2.1%	Eligible rivers identified in the amended 1990 plan have retained the values that made them eligible, and many rivers originally identified are now congressionally designated as Wild & Scenic Rivers. (Note: WSR amendments to 1990 plan changed this DFC.)
4: Special Emphasis Area for Municipal Water Supply	An area managed to protect municipal water supplies.	43,118	1.2%	While this DFC has protected municipal water supplies and sources, the forest has not been able to implement all the standards associated with this DFC (e.g. standard related to motorized routes). Afton and Star Valley Ranch have recently begun to treat their water.

Desired Future Condition (DFC)	Theme	Acreage	% of Forest	Did we make progress towards achievement of DFC? What has changed since 1990?
6A-6D and 6S: Wildernesses, Wilderness Study Areas (WSAs), and Wild Rivers	A mostly pristine area where the presence of people is rarely or never noticed.	1,409,570	40.8%	The wilderness character of existing areas has largely been preserved. However, increased summer recreation use, particularly in the Bridger Wilderness is a growing concern. The bio-physical character of the WSAs has been maintained but snowmobile and mountain bike use remains contentious.
7A: Grizzly Bear Habitat Recovery Through Scheduled Timber Harvest	An area managed to provide forage and security for the recovery of grizzly bears, allowing for some resource development and roads.	38,540	1.1%	Three timber harvest units have occurred in this DFC since 1990 and recovery of the grizzly bear population has also occurred.
7B: Grizzly Bear Habitat Recovery	A mainly primitive area with few roads and limited human access, managed to provide food and security for grizzly bears.	34,896	1.0%	Grizzly bear population numbers have improved dramatically.
8: Environmental Education About Integrated Multiple Use	An area managed to provide conservation and environmental education, including the study of resources and the practice of forest management.	22,039	0.6%	This DFC was specifically set aside for the Teton Science School (TSS). Initial efforts were made to establish a TSS field camp in Ditch Creek but the focus of the school changed.
9A: Developed and Administrative Sites	An area managed for campgrounds, other noncommercial areas, and Forest Service administrative sites, including related roads and sites.	7,306	0.2%	Some campgrounds and guard stations have been re-designed and improved (Fremont Lake Campground, Green River Lake Lodge, etc.) however the ability to adequately maintain older facilities and water systems has declined.
9B: Special-Use Recreation Areas	An area managed for permitted, private recreation homes, permittees, and others offering services to the public, including related roads and sites.	7,664	0.2%	There has been substantial investment in ski area improvements at JHMR and Snow King within this DFC while White Pine ski resort has experienced ups and downs.

Desired Future Condition (DFC)	Theme	Acreage	% of Forest	Did we make progress towards achievement of DFC? What has changed since 1990?
10: Simultaneous Development of Resources, Opportunities for Human Experiences, and Support for Big-Game and a Wide Variety of Wildlife Species	An area managed to allow for some resource development and roads while having no adverse and some beneficial effects on wildlife.	767,214	22.1%	280 timber harvest units have occurred here since 1990. 12% of those projects included a purpose of benefiting wildlife.
12: Backcountry Big-Game Hunting, Dispersed Recreation, and Wildlife Security Areas	An area managed for high-quality wildlife habitat and escape cover, big-game hunting opportunities, and dispersed recreation activities.	680,886	19.6%	Ample opportunities for mule deer and elk hunting have been provided within this DFC with outfitted hunting remaining stable. Although more work is needed, travel management planning and implementation has increased secure habitat by focusing motorized use on designated routes. Seasonal winter restrictions to secure winter wildlife habitat and establishing the Path of the Pronghorn are examples of projects within this DFC.

Engagement with Native American Tribes

The Federal government interactions with tribal nations are on a nation-to-nation level and unlike other public outreach efforts. Engagement with Tribes with connections to the Bridger-Teton happens between Bridger-Teton leadership and mutual staff. Consultation with Tribal Nations is a unique relationship from other public outreach efforts, since it is a government to government working relationship. Not only do Bridger-Teton staff have an obligation to meet trust responsibilities and honor treaty rights, but Bridger-Teton staff seek the participation of Tribal Nations for the sharing of valuable information for the protection and care of all Bridger-Teton resources and for co-stewardship in land and resource management.

Preparing for the 1990 Forest Plan revision and for the Forest Plan Revision Assessment, Bridger-Teton leadership engaged with available Tribal representatives for nation-to-nation consultations. During those meetings, Bridger-Teton leadership shared information about the Bridger-Teton, generally about the Assessment, and invited Tribal representatives to share any information of importance to them during these efforts. Tribal comments have been general, since forest planning is in its very early stages.

Generally, Tribal comments have noted that Trust responsibilities, honoring treaty rights and continued Tribal access to forest lands, are of importance to the Tribes. Protection of any traditional cultural properties or resources and of culturally significant species is also critical.

Bridger-Teton staff continue to develop robust tribal relations and outreach, including phone calls, emails, and in-person meetings with tribal leadership, to gather their input and knowledge pertaining to the Bridger-Teton.

Consultation invitations were made to the following Tribal Nations, which have expressed interest in the Bridger-Teton, including: Eastern Shoshone Tribe, Shoshone Bannock Tribes, Northern Arapaho Tribe, Nez Perce Tribe, Crow Tribe, Ft. Belknap Indian Community, Confederated Salish & Kootenai Tribes, Blackfeet Nation, Kiowa Tribe, Lower Brule Sioux Tribe, Comanche Nation, and Rosebud Sioux Tribe. Tribes are being invited to fully participate in forest plan revision. As planning efforts progress, Bridger-Teton staff hope to learn more about traditional ecological knowledge from participating tribes.

The current forest plan does not directly address specific Tribal uses and connections to Bridger-Teton lands. However, over the years, Bridger-Teton staff have issued free use permits for Tribes for the use of traditional forest products, as well as engaging with tribes in the work of the Bridger-Teton. For instance, Bridger-Teton archaeological staff have worked with interested Tribes on projects as well as regarding cultural/archaeological finds needing tribal consultation. Such information-sharing also has included regular, quarterly meetings with tribal representatives to solicit their input in the management of the Bridger-Teton. Geographical areas, resource values, and other uses that are important to various tribes are noted in this Assessment.

Public Engagement, Cooperation, and Coordination

The 2012 Planning Rule requires public participation during the Assessment, plan development, and monitoring phases of land management planning. The specific goals of public engagement are to:

- **Design a fair, inclusive, and open process** with a variety of opportunities for diverse interests to participate. Build trust and credibility by demonstrating that the process is fair, transparent, and reasonable, offering multiple opportunities for listening and honest dialogue, and ensuring clear communication and follow through.
- **Encourage and facilitate shared learning** to build a common understanding of data and information with focus on what is within the scope of the Bridger-Teton plan revision and clearly identifying what is not and why.
- **Facilitate opportunities for "cross-pollination"** among diverse perspectives throughout the Bridger-Teton plan revision process to explore areas of agreement as well as differences.
- Construct a strong foundation to work with local, state, and Federal government entities, and tribal nations for consultation and coordination throughout the entire Bridger-Teton plan revision process.
- **Inform and engage employees** in all aspects of Bridger-Teton plan, particularly at key milestones in the process.

The Assessment provides opportunities for the public and governmental entities to participate, commensurate with their interest. Public participation in the assessment phase also supports the development of relationships with and among members of the public and it can contribute to a common understanding of current conditions and available data (FSH 1909.12, 42.11 and 13.21).

The Bridger-Teton and the plan revision team began preparing for public engagement by commissioning a *Situation Assessment* with the University of Utah Environmental Dispute Resolution Program and the University of Wyoming Ruckelshaus Institute. There were 37

individuals, representing diverse interests, interviewed to illuminate potential challenges and opportunities for future forest management, planning, and engagement. The report was completed in July 2019. The situation Assessment will continue to inform public engagement efforts throughout Bridger-Teton planning. A *Forest Plan Revision Public Participation and Collaboration Strategy* was then drafted. Tiering to this strategy, a public engagement plan was drafted in March 2024, and it has been regularly updated.

Engagement with the Public

During the preassessment and draft assessment phase, informal opportunities were offered with the purpose of letting people know that the Bridger-Teton planning process was beginning, providing information to help people understand the forest planning process, and listening to people's initial thoughts on trends and important topics for the future. Thus far, engagement opportunities have included the following formats:

1. information booths at community events around Bridger-Teton, such as county fairs and farmers markets;
2. implementation of an independent social survey conducted in collaboration with Big Goose Creek Resolution, the State of Wyoming, and four counties;
3. a story map released in conjunction with a public comment form;
4. a Forest Plan Symposium featuring diverse panelists, including those who were deeply involved in the citizen task force, to produce implementation products for the 2012 Planning Rule,
5. informal conversations with non-profit organization leaders and interested citizens; and
6. sharing information via Forest Futures newsletters and a webpage dedicated to Forest Plan Revision.

The social survey results were compiled in a report available on the Bridger-Teton webpage – Study of Preferences and Values on the Bridger Teton National Forest. Forest Futures newsletters have highlighted results from both the social survey and the public comment form. To date, roughly 800 people have engaged in some form of in-person conversation with Bridger-Teton staff and an estimated 300 people are receiving updates through GovDelivery. Future engagement efforts will include continued informal one-on-one conversations, webinars, and open houses focused on key Assessment topics with an eye on the implication for what needs to change in the current forest plan. Links to engagement events and plans can be found at the Bridger-Teton Forest Plan Revision webpage.

Engagement with State and Local Governments and other Federal Agencies

Engagement is essential between Bridger-Teton, county officials, and state agencies, particularly entities that have jurisdictional responsibility for lands within the Bridger-Teton boundary so that there is an opportunity to work towards shared goals and coordinated management. Likewise, Bridger-Teton must coordinate with conservation districts and adjacent Federal land agencies. In accordance with planning regulations, counties and State entities can be granted cooperating agency status based on their jurisdictional responsibility and special expertise. In preparing for the Assessment, Bridger-Teton staff have been working with four counties (Lincoln, Sublette, Teton, and Fremont), four conservation districts (Lincoln, Star Valley, Sublette, and Teton), and the State of Wyoming, all of which have requested cooperating

agency status. Coordination also has occurred among Federal land agency partners. Discussions at the introductory meetings in March and April 2023 centered around initial thoughts regarding important topics to address in the forest plan revision, identification of relevant local plans, and interest in cooperating agency status. In April and November 2023, the Bridger-Teton staff individually followed up with Federal agency leaders who are members of the Greater Yellowstone Coordinating Committee. In December 2023, a briefing was held with counties, the State of Wyoming, and local conservation districts to provide a status update on the Assessment and to discuss roles and expectations around participation as a cooperating agency. In March and April 2024, the results of the social survey conducted by Big Goose Creek Resolution was presented to each county and State agencies. This was followed by a joint training session focused on the planning process in May 2024 and a check-in in July 2024 to provide an Assessment status update and additional information about cooperating agency expectations. Important topics vary by county and State agencies, but themes center around ensuring: public access (roads, trails, and easements), recreation use and development, fire management, migration corridors, municipal water supply, mortality from insects and disease, and livestock grazing.

Chapter 2. Assessment Findings: Ecological Sustainability and Diversity of Plant and Animal Communities

This chapter provides an overview of the primary ecosystem drivers and stressors on the Bridger-Teton National Forest, followed by assessment findings regarding ecological sustainability and the diversity of Bridger-Teton plant and animal communities. The USFS presents key takeaways; a summary of background information and context; and a more detailed discussion of the current conditions, status, and trends, which includes descriptions of key interactions and system drivers and stressors. This information provides the context necessary to understand the existing conditions and current management framework.

Drivers and stressors are alphabetically presented below. However, the four primary stressors that are affecting Bridger-Teton ecosystems are: climate change, increased human use and development, invasive species, and insects and disease.

Ecosystem Drivers and Stressors

Overview

Ecosystem “drivers” are the dominant ecological or human-influenced processes that shape ecosystems; they include vegetation successional and disturbance regimes.

“Stressors” are closely related and interconnected with drivers; they are natural or human-induced agents that strain ecosystems and can cause imbalances. This section provides an overview of four primary stressors that influence conditions on the Bridger-Teton. More detailed discussion about the role of drivers and the effects of human-induced stressors on specific ecosystem conditions is found within the specific section of this assessment for that topic.

Climate Change

Climate is a key system driver and human influenced climate change is a stressor that interacts with other ecosystem stressors to affect vegetation, ecological and hydrologic processes, and overall ecosystem function at long time scales. Climate change effects can be both direct and indirect. Examples of direct climate change effects include increased temperatures and shifts in precipitation from a more snow-dominated to rain-dominated regime. Examples of indirect climate change effects include shifts in habitat and species distributions, shifts in the seasonality and intensity of streamflow, increased air pollutant exposures, decreased water quality, shifts in fire regimes, changes in human land use and development, increased insect and disease outbreaks, increased invasions of non-native species, and shifts in spring green up, flowering, and phenology of plants and migrating animals (Bloom et al. 2018; Bloom et al. 2022). This section of the Assessment provides a detailed overview of climate as a driver and a stressor to the Bridger-Teton. Specific effects of climate are described throughout the Assessment within respective sections.

Climate across the Bridger-Teton has historically been characterized by cold, wet winters, where most of the total annual precipitation falls as snow, and summers that are typically warm and dry (Halofsky et al. 2018). However, the climate is changing. Temperatures have already risen across the Bridger-Teton since 1990, and the climate is projected to continue to depart from pre-Industrial Era conditions throughout the 21st century (Halofsky et al. 2028, Hostetler et al. 2021). There are different emission scenarios for future warming based on the trajectory of greenhouse gas emissions, known as Relative Concentration Pathways (RCPs) defined by the Intergovernmental Panel on Climate Change (IPCC). Two of the most common scenarios are RCP 4.5, which is a "moderate emission" scenario that assumes emissions peak around 2040 and then decline due to largescale greenhouse gas mitigation, and RCP 8.5, which is a "business as usual" scenario that assumes emissions continue to rise throughout the twenty-first century at the same rate currently experienced (Halofsky et al. 2018, Hostetler et al. 2021). Based on the current rate of greenhouse gas (GHG) emissions, the climate trajectory of North America is consistent with the business as usual, RCP 8.5 scenario (Miller & Brock 2024; Davariashtiyani et al. 2023).

Research conducted across a range of spatial scales has provided information for this Bridger-Teton Assessment. At the national scale, efforts include the Resources Planning Act Assessment (USDA 2023h) and the National Climate Assessment (USGCRP 2025) that consider a range of future scenarios to examine how climate change, population growth, land use change, and other stressors might influence forest and rangeland ecosystems across the United States. Regionally, the Climate Change Vulnerability and Adaptation in the Intermountain Region (Halofsky et al. 2018) report focuses on climate change effects on the Intermountain Region and specifically address the Bridger-Teton within the Southern Greater Yellowstone subregion. The Greater Yellowstone Climate Assessment (Hostetler et al. 2021) addresses past, present, and future climate change in the Greater Yellowstone Ecosystem (GYE), including the upper Green, upper Snake, and upper Yellowstone River watersheds, which all originate as headwaters on the Bridger-Teton. Additional peer-reviewed studies address specific effects across the forest and surrounding region. This section of the Assessment synthesizes these resources to better inform existing and future impacts to the Bridger-Teton.

Current and Future Changes in Temperature

Increased minimum, maximum and average temperatures across all seasons are a current stressor on the Bridger-Teton National Forest and expected to rise into the future. Since the Forest Plan was established in 1990 through 2024, the mean annual temperatures across 25 Snow Telemetry (SNOTEL) sites representing all ranger districts across the Forest have risen 2°F from 33.7°F to 35.7°F (Figure 6). Minimum and maximum temperatures show similar upward trends since 1990. This is consistent and slightly exceeds the average annual temperatures across the coterminous states, which have increased at a rate of approximately 0.48 °F per decade since 1970, with some regions experiencing even higher rates of warming (USDA 2023d). The Bridger-Teton has warmed at a rate of approximately 0.59°F per decade since 1990.

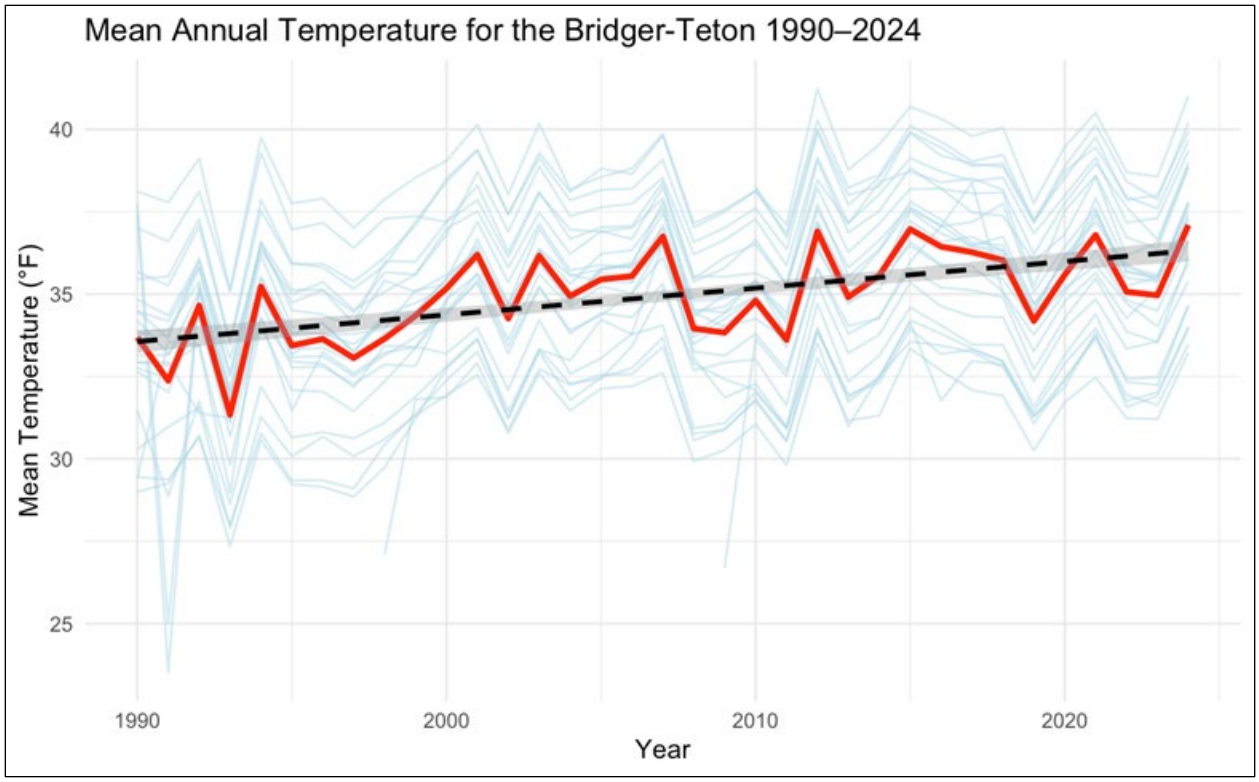


Figure 6. Mean annual temperature of the Bridger-Teton National Forest has risen over 2°F since 1990. Observed data from the instrument record of 25 SNOTEL sites managed by the National Water and Climate Center of the USDA representing all Ranger Districts of the Bridger-Teton. The red line represents the average across all sites, the dotted line shows the trend, and the blue lines are actual data from each of the 25 sites.

Long-term increases in temperature are expected to continue across the Bridger-Teton for the foreseeable future (Figure 7). Under the business as usual scenario, mean annual temperature is expected to rise from the current 35.7°F upwards of 5.8°F to 41.5°F by 2050 and 11.5°F to 47.2°F by 2100. Even under the moderate scenario, mean annual temperatures rise 4.7°F to 40.4 °F by 2050. This is consistent with both the Greater Yellowstone Climate Assessment and Climate Change Vulnerability and Adaptation in the Intermountain Region report which state average annual temperatures are expected to rise by upwards of 11°F by 2100 (Halofsky et al., 2018; Hostetler et al., 2021). Minimum temperatures for all seasons are projected to be outside of historical ranges leading to more freeze-thaw cycles during the fall, winter, and spring. Minimum temperatures above freezing have major implications for ecosystems that rely on frozen conditions, drive snowmelt timing in the spring, and provide natural constraints on insect outbreaks especially mountain pine beetle outbreaks.

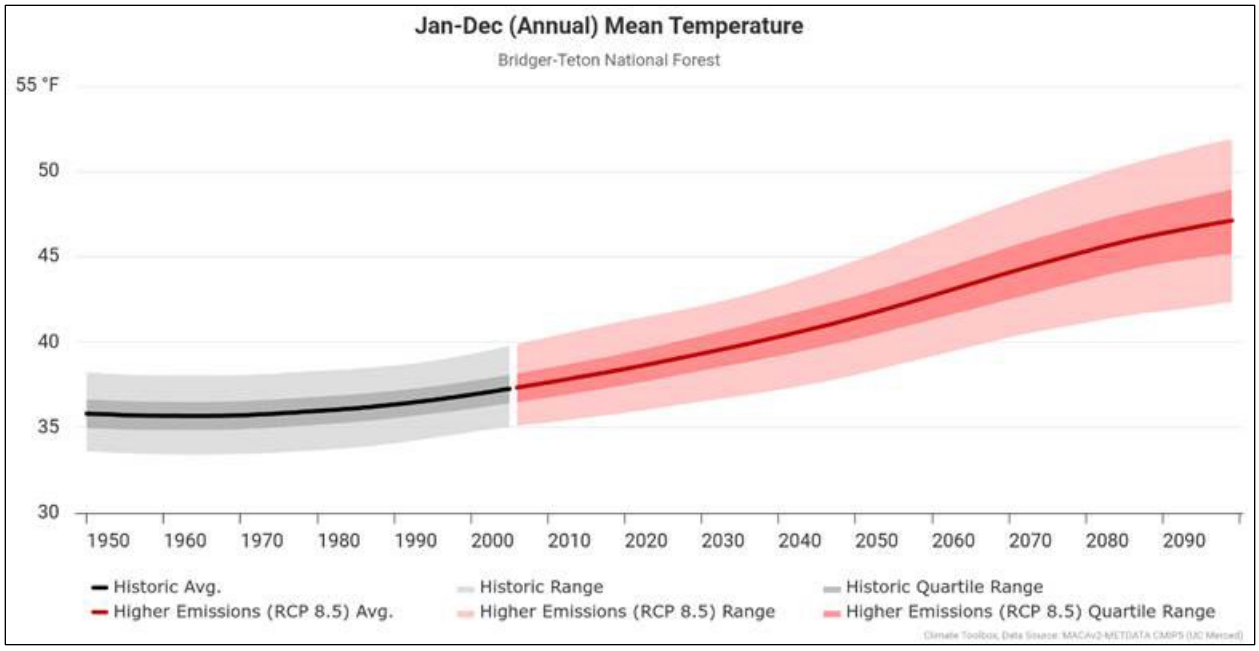


Figure 7. Mean annual temperature of the Bridger-Teton National Forest depicted under historic and future conditions modeled with the RCP 8.5 "business-as-usual" scenario. Data averaged across the Bridger-Teton includes projections from an ensemble of 20 climate models downscaled to an approximate 2.5-mile resolution. Data Source: Hegewisch & Abatzoglou 2025.

Current and Future Changes in Precipitation

In the GYE, average total precipitation has not significantly changed since the 1950s (Figure 8) but there has been a transition in precipitation from snow to rain. Compared to 1950, the GYE receives 23 inches or 25% less snowfall, though many of the current changes are experienced at lower elevations (Hostetler et al. 2021). In contrast, snowfall above 8,000 feet above sea level has increased since 1950 (Hostetler et al. 2021). Since about three-quarters of the Bridger-Teton is above 8,000 feet, most areas have likely not seen a decrease in snowfall amount currently. However, the snowpack, or the water equivalent found in the snow on the ground, has been declining across the West attributed to large amounts of spring warming. Since the 1970s, the onset of snowmelt timing has advanced by nearly 3 weeks in Grand Teton National Park, which borders the Bridger-Teton (Figure 8; Bloom et al. 2022).

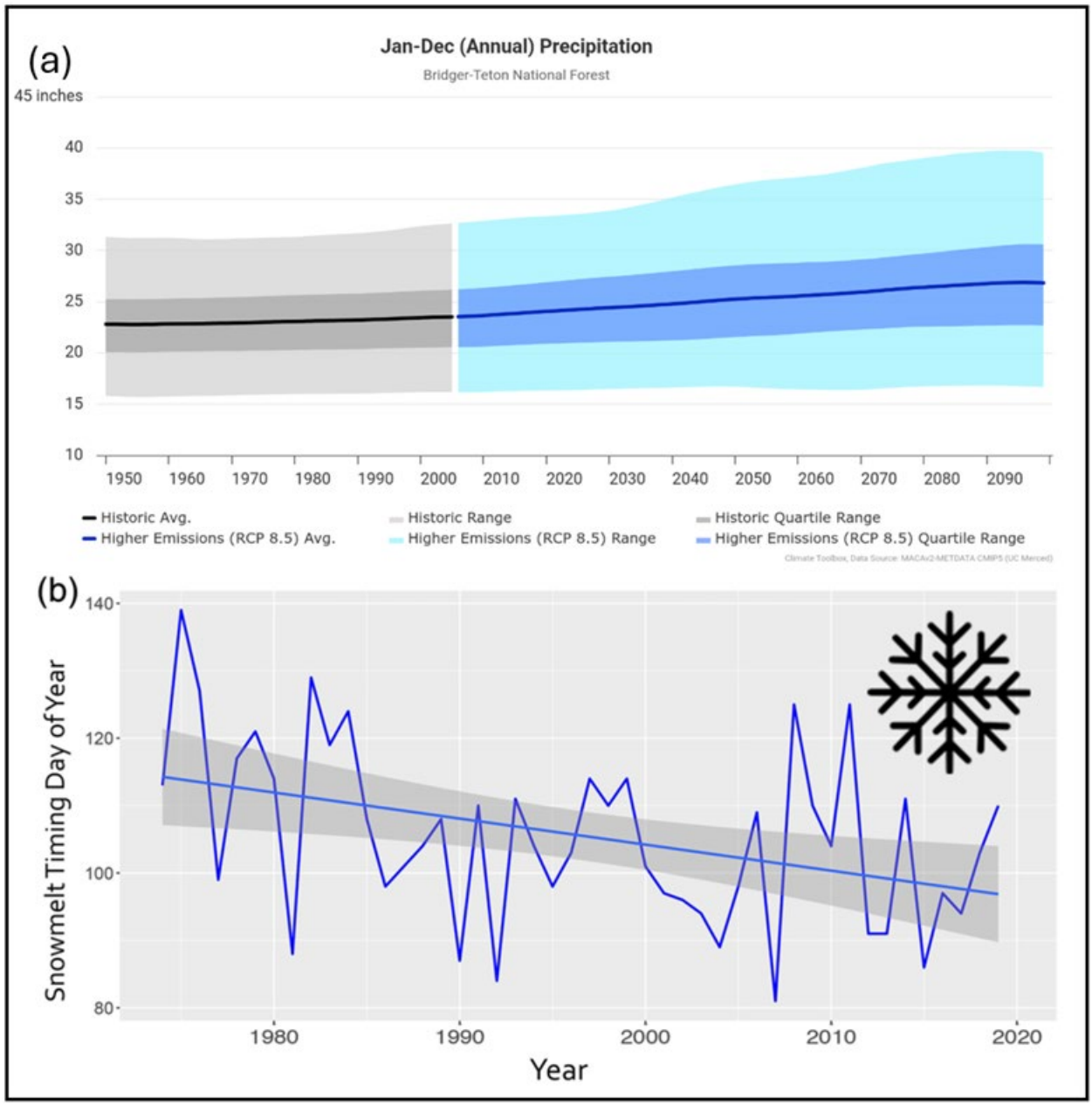


Figure 8. (a) Mean annual precipitation of the Bridger-Teton for historic and future modeled data under RCP 8.5 scenario depicts a slight increase in overall precipitation with a shift from a snow to a rain dominated system. (b) Date of snowmelt timing has advanced 21 days from 1975 to 2020 in Moose, WY which borders the Bridger-Teton (Data source: Hegewisch & Abatzoglou 2025; Bloom et al. 2022).

Future changes in precipitation are more uncertain than temperature forecasts, although most models predict a slight increase in annual precipitation across the region (USDA 2023d, Hostetler et al. 2021). Under the RCP 8.5 scenario precipitation in the GYE is projected to increase by approximately 9 percent mid-century (2041-2060) and 15 percent by the end of the century (2081-2099) relative to the 1986-2005 base period. In general, the Bridger-Teton and Greater Yellowstone are expected to experience warmer, drier summers and warmer wetter winters. The increases in precipitation are more likely to primarily occur in the winter months

from December-April (Hostetler et al. 2021). Temperature can directly influence moisture availability and precipitation in many ways. Warmer air can hold more moisture, potentially altering precipitation patterns. Increasing temperatures simultaneously drive higher rates of evaporative demand (e.g., vapor pressure deficit [VPD]) and affect the type of precipitation (i.e., rain versus snow). However, projections of the timing and magnitude of precipitation are far more variable and uncertain than those of temperature.

Table 3 describes changes in the future climate by 2050 relative to the 1971-2000 period under climate scenario RCP 8.5 using the Coupled Model Intercomparison Project (CMIP5) 20 model mean (Data source: Hegewisch and Rangwala 2025). Data summarized across a wide range of elevations and latitudes providing a general trend that will vary depending on location within the forest. Compared to historical values, the water stored in the spring snowpack would be 39% reduced by 2050 (March-April-May snow water equivalent). The hottest and coldest days are predicted to be 7°F and 9°F warmer, respectively. Additionally, there would be 21 more days that are hotter than 86 °F. The first fall freeze would be about 40 days later, and the last spring freeze would be 14 days earlier by 2050.

Table 3. Summary table describing changes in the future climate by 2050 relative to the 1971-2000 period

Climate Metric	Historical value 1971-2000	Future value in 2050 (RCP 8.5)
MAM[1] Snow Water Equivalent (in)	6.2	3.24
Coldest Winter Day (°F)	-19.4	-10.1
Hottest Summer Day (°F)	83.6	90.6
Number of Days with Maximum Temperature Above 86 (°F)	4.2	25.3
Date of First Fall Freeze	Aug. 5	Sept. 14
Date of Last Spring Freeze	Jun. 17	Jun. 3

1 MAM = March-April-May or spring.

Drought

While droughts are natural events that vary in timing, magnitude, and duration, warming air temperatures along with shifts in precipitation will likely increase the extent and severity of droughts that affect the Bridger-Teton. Climate change-driven droughts can manifest in numerous ways including:

- meteorological drought (e.g., reduced precipitation and increased evaporative demand),
- hydrologic drought (e.g., reduced water resource availability),
- snow drought (e.g., reduced precipitation falling as snow), and,
- broadly speaking, ecological drought (e.g., drought events that push ecosystems beyond their adaptive capacity and affect socioecological relationships (Crausbay et al. 2017).

Although future precipitation projections are difficult to predict at local scales, the Bridger-Teton will likely experience more frequent and severe drought events in the summer driven by warming temperatures at broader scales, despite predicted increases in winter precipitation. Warming trends suggest increased drought severities will exceed those estimated for the past 1,200 years (Turner et al. 2022).

Altered Stream Temperatures and Flows

Warming temperatures can affect streamflow timing and water temperatures, potentially impacting aquatic wildlife, water resources, aquatic and riparian vegetation and other ecosystem services derived from freshwater ecosystems (Halofsky et al. 2018). Currently, fifteen of the years between 1998 and 2018, and all years since 2008, have experienced earlier-than-average peak streamflow (Hostetler et al. 2021). Perennial and intermittent water resources may decrease with changes in surface flow quantities. Warmer temperatures may lead to earlier and larger spring stream flows, followed by lower summer stream flows and increased stream temperatures. Reductions in precipitation falling as snow will reduce the amount of available water stored in snowpacks and glaciers. Additionally, rain-on-snow events can lead to rapid snowmelt, potentially increasing flood risk and erosion. Changes in timing and duration of snowmelt and runoff can alter groundwater recharge, which is a critical driver of many aquatic ecosystems. The important role that wetlands and fens play can be compromised if these ecosystems are degraded or decrease across the landscape. Drying of these systems also can promote decomposition of organic material releasing previously sequestered carbon into the atmosphere.

Indirect Effects and Shifts in Disturbance Regimes

The impacts of rising temperatures and decreasing snowpack with extend well beyond the boundaries of the Bridger-Teton and the GYE, which contain the headwaters of the Yellowstone, Snake, and Green Rivers. As major tributaries for the Missouri, Columbia, and Colorado Rivers, they are important sources of water for drinking, agriculture, recreation, and energy production for the United States. A decrease in the Forest's snowpack could affect millions of people who depend on this critical source of water. Increased temperatures also drive indirect effects of climate change, or shifts in disturbance regimes. These include, but are not limited to longer, more severe fire seasons, fires moving up in elevation, spread of invasive species, shifts in the seasonal timing of ecological events (phenology), increased geohazards such as flooding and landslides, more exposure to harmful air pollutants including smoke, and increased outbreaks of insect pathogens. Indirect effects may reshape forest landscapes and act as trigger points that could lead to sudden ecosystem shifts (Bloom et al. 2018; Bloom et al. 2022; Turner et al. 2022).

The 21st century will experience exponential increases in extreme events. The most likely extreme events are heat waves, where present day, extreme but rare, high temperature events will become common (Davariashtiyani et al. 2023). In the Bridger-Teton the number of days above 86°F is expected to rise from 4 to 25, increasing five-times by 2050 (See Table 3). Other extreme events include more frequent and severe precipitation events, rapid snowmelt driven by warming or rain-on-snow events, flooding, landslides, and periods of extreme fire weather (Halofsky et al. 2018). Changes in the frequency, magnitude, and duration of extreme events have implications for the ability of ecosystems and humans to adapt and recover.

Air pollution is the fifth leading cause for human morbidity and mortality globally (Singh et al. 2021). Climate change has and will worsen air pollution from increased events including wildfire smoke and dust storms as well as chemical pollutants, leading to more cardiovascular and lung disease (Alahmad et al. 2023). The increasing frequency of extreme events and air pollution will affect the health and resiliency of social, biological, and infrastructure systems, highlighting the need for accurate and reliable long-term assessments of the direct and indirect effects of climatic change (Davariashtiyani et al. 2023).

Ecosystems on the Bridger-Teton are vulnerable to climate change mediated shifts in disturbance. While many disturbances – like fire, insects, disease, and flooding – are a natural and important part of normal ecosystem function, a warmer climate may alter the timing, frequency, and intensity of these events. For example, the duration of fire seasons has increased over six weeks since the 1970s (Westerling et al. 2016) and will continue to increase as conditions suitable for ignition occur earlier in the summer and extend longer into the fall (Halofsky et al. 2018). Rapid changes in disturbance regimes may facilitate long-lasting or permanent shifts from one ecosystem type to another for example from forest to non-forest due to more frequent wildfires (Turner et al. 2023). Climate change can also interact with, and exacerbate, human-caused stressors. For example, the establishment and spread of terrestrial and aquatic invasive species may accelerate as more of the Bridger-Teton is affected by disturbance and conditions that favor invasive species (Halofsky et al. 2018). Earlier snowmelt timing will continue to drive earlier green-up of vegetation which can alter wildlife migration patterns, hibernation, and grazing conditions (Bloom et al. 2022). Earlier spring snowmelt can also lead to earlier and increased recreational use across National Forest lands. Changes in disturbance patterns also may increase risk and hazards to human communities and visitors. Fire, flooding, extreme heat, increased smoke, and other seasonal disturbances can shift spatial and temporal patterns of human use, thereby increasing stress to both humans and sensitive ecosystems. Additionally, climate-induced warming and drought experienced by surrounding regions that depend on the Bridger-Teton for water and refuge, may increase demand for our natural resources.

Summary

Climate change is and will be one of the greatest stressors to the Bridger-Teton National Forest, ultimately leading to unprecedented conditions and ecosystem shifts across the western United States. Although the Bridger-Teton is in a region with some of the coolest temperatures in the western United States, it is nevertheless vulnerable to the direct and indirect effects of climate change and will experience increased impacts over the next decades. Climate change effects can be both gradual, such as the continued rise in average annual temperature, or rapid and difficult to predict, such extreme fire events driven by record hot temperatures or spring flooding caused by rapid snowmelt events. Climate change projections provide land managers a science-based framework to evaluate trends at relevant spatial and temporal scales, allowing them to identify adaptation strategies and tactics to implement appropriate management actions (Halofsky et al. 2018, Hosteltler et al. 2021). It is imperative that we take all these factors into account as we move forward with land management for the Bridger-Teton now and into the future.

Fire

Wildland fire on the Bridger-Teton is a key driver that shapes forest and grassland plant communities and supports their ecological integrity. Although wildfire is natural, climate change will continue to increase the frequency and intensity of wildfires with unknown consequences for forest resources. Wildfire plays an important ecological role in maintaining and restoring ecosystem functions and reducing hazardous fuels. Periodic fire alters: vegetation composition, patch size, age class distribution, and watershed conditions.

Functional aquatic ecosystems have evolved to sustain channel stability and water resource health in a natural wildfire regime. However, wildfire suppression has led to greater biomass accumulation in watersheds and the potential for larger scale, higher intensity wildfires. Such

wildfires alter natural hydrologic flow patterns, produce greater amounts of ash, sediment and debris loading to waterbodies, which can degrade water quality and channel stability.

Human-caused changes to the frequency and severity of wildland fire, including climate change, may be considered a stressor that impairs the ecological integrity. For example, a lack of – or too frequent or severe – wildland fire may benefit or adversely affect the ecological conditions needed for at-risk species. In absence of proper planning, prescribed and wildland fires also may increase the spread of invasive species; preventing the spread of invasive species in burned areas is essential to maintaining ecological integrity.

Human Land Use and Development

Increased Human Population

During the last three decades, population increase has made the Greater Yellowstone Area one of the fastest growing regions in the nation, leading some to refer to the Intermountain West as the “Third Coast” (Hansen et al. 2002a) (See Table 4). Growing populations and development place more demand on forest resources and affect the use of National Forest System Lands, as well as affect the character and affordability of communities (Sonoran Institute 2008, Lawson and Smith 2023, Hansen and Phillips 2018).

Factors contributing to the influx of people to the Greater Yellowstone Area are largely related to the natural amenities, which are found in abundance in the Bridger-Teton; these include access to: outdoor recreation, scenery, wildlife, and open space (Rasker and Hansen 2000). For the Bridger-Teton region, the nearby National Parks and destination ski resorts are key amenities that contribute to regional growth. The desire to live in an amenity-rich environment accelerated during the pandemic. The societal change towards “knowledge work” and continued technological advances that enable remote work likely will continue to push people to make the move, although the rate of in-migration has recently slowed. Wyoming’s favorable tax and regulatory environment combined with wealth generated through investment income also contribute to retired or semi-retired people moving to the region, often part-time (Farrell 2020).

Table 4. Change in counties encompassing or near the Bridger-Teton from 1990 to 2022

County	Population in 1990	Population in 2022	% Population Change 1990-2022	% Change in Residential Development Area 2000-2010
Lincoln, WY	12,710	20,660	62.5%	69.9%
Sublette, WY	4,883	8,763	79.5%	16.7%
Teton, WY	11,328	23,287	105.6%	84.7%
Fremont, WY	33,565	39,472	17.6%	38.3%
Park, WY	23,190	30,518	31.6%	50.9%
Teton, ID	3,458	12,544	262.8%	121.4%
Bonneville, ID	72,608	129,496	78.3%	44.7%
Sweetwater, WY	38,792	41,345	6.6%	59.1%
Unita, WY	18,638	20,712	11.1%	7.7%

Source: Headwaters Economic Profile System, 2024, USFS Report.

Population increases alone do not tell the whole story, since these have not been evenly distributed. In the past, many Wyoming counties experienced boom-and-bust cycles coinciding with changes in energy markets. Counties in western Wyoming near the Bridger-Teton generally have fared better due to their amenity-rich environment. West and south of the Bridger-Teton, however, some counties in Idaho and Utah are experiencing triple digit growth (e.g., Teton County, Idaho and Salt Lake County, Utah) and these counties are increasingly affecting visitation to the Bridger-Teton.

A tangible effect of human population growth affecting the Bridger-Teton is the increase in recreation and infrastructure such as roads, trails, facilities, resorts, and development on adjacent private lands. As noted in the findings for Recreation Settings and Opportunities in Chapter 3, about 75 percent of the Bridger-Teton's estimated 2.2 million annual visits come from people who live within a 50-mile radius. As such, the growth in Bridger-Teton recreation use mirrors regional population growth. Like any human activity, recreation use and development can stress ecological systems if use occurs in a haphazard, unplanned manner. These effects include the: introduction and spread of terrestrial and aquatic invasive species, wildlife disturbance, food conditioning and habitat loss, wildfire due to unattended campfires, streambank degradation, vegetation loss, soil erosion, and introduction of water pollutants from sedimentation or improper waste disposal. Dispersed recreation is of particular concern, since impacts are spread over larger areas and wildlife disturbance can ultimately affect populations (Gutzwiller et al. 2017).

Another stressor related to human land use and development is the increase in residential development near the Bridger-Teton. Such growth is significant since the change in residential housing development in the five counties encompassing the Bridger-Teton is increasing faster than population, likely due to second home ownership (Table 4). This is most apparent in Teton, Lincoln, and Park Counties where respective population increased 16.7 percent, 24.2 percent, and 9.4 percent between 2000-2010, while the area of housing development increased 84.7 percent, 69.9 percent and 50.9 percent. While private land development is outside the scope of Bridger-Teton management, the increasing number of new houses within the wildland-urban interface (WUI) creates additional fire structure and human safety risk, and it can lead to user-created road and trail development as people seek to access public land directly from their homes.

The most significant increase in WUI complexity has been in Teton County, Wyoming on the north end of Bridger-Teton. Teton County includes several large WUI areas that are adjacent to, and often downwind of, USFS lands. Most notable are the Teton County interface areas in Wilson and Buffalo Valley.

Sublette and Lincoln Counties continue to see increased development with a potential for more exposure at the WUI. Much of the interface area in Lincoln County lies between Alpine, Wyoming and Afton, Wyoming. Although there are risks associated with this area, the Bridger-Teton is located downwind and often uphill from private lands, lessening the risk. Sublette County has a mix of wildfire risk challenges, including private lands and structures that have oil and gas development adjacent to the Bridger-Teton.

Road and Trail Infrastructure, Maintenance and Construction Activities

Roads, motorized trails, and their associated use are stressors with some of the greatest impacts to wildlife in non-wilderness portions of the Bridger-Teton. Some of the main ways in which this stressor affects wildlife include: disturbance (e.g., habitat displacement, diminished

physiological condition, and reduced nest success), direct mortality, reduced habitat connectivity, and habitat loss. Elk, moose, wolverine, grizzly bears, forest raptors, sage grouse, forest songbirds, and riparian songbirds are some species negatively affected by motorized use. Riparian areas, which are by far the most bio-diverse ecosystems on the Bridger-Teton, are also where most motorized use occurs, and thus see the greatest impacts. Another area of acute concern is illegal motorcycle activity along the crest of the Wyoming Range.

Roads, trails and drainage features outside of aquatic, riparian and wetland areas alter overland and shallow subsurface flow patterns, increase erosion, and they can increase sediment delivery to these ecosystems. When roads and trails are properly located, designed and maintained, erosion and sedimentation is typically reduced to an acceptable level. However, many roads, trails and other recreational areas are not properly located, designed or maintained, and they are increasing erosion and sedimentation into waterways. When placed on unstable slopes, roads and trails can trigger mass wasting events.

Road and trails adjacent to or within floodplains can encroach upon riparian areas and decrease the natural process of trees falling into streams, restricting riparian vegetation and geomorphic processes. Existing and legacy road systems can unnaturally extend the stream network into upland areas by collecting, concentrating and routing precipitation runoff onto road surfaces that discharge into streams at road-stream crossings and other road drainage infrastructure, which alters the hydrologic function of watersheds to capture, store and safely release water. Road systems, culverts and other stream crossing infrastructure also can alter sediment transport dynamics, affect large woody debris movement, and if infrastructure failure occurs, can create localized areas of floodplain instability and degradation. Poorly designed infrastructure, primarily culverts, also can restrict aquatic organism migration and movement throughout the watershed. Undersized culverts restrict movement of terrestrial animals under the road prism, instead forcing them to cross over the road prism, where they are subject to increased mortality from vehicle collisions. Many main arterial roads on the Bridger-Teton parallel or cross streams and rivers; for example, Greys River Road, Gros Ventre Road, and Green River Lakes Road. Roads and trails that parallel waterways with a relatively small vegetative buffer between them pose greater risk for aquatic and terrestrial ecosystem impairment.

Insects and Disease

Forest insects and diseases can be drivers or stressors. As discussed in the climate change section, temperatures are rising. While bark beetles are native and have co-evolved with forests, elevated temperatures reduce beetle winter mortality as well as the time needed for beetles to complete a life cycle, both of which allow populations to grow quickly (WGFD 2017a). Winter temperatures are not getting cold enough for long enough to negatively impact winter survival of these insects. To successfully control bark insect populations, winter temperatures must drop for sustained periods of time. Increasing temperatures associated with climate change fundamentally may increase the scope of insect infestations by significantly increasing population numbers and enabling them to attack healthier trees at higher elevations and latitudes (WGFD 2017a). Large trees stressed from drought, high summer temperatures (“hot drought,” i.e., high temperatures combined with lack of precipitation), and/or diseases like white pine blister rust are more susceptible to insect attacks.

White pine blister rust is caused by *Cronartium ribicola*, an Asian fungus that was introduced into North America from Europe in the early 1900s. The disease continues to spread to five-needle pines throughout North America (USFS 2011) and is prevalent on the Bridger-Teton, with

whitebark pine (*Pinus albicaulus*) and limber pine (*Pinus flexilis*) susceptible host species. White pine blister rust cannot spread from pine to pine but is transmitted to pines from basidiospores produced on infected *Ribes* spp. leaves, and the most promising strategy for managing white pine blister rust is to increase the frequency of rust-resistant individuals across the landscape (USDA 2011c).

Insect outbreaks are believed to be facilitated by a combination of factors. Years of successive droughts have likely weakened some trees. Additionally, many forests consist of significant amounts of aging, denser stands, which are susceptible to insect attacks, although many of these stands on the Bridger-Teton experienced high mortality of large trees in previous bark beetle outbreaks. Fire suppression can lead to increased stand densities by allowing understory trees to survive and mature. Adding to these forest conditions are warmer winter temperatures and earlier snow melt, which increases tree drought stress and may create conditions that allow successful insect attacks on trees. Management actions in dense, overstocked stands can reduce the susceptibility to bark beetles by reducing density and susceptible host species where management can occur.

For example, the mountain pine beetle (*Dendroctonus ponderosae*) (MPB) outbreak from 2004 to 2011 was a result of increased average daily temperatures that allowed population increases to successfully attack lodgepole and whitebark stands with ample large trees, the preferred size class for MPB attacks. A similar event also was documented with spruce beetles (*Dendroctonus rufipennis*).

In recent decades, the populations of several types of beetles have exploded to epidemic levels affecting trees in a variety of age classes. The most influential bark beetle pests are the MPB and the spruce beetle. From 2004-2012, the Bridger-Teton witnessed outbreaks of MPB and spruce beetles, which peaked in 2009. These outbreaks began in high elevation whitebark pine trees and then moved down in elevation to affect lodgepole pine. Since 2019, MPB-caused mortality is again increasing in whitebark pine. White pine blister rust (*Cronartium ribicola*), a non-native fungus, is a stressor of whitebark pine that kills cone-bearing branches, thus lowering reproductive potential, and eventually girdles and kills non-genetically resistant individuals. Large trees that are weakened from drought, high summer temperatures, and/or diseases like white pine blister rust are less resistant to insect outbreaks. Mortality caused by mountain pine beetle and white pine blister rust has impacted over 50 percent of the overstory in some areas of the Bridger-Teton National Forest. Similar patterns have been observed in concentrated areas of the Greater Yellowstone Ecosystem.

Continued high population levels of bark beetles have resulted in large-scale tree mortality among pine, Douglas-fir, and Engelmann spruce forests in the Rocky Mountains (WGFD 2017a). Bark beetle-caused tree mortality significantly has affected the Bridger-Teton. Surrounding state and private lands are also experiencing increasing levels of tree mortality caused by bark beetles (WGFD 2017a). In some locations, there is a near complete loss of mature forests and considerable mortality in immature stands (WGFD 2017a).

Bark beetle-caused tree mortality can provide important habitat for some species of wildlife, provide coarse woody debris to streams, and contribute to nutrient recycling. Bark beetle epidemics could result in increased aspen regeneration as competition from conifers is reduced (WGFD 2017a). Bark beetle disturbance at a smaller scale can create small canopy openings, creating early seral habitat. However, large-scale outbreaks also may have negative effects on

wildlife, including loss of hiding cover and older tree habitat that is crucial for some species of threatened and endangered wildlife (WGFD 2017a).

Aquatic diseases include whirling disease, bacterial kidney disease, and amphibian chytrid fungus. Whirling disease was discovered in Wyoming in 1988. Bacterial kidney disease (BKD) was recently discovered in grayling in Meadow Lake and in Colorado cutthroat in some small drainages in the Wyoming Range. Although to date neither disease has significantly affected any of the major salmonid fisheries, it is still considered a pathogen of concern in Wyoming and impacts could occur in the future (Gagliardi 2024). Amphibian chytrid fungus can cause the infectious disease chytridiomycosis in susceptible amphibian species and is responsible for significant declines in several species in Wyoming, including populations of the Western (boreal) Toad which is common to the Bridger-Teton. Amphibian chytrid fungus is spread by inadvertently moving water (via mud, debris, aquatic vegetation, boots, clothing, or gear) from one waterbody to another (WGFD 2025a).

Invasive Species

Invasive species pose one of the greatest risks to: native plants, wildlife, waters, and intact ecosystems of the Bridger-Teton and they have been described as a catastrophic wildfire in slow motion in the National Strategy and Implementation Plan for Invasive Species Management (USDA 2004).

Terrestrial Invasive Species

Terrestrial invasive species (TIS) on the Bridger-Teton are plants. Invasive plants are non-natives that: can out-compete native plants for resources, reduce biodiversity, reproduce prolifically, alter soil chemistry, reduce forage production, alter hydrologic cycles, change fire regimes, increase erosion, and have the potential to dominate entire ecosystems. Non-native and naturalized animal species are addressed in the Terrestrial Wildlife section and are not considered invasive species.

To maintain consistency, the following USFS definitions are used.

- **Native plants** - the indigenous terrestrial and aquatic species that have evolved and occur naturally in a particular region, ecosystem, or habitat.
- **Non-native plants** – plants that are not native or indigenous to a region are typically introduced either intentionally through agriculture and landscaping or accidently by people or livestock.
- **Noxious weeds** - A plant species that is highly injurious or destructive and has the greatest potential for economic impact on forage and crop production. Designated noxious weeds are weeds that are designated statewide. Declared noxious weeds are those that have been declared on a county-by-county basis.
- **Invasive plants** - All state and county-listed noxious weeds are considered invasive plants. Also included in this designation are non-native plants that can successfully out-compete native plants and displace native plant communities, but they are not listed by state or counties as noxious weeds.
- **Naturalized** – a non-native species is described as naturalized when it is not invasive in behavior, meaning it does not displace native species. Dandelions *(Taraxacum officinale*) are an example of a non-native naturalized species.

Currently, invasive plants infest more than 45,000 acres (1 percent) of the Bridger-Teton. Density of infestations varies from a few plants per acre to nearly solid monocultures of invasive species. Invasive plants on the Bridger-Teton have invaded important big game transition and winter ranges, reducing forage available for migrating and over-wintering: mule deer, elk, moose, pronghorn and bighorn sheep. While funding levels and capacity determine annual treatment levels, invasive species are rapidly increasing over time as illustrated by the following chart showing acres treated by year.

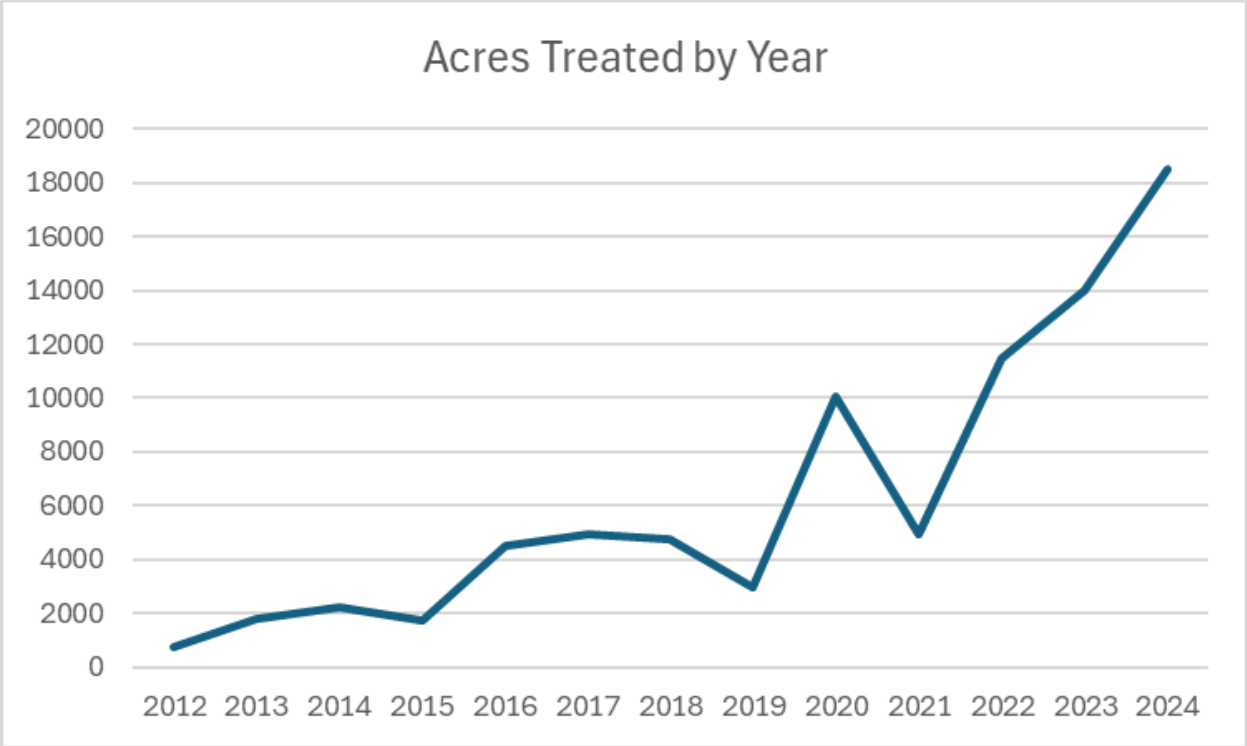


Figure 9. Annual acreage on the Bridger-Teton treated for invasive species, 2012-2024

One of the most concerning invasive species is cheatgrass (*Bromus tectorum*), an invasive annual grass that reproduces rapidly, and acts as a fine fuel that can increase fire frequency and completely alter fire regimes. At high enough densities, invasive annual grasses dramatically increase the risk of rangeland wildfires, which in other parts of the West have been devastating for wildlife and ranching operations and threaten towns and outlying communities. Fires also promote more invasive annual grasses in a positive feedback cycle that is very hard to break. Over time, invaded areas lose carbon from the soils – and when this occurs over large areas, the net effect can be significant loss of carbon storage. Cheatgrass invasion into big sagebrush (*Artemisia tridentata*) stands have reduced native plant communities and degraded habitat for sagebrush-dependent species such as the greater sage-grouse (*Centrocercus urophasianus*). Wildfires supported by fine fuels, such as cheatgrass, may kill big sagebrush, thereby reducing or degrading sage-grouse habitat. The Bridger-Teton began an aerial treatment program in 2020, treating approximately 20,000 acres through 2024. Cheatgrass is a county declared noxious weed in Lincoln, Sublette, and Teton counties, but an attempt at statewide designation was unsuccessful in 2025.

Other invasive species of concern on the Bridger-Teton include, but are not limited to, the following: nodding plumeless thistle *aka* musk thistle *(Carduus nutans*), spotted knapweed

(*Centaurea stoebe*), Canada thistle (*Cirsium arvense*), gypsyflower *aka* houndstongue (*Cynoglossum officinale*), leafy spurge (*Euphorbia esula*), black henbane (*Hyoscyamus niger*), Dyer's woad (*Isatis tinctoria*), whitetop (*Cardaria draba*) and Dalmatian toadflax (*Linaria dalmatica*). Bulbous bluegrass (*Poa bulbosa*) is an emerging concern that has been declared a noxious weed in Sublette and Teton counties.

On the Bridger Teton, invasive plant species are mostly associated with roads, trails and trailheads where people inadvertently introduce noxious plant seeds transported by: vehicles, stock, pets, or clothing. Additionally, wind and wildlife can also transport invasive species. This can negatively impact understory vegetation where invasive species may outcompete native plants, or change the entire fire regime, especially in sagebrush ecosystems. Climate change is also a major contributor to the spread of invasive species. Notably, periods of extended drought have allowed invasive plants to establish and spread rapidly, particularly in prescribed burn units, roadsides, and areas burned by wildfire. Large scale MPB outbreaks and other disturbances also can result in increased areas of degraded habitat susceptible to invasive plant establishment. Rapidly identifying, monitoring, and treating invasive species should be a Bridger-Teton priority.

Terrestrial invasive species occur in both uplands and in riparian and wetland habitats. They have the potential to alter hydrologic flow patterns on a watershed scale. This can alter the timing and duration of runoff. Certain types of invasive plant species withdraw more groundwater than native vegetation, causing the water table to lower and conditions to become drier (Di Tomaso 1998, Ehrenfeld 2003). These types of invasions can initiate a positive feedback loop in which drier conditions facilitate more invasive species and an even lower water table (Macfarlane et al. 2016, Smith et al. 2020). Invasive species control treatments using herbicides also poses a risk to water resources through contamination of surface and groundwater. Similar to invasive species, vegetation mortality due to insects and disease have the potential to alter hydrologic flow pattern on a watershed scale. Invasive species of concern for degrading wetland, wet meadow, and riparian areas on the Bridger-Teton include: leafy spurge, tamarisk aka saltcedar (Tamarix spp.), scotch thistle (*Onopordum acanthium*), Dalmatian toadflax, whitetop, Canada thistle, purple loosestrife (*Lythrum salicaria*), houndstongue, marsh sowthistle (*Sonchus arvensis*), and spotted knapweed.

Aquatic Invasive Species

Aquatic invasive species (AIS), also known as aquatic nuisance species in Wyoming, are defined as exotic or non-native aquatic organisms that have been determined by the Wyoming Game and Fish Commission to pose a significant threat to aquatic resources, water supplies or water infrastructure in the State (WGFD, Title 23 W.S. § 23-4-201(a) (i) 2025b). AIS threaten aquatic ecosystem integrity and interfere with recreation, aquatic food webs, and municipal, commercial, and agricultural water supply and distribution as well as power facilities. They decrease forage, compete with native species for resources, interrupt food-webs, change the aquatic community structure, pose a threat to human health, and decrease overall ecosystem biodiversity. Once introduced, AIS spread through inadequate cleaning and sterilization of watercraft, fishing gear, and waders, wading shores and the introduction of illegal live bait fish. Prevention and avoidance as well as early detection and rapid response (EDRR) measures are key to avoiding impacts from AIS.

According to the Wyoming Game and Fish Commission, designated AIS include, but are not limited to, aquatic plants – Eurasian watermilfoil (*Myriophyllum spicatum*), curly pondweed

(*Potamogeton crispus*) and water thyme (*Hydrilla spp.*), none of which have been detected on the Bridger-Teton; and animals including members of the genus *Dreissena* including, but not limited to, the following: zebra mussels (*D. polymorpha*) and quagga mussels (*D. rostriformis*), New Zealand mudsnails (*Potamopyrgus antipodarum*), Asian clam (*Corbicula fluminea*), and rusty crayfish (*Orconectes rusticus*) (Wyoming Game and Fish Commission, Chapter 62-2, 2022a). Watercress (*Nasturtium officinale*) is an introduced aquatic plant species that may pose a threat in certain waterways. Another impending threat is the increasing presence of Harmful Cyanobacteria Blooms (HCBs), which are native species that can exist in harmful quantities causing low oxygen conditions and cyanotoxins. HCBs are not considered Aquatic Invasive Species and are addressed in the Air, Soil and Water Resources section of the assessment. Likewise, non-native and naturalized aquatic species are not considered AIS, and they are addressed in the Lacustrine: Lakes and Reservoirs and Aquatic Species of Concern sections of the assessment.

Pursuant to Special Order 04-03-326 and Title 36 CFR 261.50, possessing, storing, or transporting any aquatic invasive species (plants and animals) is prohibited in the Bridger-Teton as defined by Wyoming Game and Fish Commission, Chapter 62-4. Annually, the Bridger-Teton monitors select waterbodies through eDNA analysis for both New Zealand mud snails and dreissenid mussels; there have been no confirmed samples of either species on the Bridger-Teton to date. Monitoring protocol is coordinated with the Greater Yellowstone Coordinating Committee (GYCC) and results are shared with Wyoming Game and Fish Department (WGFD) as part of the GYCC Aquatic Invasive Species subcommittee. Forest monitoring is complementary to WGFD established protocols, adding an extra layer of detection on the forest.

Although some definitions of Aquatic Nuisance Species (ANS) include any species or taxa that are native or non-native, and have significant deleterious effects on native aquatic species and ecosystems, recreation, water development structures and other important resources (USFS 2009c), pathogens such whirling disease, bacterial kidney disease, and Chytrid fungus are not considered AIS in Wyoming and are addressed in the insects and disease section of the assessment.

Ecological Connectivity

The 2012 Planning Rule defines connectivity as “ecological conditions that exist at several spatial and temporal scales that provide landscape linkages that permit the exchange of flow, sediments, and nutrients; the daily and seasonal movements of animals within home ranges; the dispersal and genetic interchange between populations; and the long-distance range shifts of species, such as in response to climate change” (36 C.F.R. § 219.19). Additionally, the Planning Rule specifically states that revised forest plans should consider “contributions of the plan area to ecological conditions within the broader landscape influenced by the plan area, as well as conditions in the broader landscape that may influence the sustainability of resources and ecosystems within the plan area” (§ 219.8(a) ii and iii).

Terrestrial Wildlife

Because the 2012 Planning Rule requires national forests and grasslands to evaluate, protect, and/or restore ecological connectivity as they revise their forest plans, the USFS has an opportunity to improve ecological connectivity across much of the American West. From 2017 through 2019, the Center for Large Landscape Conservation worked with biologists and

planners from the Custer Gallatin National Forest, approximately 50 miles north of the Bridger-Teton, to develop an approach for addressing connectivity that could serve as an example for the new generation of forest plans; (Creech and Williamson 2019, Williamson et al. 2020). Creech (2020) used the same approach to provide connectivity information for the Bridger-Teton. To capture connectivity between the Bridger-Teton and other ecologically valuable lands within the dispersal range of wildlife in those units, Creech (2020) buffered Bridger-Teton boundaries by 93 miles (150 kilometers), to encompass likely dispersal movements of wildlife species, and used this buffered area as the study area for connectivity analyses. This section summarizes that detailed report. (Refer to Creech (2020) for details on: methods, modeling, results, discussion, maps, and tables.)

Summary of Results

The analysis focuses on ecological connectivity for terrestrial species, although connectivity for avian and aquatic species is also important. Aquatic connectivity occurs along stream networks that are more easily identifiable than terrestrial corridors. Avian species are often less limited than terrestrial species in their movements by conditions on the ground (e.g., vegetation type and presence of roads); avian species that are highly sensitive to ground conditions with respect to habitat selection and movement behavior should be at least partially represented by the terrestrial connectivity models included in this analysis.

Single-species connectivity analyses relying on telemetry data, genetic data, or expert opinion to delineate high-quality habitat patches and define movement behaviors are very common; however, Bridger-Teton is mandated to assess and manage connectivity for all species occurring on the Forest. Thus, Creech (2020) modeled for 10 generic species that represent different combinations of five vegetation type preferences (forest specialist, alpine specialist, grassland specialist, shrubland specialist, or habitat generalist), and two body sizes (large or small). Body size is positively correlated with dispersal ability (Jenkins et al. 2007) and perceptual range (Mech and Zollner 2002), both of which influence connectivity and habitat selection. As such, generic species analyses strike an appropriate balance between fine-filter connectivity models designed for individual species and coarse-filter models that are entirely species-agnostic (i.e., independent of the biological or ecological characteristics for specific taxa).

The large- and small-bodied generic species defined for this analysis roughly correspond to large ungulates or carnivores (e.g., deer, elk, pronghorn, grizzly bear, and mountain lion) and mesocarnivores (e.g., fox, marten, bobcat, and badger), respectively. Although connectivity for smaller animals (e.g., rodents and herpetofauna) is also important, earlier research found that broad-scale connectivity models did not provide useful information for these very small species.

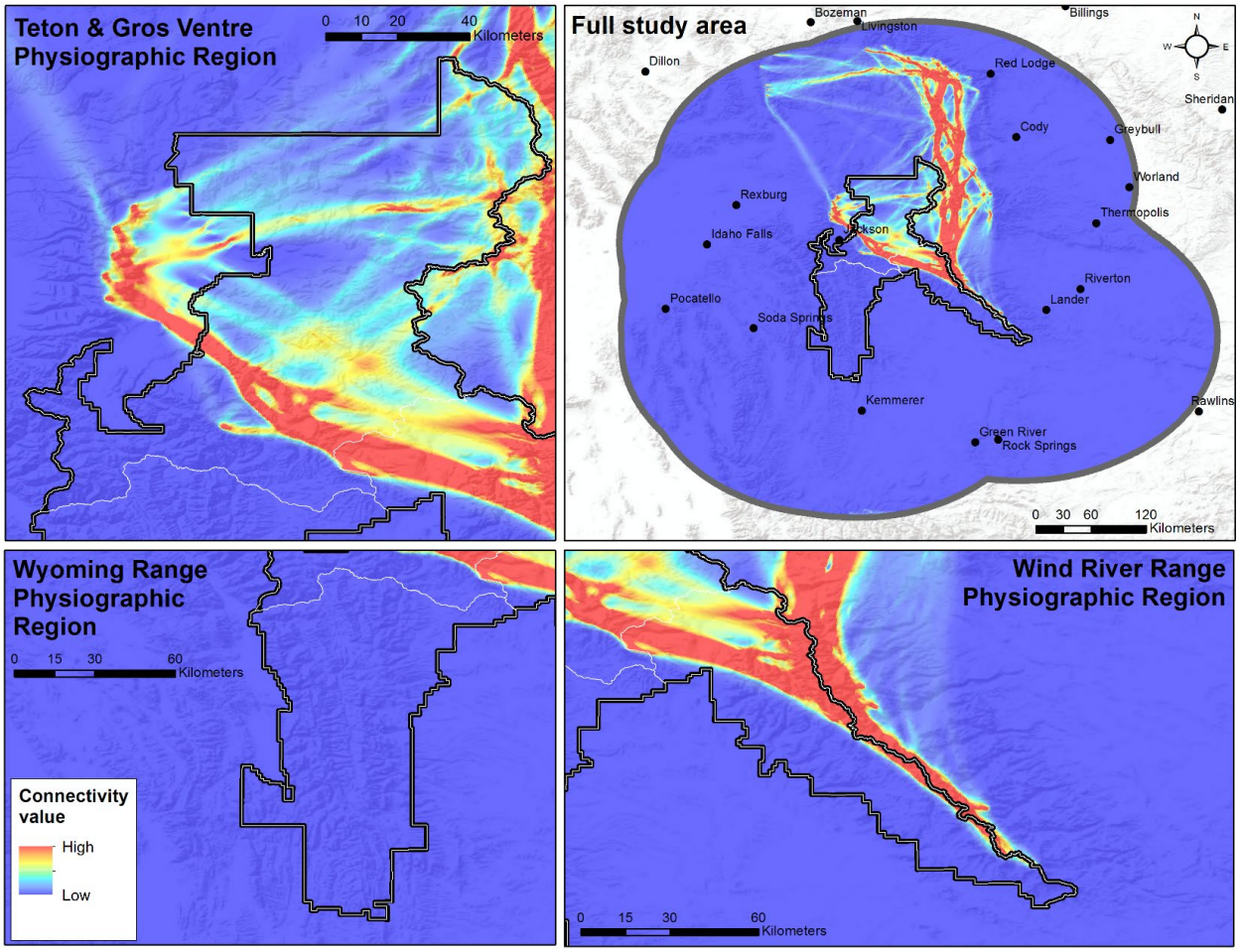


Figure 10. Connectivity modeling results for large alpine specialists assuming optimal movement behavior. Thick black lines are forest boundaries; thin white lines are physiographic region boundaries (Creech 2020).

Modeling shows that within the Bridger-Teton a major east-west movement corridor for large alpine specialists extends from the southern Wind River Range through the Gros Ventre Range to the Teton Range (See Figure 10). Core areas for large and small forest specialists are scattered throughout the Bridger-Teton, primarily along valleys and low- to mid-elevation slopes. Connectivity models indicate that important movement corridors for forest specialists occur throughout the Bridger-Teton, but especially near the northern and western boundaries of the Bridger-Teton, linking the Bridger-Teton core areas to the larger concentrations of forest core areas outside the Bridger-Teton to the north and west (See Figure 11). Core areas for grassland specialists occur almost exclusively outside of the Bridger-Teton. Shrubland specialist core areas are rare within the Bridger-Teton, occurring only in very small patches in the Upper Green River and Gros Ventre River valleys and along the eastern flank of Jackson Hole.

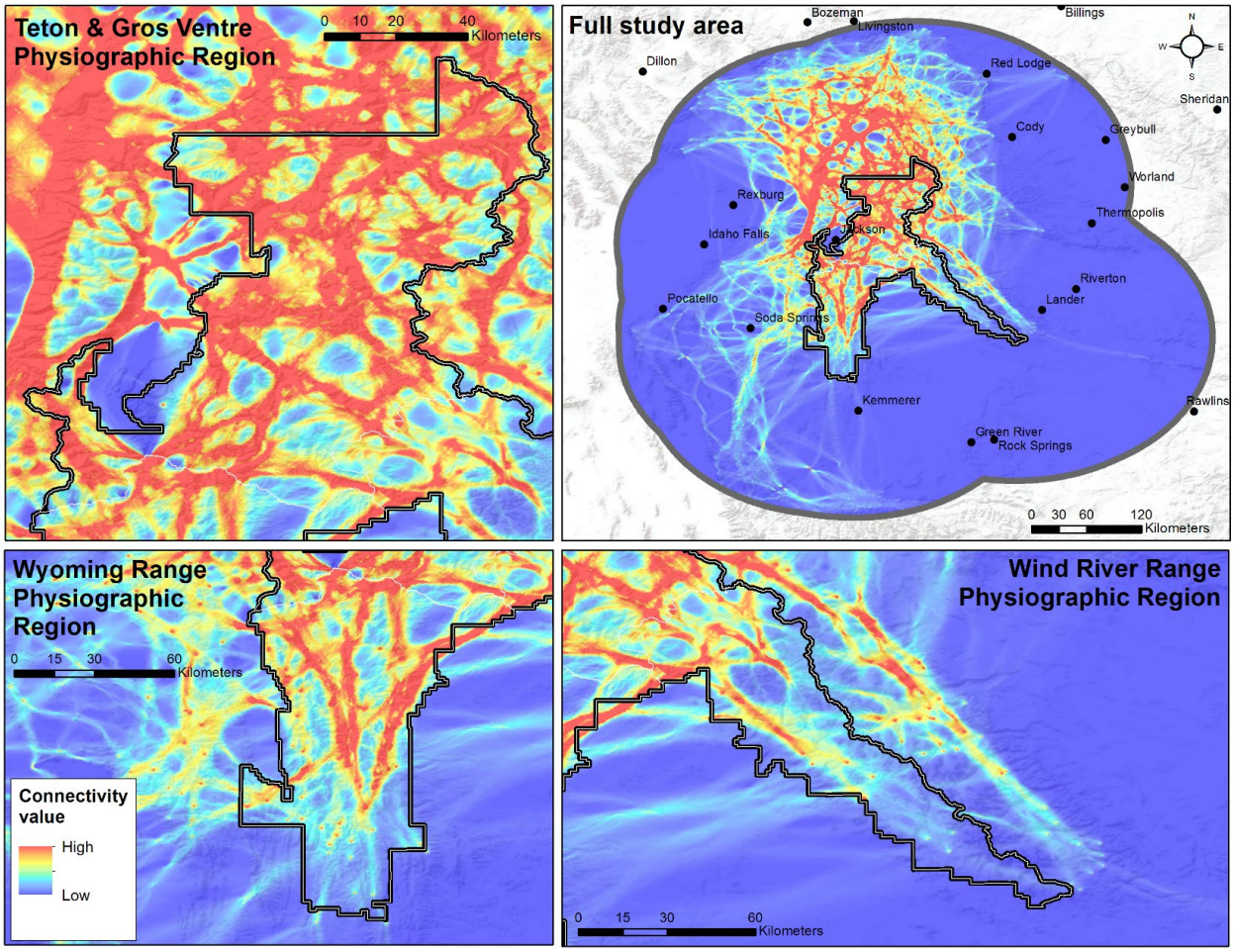


Figure 11. Connectivity modeling results for large forest specialists assuming optimal movement behavior. Thick black lines are forest boundaries; thin white lines are physiographic region boundaries (Creech 2020).

Creech (2020) noted that the results for large generalist species may be most useful for identifying optimal locations for animals to cross major barriers within the landscape, such as highways. For instance, the large generalist connectivity models suggest that the junction of U.S. 191 and U.S. 89 south of Jackson is an area of concentrated animal movement (i.e., a bottleneck) that represents the least costly location in the landscape for animals to cross these highways (See Figure 12). This is an important area for migrating mule deer and elk, and because the traffic volume is relatively low (about 1,600 vehicles per day), it is considered a suitable location to experiment with at-grade crossing opportunities. This area ranks high for implementing wildlife crossings in the Teton County Wildlife Crossings Master Plan (Huijser et al., 2018). Agreement among connectivity model outputs for species with different preferred vegetation types (e.g., forest specialists versus grassland specialists) tended to be quite low. This lack of overlap among high-value connectivity areas for different generic species presents a management challenge. The Bridger-Teton is ecologically important because of the diversity of high-value habitats, and therefore species, which presents relatively few opportunities to preserve or restore multi-species connectivity through management actions targeting a single location or corridor within the Bridger-Teton or the surrounding area. Rather, it may be necessary to manage for connectivity of: alpine, forest, grassland, and shrubland specialists

separately. The rarity of core habitat and high-value connectivity areas within the Bridger-Teton for grassland and shrubland specialists may simplify this challenge for planning purposes, and focus connectivity efforts for alpine and forested areas only, which makes-up roughly 2.5 million acres or 76% of the Forest. However, the issue remains for these grassland/shrubland specialists in the broader landscape surrounding the Bridger-Teton.

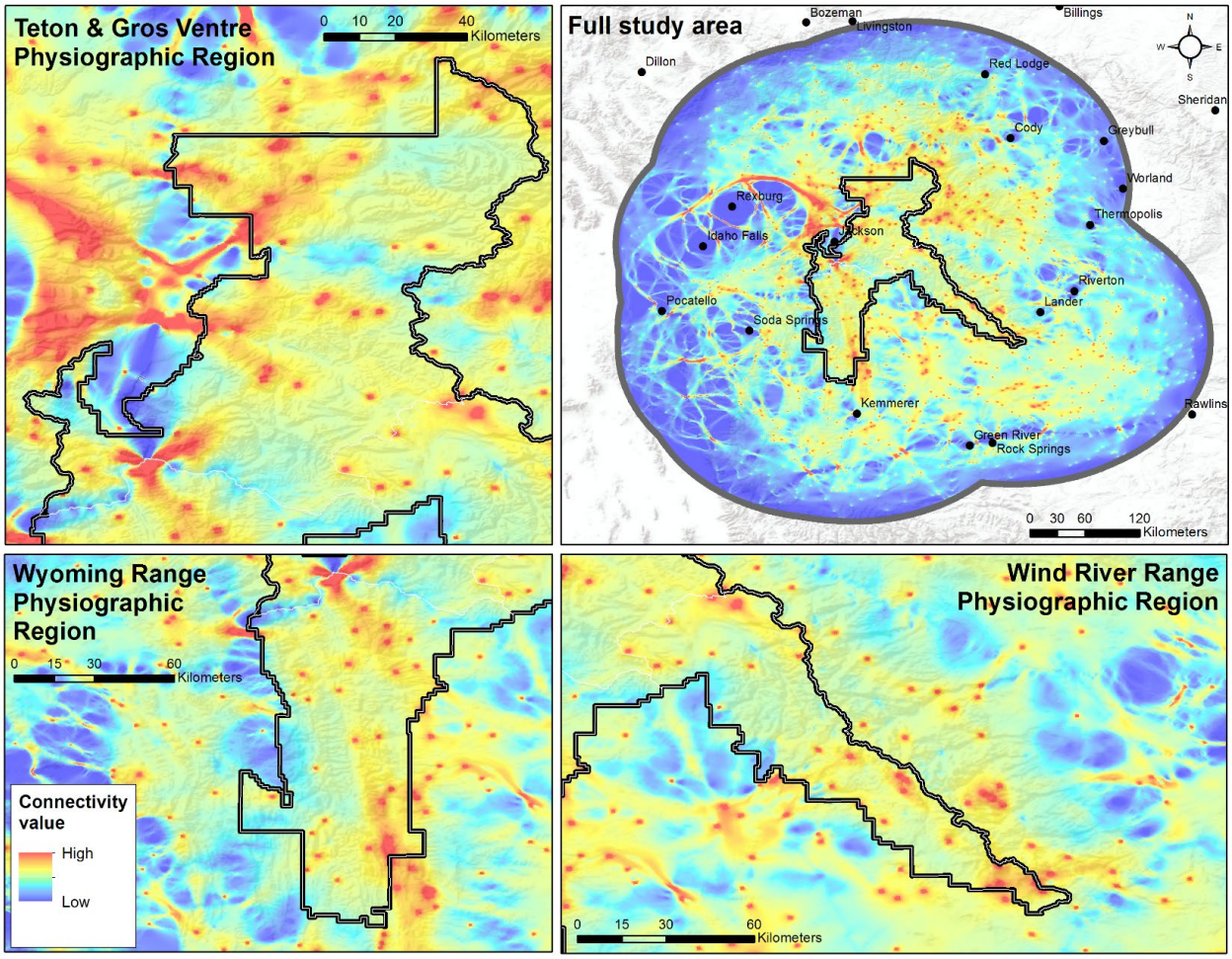


Figure 12. Connectivity modeling results for large generalists assuming optimal movement behavior. Thick black lines are forest boundaries; thin white lines are physiographic region boundaries (Creech 2020).

Limitation of Modeling Results and Discussion

One key limitation of the connectivity models used in this study is they are based on a static view of the landscape—that is, they predict movement between areas of current high-quality habitat assuming resistance to movement based on the current landscape composition and configuration. In reality, Bridger-Teton lands and the surrounding region will experience changes associated with: human development, wildfire, climate change, and a host of other factors over the lifespan of the revised forest plan. For instance, areas currently dominated by trees and classified as forests by Landfire (USDA 2023d) provides landscape scale geo-spatial products to support cross-boundary planning, management, and operations) may transition to grasslands or shrublands in response to changes in climate, the disturbance regime, and management practices. An ideal connectivity analysis would incorporate these anticipated changes, but in

practice, this would be exceedingly challenging because of data limitations and uncertainty surrounding the location and magnitude of future changes. Nonetheless, these modeling results provide the best currently available information on connectivity for the Bridger-Teton, and this analysis could be periodically repeated as warranted by major changes to the landscape. Monitoring under an adaptive management framework is needed to identify when such landscape shifts have occurred.

Terrestrial Ecosystems - Natural Plant Communities

Six of the eight terrestrial ecosystems that were assessed for ecological integrity account for 82 percent of the Bridger-Teton land area (Helmbrecht et al. 2012) displayed in Figure 13, which shows the spatial distribution of these ecosystems on the Bridger-Teton as well as within 93 miles (150 km) of the Bridger-Teton boundary. (Details on ecosystem integrity, status and trends, and drivers and stressors are discussed later in the Terrestrial Ecosystems, Aquatic Ecosystems, and Watersheds section.) The two other assessed ecosystems, Sub-alpine Forb and Rocky Mountain Alpine are not discussed in this connectivity section. Sub-alpine Forb is actually a more distinct, sub-system nested within one or more of the six ecosystems listed here and Alpine is covered in the previous section as its own ecosystem. The forested ecosystems were combined for the wildlife connectivity analysis previously discussed.

The Bridger-Teton supports a diversity of vegetation types due to its geography, geology, elevation, and climate. Due to its landform and juxtaposition on the landscape, it plays a crucial role in providing habitat connectivity across the GYE. The Bridger-Teton is known for its large expanses of undeveloped land. Other major land managers in the region include the BLM, the U.S. Fish and Wildlife Service (USFWS) and the National Park Service (NPS). The communities within and adjacent to the forest are relatively small and discrete. Limited sprawl exists, so connectivity between the Bridger-Teton and similar ecosystems on adjacent lands is relatively intact with regard to development. The “checkerboard” pattern that is common on other national forests is limited on the Bridger-Teton. The Bridger-Teton shares boundaries with Grand Teton and Yellowstone National Parks, the National Elk Refuge, BLM, private entities, and other national forests. This provides a large contiguous area where plants and animals can move freely.

Ecosystem connectivity, defined as the distribution of vegetation types, as well as combinations of cover types, size classes, and densities, is a measurable characteristic of forest landscapes that helps facilitate ecological connectivity and is meaningful for: disturbance processes, genetic flow, integrity, and functionality. Although each ecosystem is impacted by drivers and stressors that affect its integrity, the ecosystem still provides connectivity across the landscape in a broader sense. Ecosystem integrity and the factors affecting that integrity are described in the next section. Ultimately, the vegetative composition of these ecosystems on and adjacent to the Bridger-Teton remains intact and it provides connectivity across the GYE. This is not to be confused with the more detailed connectivity analysis done for terrestrial wildlife, which can be impacted more discretely by human influences.

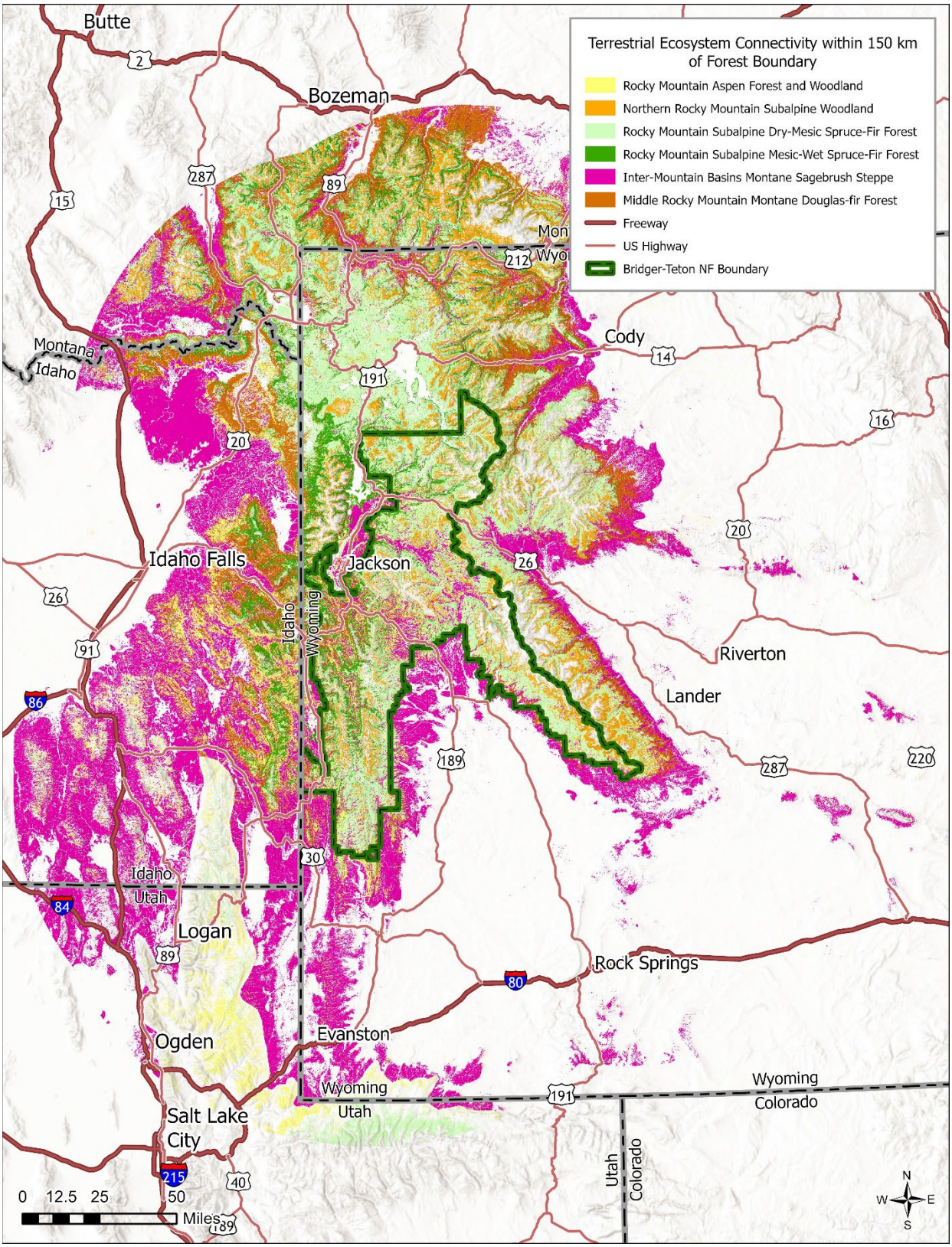
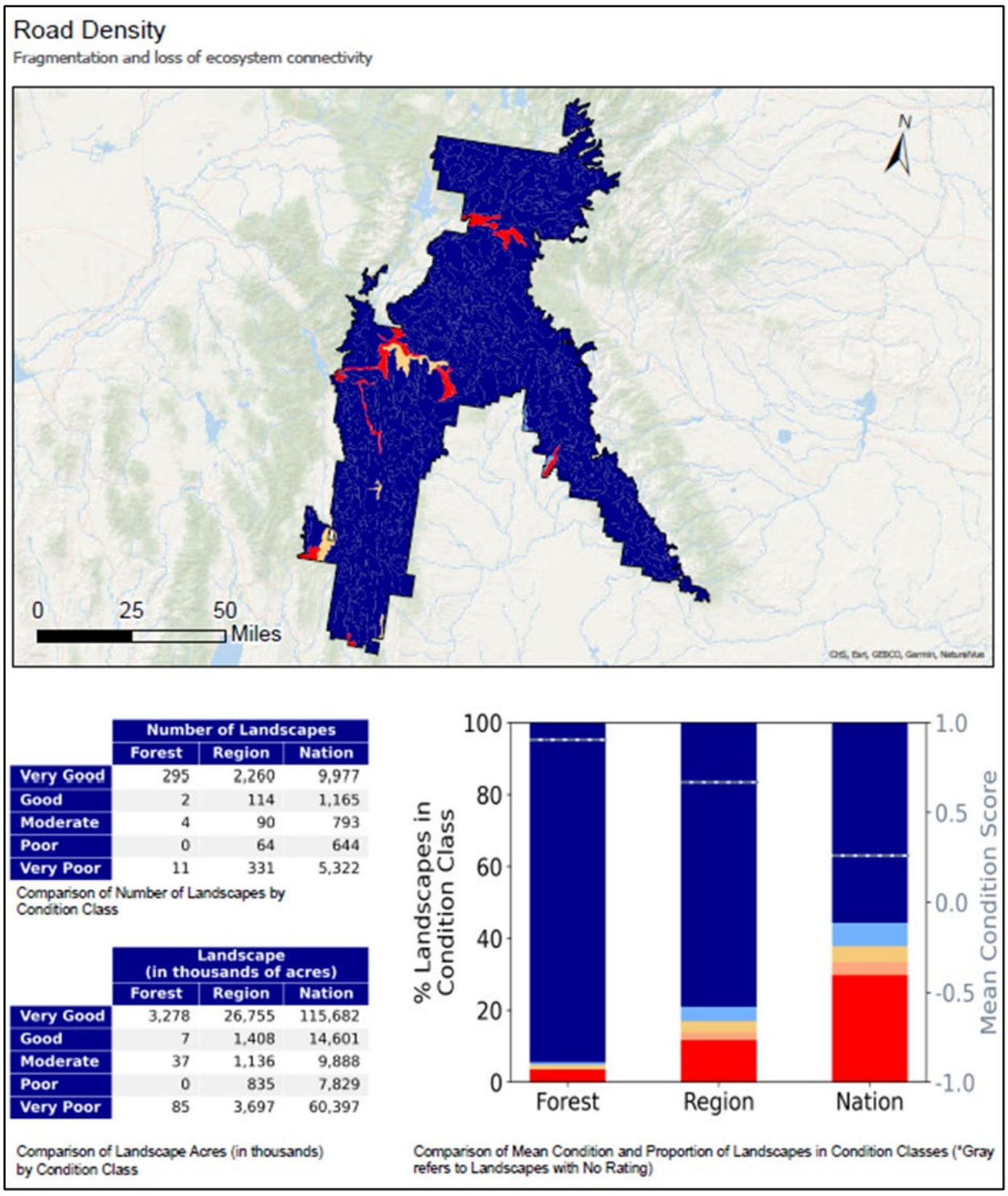


Figure 13. Distribution of the six major ecosystems on the Bridger-Teton and adjacent lands within 93 miles (150 km)



	Number of Landscapes		
	Forest	Region	Nation
Very Good	295	2,260	9,977
Good	2	114	1,165
Moderate	4	90	793
Poor	0	64	644
Very Poor	11	331	5,322

Comparison of Number of Landscapes by Condition Class

	Landscape (in thousands of acres)		
	Forest	Region	Nation
Very Good	3,278	26,755	115,682
Good	7	1,408	14,601
Moderate	37	1,136	9,888
Poor	0	835	7,829
Very Poor	85	3,697	60,397

Comparison of Landscape Acres (in thousands) by Condition Class

Comparison of Mean Condition and Proportion of Landscapes in Condition Classes (*Gray refers to Landscapes with No Rating)

Figure 14. TCA results for road density impacts across the Bridger-Teton compared to regional and national averages

As part of the assessment process, the Terrestrial Condition Assessment (TCA) was updated for the Bridger-Teton (USDA 2023a). The TCA is a management tool that provides a mid-scale assessment of ecological conditions and stressors. The TCA can be used to focus on specific

indicators, such as climate, or to provide a synthesized picture of the overall ecological condition of landscapes. One of the indicators analyzed across the Bridger-Teton was road density, which can affect connectivity through fragmentation. The metrics used in the analysis included (1) paved roads, (2) light duty roads, and (3) unimproved roads. Results indicate the Bridger-Teton is in "Very Good" condition and much less fragmented than other forests in the region or nation (Figure 14).

In summary, natural plant communities, expressed in terms of the major terrestrial ecosystems that occupy the Bridger-Teton, are well connected within and outside the Bridger-Teton. The lack of a “checkerboard” ownership within the boundaries of the Bridger-Teton, adjacent land management agencies such as the NPS, BLM and other USFS units, resilient plant communities and limited human development are the primary contributors for providing connectivity of these ecosystems throughout the GYE.

Ungulate Migrations

This section is largely adapted from Yovovich et al. (2021).

Wyoming is home to some of the longest intact big game migrations on the planet. Migration corridors are pathways for big game traveling between summer and winter ranges. Stopover sites, where habitat quality is highest along the migration route, are where ungulates spend much of their time during migration. These areas are used year after year, and they provide an important early spring and fall forage resource. Effectively protecting and enhancing Wyoming’s ungulate migration corridors and stopover areas is vital to maintaining big game populations.

Ungulate species, such as: mule deer, elk, bighorn sheep, Rocky Mountain goat, and moose, typically migrate from high-elevation summer range, where snow-fed forage is seasonally abundant, to lower-elevation winter grounds as autumn sets in. In the spring, when the snows retreat and plants begin to grow in the high country, the ungulates reverse course and travel from low-elevation winter range back to higher summering grounds. Tracking seasonal resources enhances foraging opportunities and reduces exposure to harsh conditions. When ungulates cannot appropriately follow resources, they suffer from elevated energy expenditure, insufficient fat reserves for the winter, reduced reproductive output, and mortality.

Losing the ability to migrate has led to sudden and dramatic declines in ungulate populations. It is vital that corridors be preserved before these routes are lost, along with individual animals that know the route and can pass that knowledge on to future generations. Ungulates encounter many anthropogenic and natural hazards as they migrate between seasonal ranges. In addition to predation, disease, and harsh natural conditions, there is a growing number of human-derived disturbances, such as: roads, trails, oversnow travel (i.e., snowmobiles), timber harvest, energy development, and livestock grazing.

When disturbed by human activities or development, migrating ungulates may move through areas faster, detour around disturbances, and reduce their use of stopover areas, which are critical habitat patches along the migration route in which animals rest and forage. These changes in behavior can have profound impacts on migration and result in spatial restrictions in corridors or a mismatch between migration timing and the time when spring forage quality is highest. This temporal mismatch may hamper an animal’s ability to access newly emergent spring forage, reducing their ability to accumulate sufficient fat reserves.

Conservation Efforts and Policy Frameworks

After intense hunting pressure in the 19th century, pronghorn had been hunted to near extinction and were no longer present in the Jackson Hole region. In the 1950s, pronghorn began to reappear in the valley. Studies indicated that pronghorn were migrating from winter range in the Green River Basin to summer range around Jackson Hole. Further studies using global positioning system (GPS) collars resulted in better delineation of the migration route termed the Path of the Pronghorn (See Figure 15). The Path of the Pronghorn became the first federally designated migration corridor in the United States, when, in 2008, the Bridger-Teton amended its forest plan to protect the northernmost 45 miles of this migration corridor (USDA 2008a). The Forest Plan was amended to add the following standard: “all projects, activities, and infrastructure authorized in the designated Pronghorn Migration Corridor will be designed, timed and/or located to allow continued successful migration of the pronghorn that summer in Jackson Hole and winter in the Green River basin.” This standard has contributed to successful maintenance of the last remaining pronghorn migration to and from Grand Teton National Park.

Furthermore, Wyoming has taken significant steps toward protecting migration corridors. In 2016, the Wyoming Game and Fish Commission approved the Migration Corridor Strategy, establishing a process for designating ungulate migration routes (WGFD 2019a). Subsequently, in 2020, the Governor of Wyoming signed an Executive Order (EO 2020-1) that outlined a framework for identifying and protecting additional migration routes for mule deer and antelope in the future and formally designated specific migration corridors, such as the Sublette Mule Deer corridor (See Figure 16) (EO 2020-1, WGFD 2017b). The Sublette Herd supports an estimated 20,000 to 25,000 animals, and the corridor includes movements from three subpopulations, including the Ryegrass, Mesa, and Red Desert segments. As of Dec 2024, the Sublette Pronghorn corridor has been identified and is currently in the process toward designation (Figure 15) and the Upper Wind River mule deer corridor has been identified (Figure 16). The WGFD will continue to work through the Governor’s Executive Order on other herds; this will put the Bridger-Teton in an adaptive management situation, where migration status is not static.

Secretarial Order 3362 (USDI 2018), signed in 2018 by the Department of the Interior (DOI) and Secretarial Memorandum 1077-013, issued in 2024 by the Department of Agriculture (USDA 2024b), collectively emphasize improving habitat quality for western big game winter ranges, terrestrial wildlife connectivity and migration corridors through collaborative conservation efforts involving federal agencies, states, Tribes, and private stakeholders, while addressing ecological challenges. The Secretarial Order outlines several practices that the Bridger-Teton could adopt to improve conditions for migrating ungulates. The DOI advocates restoring degraded winter range and migration corridors by removing encroaching trees from sagebrush ecosystems, rehabilitating areas damaged by fire, and eradicating invasive species to improve the habitat value for big game. Further, the DOI recommends working cooperatively with private landowners and state highway departments to promote wildlife-friendly fencing. The USDA-Wyoming Big Game Conservation Partnership was a pilot program initiated through collaboration between the USDA and the State of Wyoming to support the voluntary conservation of private lands and migratory big game populations (USDA 2023j). In 2024, the USDA expanded this Wyoming-based pilot into a national landscape initiative, extending conservation efforts to Wyoming, Idaho, and Montana using existing Farm Bill Program (USDA 2023k).

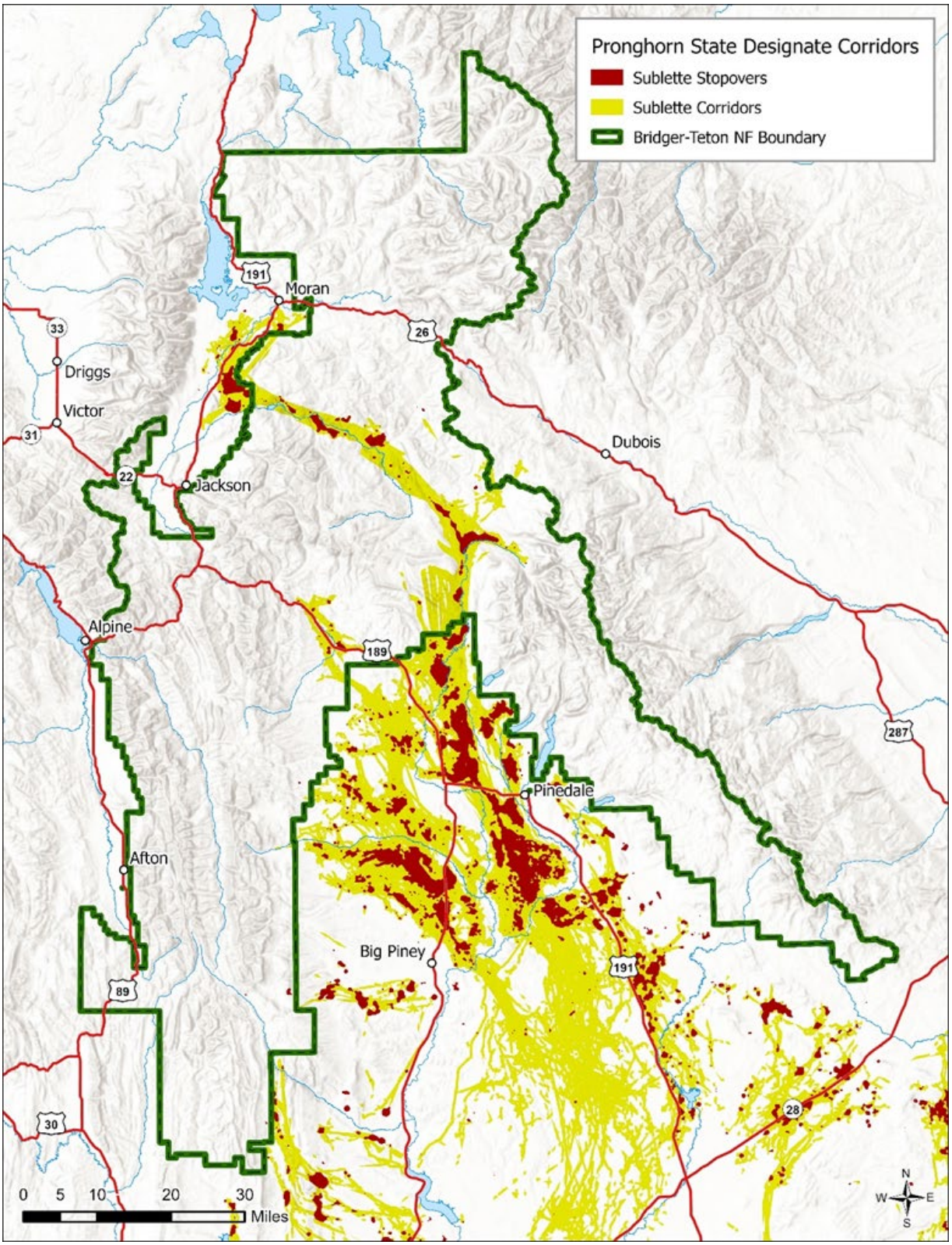


Figure 15. Pronghorn corridors. The Path of the Pronghorn-migration corridor (winter range in the Green River Basin and summer range around Jackson Hole) federally designated in 2018 and the Sublette Pronghorn corridor identified and is currently in the process toward designation.

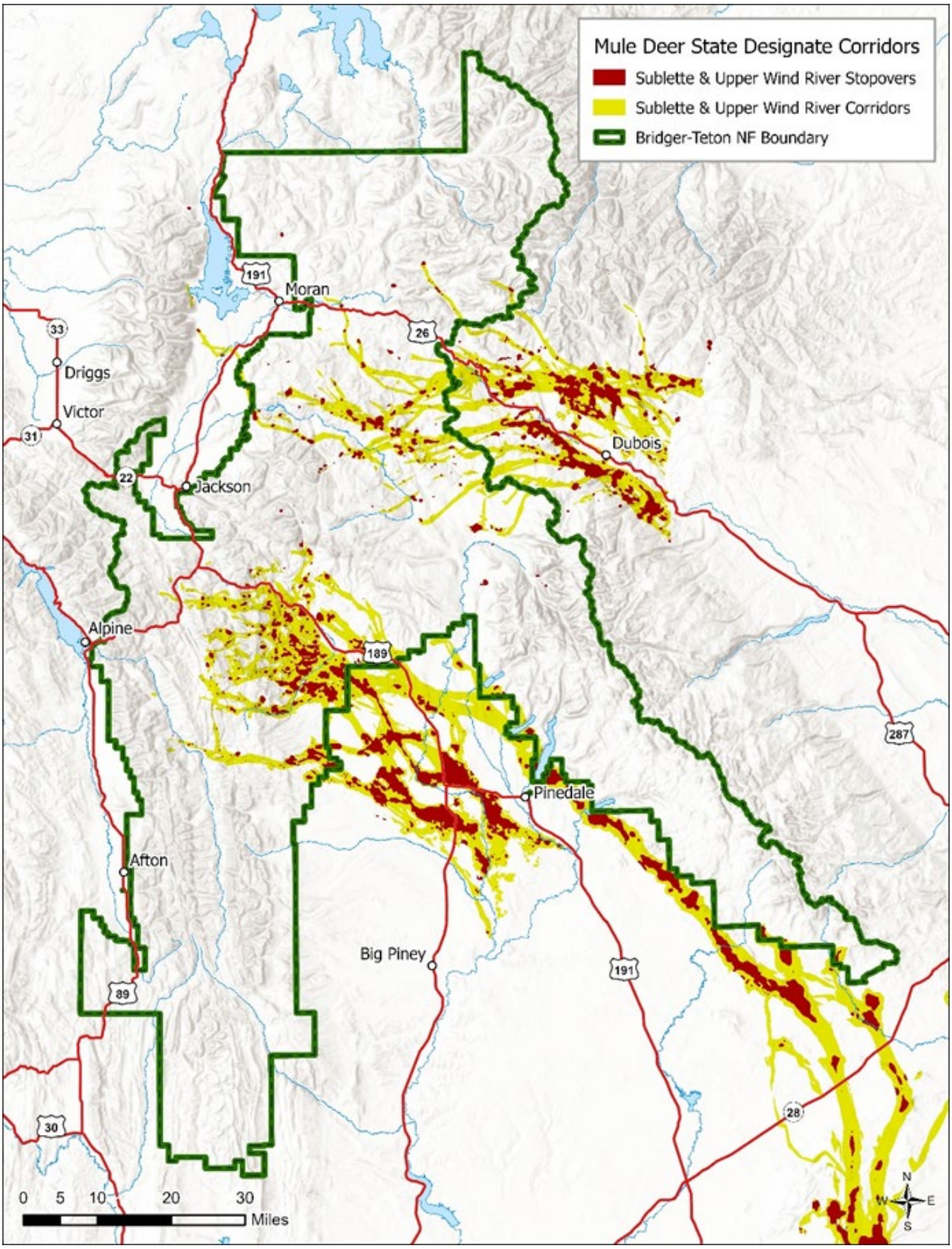


Figure 16. Mule deer corridors. The identified and designated Sublette mule deer migration corridor and the identified Upper Wind River mule deer migration corridor.

Prioritizing Key Habitat for Protection

Identifying high priority conservation areas (See Figure 15 and Figure 16) allows managers to focus on key areas to protect. Among the top habitat types to protect are: stopover habitat sites, crucial ranges, parturition areas (i.e., birthing grounds), areas utilized by multiple herds and/or species, travel bottlenecks, and other areas where sensitive behaviors occur. These areas are used year after year, so these areas should be protected and managed to provide a lasting benefit. For example, for decades the Bridger-Teton implemented annual closures, in coordination with WGFD, to protect ungulates on parturition areas and crucial winter range from human disturbance Crucial winter ranges protected by the Teton Division Winter Travel Order (#04-03-24-205) are summarized in Table 5 (USDA 2024a).

Table 5. Crucial winter ranges protected acres by the Teton Division Winter Travel Order

	Mule Deer (Acres)	Mule Deer (%)	Elk (Acres)	Elk (%)	Bighorn Sheep (Acres)	Bighorn Sheep (%)	Total Acres (%)
Closed (no human entry)	795	13%	78,060	53%	14,061	64%	**92,916 (53%)**
Restricted (Non-motorized)	1,951	33%	28,168	19%	5,229	24%	**35,347(20%)**
Open	3,229	54%	40,574	28%	2,572	12%	**46,376(27%)**
Total	**5,975**	**Blank**	**146,802**	**Blank**	**21,862**	**Blank**	**Blank**

In October 2023, the Bridger-Teton signed a special order (#04-03-23-202) creating a seasonal recreational closure near the outlet of Fremont Lake (USDA 2023i). The purpose of the closure is to minimize human disturbance to migrating mule deer in the spring and fall. In collaboration with the Wyoming Game and Fish Department, Bridger-Teton specialists identified the need for a no human presence closure from November 1 through November 30 and from April 1 through April 30, in a crucial 240-acre area along the Sublette Mule Deer Migration Route. The closure area represents an important portion of the migration route known as the “Fremont Bottleneck.” This bottleneck is a top concern for mule deer managers, as this narrow segment of the migration route is critical for the passage of an estimated 4,000 to 5,000 mule deer each fall and spring.

Impacts of Roads and Infrastructure

Roads present challenges to migrating ungulates, both directly, such as mortality from vehicle collisions or as an impermeable or semi-permeable barrier, and indirectly, such as increasing human activity. Efforts are ongoing to reduce wildlife-vehicle collisions (WVC) and improve safety for both humans and animals. Data on WVCs has been collected to identify critical target areas for mitigation measures and to guide agency decision-making through scientific research (Smith et al., 2024). The Teton County Wildlife Crossings Master Plan provides Teton County with the necessary information and tools to pinpoint high-priority road sections suitable for implementing mitigation measures for migrating ungulates (Ramage, 2018; Huijser et al., 2018). Trails in and of themselves may not directly hinder big game migration, but they do facilitate potential disturbances by increasing access for recreationalists, domestic animals, and natural predators. Recent research demonstrates that elk, bighorn sheep, and mule deer avoid human

activity associated with trails (Yovovich et al. 2021). Avoiding trails and other behavioral responses result in a relatively cryptic and insidious form of habitat loss and fragmentation. Snowmobile traffic can disturb ungulates, potentially displacing them to poor habitats, thereby increasing their energetic demands during a time when they are already resource limited. Livestock and big game transmit diseases to one another, compete for forage, and fences erected to contain livestock also can impede migration pathways.

When new infrastructure is necessary, conserving ungulate migration requires forest managers take migration routes, stopover locations, and other important habitat features into consideration. The Bridger-Teton calls for creating low human use zones containing security areas in locations adjacent to concentrated human activity (USDA 2015). Zone size should depend on the ungulate species and type of human use typical for a particular area. For instance, elk respond strongly to: ATVs (fleeing 0.8 miles (1,350 m)), followed by cyclists (fleeing 0.5 miles (750 m)), then equestrians (fleeing 0.3 miles (550 m)), and least strongly to hikers (fleeing 0.25 miles (400 m)) (Yovovich et al., 2021).

Research conducted in Alberta, Canada suggests that elk start avoiding areas when road densities exceed 0.6 to 0.9 mi/mi^2 (1 to 1.5km/km^2). In migration pathways and crucial ranges where road densities exceed these thresholds, it would benefit elk to reduce road densities through seasonal or permanent closures. The average roads per square mile on the Bridger-Teton is: 3.27 mi/mi^2, within elk migration routes it is 8.07 mi/mi^2, within elk winter crucial ranges it is 1.75 mi/mi^2, and within elk winter/yearlong crucial range is it 1.4 mi/mi^2. Another research study conducted in Washington State shows that elk detection remains steady with low human recreation (0–11 people/day) but drops by over 41% when recreation increases to 12–22 people/day. Analysis shows elk shift their activity toward the evening at locations with above-average recreation. Modeling confirms elk become more crepuscular or nocturnal when hiker numbers exceed 10 per day (Procko et al 2024).

Finally, educating the public could help create cultural norms and appetite for protecting ungulate migration. Increasing signage, engagement on social media, and other outreach efforts could all build understanding of and support for compliance with migration preservation policies. For example, open areas where people are likely to see migrating ungulates, such as the path of the pronghorn and Sublett mule deer corridors, provide opportunities for educational signage letting people know how to enjoy big game while avoiding disturbing wildlife.

Aquatic Connectivity and Organism Passage

Aquatic connectivity is important for myriad biological and physical processes throughout the Bridger-Teton. These can range from: gene flow among native fish populations; access to thermal refugia during hot or cold times of the year; transport of spawning gravels throughout streams and rivers; large wood movement/transport facilitating aquatic habitat complexity; and transport and/or flushing of sediment in streams and rivers. Organism passage is important for both aquatic and terrestrial species at road crossings. Roads, utility terrain vehicle (UTV) trails, and irrigation diversions blocked movement of cutthroat trout throughout their historical range. Impassible culverts were installed at road and railroad crossings, and some irrigation diversions block upstream movement of native fish. In some cases, these barriers blocked fish from spawning habitat. Barriers also isolate fish populations, which restricts gene flow. Paradoxically, some barriers have been beneficial, as some native cutthroat trout would likely no longer exist in some streams (e.g. Bare Creek Big Piney Ranger District and LaBarge Creek Kemmerer

Ranger District) without the presence of these human-made barriers that keep non-native fish from invading.

Until recently, efforts to quantify and remedy barriers to aquatic organism passage on the Bridger-Teton occurred on a project scale basis, or a sub-watershed basis and were opportunistic in nature. Culverts were surveyed and replaced with passable structures in conjunction with preparations for timber sales, culvert repair work following wildfires, etc. In 2023, Trout Unlimited (TU) with assistance from Wyoming Game and Fish Department (WGFD) and Bridger-Teton staff, made a concerted effort to inventory aquatic barriers associated with road-stream crossings on the Bridger-Teton. The National Aquatic Barrier Inventory and Prioritization Tool was the method used to inventory and survey road-stream crossings (https://aquaticbarriers.org/)

Survey efforts were focused on the Blackrock and Jackson Ranger Districts and included the Gros Ventre, Buffalo Fork, Spread Creek, Mosquito Creek and Fall Creek watersheds. Culverts were also surveyed on the Big Piney and Kemmerer Districts and included the Hams Fork watershed and tributaries to the Hoback River (Cliff Creek, Fisherman Creek, Granite Creek). Road-stream crossings over perennial streams were prioritized for the survey. Table 6 contains a summary of the survey information from the 2023 effort.

Table 6. Summary of 2023 Aquatic Organism Passage Survey

Total crossings on BTNF (perennial streams only)	Crossings surveyed in 2023	Crossings rated minor, insignificant, or no barrier	Crossings rated severe, moderate or significant	Perennial stream miles upstream of severe, moderate or significant barriers	Unassessed perennial stream crossings
457	108	73	35	67.2	349

To date, approximately 24% of the road-stream crossings on the Bridger-Teton have been surveyed. Of the sites surveyed in 2023, 32% or approximately one out of every three road-stream crossings pose a severe, moderate or significant barrier to aquatic organism passage. If this one to three ratio seen in the 2023 data is extrapolated across the remaining 349 unassessed perennial stream crossings, there are an estimated 113 additional barriers that have yet to be surveyed (unpublished data, available at Bridger-Teton Supervisor's office).

Aquatic organism passage at road-stream crossings is only one component of connectivity in an aquatic ecosystem. Connectivity in terms of the ability of a river or stream to move sediments and other debris supplied by the watershed is also critical for channel stability, aquatic habitat diversity and overall ecosystem integrity. Road-stream crossings at perennial streams as well as intermittent and ephemeral streams are often sources of discontinuity for sediment and debris passage in channels. Sediment and debris can accumulate on the upstream side of road-stream crossings, causing instability in the channel, habitat degradation and damage to crossing infrastructure. When correctly designed and installed, road-stream crossings are typically capable of maintaining connectivity and passing baseline levels of sediment and debris supplied by the watershed. However, stressors, both natural and anthropogenic, periodically create large inputs of sediment and debris. Stressors that typically create these conditions include wildfire, flooding, timber sales, etc. Its during events that increase sediment and debris input that aquatic connectivity is most vulnerable to impacts from road-stream crossings.

There is a total of 1428 road-stream crossings over perennial, intermittent and ephemeral channels in the Bridger-Teton. Of the 171 subwatersheds (HUC6) on the Bridger-Teton, 109 have at least one road-stream crossing. Lime Creek-Green River (HUC 140401010202) has the most road-stream crossing at 61 crossings and an average of 0.69 crossings per mile of stream. Middle South Fork Fish Creek (HUC 170401020102) and Spring Creek-Greys River (HUC 170401030501) have the second and third most crossings with 57 (0.41 crossings/stream mile) and 50 (0.46 crossings per stream mile). Table 7 summarizes the density of road-stream crossings for all subwatersheds on the Bridger-Teton.

Table 7. Road-stream crossing density summarized by subwatershed

	Zero Crossings per stream mile	<0.25 Crossings per stream mile	0.25-0.75 Crossings per stream mile	>0.75 Crossings per stream mile	Total number of HUC6
No of HUC6	62	81	28	0	171

Terrestrial Ecosystems, Aquatic Ecosystems, and Watersheds

Terrestrial Ecosystems

Introduction

In this section, the status and trends of ecological integrity are described and evaluated for eight terrestrial ecosystems.

The required tasks for assessing the status of ecological integrity are as follows.

1. Identify the relevant terrestrial, aquatic, and riparian ecosystems to be assessed.
2. Select key ecosystem characteristics that can be used to predict whether future conditions will have ecological integrity.
3. Identify possible system drivers and stressors and assess their influences on key ecosystem characteristics.
4. Describe the natural range of variation for selected key ecosystem characteristics or a suitable alternative to establish a context for whether ecosystems are properly functioning.
5. Assess and document the projected status of the ecosystem based on projected trends of key ecosystem characteristics after considering the current plan and influence of climate change.

In February 2023, a group of Bridger-Teton and regional experts conducted a series of terrestrial ecosystem workshops (USDA 2023e) to assess the ecological integrity of each identified ecosystem on the Bridger-Teton by addressing the following questions. The Terrestrial Ecosystem Workshops and Integrity Report is included in this document as Appendix A.

1. What ecological drivers and stressors and other key characteristics are most responsible for ecological integrity when the system has high integrity?

2. What features of the ecosystem currently compromise (or support) ecological integrity and what are the mechanisms for the trend? Highlight important: drivers, stressors, key ecosystem characteristics, and assess the degree to which management can influence trends/conditions.
3. How does the current status and trend of the ecosystem (ecological integrity and the elements that are compromised) influence delivery of ecosystem services?
4. What is the status of each ecosystem–the level and trend of ecological integrity (high, moderate, low, or poor) (See Table 8) in the plan area and surrounding lands? To what degree can the USFS affect change in this status?

Except for the Subalpine Forb Ecosystem, each ecosystem description and fire return interval discussion below is primarily based on the "Biophysical Settings (BpS) Models, Descriptions and Related Information" for Map Zone 21 in the Landfire Database (USDA 2023d). There is currently no BpS for the Subalpine Forb Ecosystem. Landfire uses an expert-based development process to create state-and-transition models that describe pre-settlement ecosystem structure and function for every ecological system in the current BpS spatial dataset. Expert-developed models and descriptions are the source of Landfire's historic fire regime information (USDA 2023d).

Ecological integrity is defined as the degree to which ecosystems are represented across the forest and properly functioning (Table 8). In more technical terms, the 2012 Planning Rule defines ecological integrity as: the quality or condition of an ecosystem when its dominant ecological characteristics (for example: composition, structure, function, connectivity, and species composition and diversity) occur within the natural range of variation and can withstand and recover from most perturbations imposed by natural environmental dynamics or human influence. The eight ecosystems on the Bridger-Teton are listed in Table 9.

The Natural Range of Variation (NRV) is a description of the spatial and temporal variation in ecosystem characteristics under historic disturbance regimes during a reference period. The NRV is a tool for assessing the ecological integrity of ecosystems, and it does not necessarily constitute a management target or desired condition. An ecosystem functioning within its NRV is assumed to be more resilient to current and future stressors. However, in a changing world, being within the NRV does not guarantee ecosystem integrity, and being outside the NRV may represent a transition towards a new sustainable, high-integrity state as the ecosystem responds to new conditions, such as climate change. In other words, NRV does not imply a static "desired" state, but it may represent a baseline reference state by which to gauge irrepressible transitions resulting from changing biophysical conditions (e.g., climate change).

Key Ecosystem Characteristics (KECs) (USDA 2023e) provide a mechanism for evaluating the integrity of ecosystem conditions with respect to structure, composition, and function (See Table 8 and Table 9). Traditionally, an ecosystem was considered most likely to have high integrity when its KECs exhibit the range of variation that was common prior to changes in land management practices since Euro-American settlement. In other words, an ecosystem functioning within its NRV was assumed to be more resilient to current and future stressors. However, in the face of climate change impacts, that may no longer be the case, as discussed in the preceding paragraph. The main difficulty is in projecting an ecosystem's trajectory based on the projected influence of climate change in the face of uncertainty.

The importance of ecological integrity and sustainability to the 2012 Planning Rule cannot be overstated, as they are central to the outcome of the land management plan. "The plan must

provide for social, economic, and ecological sustainability within Forest Service authority and consistent with the inherent capability of the plan area," (36 CFR 219.8), and it "must include plan components, including standards or guidelines, to maintain or restore the ecological integrity of terrestrial and aquatic ecosystems and watersheds in the plan area, including plan components to maintain or restore structure, function, composition, and connectivity" (36 CFR 219.8 (a)(1)).

Meeting this requirement demands an understanding of the status and trend of ecological integrity. The link between ecological sustainability and integrity is clear–ecological integrity is the foundation for sustainability (36 CFR 219.8 (a)(1)). The evaluation of ecological integrity provides a measure for assessing sustainability in light of current conditions and trends. An assessment that describes the ecological and socioeconomic factors currently influencing (or influenced by) ecological integrity provides the knowledge needed to craft plan components to meet the Planning Rule's explicit challenge of maintaining or restoring integrity while delivering ecosystem services.

Therefore, a clear, concise assessment of ecological integrity that identifies the status and trend of key ecosystems, which ecosystems are threatened or compromised and the threats to those ecosystems, and how changes in ecosystem status affects desired ecosystem services, will inform priorities for each step in planning. For example, purpose and need, plan components, and monitoring should each reflect the conclusions regarding ecological integrity described in this Assessment. By examining the status of ecosystems at the outset of planning, this ecological Assessment provides information necessary for the public to actively engage in planning.

Ecosystem services (USDA 2023e) are a product of functioning ecosystems that affect social, cultural, and economic conditions within the plan area in the area(s) of influence and in the broader landscape. Here, the USFS identifies the key ecosystem services provided by the plan area, rather than trying to identify and evaluate information about all ecosystem services. Key ecosystem services are the ecosystem services that are important in the area(s) of influence or the broader landscape and that are likely to be influenced by the land management plan. The key ecosystem services that can be found throughout most, if not all, of the identified ecosystems include:

- provisioning services (food, fiber, genetic resources, biochemicals, natural medicines, and pharmaceuticals),
- regulating services (air quality regulation, water regulation, climate regulation, erosion regulation, natural hazard regulation, and fire regulation),
- cultural services (aesthetic values, recreation and ecotourism, and tribal community traditions), and
- supporting services (biodiversity, pollination, nutrient cycling, soil formation, and primary production).

Table 8. Criteria for ranking the level of ecological integrity: High, Moderate, Low, and Poor

Rank	Criteria for Ranking
High	If the ecosystem remains on current trajectory it is expected to continue delivering major functions and services, including supporting biodiversity and productivity. It is expected for this ecosystem without human interference. Drivers, stressors, and key ecosystem characteristics exhibit the NRV that was common in the past.
Moderate	If the system remains on current trajectory it is expected to deliver major functions and services, including supporting biodiversity and productivity, at a reduced level relative to expectations for this ecosystem. One or more drivers, stressors, and key ecosystem characteristics are compromised in a way that disrupts disturbance regimes or characteristics of the system. However, compromised features are not those that determine the identity of this system, or significant characteristics are only modestly compromised. Drivers, stressors, and key ecosystem characteristics exhibit a NRV that was not common in the past, but they are within a range that resulted in resilience.
Low	If the system remains on current trajectory it is expected to deliver some major functions and services, including supporting a portion of the biodiversity and productivity, at a reduced level relative to expectations for this ecosystem without human interference or active restoration. One or more drivers, stressors, and key ecosystem characteristics are significantly compromised. However, compromised features are not those that determine the identity of this system–the USFS does not expect a radical type-change. Drivers, stressors, and key ecosystem characteristics exhibit a NRV that was not common in the past, but they are within the range and resilience is possible.
Poor	The ecosystem currently is (or is trending toward) experiencing a type-change or is incapable of delivering major functions and services including supporting biodiversity and productivity expected for this ecosystem type without herculean human interference and maintenance. Drivers, stressors, and key ecosystem characteristics exhibit a NRV rarely or never exhibited in the past.

Source: Hayward (2022).

Table 9. Size and proportion of eight terrestrial ecosystem assessed on the Bridger-Teton National Forest

Biophysical Setting - Forest-wide	Sum of Acres	% Of Forest
Inter-Mountain Basins Montane Sagebrush Steppe	355,618	10.3%
Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	168,143	4.9%
Northern Rocky Mountain Subalpine Woodland and Parkland	340,570	9.8%
Rocky Mountain Aspen Forest and Woodland	322,024	9.3%
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	1,226,862	35.4%
Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland	314,606	9.1%
Alpine	267,261	7.7%
Subalpine Forb	72,102	*~2%
Sub Total	**2,995,084**	**86.5%**
Other BPS	398,167	11.5%
Open Water, Perennial Ice/Snow, Barren Rock/Sand/Clay	71,604	2.0%
Grand Total	**3,464,855**	**100%**

*Subalpine Forb Ecosystem acres and percentages not included in “Grand Total” since they are a subset of other terrestrial ecosystems and would be double counted.

Table 10. Summary of ecological status and trend for eight terrestrial ecosystems on the Bridger-Teton

Ecosystem	Current Status Ecological Integrity	Long-term Trend (by 2050) of Ecological Integrity	Ability of the Forest to Positively Affect Ecological Integrity in the Near Term (next 10 years)	Ability of the Forest to Positively Affect Ecological Integrity in the Long-Term (by 2050)	Main Drivers and Stressors[1]	Comments
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	Moderate. Primarily based on the current succession classes differing from the NRV. Insect outbreaks, climate change, and fire suppression are currently impacting the ecosystem and its ability to respond to these impacts. This ecosystem does positively respond to some level of disturbance as long as it is not too extreme.	Low. Primarily based on climate change that could result in more wildfires of higher severity and size, transitioning to future, shorter fire-return intervals on the landscape, and insect irruptions and changes in water availability that could severely stress trees.	Moderate. Management actions that can provide benefits to the ecosystem include prescribed fire, timber removal, thinning and restoration activities.	Low. Climate change may push this ecosystem beyond a point where management activities cannot occur at a large enough scale to keep ahead of negative impacts.	1, 2, 3	An increase in the frequency of fires with an increase in severity may eventually change the vegetation structure of this ecosystem to one that is more characteristic of shorter fire regimes.
Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland	Moderate. Primarily based on the current succession classes differing from the NRV.	Moderate. Based primarily on this ecosystem being mostly associated with high elevation, cooler, wetter sites that hold more soil moisture and provide more nutrient cycling, and “shady” north-facing slopes that	Low. Allowing naturally occurring wildland fires to burn in this ecosystem is an option, and prescribed ignitions are also possible, but will require ignition during favorable (warm and dry) conditions. Timber harvest in this ecosystem is not	Low	1, 2, 3	An increase in frequency, size, and severity of fires may eventually change the vegetation structure of this ecosystem to one that is more characteristic of shorter fire regimes.

Ecosystem	Current Status Ecological Integrity	Long-term Trend (by 2050) of Ecological Integrity	Ability of the Forest to Positively Affect Ecological Integrity in the Near Term (next 10 years)	Ability of the Forest to Positively Affect Ecological Integrity in the Long-Term (by 2050)	Main Drivers and Stressors[1]	Comments
		retain snowpack longer. For these reasons, the impacts of climate change may not be as severe as other ecosystems on the Forest, but there will still be some impacts.	generally appropriate because it is found in mesic sites, and steep, north-facing slopes that are difficult or impossible to operate in.			
Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	Moderate. Primarily based on the current succession classes differing from the NRV.	Moderate. Based primarily on the resilience of this ecosystem and its ability to adapt and survive climate shifts and changes in wildfire frequency and severity. Insect outbreaks and changes in water availability could create severe stress on trees further impacting the ability of the ecosystem to function within the NRV.	Moderate. Can utilize: fuels projects, prescribed fire, timber removal, invasive species treatments, sound livestock grazing practices, thinning, and restoration activities to alter the vegetation condition and structure. These are all a surrogate for “disturbance” and can be used to mimic natural disturbances and influence trends and conditions.	Moderate. Climate change may push this ecosystem beyond a point where the Bridger-Teton can actively manage at a large enough scale to affect change.	1, 2, 3, 4, 5	It may serve as a climate refugia in the future because of the extremes it can tolerate - it is an adaptable ecosystem. However, post-fire conversion of forests to non-forest vegetation because of regeneration failure is especially true for dry woodlands that are already on the edge of their climate tolerance.
Northern Rocky Mountain Subalpine Woodland and Parkland	Low. Primarily based on the large-scale mortality of coniferous trees from insects and	Low. Based primarily on climate impacts that could result in more wildfires on the landscape and	Low. Because of the high elevation, extreme environment this ecosystem typically occupies, the Bridger-Teton is	Low	1, 2, 3	Warmer summer temperatures and reduced precipitation may shorten the fire return interval as well as the intensity and size of fires on the

Ecosystem	Current Status Ecological Integrity	Long-term Trend (by 2050) of Ecological Integrity	Ability of the Forest to Positively Affect Ecological Integrity in the Near Term (next 10 years)	Ability of the Forest to Positively Affect Ecological Integrity in the Long-Term (by 2050)	Main Drivers and Stressors[1]	Comments
	disease, fire suppression, projected impacts of climate change, and inability of the Bridger-Teton to actively address the issues at a landscape scale.	of higher severity and additional stress to trees that could be severely impacted by insect outbreaks.	hindered in its ability to conduct active management in the form of prescribed fire, thinning and timber harvest practices that can provide benefits to the ecosystem. The Bridger-Teton will continue Whitebark pine restoration activities and can alter livestock grazing practices in problem areas. The issue with these activities is "scale" and if the Bridger-Teton can do enough to impact large landscapes.			landscape. An increase in the frequency of fires with an increase in severity may eventually change the vegetation structure of this ecosystem to one that is more characteristic of shorter fire regimes.
Rocky Mountain Aspen Forest and Woodland	Moderate. Primarily based on the current succession classes differing from the NRV. This is mainly a result of fire suppression activities over the last 100+ years.	Moderate. Primarily based on the resilience of this ecosystem and changes in wildfire frequency and severity, which may be beneficial.	Moderate. Can implement prescribed fire, conifer removal, invasive species treatments, sound livestock grazing practices, thinning, and beaver restoration.	Moderate	1, 2, 4, 5, 6	Aspen forests are the richest and most diverse terrestrial ecosystems on the Bridger-Teton. Resilient, able to adapt and survive climate shifts and changes in wildfire frequency and severity, which may be beneficial in stimulating suckering and removing conifer competition.
Inter-Mountain Basins Montane	Moderate. Primarily based on the current	Moderate. Based primarily on the resilience of this	High. Can implement: invasives control, prescribed fire,	High	1, 2, 4, 5	One of the most imperiled ecosystems in North America. Although this

Ecosystem	Current Status Ecological Integrity	Long-term Trend (by 2050) of Ecological Integrity	Ability of the Forest to Positively Affect Ecological Integrity in the Near Term (next 10 years)	Ability of the Forest to Positively Affect Ecological Integrity in the Long-Term (by 2050)	Main Drivers and Stressors[1]	Comments
Sagebrush Steppe	succession classes differing from the NRV. This is mainly a result of fire suppression activities over the last 100+ years.	ecosystem and the successes the Bridger-Teton has had treating invasive annual grasses.	modifying livestock grazing, conifer removal, and managing unauthorized vehicle use.			ecosystem is resilient to drought and fire under the NRV, projected climate change could transition this shrub-dominated ecosystem to one consisting of less sagebrush and more of a grass/forb cover type.
Subalpine Forb Ecosystem	Moderate. Primarily based on historic grazing management with domestic sheep and recreational activities, which resulted in alteration and soil loss on localized sites, altering site potential.	Moderate. Based on current ground cover monitoring, which shows that most sites are stable or in an upward trend and provide services expected for this ecosystem, including: wildlife and pollinator habitat, watershed function, biodiversity, and biomass.	Moderate. For moderately altered areas (at-risk), management actions may prevent further alteration over the long-term including: invasive species treatments, managed livestock grazing, seed collection and planting, and managing recreation impacts.	Low-Moderate	1, 4	The subalpine forb ecosystem is minor in size (acres), but high in ecological importance.
Alpine Ecosystem	Moderate. Primarily due to increasing recreation impacts and climate change.	Low. Based on the likely continued increase in recreation activity in the future. Climate change impacts will continue to stress the system.	Moderate. The Bridger-Teton can manage recreation impacts.	Moderate	1, 6	Disproportionally affected by climate change. Recreationists are often drawn to alpine areas where recovery of vegetation impacts is very slow.

Source: USDA (2023a).
1 - Stressors: 1: Climate change; 2: Fire exclusion/suppression; 3: Insects and disease; 4: Livestock grazing; 5: Invasives; 6: Recreation

Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland

Key Takeaways

The current status of the integrity of this ecosystem is moderate, primarily based on the current succession classes differing from the NRV and because of the climate variability experienced to-date. Insect outbreaks, climate change, air pollution deposition, fire suppression, and invasive species are currently impacting the ecosystem and its ability to respond to these impacts. This ecosystem positively responds to some level of disturbance, as long as it is not too extreme.

The long-term trend (to 2050) for the integrity of this ecosystem is considered low. This rating is primarily based on climate impacts that could result in more wildfires of higher severity and size, transitioning to future, shorter fire-return intervals on the landscape, and insect irruptions and changes in water availability that could severely stress trees.

Status and Trends

The Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland is found in west-central Wyoming, ranging from the eastern flanks of the Wind River Range, north to the Gallatin Range and west towards Island Park, Idaho. It encompasses mid-elevations and upper elevations of the Bridger-Teton, and it makes-up approximately 1,226,862 acres or 35.4 percent of the Bridger-Teton (USDA 2023a) (See Table 11).

This ecosystem occurs in areas that are relatively moist with a subalpine cold climate. Precipitation usually comes in the winter months as snow, except on the eastern flanks of the Wind River Range where much of the precipitation occurs in the spring months. Soils are usually excessively well-drained, residual, or glacial till and alluvium on valley floors. Soils are droughty moderately deep to deep over fractured granodiorite, quartzite, and sandstone bedrock. Coarse fraction is 30-50 percent in soil. Soils are: moderately deep, deep, broken rock, or bedrock. Soils are acidic and rarely formed from calcareous parent materials.

These forests are dominated by lodgepole pine (*Pinus contorta*) with shrub, grass, or barren understories. These are sometimes intermingled with mixed conifer-aspen stands, with the latter occurring in inclusions of deeper, typically fine-textured soils. The shrub stratum may be conspicuous to absent. Dominant species of this ecosystem include: lodgepole pine (*Pinus contorta*), subalpine fir (*Abies lasiocarpa*), Engelmann spruce (*Picea engelmannii*) grouse whortleberry (*Vaccinium scoparium*), heartleaf arnica (*Arnica cordifolia*), creeping barberry (*Mahonia repens*), and Geyer's sedge (*Carex geyeri)*.

Key ecosystem characteristics when the system exhibits high integrity include succession classes (S-Classes) within the NRV and mixed-serotiny cones (USDA 2023e). The Bridger-Teton staff conducted a Biophysical Setting Departure Analysis (USDA 2023c) (See Appendix B) that concluded there is a deficit of succession classes B and C and a surplus of succession classes A and D. One likely explanation for this succession class distribution is low fire activity through the early and mid-1800s followed by large fires that burned through the Bridger-Teton during the late 1800s. Young stands and the initiation of fire exclusion in the early 1900s led to a lower number of acres burned through the 1980s. The exception was the 1930s characterized by several active fire years. Another explanation is the MPB outbreak in lodgepole pine from 2004-2011 peaking in 2007 in Wyoming. During the peak of the outbreak in 2009 at least 468,179 acres of damage were detected across the Bridger-Teton (USDA 2023c). MPB killed a

great percentage of larger size classes, but during the landscape-level outbreak trees as small as 3.5 inches diameter breast height (DBH) were killed (Audley et al. 2020).

Warming temperatures now combine with aging stands to create receptive fuels leading to increased fire activity. Following stand-replacing fires, lodgepole pine will often rapidly colonize and develop into dense, even-aged stands depending on site characteristics and cone serotiny. In areas with low serotiny, the stands will be less dense and only gradually seed-in.

Table 11. Description of succession classes and departure within the Rocky Mountain Sub-Alpine Dry-Mesic Spruce-Fir Forest and Woodland Ecosystem on the Bridger-Teton National Forest

S-Class	Description of Composition/Structure	Reference Percent	Current Percent	Status	Sum of Acres
A: Early development, all structures	Post-replacement disturbance vegetation of grasses, forbs, shrubs, and Lodgepole pine seedlings-saplings. Aspen may also be present. Canopy cover: 0-100%. Tree height: 0-5 meters [0-16 feet]. Maximum Tree Size Class: Sapling >4.5-feet; <5-inch DBH. Transitions to S-Class B after approximately 20 years.	7%	28.5%	Surplus	350,044
B: Mid-development, all structures	Moderate to dense pole-sized trees, sometimes very dense (dog-hair). Aspen usually not present. Closed canopy is 51-100%. Mid-open stands are at 21-50% canopy cover and would have mature and immature Aspen present. Mid-open stands would have Subalpine fir in the understory. Tree height: 5-10 meters [16-33 feet]. Maximum Tree Size Class: Pole 5–9-inch DBH. Therefore, this class is considered a mid-development all-structures class. Transitions to S-Class C after approximately 60 years without stand-replacing disturbance.	33%	0.4%	Deficit	4,761

S-Class	Description of Composition/Structure	Reference Percent	Current Percent	Status	Sum of Acres
C: Late development, all structures	Medium-sized Lodgepole pine. Subalpine fir present in the mid- to upper story. Canopy cover: 10-100%. Tree height: 10-50 meters [32-164 feet]. Maximum Tree Size Class: Medium 9–21-inch DBH. Class transitions to S-Class D after approximately 270 years without stand-replacing disturbance.	48%	12.1%	Deficit	148,446
D: Late development, all structures	Mature Engelmann spruce/Subalpine fir forest. Canopy cover: 10- 100%. Tree height: 5-50 meters [16-164 feet]. Maximum Tree Size Class: Large 21–33-inch DBH. This class is distinguished from S-Classes B and C by species composition (Spruce-fir dominance rather than Lodgepole pine).	12%	59.0%	Surplus	723,376
UE: Uncharacteristic exotic	Non-native plant communities becoming established on the Biophysical Setting	No data	No data	N/A	235
Total		100%	100%	N/A	1,226,862

Source: Helmbrecht et al. 2012, USDA 2023c, and USDA 2023d.

A key system driver is fire return interval within the NRV. A fire frequency below 300 years and above 30 years will maintain lodgepole pine on the landscape. Climate change, which pushes fire outside NRV, is a key stressor. The mean fire return interval is variable ranging from 200-400 years depending on elevation, precipitation, and temperature. Fire size is also largely dependent on climatic conditions. Usually, average fire size is about 100 acres, but when dry summers are more common, fires of 1,000-100,000 acres are more frequent (USDA 2023e). Under extreme (95 percentile) weather conditions, where the herbaceous fuel load is sufficient to carry fire, even early successional stands will burn.

Warmer summer temperatures and reduced precipitation can change the fire return interval as well as the intensity and size of fires on the landscape. An increase in the frequency of fires with an increase in severity may eventually change the vegetation structure of this ecosystem to one that is more characteristic of shorter fire regimes. A more frequent fire interval in this ecosystem could result in cones and seedlings being consumed before they are mature enough to positively respond to fire and larger trees being removed prior to reproducing. In addition, the soil nutrient pool could be reduced due to a more frequent loss of organic matter and soil cover.

Other natural disturbance events within the NRV help maintain the mix of succession classes as well as vegetation diversity. In trees approximately 80-100 years of age, insects, disease, and/or blow-down typically create small openings in forest canopy.

The soil orders associated with this ecosystem are typically Entisol, Inceptisol and Alfisol.

Insects and Disease

The MPB irruption from 2004 to 2011 (peaking in 2009) was a result of increased daily average temperatures that created conditions for insect irruption in stands of lodgepole pine and whitebark pine with diameters preferred by MPBs. The MPB irruption began in high elevation whitebark pine trees and then moved down in elevation to impact lodgepole pine. Prior to the 2004-2011 outbreak, whitebark pine in the northern Rockies escaped most widespread MPB-caused mortality except for a 1930s outbreak; snags from the 1930s outbreak are still visible across the region. Increased temperatures associated with a changing climate have increased MPB adaptive seasonality at higher elevations where whitebark pine grows (Hicke et al 2006).

Additionally, increased nutrient deposition from air pollution and increased dust events can add nitrogen and phosphorus to this ecosystem, which can negatively affect: certain tree species growth rate and decadal survival, soil health, lichens, mycorrhizae, native aquatic and terrestrial plant communities, increase invasive species colonization, and reduce snowpack retention. Air pollution acts as an additive stress making some trees more vulnerable to insects or diseases.

Invasive plant species can be an issue in this ecosystem, especially along motorized roads, trails, and trailheads where people inadvertently introduce noxious plant seeds accumulated on vehicles, stock, pets, or clothing.

The current status of the ecological integrity of this ecosystem is moderate. This ecosystem consists of successional classes lacking in the mid-development phase (B and C), but overrepresented in the early and late development classes (A and D). Insect outbreaks, climate change, air pollution deposition, fire suppression, and invasive species are currently impacting the ecosystem. The trend for integrity will likely continue to be negatively impacted by climate change, which could result in more wildfires of higher severity and size and a transition to future, shorter fire return intervals on the landscape. An increase in the frequency of fires with an increase in severity may eventually change the vegetation structure of this ecosystem to one that is more characteristic of shorter fire regimes. Insect irruptions and changes in water availability could also severely stress trees further impacting the ability of the ecosystem to function within the NRV.

Drought, wildfire, insects, and disease could change portions of this ecosystem to one that is more adapted to these types of disturbance and more “open”. The degree the Bridger-Teton can affect change in this ecosystem is moderate for the near-term and low for the long-term. Management actions that can provide benefits to the ecosystem include prescribed fire, timber removal, and thinning and restoration activities. These actions may provide enhanced ecosystem benefits in the near-term, but over the long-term, climate change may push this ecosystem beyond a point where management activities cannot occur at a large enough scale to keep ahead of negative impacts. A better understanding of likely climate-induced changes to this ecosystem is needed to inform future management direction.

Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland

Key Takeaways

The current status of the integrity of the ecosystem is moderate. This is primarily based on the current succession classes differing from the NRV. Insect outbreaks, climate change, and fire suppression are currently impacting the ecosystem and its ability to respond to these impacts.

The long-term trend (to 2050) integrity is considered moderate. This rating is primarily based on the dynamics of where this ecosystem is located- mostly associated with high elevation, cooler, wetter sites that hold more soil moisture and provide more nutrient cycling, and shady north-facing slopes that retain snowpack longer. For these reasons, the impacts of climate change may not be as severe as other ecosystems on the Bridger-Teton, but there will still be some impacts. Climate impacts could result in more wildfires on the landscape and of higher severity. Additional stress to trees could result in landscape-level tree mortality from insect outbreaks.

Status and Trends

This ecosystem is found in the Northern Rockies, including Montana, Idaho, and Wyoming, often adjacent to drier, lower subalpine forests (lodgepole-spruce-fir) and to krummholz and alpine vegetation. This system typically has more precipitation and longer winters than lower subalpine types. This system is like Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland, but it is distinguished by its occurrence on mesic to wet microsites within the matrix of the drier (and warmer) subalpine fir-Engelmann spruce or lodgepole pine forests. The microsites include: north-facing slopes, swales or ravines, toe slopes, cold pockets, and other locations where available soil moisture is higher or lasts longer into the growing season. This ecosystem is mapped at approximately 314,606 acres or 9.1 percent of the Bridger-Teton (See Table 12, USDA 2023c).

This ecosystem is characterized by a subalpine cold climate and it is relatively moist. Precipitation usually comes in the winter months as snow, except at the eastern flanks of the Wind River Range where much of the precipitation occurs in the spring months. Soils are usually excessively well-drained, residual, or glacial till and alluvium on valley floors, droughty, moderately deep- to deep soils over fractured granodiorite, quartzite, and sandstone bedrock. Coarse fraction 30-50 percent in soil, soils moderately deep, to deep, to broken rock, or bedrock. Soils are acidic, and rarely formed from calcareous parent materials.

The fire return interval for this ecosystem is classified as 200-500 years. Key ecosystem characteristics, when the system exhibits high integrity, include succession classes (S-Classes) within the NRV. The Bridger-Teton staff conducted an analysis (USDA 2023c) that concluded there was a surplus of succession class A, a deficit of S-Classes B and C, and S-Classes D and E were like the reference condition (See Table 12). The fire return interval for stand replacement fire is >300 years. Most of the fire is modeled as replacement fire. There might be some mixed-severity fire in this system and there is no equilibrium achieved; it fluctuates widely in each class.

Drivers and stressors include climate and fire return interval. Climate (severely dry conditions) is the primary driver of fire regimes in this system. Typical fires in this system are small, stand-replacing fires with spots to adjacent groups of trees. The interspersed unburned trees provide a seed source to recolonize burned areas.

Table 12. Description of succession classes and departure within the Rocky Mountain Sub-Alpine Mesic-Wet Spruce-Fir Ecosystem

Succession Class Description	Composition/Structure	Reference Percent	Current Percent	Status	Sum of Acres
A: Early development, all structures	Post-replacement disturbance vegetation of grass and Engelmann spruce, lodgepole pine, and subalpine fir seedlings. Canopy cover: 0-100%. Tree height:0-5 meters [0-16 feet]. This stage transitions to S-Class B after approximately 40 years or alternatively to S-Class C.	8%	18.5%	Surplus	58,154
B: Mid-development, closed structure	Mix of pole-sized Engelmann spruce, lodgepole pine, and subalpine fir. Canopy cover: 40-100%. Tree height: 5-10 meters [16-33 feet]. In the absence of stand-replacement fire this class transitions to S-Class E after approximately 110 years. Wind or weather stress may thin this class causing transition to S-Class C.	19%	0.1%	Deficit	233
C: Mid-development, open structure	Mix of pole-sized Engelmann spruce, lodgepole pine, and subalpine fir. Canopy cover: 40-100%. Tree height: 5-10 meters [16-33 feet]. This class transitions to S-Class D after approximately 110 years in the absence of stand-replacement fire.	7%	2.2%	Deficit	6,922
D: Late development, open structure	Mix of medium to large-sized Engelmann spruce, subalpine fir, and lodgepole pine. Canopy cover: 10-50%. Tree height: 10-50 meters [33-164 feet]. This class may persist in the absence of disturbance or transition to S-Class E with increased canopy closure.	43%	50.8%	Similar	159,734
E: Late development, closed structure	Mix of medium to large-sized Engelmann spruce, subalpine fir, and lodgepole pine. Canopy cover: 50-90%. Tree height: 10-50 meters [33-164 feet].	23%	28.4%	Similar	89,345
UE: Uncharacteristic exotic	Non-native plant communities becoming established on the Biophysical Setting	0.0%	0.1%	Surplus	218
Total		**100%**	**100%**	**Not applicable**	**314,606**

Source: Helmbrecht et al. 2012, USDA 2023c, and USDA 2023d.

Other natural disturbance events within the NRV are important components of maintaining the mix of succession classes as well as tree and ground vegetation diversity. In some areas, spruce beetle (*Dendroctonus rufipennis*) can influence successional stage, species composition, and stand density. Spruce beetle epidemics may act to accelerate succession. During epidemics, fine fuels increase while standing live trees decrease and standing dead trees increase. Subalpine fir dominates regeneration while Engelmann spruce regeneration is low (Ott et al 2018).

Soil orders associated with this ecosystem are primarily Alfisols and to a smaller extent Entisols and, Inceptisols.

Warmer summer temperatures and reduced precipitation may increase the fire return interval and severity of fire behavior. This ecosystem typically experiences small, patchy fires. Because of the patchy nature of these stands, fires will still often be limited to the specific stand, although there may be increased spotting from one stand to another. An increase in frequency, size, and severity of fires may eventually change the vegetation structure of this ecosystem to one that is more characteristic of shorter fire regimes. A more frequent fire interval could result in cones and seedlings being consumed before they are mature enough to positively respond to fire and larger trees taken out of the system prior to reproducing. Larger fires in non-serotinous lodgepole, Engelmann spruce and subalpine fir stands result in more burned areas that are further from the seed source, which is released from neighboring live trees and is necessary to recolonize burned areas.

Insects and Disease

Western spruce budworm (*Choristoneura occidentalis*) a native defoliator, is currently impacting Douglas-fir and subalpine fir, in particular, through subsequent years of defoliation across the Bridger-Teton. Currently, balsam wooly adelgid (*Adelges piceae*), a non-native sucking insect, is killing subalpine fir trees throughout the Rocky Mountain subalpine mesic spruce-fir region.

Air pollution is a concern with increased deposition at higher elevations and on the west side of the mountains where this ecosystem is typically found. Adding nitrogen and phosphorus to the ecosystem can affect certain tree species such as spruce and subalpine fir, soil health, lichens, mycorrhizae, and increase the ability of invasive species to colonize.

The Bridger-Teton does not conduct much active vegetation management in this ecosystem because it is located on mesic sites, north-facing slopes, and high elevation. Thus, trying to mimic disturbance through prescribed fire or timber harvest will be limited. There will be little chance to influence stand or succession dynamics through those type of management actions.

The current status of the ecosystem consists of succession classes lacking in the mid-development phase (B and C), overrepresented in the early development class (A), and late development classes (D and E) are similar to the reference condition. Insect outbreaks, climate change, and fire suppression are currently impacting the ecosystem and its ability to respond to these impacts. An increase in frequency, size, and severity of fires may eventually change the vegetation structure of this ecosystem to one that is more characteristic of shorter fire regimes.

Timber harvest in this ecosystem is not generally common because it is found in mesic sites, and steep, north-facing slopes that are difficult for operations. The degree the Bridger-Teton can affect change in this status is low for the near term and low for the long-term. Allowing naturally occurring wildland fires to burn in this ecosystem is an option, and prescribed ignitions are also possible, but will require ignition during favorable (warm and dry) conditions. A better understanding of likely climate-induced changes to this ecosystem is needed to inform future management direction.

Middle Rocky Mountain Montane Douglas-Fir Forest and Woodland

Key Takeaways

The current status of the integrity of the ecosystem is moderate. This is primarily based on the current succession classes differing from the NRV. Insect outbreaks, climate change, invasive plant species and fire suppression are currently impacting the ecosystem and its ability to respond to these impacts. However, this is a very resilient ecosystem that can positively respond to disturbance events.

The long-term trend (to 2050) for integrity is considered moderate. This rating is primarily based on the resilience of this ecosystem and its ability to adapt and survive climate shifts and changes in wildfire frequency and severity.

Status and Trends

This ecosystem is the most common low-elevation forest type in the GYE and it occurs across eastern Idaho, southwestern Montana, and northwestern Wyoming. Douglas-fir makes up 8 percent of the forested area in Wyoming (WGFD 2017a). This ecosystem is mapped at approximately 168,143 acres or 4.9 percent of the Bridger-Teton (USDA 2023c) (See Table 13).

Douglas-fir (*Pseudotsuga menziesii*) forests occupy a broad elevational range between the limber pine (*Pinus flexilis*) type and grasslands/shrublands on lower foothills and the cool/dry subalpine vegetation types. This ecosystem often occurs at higher elevations on slopes with southern aspects where it can be co-dominant with whitebark pine (*Pinus albicaulis*) or limber pine (*Pinus flexilis*). Slopes with northern aspects tend to be more mesic and can support a mixed conifer community including several subalpine tree species. This can also occur in the mid-elevation ranges (6,000-8,000 feet) in southwestern Wyoming.

This ecosystem is generally dominated by Douglas-fir with an understory of graminoids, shrubs, and/or other conifer species. Shrub cover varies from sparse to dense. Additional dominant species include: lodgepole pine (*Pinus contorta*), quaking aspen (*Populus tremuloides*), common snowberry (Symphoricarpos albus), and elk sedge (*Carex garberi)*. Co-dominant species include limber pine (*Pinus flexilis*), Rocky Mountain juniper (*Juniperus scopulorum)*, and quaking aspen (*Populus tremuloides*) at lower elevations and lodgepole pine, subalpine fir (*Abies lasiocarpa*), Engelmann spruce (*Picea engelmannii*), and whitebark pine (*Pinus albicaulis*) at higher elevations. Composition can widely vary based on disturbance history and site conditions. Stand structure ranges from young, even-age stands to multiple age class, old-growth stands to sparsely treed open parklands and woodlands.

Key ecosystem characteristics, when the system exhibits high integrity, include succession classes within the NRV. The Bridger-Teton staff conducted an analysis (USDA 2023c) that concluded individual succession classes show departure from NRV and they may provide an opportunity for restoration or maintenance. For example, succession classes B and C are nearly absent indicating a need to recruit more acres into these classes (See Table 13). Also, without fire or another form of disturbance maintaining an open canopy, S-Class D will succeed to the late, closed S-Class E, which is already over-represented relative to the reference percent. The fire regime is predominantly mixed severity with a mean fire return interval 36 to 300 years.

Drivers and stressors include climate and fire return interval. Climate is the primary driver of fire regimes in this system. Mixed-severity fires are generally characterized by spatially

heterogeneous burning that results in a complex and dynamic mosaic of low-severity surface fires and high-severity surface or crown fires. Large, stand-replacing fire occurs to a lesser degree mostly in dense stands and/or with severe fire weather.

Other natural disturbance events within the NRV are important components of maintaining the mix of succession classes as well as tree and ground vegetation diversity. The most common insects causing mortality include Douglas-fir bark beetle in Douglas-fir and MPB in lodgepole pine, whitebark pine, and limber pine. Medium to large trees are most susceptible, although poles may be infrequently infected. Whitebark pine and limber pine are also affected by white pine blister rust. Spruce budworm is present in pockets within the zone. Wind/weather/stress may infrequently affect stands.

Table 13. Description of succession classes and departure within the Middle Rocky Mountain Montane Douglas-fir Forest and Woodland Ecosystem

S-Class Description	Composition/Structure	Reference Percent	Current Percent	Status	Sum of Acres
A: Early development, all structures	Post-replacement disturbance vegetation dominated by grasses and seedling/sapling Douglas-fir and possibly lodgepole pine. Canopy cover 0-100%. Tree height: 0-5 meters [0-16 feet]. Maximum Tree Size Class: Sapling >4.5-feet; <5-inch DBH. This class transitions to S-Class C or alternately to S-Class B after approximately 40 years.	7%	22.4%	Surplus	37,721
B: Mid-development, closed structure	Pole-size to medium Douglas-fir and possibly lodgepole pine. Canopy cover: 40-100%. Tree height: 5-10 meters [16-33 feet]. Maximum Tree Size Class: Pole 5-9-inch DBH. In the absence of disturbance this class transitions to S-Class E after approximately 80 years.	12%	0.1%	Deficit	238
C: Mid-development, open structure	Pole-size to medium Douglas-fir and possibly Lodgepole pine. Canopy cover: 10-40%. Tree height: 5-10 meters. [16-33 feet] Maximum Tree Size Class: Pole 5-9-inch DBH. In the absence of stand- replacing disturbance this class transitions to S-Class D or alternately S-Class B after approximately 60 years.	14%	2.0%	Deficit	3.339
D: Late development, open structure	Medium to large Douglas-fir and possibly lodgepole pine. Canopy cover: 10-40%. Tree height: 10-50 meters [33-164 feet]. Maximum Tree Size Class: Large 21-33-inch DBH. In the absence of disturbance this class may transition to S-Class E in approximately 45 years.	47%	27.8%	Deficit	46,714
E: Late development, closed structure	Multi-storied mature Douglas-fir stand. Lodgepole pine may be present. Canopy cover: 40-100%. Tree height 10-50 meters [33-164 feet]. Maximum Tree Size Class: Large 21-33-inch DBH. Insect, weather, or mixed severity fire may transition this class to S-Class D.	20%	47.6%	Surplus	80,072

S-Class Description	Composition/Structure	Reference Percent	Current Percent	Status	Sum of Acres
UE: Uncharacteristic exotic	Non-native plant communities becoming established on the Biophysical Setting.	0.0%	0.0%	Similar	59
Total	**Blank**	**100%**	**100%**	**Not applicable**	**168,143**

Sources: Helmbrecht et al. 2012, USDA 2023c, and USDA 2023d.

Soil orders associated with this ecosystem are primarily Alfisols and to a smaller extent Entisols and Inceptisols.

Threats and stressors to this ecosystem include climate change, altered fire regimes, and altered stand structure from fragmentation due to roads, logging, or other human disturbances. These disturbances can cause significant soil loss/erosion and negatively impact the water quality within the immediate watershed. Invasive species can become abundant in disturbed areas and alter floristic composition. Direct and indirect effects of climate change may alter dynamics of indigenous insects such as Douglas-fir beetle (Dendroctonus pseudotsugae) causing a buildup in population size (with warmer winters) leading to large outbreaks that can cause high mortality in mature trees. Douglas-fir beetle has affected scattered stands that have been stressed by: drought, fire, root rot, defoliation by western spruce budworm, or windfall. Noted outbreaks have occurred in the North Fork of the Shoshone River and on the west side of the Bighorn National Forest (WGFD 2017a).

Potential climate change effects on this ecosystem likely would include a shift to plant species more common on hotter, drier sites. Average annual temperature is projected to continue to increase in the Middle Rocky Mountains along with increasing number and severity of wildfires and insect outbreaks (McKenzie et al. 2004, McKenzie et al. 2008, Westerling et al. 2006, and Shafer et al. 2015). Ecological consequences from such a climate shift would be similar to extended drought. Seedling establishment and survival would be reduced or possibly eliminated, effectively eliminating tree recruitment. Without recruitment Douglas-fir stands are essentially relicts of past climate conditions; seedling establishment is low to non-existent in many south-facing Douglas-fir stands. Stevens-Rumann et al. (2017) documented a decrease in post-fire forest and woodland resilience during 2000-2015 when compared to the 1985-1999 interval. Post-fire conversion of forests to non-forest vegetation because of regeneration failure is especially true for dry woodlands that are already on the edge of their climate tolerance (Stevens-Rumann et al. 2017).

A warming climate with more frequent droughts may weaken Douglas-fir trees and may make them more susceptible to lethal attacks by forest diseases, such root and butt rot (*Armillaria mellea*) and red-brown butt rot (*Phaeolus schweinitzii*), and native Douglas-fir beetle (*Dendroctonus pseudotsugae*) and defoliators, Douglas-fir tussock moth (*Orgyia pseudotsugata*), and western spruce budworm (*Choristoneura fumiferana*) (Burns and Honkala 1990, Steinberg 2002).

Many stands of this woodland type occur in the montane zones of ranges. It may be possible for the species of this system to transition into upper montane and subalpine zones in taller mountain ranges as suitable climate is diminished at lower elevations. Douglas-fir trees are long-lived and frequently live more than 400 years and so may be able to survive for centuries without regeneration (Burns and Honkala 1990, Steinberg 2002). However, there could be

accelerated loss of mature trees because of more frequent and extended drought resulting from hotter, drier climate.

Fire regimes in this ecosystem vary based on moisture and aspect. Wetter forests on north aspects burn at high intensity with stand replacing fires every 100-300 years. Warmer summer temperatures and reduced precipitation may result in more frequent and larger stand replacing fires that will be slower to recover due to increased distances for seed dispersal from neighboring live trees. In addition, the soil nutrient pool could be reduced due to subsequent loss of organic matter and soil cover. The drier forests on south aspects in this ecosystem are more resilient to low intensity ground fires every 25-60 years; however, there has been an absence of fire in the last 100 years, most likely due to successful fire suppression. This has subsequently resulted in denser stands of pole-sized trees, making them more susceptible to hotter, larger fires. An increase in the frequency of low intensity fires may benefit portions of this ecosystem by removing the smaller trees. The larger trees have thick, insulating bark allowing them to persist after low intensity fire. Lack of fire has also reduced Douglas-fir regeneration due to lack of bare mineral soil.

Insects and Disease

The most common insects causing mortality in Douglas-fir include Douglas-fir bark beetle. Medium to large trees are most susceptible, although poles may be infrequently infected. Western spruce budworm is present in pockets within the zone. While it often weakens Douglas-fir and may make them more susceptible to bark beetles, direct mortality from budworm is uncommon. Winter temperatures are not getting cold enough for long enough periods to impact winter survival of these insects. Large trees that are stressed from drought, high summer temperatures or diseases are less resistant to fight off insect irruptions. The most common disease affecting older Douglas-fir stands is Schweinitzii butt rot (*Phaelous schweinitzii*). Dwarf mistletoe is also a parasitic shrub that takes nutrients away from the tree, making it more susceptible to insect mortality.

The Forest can utilize prescribed fire, livestock grazing and fuels projects to alter the vegetation condition and structure in this ecosystem. All three of these management actions are a surrogate for “disturbance” and can be used to mimic natural disturbances and influence trends and conditions. Reducing stress on trees can help with survival during insect irruptions. It may serve as a climate refugia in the future because of the extremes it can tolerate - it is an adaptable ecosystem. Douglas-fir will often encroach into adjacent shrublands or grasslands with fire exclusion and during moist climatic periods.

The current status of the ecosystem consists of significant deficits in the amounts of succession classes B and C and an over-representation of S-Class E. Insect outbreaks, climate change, and fire suppression are currently impacting the ecosystem. The trend for integrity likely will not be as severe as other ecosystems on the Bridger-Teton based on its resiliency and its ability to adapt and survive climate shifts, and changes in wildfire frequency and severity. Insect irruptions and changes in water availability could create severe stress on trees further impacting the ability of the ecosystem to function within the NRV.

Although this ecosystem is resilient to drought and fire, extreme conditions could transition this forested ecosystem to one consisting of more open space, which may increase the amount of the Bridger-Teton that is considered big game winter range and also provide more available acres to livestock grazing. However, this could come at a cost to available cover habitat

provided by conifer forests that is important to some big game species. The amount of timber removal, whether for firewood, post and poles or saw logs, may be impacted with less availability in both quantity and quality.

The degree the Bridger-Teton can affect change in this status is moderate for the near term and moderate for the long-term. Management actions that can provide benefits to the ecosystem include: prescribed fire, timber removal, invasive species treatments, sound livestock grazing practices, thinning, restoration activities, and managing recreation activities and practices. These actions may provide enhanced ecosystem benefits in both the near and long-term. A better understanding of likely climate-induced changes to this ecosystem is needed to inform future management direction.

Northern Rocky Mountain Subalpine Woodland and Parkland

Key Takeaways

The current level and trend of ecological integrity for this ecosystem is low for the near term and low to 2050. This is primarily based on the large-scale mortality of coniferous trees from insects and disease, the projected impacts of climate change, and the inability of the Bridger-Teton to actively address the issues at a landscape scale because of the high elevation, extreme environment this ecosystem typically occupies. However, changes in management of natural wildfires have some potential to help redress past management effects. Most water in Wyoming, which is used for agriculture, industry, and municipalities, originates in these montane and subalpine forests as snowfall.

Summary

This ecosystem of the Northern Rockies is typically a high-elevation subalpine parkland mosaic of stunted tree clumps, open woodlands, and herb- or dwarf-shrub-dominated openings occurring above closed forest ecosystems and below alpine communities. Key ecosystem services include providing important wildlife habitat, human recreational opportunities, and persistent warm season water resources. The recreation opportunities and water resources provided by this ecosystem significantly contribute to Wyoming's social and economic sustainability. The low ecological integrity of this ecosystem has largely resulted from more than a century of fire suppression, and in more recent decades, large-scale impacts from insects and disease.

Subalpine forests in Wyoming contribute to the overall wildlife species diversity of the State as higher elevation forests form a continuation of subarctic forests that extend across most of Canada and Alaska. In Wyoming, several bird and mammal species that occur in this habitat type are at or near the southernmost extensions of their ranges (e.g., loon and wolverine). Many wildlife species only occupy this habitat in spring, summer, and fall, such as big game and passerine birds, which migrate to lower elevations and latitudes in the winter. Because these forests are restricted to mountains, they are regionally fragmented, and as a result, resident wildlife species are often genetically isolated.

Status and Trends

The geographic range for this ecosystem includes southwest Montana, southeast Idaho, and northwest Wyoming. It occurs in the upper subalpine zone (7,000-11,000 feet) on moderate to

steep terrain. This ecosystem is mapped at approximately 340,570 acres or 9.8 percent of the Bridger-Teton (USDA 2023c) (See Table 14).

Landforms include: ridgetops, mountain slopes, glacial trough-walls and moraines, talus slopes, land and rockslides, and cirque headwalls and basins. Some sites have little snow accumulation because of high winds and sublimation, which increases summer drought. Patchy distribution of this type may be controlled by edaphic conditions, including soil depth and susceptibility to summer drought.

Forest communities range from nearly homogeneous stands of whitebark pine (*Pinus albicaulis*) on the harshest, highest-elevation sites to mixed species stands including: lodgepole pine (*Pinus contorta*), limber pine (*Pinus flexilis*), and shade tolerant subalpine fir (*Abies lasiocarpa*) or Engelmann spruce (*Picea engelmannii*). Intermingled with these coniferous forests in the subalpine habitat are: mountain grasslands and meadows, quaking aspen (*Populus tremuloides*) groves, wetlands, riparian areas, and mountain shrublands with mountain lakes and streams.

Vegetation is largely influenced by temperature, given the short, cool, and often dry growing season, which limits photosynthesis, with frosts possible throughout the year. Vegetation patterns are heavily influenced by: elevation, aspect, soil type, snow accumulation, and major disturbances such as fire, windstorms, and insect outbreaks. Vegetation growing in the harshest, windswept areas along treeline can take on krummholz growth forms – stunted and twisted trunks and branches, often without vegetation on the windward side.

Undergrowth on these sites is usually sparse and at timberline is highly variable. Dominant vegetation includes whitebark pine, subalpine fir, and Engelmann spruce. Shrubs that may occur include: *Vaccinium* species, common juniper (J*uniperus communis*), russet buffaloberry (s*hepherdia canadensis*), and Oregon boxleaf (*Paxistima myrsinites)*. Grasses include Geyer's sedge (*Carex geyeri*), Ross' sedge (*Carex rossii*), and Idaho fescue (*Festuca idahoensis*). Herbs include: common yarrow (*Achillea millefolium*), old man's whiskers (*Geum triflorum*), mountain dandelion (*Agoseris spp)* and currant (*Ribes spp*).

Whitebark pine is considered a keystone species at high elevations throughout the northern Rocky Mountains due to its abundant seed production, which is an important food source for wildlife. Whitebark pine is a slow-growing, long-lived conifer of high-elevation forests and timberlines of the northwestern United States and southwestern Canada. In Wyoming, whitebark pine exists often in association with limber pine in the western part of the State from the Commissary Ridge area into Yellowstone National Park. The Wind River Range in Wyoming is the eastern-most distribution of the species (USFWS 2023).

Key Ecosystem Characteristics

Key ecosystem characteristics that support ecological integrity in this ecosystem include climate and fire return interval within the NRV. For example, MPBs are a natural agent of mortality and disturbance affecting five-needle pines in this ecosystem, but recent climate trends have exacerbated their impact on the ecosystem. Key ecosystem characteristics when this ecosystem exhibits high integrity also include succession classes within the NRV. The Bridger-Teton staff conducted an analysis (USDA 2023c) and concluded that there is a major deficit in the amount of S-Class B and C and an abundance of S-Class A and D (See Table 14). For some forest community types, such as whitebark pine, perpetuation is dependent on occasional disturbance, most commonly by fire. The fire regime in this ecosystem primarily consists of long-

interval (e.g., 100-200 years+), mixed severity (25-75 percent top kill), and stand replacement fires. Without fire, subalpine fir and Engelmann spruce increase and support fire events, which can set back succession, again favoring whitebark pine (See Table 14). Healthy soils provide nutrient exchange, erosion control, an ideal substrate for plant growth and establishment, and functioning soil structure increases water infiltration and storage. This is especially relevant for this system since it is typically found on shallow, rocky soils. The soil orders typically associated with this ecosystem are Entisol and Inceptisol.

Table 14. Description of succession classes and departure within the Northern Rocky Mountain Sub-Alpine Woodland and Parkland Ecosystem

S-Class Description	Composition/Structure	Reference Percent	Current Percent	Status	Sum of Acres
A: Early development, all structures	Post-replacement disturbance vegetation typically whitebark pine and Engelmann spruce seedlings and saplings. Lodgepole pine, limber pine, and herbaceous species also may be early pioneers. Canopy cover: 0-40%. Tree height: 0-5 meters [0-16 feet]. Maximum Tree Size Class: Sapling >4.5-feet; <5-inch DBH. This class transitions to S-Class B or C after approximately 50 years.	21%	46%	Surplus	158,824
B: Mid-development, closed structure	Mix of pole sized whitebark pine, subalpine fir, Engelmann spruce, and lodgepole pine. Some sites may exhibit krummholz growth form. Canopy cover: 30-100%. Tree height: 5-10 meters [16-33 feet]. Maximum Tree Size Class: Pole 5-9-inch DBH. Class transitions to S-Class E after approximately 80 years without disturbance.	35%	1%	Deficit	4,712
C: Mid-development, open structure	Mix of pole sized whitebark pine, subalpine fir, Engelmann spruce, and lodgepole pine. Some sites may exhibit krummholz growth form. Canopy cover: 10-30%. Tree height: 5-10 meters [16-33 feet]. Maximum Tree Size Class: Pole 5-9-inch DBH. Class transitions to S-Class E or alternatively to S-Class B after approximately 80 years without disturbance.	12%	8%	Deficit	23,016
D: Late development, open structure	Mix of medium to large diameter whitebark pine, subalpine fir, Engelmann spruce, and lodgepole pine. Limber pine may be present. Generally found in small to moderate size patches on southerly aspects or sites where soil is less developed. Canopy cover: 10-40%. Tree height: 10-50 meters [33-164 feet]. Maximum Tree Size Class: Medium 9-21-inch DBH. This S-Class is persistent in the absence of disturbance, although a small percentage will eventually transition to S-Class E.	5%	20%	Surplus	67,711

S-Class Description	Composition/Structure	Reference Percent	Current Percent	Status	Sum of Acres
E: Late development, closed structure	Mix of medium to large diameter whitebark pine, subalpine fir, Engelmann spruce, lodgepole pine, and limber pine. Generally found in small to moderate size patches on more protected northerly aspects or sites where soil is more developed than in S-Class D. Canopy cover: 40-100%. Tree height: 10-50 meters [33-164 feet]. Maximum Tree Size Class: Medium 9-21-inch DBH. This S-Class is persistent in the absence of disturbance.	27%	25%	Similar	86,306
UE: Uncharacteristic exotic	Non-native plant communities becoming established on the Biophysical Setting.	0%	0%	Similar	1
Total	**Blank**	**100%**	**100%**	**Not applicable**	**340,570**

Source: Helmbrecht et al. 2012, USDA 2023c, and USDA 2023d.

Subalpine forests that include large components of coarse woody debris and have high structural diversity are particularly important to forest carnivores such as wolverine. These habitats create subnivean spaces for thermoregulatory shelter and foraging sites in the winter. Subalpine conifer forests are usually more diverse and provide more roost sites for bats than high-elevation forests. Subalpine spruce-fir forests provide hiding and thermal cover for moose and elk, forage for wintering moose, and important winter habitat for snowshoe hare. Mule deer often use subalpine forests as summer and transitional ranges.

Whitebark pine is almost exclusively dependent upon Clark's nutcrackers for seed dispersal and subsequent tree establishment. The Clark's nutcracker may distribute seeds up to 20 miles (32 kilometers) from the source tree. The tree’s multi-stem form results from seeds sprouting from Clark’s nutcracker caches, commonly in burned areas or wind-swept ridges. Reproduction following disturbance is slow; trees may not produce cones until they are 50 years or older.

Whitebark pine seeds are an extremely important wildlife food in high mountain ecosystems for: grizzly bears, Clark's nutcrackers, red squirrels, black bears, ground squirrels, chipmunks, woodpeckers, nuthatches, Steller’s jays, ravens, and pine grosbeaks (WGFD 2017a). Mature whitebark pine trees ameliorate local conditions on harsh sites and facilitate the establishment of less hardy subalpine species. It serves an important role as a nurse tree in facilitating the establishment of other types of vegetation. In northwestern and west-central Wyoming, whitebark pine is the initial colonizer and trees of other species become established in the micro-sites that it creates (NatureServe 2017). Its growth in alpine areas helps to stabilize soil and it may accumulate snow.

Timber is not a major commodity in this ecosystem. Because of its high wildlife, scenic and recreational qualities, Wyoming’s subalpine forest habitat type receives significant human use including hiking, camping, hunting, birdwatching, skiing, and snowmobiling. Most water in Wyoming, which is used by agriculture, industry, and municipalities, originates in montane and subalpine forests as snowfall. Trees and understory vegetation help form soils and hold soil particles together to create structure and store carbon.

Drivers and stressors include climate and fire return interval. Fire frequency is largely controlled by climate in this system and there is a relatively long mean fire return interval. Ignitions are frequent due to lightning, though fires seldom carry due to lack of fuel from the slow-growing vegetation and cool, moist conditions. Fires in tree clumps may burn without carrying through adjacent meadows or spot from one clump to the next. Individual tree torching is common. Non-lethal surface fires may dominate where continuous light fuel loading (i.e., grasses) exists.

Other natural disturbance events within the NRV are important components of maintaining the mix of succession classes as well as tree and ground vegetation diversity. Snow, wind, and other weather events may cause transitions between succession classes.

However, a “perfect storm” of the combined effects of fire suppression, large-scale insect and disease infestations, and climate change are currently resulting in landscape-scale changes to the flora in many Wyoming subalpine forests. These threats are interrelated and often magnify the impacts of other disturbances.

Fire Suppression

Fire suppression has had a significant influence on montane subalpine habitat in some locations. Fire suppression has contributed to a loss of age, structural, and species diversity; increased stand densities; and the buildup of live and dead fuels. Timber patch size has remained unchanged, but due to suppression of surface and moderate intensity fires, forest openings or small breaks have either decreased in size or do not exist (WGFD 2017a).

These changes have resulted in a more homogeneous forest landscape pattern (WGFD 2017a), which has contributed to several forest health concerns including intensifying bark beetle outbreaks. Tree mortality from bark beetles has occurred on an unprecedented scale within the subalpine forest habitat type. High fuel loads create conditions more favorable to large-scale, high intensity fires. Such fires may cause: significant impairment to regeneration; loss of valuable seed trees; loss of relict stands of mature trees and remnant populations of locally uncommon wildlife and floral species; aid in establishment of invasive plants; and further promote homogeneous landscape patterns. In some areas, catastrophic fires may result in the long-term conversion to non-forest landscapes.

Insects and Disease

Subalpine forests are home to a variety of beetles, which under normal circumstances are a natural component of forest ecology and serve the purpose of renewing a forest by killing older trees.

The most important insect impacting mixed forests of Engelmann spruce and subalpine fir is the spruce beetle. Usually, these beetles are restricted to recently wind-thrown trees or trees weakened by root disease, but they can reach epidemic levels if the right stand structure and climatic conditions are present (WGFD 2017a).

Spruce budworm is the most common endemic defoliator across the western United States. It effects Douglas-fir, spruce, and subalpine fir on the Bridger-Teton. Outbreaks sporadically occur and appear associated with as-yet-undefined interactions between climatic trends and host abundance and quality. Western spruce budworm populations are always present at very low levels between outbreaks. The larval stage consumes conifer needles and buds on host trees, using silken webs to balloon onto trees in lower canopy positions. Trees that experience three or

more years of successive spruce budworm defoliation may die or become more susceptible to other agents of mortality.

White pine blister rust (*Cronartium ribicola*) is an invasive fungal infection that is either well established or becoming established within almost all Wyoming whitebark and limber pine stands. Only 5 percent of whitebark pine trees have genetic resistance to white pine blister rust (WGFD 2017a). Historically, MPB mortality would cause an increase in fuel loads and large fires that would create opportunities for natural regeneration. Blister rust has changed this normal progression by killing young whitebark pine and reducing cone crops by killing cone-bearing branches and tops. Blister rust is becoming more prominent in the: Teton Range, Mount Leidy Highlands, Wyoming Range, and Wind River Mountains.

In combination, white pine blister rust and MPB form a decline complex. MPB is killing mature whitebark pine at a high rate similar to the 1930s outbreak which killed most of the mature whitebark pine in Yellowstone National Park (WGFD 2017a). Recent surveys suggest that the mortality of whitebark pine in the GYE may be as high as 85 percent as a result of MPB and blister rust infestations. MPB usually kills larger cone-producing trees thus reducing regeneration potential (WGFD 2017a). Both seed production and the opportunity for germination have been reduced. Since whitebark pine regeneration is reduced, less natural selection for blister rust resistance occurs (WGFD 2017a). Some tactics for decreasing blister rust include blister rust-resistant breeding and planting programs and removal of alternate plant hosts, namely currants (*Ribes* spp.). However, blister rust is a significant threat because no practical methods are available to limit its spread on a broad scale and genetic resistance is low.

Climate Change

Warmer summer temperatures and reduced precipitation may shorten the fire return interval as well as the intensity and size of fires on the landscape. An increase in the frequency of fires with an increase in severity may eventually change the vegetation structure of this ecosystem to one that is more characteristic of shorter fire regimes. A more frequent fire interval could result in cones and seedlings being consumed before they are mature enough to adapt to fire or produce cones. For example, on Mount Washburn in Yellowstone National Park, one of the whitebark pine plots that burned in a crown fire is regenerating entirely to Engelmann spruce. However, this is an occurrence that is likely happening on a small scale and is not necessarily currently widespread. Understory vegetation may shift in response to decline in canopy and changes in tree species composition.

Other Threats and Stressors

Nutrient inputs from air pollution deposition are a concern. Deposition often increases with elevation and adding nitrogen and phosphorus to the ecosystem can affect certain tree species such as spruce, fir, and whitebark pine, soil health, lichens, mycorrhizae, and increase the ability of invasive species to colonize. Increases in large dust events add nutrients and can reduce snowpack retention-by reducing reflectance. Air pollution and reduction in snowpack retention can add stress to trees making them more vulnerable to insects and disease.

The soils in this ecosystem are shallow and prone to erosion from extreme weather events, recreation, and livestock grazing. Whitebark pine restoration is ongoing, but it is at a small-scale when compared to the size of this ecosystem; it is still uncertain if the Bridger-Teton can facilitate landscape-scale improvement.

Current Status and Long-Term Trend

The trend for integrity will likely continue to be negatively impacted by climate effects that could result in more wildfires of higher severity and size transitioning to future shorter fire return intervals on the landscape. Insect irruptions and changes in water availability could severely stress trees, further impacting the ability of the ecosystem to function within the NRV. The long-term trend (to 2050) for ecosystem integrity is considered low.

Management Options

The degree the Bridger-Teton can affect change in this status is low for the near term and low for the long-term. Because of the high elevation extreme environment this ecosystem typically occupies, the Bridger-Teton is hindered in its ability to conduct active management that can provide benefits to the ecosystem.

The Bridger-Teton staff will continue whitebark pine restoration activities and they can alter livestock grazing practices in problem areas. Additionally, managing the increased impacts from recreationists also could be an action the Bridger-Teton undertakes. Managing wildfire for resource benefits could become more common in this system. The issue with these activities is "scale" and if the Bridger-Teton can do enough to impact large landscapes.

Available management actions on the Bridger-Teton have little to no influence on major air pollution sources or the climate trajectory. The Bridger-Teton does not do a lot of active vegetation management in this ecosystem because it is located at such a high elevation. Thus, efforts to mimic disturbance through prescribed fire or timber harvest will be minimal. However, the Bridger-Teton can actively manage natural wildfires for resource benefit in this ecosystem. Additionally, whitebark pine restoration activities are also conducted on the Bridger-Teton and include: small-scale prescribed fire, thinning, cone, scion and pollen collection for seed orchard and reforestation, Verbenone application, plus tree marking, regeneration surveys, and research projects. However, there will be little chance to influence stand or succession dynamics through those type of management actions.

Rocky Mountain Aspen Forest and Woodland

Key Takeaways

Due to the presence of relatively moist conditions and abundant flora, Rocky Mountain montane aspen and woodland ecosystems are the richest and most biodiverse terrestrial ecosystems on the Bridger-Teton. Currently, these ecosystems have moderate ecological integrity and they are expected to continue to have moderate integrity to 2050. The degree the Bridger-Teton can affect change in this status is moderate for the near term and long-term. Primary factors affecting ecological integrity in this system are: drought, fire suppression, beaver extirpation or absence, and ungulate browsing, including permitted livestock. Tools the Bridger-Teton can utilize to improve the vegetation condition and structure of this ecosystem include: prescribed fire, modifying livestock grazing, reintroducing beaver where conditions are suitable, conifer removal and fuels projects. The Bridger-Teton also will continue to manage invasive species and recreation to address problem areas.

Summary

This ecosystem is widely distributed within a mosaic of other communities on the Bridger-Teton. The location of aspen (Populus tremuloides) groves is highly related to microsites that provide favorable moisture and soil site conditions. Aspen communities commonly occur in riparian or spring/seep situations where there is permanent or semi-permanent surface water. Communities are usually of small spatial extent, generally <25 acres in size. Patches may be linear along riparian areas and the forest/grassland ecotone. Nonlinear patches are often localized in swales, depressions, and toe slopes.

Most aspen occurs at elevations from 5,000-7,500 feet. Aspen is occasionally found at lower and higher elevations, but these stands are often isolated and small. Aspen typically occurs between the sagebrush steppe and subalpine forest zone, usually in close association with Douglas-fir and other conifer forests. The understory structure may be complex with multiple shrub and herbaceous layers, or simple with just an herbaceous layer. The herbaceous layer may be dense or sparse and dominated by graminoids or forbs. Dominant species include: aspen (*Populus tremuloides*), Douglas-fir (*Psuedotsuga menziesii*), lodgepole pine (*Pinus contorta*), big sagebrush (*Artemesia tridentata*), subalpine fir (*Abies lasiocarpa*), and Engelmann spruce (*Picea engelmannii*).

Due to their productivity and species diversity, aspen communities are one of the most valued western habitat types. Key ecosystem services provided by aspen forests include: rich, diverse wildlife habitat; stable, reliable water delivery; aesthetically pleasing recreation settings; and foraging habitat for big game and livestock. Historical activities that influenced the status and trend of this ecosystem include fire exclusion over the last 100+ years, ungulate browsing and livestock grazing, and the extirpation of beavers from many areas on the Bridger-Teton. In a state of high ecological integrity, these ecosystems experience 20-150 years between disturbances and temperature and precipitation occur within the NRV. The stressors that diminish the integrity of the aspen ecosystem also diminish the delivery of the key ecosystem services listed above, and their contributions to social and economic sustainability.

Distribution of this ecological system is primarily limited by adequate soil moisture required to meet its high evapotranspiration demand and secondarily by the length of the growing season or low temperatures. In the long-term absence of fire, these sites may transition to conifers or sagebrush, so there is likely some overlapping with those ecosystems. Because patch sizes tend to be small and because one state in the disturbance model can include aspen in the understory of a predominantly coniferous stand, aspen patches may be difficult to map and identify. Mapped aspen forest and woodland covers approximately 322,024 acres or 9.3 percent of the Bridger-Teton (USDA 2023c).

Status and Trends

The current status of the ecological integrity of this ecosystem is MODERATE. This is primarily based on the current succession classes differing from the NRV (See Table 15), mainly as a result of fire suppression activities over the last 100+ years. Bridger-Teton-wide this has resulted in smaller patch sizes, lack of regeneration and a higher percentage (relative to NRV) of early (succession class A) and late seral (succession class D and E) classes with an increase in conifers within stands. The surplus in succession class A is likely a result of the increased acreage burned in wildfires in the last 15-20 years. Furthermore, succession class A will progress into class B within the planning period. Bridger-Teton-wide, there is also a deficit of

succession class B and C relative to NRV. Aspen enhancement is a priority across the Bridger-Teton.

Aspen integrity varies across the Bridger-Teton. For example, the Wyoming Range landscape has the most acres (55,460) in succession class A, which is a post-disturbance replacement community dominated by: Aspen suckers, grasses, forbs, and shrubs that typically succeeds to succession class B within 15 years (USDA 2023c). However, in the Wyoming Range many stands in this succession class remain as an established, persistent, shrub-type aspen clone <4.5 ft. that are maintained in this state either because of continual browsing or suboptimal site conditions. All landscapes on Bridger-Teton show significant deficits from NRV in succession classes B and C, which encompass stands of aspen from 5-21” DBH (See Table 15).

Table 15. Succession class departure within Rocky Mountain Aspen Forest and Woodland, by landscape

Biophysical Setting Name Row Labels	Rocky Mountain Aspen Forest and Woodland Reference Percent	Rocky Mountain Aspen Forest and Woodland Current Percent	Status	Sum of Acres
Leidy Highlands	Blank	24.7 percent	Blank	79,494
A	7.0 percent	36.8 percent	Surplus	29,244
B	24.0 percent	5.4 percent	Deficit	4,269
C	27.0 percent	3.4 percent	Deficit	2,685
D	27.0 percent	34.7 percent	Similar	27,560
E	15.0 percent	19.4 percent	Similar	15,383
UE	0.0 percent	0.4 percent	Surplus	351
Wyoming Range	Blank	53.3 percent	Blank	171,486
A	7.0 percent	32.3 percent	Surplus	55,460
B	24.0 percent	3.4 percent	Deficit	5,780
C	27.0 percent	2.8 percent	Deficit	4,763
D	27.0 percent	40.3 percent	Similar	69,073
E	15.0 percent	20.9 percent	Similar	35,920
UE	0.0 percent	0.3 percent	Surplus	491
Wind River Mountains	Blank	9.6 percent	Blank	30,773
A	7.0 percent	27.5 percent	Surplus	8,459
B	24.0 percent	7.0 percent	Deficit	2,153
C	27.0 percent	7.4 percent	Deficit	2,288
D	27.0 percent	37.1 percent	Similar	11,426
E	15.0 percent	20.9 percent	Similar	6,443
UE	0.0 percent	0.0 percent	Surplus	2
Kemmerer	Blank	12.5 percent	Blank	40,272
A	7.0 percent	29.0 percent	Surplus	11,680
B	24.0 percent	3.3 percent	Deficit	1,341
C	27.0 percent	1.5 percent	Deficit	609
D	27.0 percent	31.7 percent	Similar	12,772
E	15.0 percent	34.4 percent	Surplus	13,851

Biophysical Setting Name Row Labels	Rocky Mountain Aspen Forest and Woodland Reference Percent	Rocky Mountain Aspen Forest and Woodland Current Percent	Status	Sum of Acres
UE	0.0 percent	0.0 percent	Surplus	17
Total	**Not applicable**	**100.0 percent**	**Not applicable**	**322,024**

Aspen have declined from 50 to 96 percent throughout the West (WGFD 2017a). It has been estimated that aspen loss in Wyoming since European settlement is as high as 53 percent (WGFD 2017a), but there is some debate by researchers over such high estimates. A recent study estimated an average of only 10 percent loss in the GYE (WGFD 2017a).

Perhaps the greatest value in aspen communities is their capacity to support so many plants and animals. Among western montane forests, aspen are the most biodiverse communities. Aspen can be considered a keystone species because of the relatively high diversity of plants and animals that depend on them (WGFD 2017a).

Successful regeneration of aspen is associated with natural and human-caused disturbances and gaps in the vegetation canopy. Multiple, overlapping, disturbance events generally favor aspen over conifer forest types (Rogers 2017). This is due to the inability of aspen to compete in low light environments (WGFD 2017a). Natural disturbances include: blowdowns, landslides, flooding, beaver activity, and disease, but fire is probably the most important. Current extensive mortality of conifers from bark beetle infestations may benefit aspen regeneration and expansion in much of Wyoming. Aspen regenerates both sexually (new genotype establishment by seed germination) and asexually (root sprouting from the adjacent clone). Sexual regeneration is increasingly recognized as an important pathway of regeneration following wildfire (Kreider and Yocom 2021).

Aspen communities are valued for their high-water yield and high biomass productivity and they are ranked second by the WGFD only to riparian areas in wildlife diversity. These attributes result in aspen having the second highest priority for habitat improvement projects in the WGFD Strategic Habitat Plan (SHP). Aspen stands typically support high grass and forb production in their understories, providing important foraging sites for large and small herbivores such as: mule deer, elk, moose, black bear, dusky grouse, chipmunks, and snowshoe hares. High productivity conditions also usually produce large numbers of invertebrates, which make aspen forests important foraging sites for insectivores such as shrews, bats, and many bird species.

About 88 species of birds potentially use aspen habitats in Wyoming (WGFD 2017a). Bird communities within aspen stands include species that spend most of their time within the aspen community, as well as species that visit aspen stands periodically for foraging or other specific purposes while also using surrounding habitats. Breeding bird density in aspen stands is related to surface water and ground moisture levels, the number and size of insects in the aspen understory, and the structure and species diversity of plants found on the border of adjoining habitat types (WGFD 2017a). Bird diversity has been positively correlated to the size and maturity of aspen stands (WGFD 2017a) and mature stands of aspen have greater bird diversity than younger stands and those being invaded by conifers. Mature aspen stands are particularly important to cavity nesting birds, as the trees have soft wood and they are prone to infection and decay. Aspen trees greater than 40 years of age almost always harbor heart rot while they are alive and provide excellent conditions for primary cavity excavators (such as woodpeckers)

and natural cavity formation. Cavities excavated by primary cavity excavators are then followed by secondary cavity nesters including bluebirds, swallows, and wrens.

Deciduous and aspen forests are especially important to bats. Generally, activity increases as the proportion of deciduous vegetation bordering streams and moth abundance increase. Bat diversity is greater in deciduous habitats than in coniferous habitats. Proximity to open water may provide a critical element for many bats that use deciduous forests. The greatest resources that aspen woodlands provide for bats are cavities for roosting. Live trees are potentially more important to bats in this habitat type than snags (WGFD 2017a).

The northern pocket gopher and beaver serve as keystone species in aspen communities by increasing local productivity and site diversity. Northern pocket gophers accomplish this through constant soil disturbance and root herbivory, which facilitates nutrient cycling, air and water penetration into the soil, and it creates a fine-grained patchwork of understory plant communities in various stages of vegetational succession. In riparian and spring/seep situations, beavers create wetlands through damming, which can drown some aspen stems, but they can also increase adjacent soil moisture, which favors aspen growth. Beavers also affect aspen successional dynamics by heavily browsing aspen. Over time, older beaver ponds fail and drain leaving moist soils and meadows that can be reclaimed by aspen.

Forest fires generally favor aspen rejuvenation, growth, and expansion in seral types. Currently, many aspen stands on the Bridger-Teton are over 100 years old as a result of extensive fire episodes during the late 1800s and early 1900s. Since that time, fire suppression and reduction of intentionally set human fires reduced fire frequency in aspen communities. Many aspen stands are now reaching maturity and they are increasingly vulnerable to disease, succession, or senescence. In many instances, particularly where herbivory is problematic, continued fire suppression may result in decreased resilience (Rogers 2017).

Over-browsing and trampling by wild and domestic ungulates can have a negative impact on aspen regeneration and understory plants, if not properly managed. Browsing may result in the loss of multi-layer stand structures (sometimes complete stand collapse) important to local biodiversity. Single-story aspen stands are highly vulnerable to stand collapse as mature trees age and die. Periodic wildfire may rejuvenate seral aspen, though intense browse pressure may eliminate such gains following disturbance (Rogers 2017). Both cattle and sheep browse on aspen leaves and twigs, but sheep typically eat four times as many aspen sprouts as cattle (Sampson 1919 as cited in DeByle 1985). However, sprout height controls impacts from cattle and sheep grazing. By the time sprouts reach 45 inches, damage by sheep is no longer a problem. Thus, after 3 years, sprouts are not damaged extensively by sheep and for cattle, the period would be 4 or 5 years. It is important to note that grazing is not necessarily harmful to the young sprouts and removal of the terminal shoot once or twice will not kill the plant because lateral shoots can develop (Tew 1981). Several management options may be effective to reduce the negative impacts of browsing on aspen regeneration, such as herding and utilizing a rest-rotation cycle for allotment pastures, especially in late summer (Shinneman et al., 2015); both of which are implemented on the Forest.

Deer and moose can impact aspen regeneration, but elk are usually the most damaging because elk typically winter in or near mid-elevation zones where aspen forests are most common. This is especially problematic in aspen stands in the vicinity of elk feedgrounds. Additionally, elk populations in Wyoming have dramatically increased over the last century.

Moose, which can spend the entire winter within a single aspen patch, can also cause significant, localized damage.

Fire suppression works in concert with over-browsing to reduce aspen regeneration. As aspen stands mature and sprouts become less common, browsing pressure intensifies on sprouts that remain. Furthermore, the removal of fine fuels by browsing and grazing can reduce fire frequency. Fire suppression and over-browsing, along with other factors such as disease, drought, and natural succession, often lead to the replacement of aspen by conifers. A decrease in plant diversity and water yield is common as conifers begin to dominate aspen stands (WGFD 2017a). This results in less water being available for undergrowth and groundwater recharge. Over time this water loss reduces overall site productivity.

Infestations of bark beetles can damage or kill entire landscapes of conifer species competing with aspen for resources. Theoretically, these situations may create opportunities for aspen establishment (seedlings) or regrowth and expansion (suckers). Although some have voiced concerns that increased wildfire intensity resulting from heavy fuel loads created by beetle kill could negatively affect aspen, research indicates that that concern is unjustified (Hart et al. 2015, Meigs et al. 2016, and Simard et al. 2011).

Projections of warming and drying conditions throughout the Rocky Mountain West suggest that aspen habitat may significantly shrink in the coming century (Rogers 2017). Drought has been known to cause the loss of seral aspen stands and contribute to a decline in aspen regeneration. Aspen stands located at low elevation, on south to west aspects, or with open canopies, are the most vulnerable, possibly due to higher localized temperatures. Simultaneously, drought-weakened trees are more susceptible to attack from disease and insects, which would not be fatal for healthy trees. Conversely, increased wildfires under warming scenarios may pose greater opportunities for aspen expansion, and the complexity of multiple disturbances seems to favor aspen dominance over competing conifers.

The extirpation of beaver from their historic distribution on the Bridger-Teton negatively affects riparian aspen communities. Aspen woodlands in riparian situations may be suffering drought-like effects from the historic reductions in beaver numbers and distribution. Fur trapping in the 19th century greatly reduced beaver numbers, extirpating them from many areas in Wyoming. By the late 20th century, beavers re-occupied most of their historic range, but only at roughly 10 percent of pre-European-contact densities (WGFD 2017a). Among other important effects, beaver ponds raise water tables and increase the size of the riparian zones near surface water, which increases habitat quality for aspen. Ponds and adjacent banks also store snowmelt for release later in the year, increasing flows, riparian quality, and aspen habitat quality downstream. Although beaver browsing and ponding can reduce aspen numbers at times, over the long-term a healthy beaver population forms a dynamic mosaic of patches of varying aspen seral stages along a stream network.

Forests dominated by aspen can increase water storage capacity as they tend to accumulate more snow and contribute to increased soil organic matter, a property that helps to retain soil moisture. Aspen accumulates more snow than adjacent conifer stands (snow–water equivalent), but higher evapotranspiration rates in aspen forests lead to faster summer water loss (Rogers 2017). Soil storage capacity (i.e., greater porosity) then becomes the difference in the net superiority of aspen forests to retain water.

In general, recreation impacts to aspen communities are modest. However, there are instances in: campgrounds, along trails, at ski resorts, and in surrounding parking areas where stem

scarring, soil compaction, root damage, and localized air pollution impacts threaten stand health. Conversely, recreation in and around aspen forests generates large economic benefits. People who enjoy: mountain biking, skiing, off-road vehicle use, hiking, camping, photography, hunting, and nature/wildlife viewing place a high premium on healthy aspen ecosystems.

Ungulate browsing in combination with drought-affected forests presents the most acute threat across aspen's western range. Maintenance of multi-layer and multi-age aspen stand structures, via reduction of browsing, can increase resilience to climate change and prolonged drought. Use of fire—both prescribed and lightning ignited—holds great promise for improvement of aspen conditions in the West, although post-disturbance protection will be required where elevated herbivory is expected. Additionally, climate change will have prominent effects on wildfire patterns. Increased burning, alongside interacting disturbances such as wind throw, bark beetle outbreaks in conifers, and incidence of stem and root rots, will likely enable aspen to thrive and grow in the coming decades.

Inter-Mountain Basins Montane Sagebrush Steppe

Key Takeaways

The sagebrush steppe ecosystem is one of the most important and imperiled ecosystems in North America. It faces continued and widespread degradation due to: invasive plants, altered fire regimes, climate change, and land use and development. Currently, these ecosystems have moderate ecological integrity on Bridger-Teton and they are expected to continue to have moderate integrity to 2050. Primary factors affecting ecological integrity in this system include: fire return interval, invasive species, ungulate grazing, and climate change. Bridger-Teton staff can utilize tools to improve the vegetation condition and structure of this ecosystem that include: invasive species treatments, prescribed fire, adaptively managing livestock grazing, conifer removal, and managing unauthorized vehicle use.

Summary

The sagebrush steppe is an integral part of the GYE. It is one of the most imperiled ecosystems in North America. Since the 1950s, over half of the sagebrush steppe in North America has been lost to: oil and gas development, agriculture, recreation, unmanaged grazing, and fire. Drivers and stressors that influence the status and trend of this ecosystem include grazing, fire exclusion, invasive species and climate change. In sage-steppe communities, grazing removes fine fuels, which constrains wildfire spread and size, and decreases fire intensity and severity (Orr et al. 2023). Sagebrush now occupies an estimated 160 million acres (less than 55 percent of its historical extent) over portions of 14 western states. There are concerns with the conservation of more than 350 species of plants and animals associated with sagebrush ecosystems (Remington et al. 2021). While the sagebrush steppe only occupies 10.3% of the Bridger Teton it is vitally important at a local and national scale for winter range and wildlife habitat.

Sagebrush habitats are found in cold, semi-desert climates across the Intermountain West; Wyoming has more sagebrush than any other state. Estimates vary on the amount of sagebrush dominated communities in Wyoming, but they range from 23.5 million acres to approximately 37 million acres (WGFD 2017a). Montane sagebrush steppe is mapped at approximately 355,618 acres or 10.3 percent of the Bridger-Teton (See Table 9).

Sagebrush steppe ranges from 6,000-8,500 feet on the Bridger-Teton. It is found on all aspects, although it rarely occurs on northerly slopes. It is scattered in forest openings and benches along mountain foothills throughout the Bridger-Teton and adjacent to lower forested areas. Sagebrush communities often contain a biological soil crust (WGFD 2017a). The biological soil crust is composed of: blue-green algae, bacteria, fungi, mosses, and lichens. Research indicates the crust may play an important role in sagebrush steppe communities: stabilizing soils from wind and water erosion, contributing to soil productivity, influencing nutrient levels, retaining moisture, altering soil temperature, and aiding seedling establishment (WGFD 2017a). Research shows that precipitation may drive site potential for the formation of soil crust and is more prevalent in more arid communities but still occurs in higher precipitation sagebrush communities at lower cover (Kaltenecker et al., 1999).

Dominant vegetation includes: big sagebrush *(Artemesia tridentata*), mountain big sagebrush (*Artemesia tridentata spp., vaseyana*), rubber rabbitbrush (*Ericameria nauseosa*), antelope bitterbrush (*Purshia tridentata*), a variety of perennial bunchgrasses from Idaho fescue (*Festuca idahoensis*) to basin wildrye (*Leymus cinerus*) as well as a lush array of hundreds of wildflower species including: arrowleaf balsamroot (*Balsamorhiza sagittata*), sticky geranium (*Geranium viscosissimum*), green gentian (*Frasera speciosa*), hooded phlox (*Phlox hoodii*) and berry shrubs such as chokecherry (*Prunus virginiana*) and serviceberry (*Amelanchier alnifolia*).

Key ecosystem services provided by this ecosystem include big game winter range, suitable and capable range for livestock grazing, and recreation. This ecosystem provides important habitat for: greater sage-grouse, sage obligate songbirds, mule deer, pronghorn, elk, insect and bird pollinators, and top predators such as wolves and grizzly bears (Bloom et al. 2022).

Key ecosystem characteristics when the system exhibits high integrity include succession classes within the NRV. The current status of the ecosystem consists of a deficit of succession class B across the Bridger-Teton, and a surplus in succession class C in the Wind River Mountains (See Table 16). The relative amount of succession class A is similar to the NRV across the Bridger-Teton. There is a limited amount of information available on fire regimes and reference conditions in sagebrush.

Several system processes, drivers, and KECs support ecological integrity in this ecosystem. Fire is a major disturbance factor for Mountain big sagebrush. Other natural disturbance events within the NRV are important components of maintaining the mix of succession classes as well as grass and forb diversity. Drought, insects, and native grazing were present under pre-settlement conditions in this ecosystem. Most of these disturbances were mixed severity resulting in thinning of sagebrush. Gophers tunnel underground and browse on sagebrush roots possibly giving an advantage to forb species. This ecosystem contains a variety of legume species that serve as nitrogen fixers that benefit other plant species and can lead to higher diversity. Soil orders typically associated with this ecosystem are Inceptisol and Mollisol.

Status and Trends

About 45 percent of the potential sagebrush habitat in the West is no longer sagebrush (WGFD 2017a). The West loses an additional 1.3 million acres, or roughly 2,000 square miles of its sagebrush steppe, every year (Doherty et al. 2022). The data shows 73 percent of the loss stems from ecosystem problems: invasive annual grasses, wildfire, and conifer encroachment. Just a quarter of the loss is directly due to human activities (Doherty et al. 2022).

Currently, these ecosystems have moderate ecological integrity on Bridger-Teton. They are expected to continue to have moderate integrity to 2050. This is primarily based on the current succession classes (See Table 16) differing from the NRV Table 14, and the successes the Bridger-Teton has had treating invasive annual grasses. Although the future severity of climate impacts is not fully known, the Bridger-Teton is proactive in dealing with invasive grasses and that effort will be maintained. The relative amount of succession class A is similar to the NRV across the Bridger-Teton (See Table 16). The current status of the ecosystem consists of a deficit of succession class B across the Bridger-Teton and a surplus in succession class C in the Wind River Mountains (See Table 17). This is mainly a result of fire suppression activities over the last 100 years.

Table 16. Description of succession classes and departure within the Inter-Mountain Basins Montane Sagebrush Steppe Ecosystem

Succession Class Description	Composition/Structure	Reference Percent	Current Percent	Status	Sum of Acres
A: Early development, all structures	Post-replacement disturbance vegetation dominated by grasses and forbs. Shrub cover less than 10%. Herbaceous cover 0-30%. This succession class will transition to succession class B after approximately 13 years.	23%	27.6%	Similar	98,159
B: Mid-development, open structure	Shrub cover: 10-30%. Herbaceous cover: 0-40%. After 30-40 years this succession class usually transitions to succession class C in the absence of disturbance. On very dry sites, however, a closed structure may never be attained.	47%	18.4%	Deficit	65,348
C: Late development, closed structure	Shrub cover 30-50%. Herbaceous cover is variable. Other disturbances, such as drought stress and insects, may cause this S- Class to transition to succession class B.	30%	40.4%	Similar	143,801
UE: Uncharacteristic exotic	Non-native plant communities becoming established on the Biophysical Setting.	0.0%	0.9%	Surplus	3,328
UN: Uncharacteristic native	Native vegetation cover located in areas it was not traditionally located, or having uncharacteristic cover, structure, or composition.	0.0%	12.7%	Surplus	44,982
Total	**Not applicable**	**100%**	**100%**	**Not applicable**	**355,618**

Source: Helmbrecht et al. 2012, USDA 2023c, and USDA 2023d.

Table 17. Succession class departure for Inter-Mountain Basins Montane Sagebrush Steppe, by landscape

Row Labels	Reference Percent	Current Percent	Status	Sum of Acres
Leidy Highlands	Blank	30.4%	Blank	108,160
A	23.0%	30.6%	Similar	33,127
B	47.0%	19.3%	Deficit	20,874
C	30.0%	36.4%	Similar	39,377
UE	0.0%	1.4%	Surplus	1,498
UN	0.0%	12.3%	Surplus	13,285
Wyoming Range	Blank	43.0%	Blank	152,740
A	23.0%	30.9%	Similar	47,260
B	47.0%	15.5%	Deficit	23,631
C	30.0%	39.4%	Similar	60,217
UE	0.0%	1.1%	Surplus	1,691
UN	0.0%	13.1%	Surplus	19,941
Wind River Mountains	Blank	12.1%	Blank	43,083
A	23.0%	18.8%	Similar	8,110
B	47.0%	17.8%	Deficit	7,675
C	30.0%	51.2%	Surplus	22,040
UE	0.0%	0.1%	Surplus	54
UN	0.0%	12.1%	Surplus	5,203
Kemmerer	Blank	14.5%	Blank	51,636
A	23.0%	18.7%	Similar	9,662
B	47.0%	25.5%	Deficit	13,169
C	30.0%	42.9%	Similar	22,167
UE	0.0%	0.2%	Surplus	85
UN	0.0%	12.7%	Surplus	6,553
Total	**Not applicable**	**100%**	**Not applicable**	**355,618**

Source: USDA 2023c.

Due to disruption of natural disturbance regimes, particularly fire, many felt that sagebrush in Wyoming is in late successional stages dominated by plants of relatively even age classes and older than 50 years of age (WGFD 2017a). These stands are commonly believed to display: reduced vigor, productivity, diversity, and nutritional quality (WGFD 2017a). It is also believed that a mosaic of sagebrush age classes are required to best meet wildlife forage and cover needs. As a consequence, sagebrush habitats have been subjected to a variety of treatments including burning, chemical control, and mechanical manipulation to improve wildlife habitat and livestock forage production.

However, there is no widespread agreement on what constitutes decadence and poor vigor, particularly among wildlife biologists and range managers. Prescribed fire programs and other sagebrush habitat treatments are often based on the assumption that fire suppression has substantially reduced the frequency of fire in sagebrush vegetation; however, this assumption is very hard to prove (WGFD 2017a). While fire suppression is most often associated with the perceived decadence of sagebrush systems, drought stress over the past decade has likely played a role. As a result of these uncertainties, it is difficult for natural resource managers to quantify the size and scope of the problem, determine its cause, and apply appropriate management actions. Furthermore, there is often little systematic monitoring following habitat treatments to document their extent and effectiveness. The Wyoming Governor's Sage-grouse Implementation Team identified the potential positive or negative effects of various habitat treatment practices (e.g., mowing/burning sagebrush, interseeding, and grazing), and they recommend additional monitoring and research be conducted.

The primary ecological processes, disturbance regimes, drivers, stressors, and other KECs affecting the ecological integrity for this ecosystem on the Bridger-Teton include: fire, invasive species, ungulate grazing/browsing, climate change, and healthy soils.

Big sagebrush is easily killed by fire at all intensities, and when exposed to fire, plants do not re-sprout (Montana Natural Heritage Program, Montane Sagebrush Steppe, https://fieldguide.mt.gov/displayES_Detail.aspx?ES=5455, accessed 2024). In southwestern Montana, it has been shown that fire in big sagebrush is stand replacing, killing or removing most of the aboveground vegetation, and that recovery to pre-burn cover (of sagebrush) may require on average approximately 32 years for mountain big sagebrush (Montana Natural Heritage Program, Montane Sagebrush Steppe, https://fieldguide.mt.gov/displayES_Detail.aspx?ES=5455, accessed 2024).

Big sagebrush (Artemesia tridentata) lacks the ability to sprout from roots or root crowns and thus are killed when the crown is removed by fire or mechanical treatments such as mowing. This attribute increases the importance of longevity and seed production for the species. Big sagebrush seedlings only become established during favorable precipitation years or following a disturbance that reduces competition from neighboring plants (WGFD 2017a).

Natural disturbances play an important role in determining the pattern, age structure, and species composition of sagebrush stands. Fire has played a role in shaping the sagebrush communities in Wyoming since the last ice age (WGFD 2017a). The historic ecological role and frequency for fire in sagebrush communities is debated. For mountain big sagebrush (Artemisia tridentata ssp. vaseyana) the fire return interval is poorly understood and can only be estimated using either the duration of the succession process post fire or fire scars found on adjacent trees. The latter is problematic because trees tend to burn mid-summer before sagebrush is sufficiently cured to carry a fire, so using the scars could be an over-estimation of the frequency of fire in the surrounding sagebrush. It is likely that different sagebrush communities have highly variable fire history. Fires burn in patchy mosaics in this type, and scales range from small (tens of acres) to very large (possibly hundreds of thousands of acres) fires contingent on sufficient understory fuel continuity.

Fire suppression in this ecosystem may increase conifer succession, most commonly Douglas-fir and sometimes lodgepole pine.

Both ungulate and livestock grazing can affect both the shrub component and grass/forb component. Most big game winter range is in this ecosystem. Ungulate populations that are

above population objectives can over-browse sagebrush in the winter, which could make those areas more vulnerable to invasive species and/or conifer encroachment. Timing, frequency, duration, and intensity of livestock grazing are critical factors that determine its effects on this ecosystem. These factors influence how grazing affects plant communities, ecosystem function, and overall landscape health. Other disturbances, such as fire and drought, can further interact with grazing to influence ecosystem dynamics. Grazing management can serve as an effective tool for vegetation manipulation, removing fine fuels and contributing to more manageable fire behavior (Ratliff et al., 2022). Livestock grazing that does not consider timing, frequency, and duration, and does not provide adequate plant recovery can result in an increase of annual grasses and forbs, nonpalatable perennial grass species, bare ground, erosion, and the spread of nonnative species, which can compromise ecosystem integrity.

Interactions of changes in climate with wildfire and invasive annual grasses will be the dominant challenge to ecological integrity in sagebrush communities in the next few decades.

Warmer summer temperatures and reduced precipitation can change the fire return interval as well as the intensity and size of fires on the landscape. Mountain big sagebrush (*Artemesia tridentata var. Vaseyana*) was probably not as abundant in pre-settlement conditions, since the original vegetation of sagebrush-grass consisted of a dense cover of perennial grasses among scattered moderate-sized shrubs. Sagebrush might be denser now in these communities due to fire exclusion, grazing, and/or climate change.

Studies of age-class structure in sagebrush communities suggest the establishment of new sagebrush plants is episodic, and in many cases, depends on above-average precipitation either during the first or second year of growth (WGFD 2017a). Some climate models predict Wyoming's climate will become drier (WGFD 2017a). More frequent and severe dry years could decrease the establishment of new sagebrush plants and slow or prevent recovery of sagebrush stands following fire, habitat enhancement treatments, or other disturbances that kill adult shrubs.

Drought also causes a decrease in the production of herbaceous cover and forb availability, which may affect the abundance of many species of wildlife. The difference between sagebrush production in drought versus non-drought years can be as much as 900 percent (WGFD 2017a). Loss in production can lead to increased competition between livestock and wildlife for food and cover. For example, plants in the sagebrush steppe of Jackson Hole are flowering 3 weeks earlier now than in the 1970s (1970-2020) driven by warming temperatures and earlier snowmelt timing (Bloom et. al 2022). Earlier shifts in phenology can have cascading impacts on pollinators, greater-sage grouse, and grizzly bears.

The establishment of invasive plants can lead to loss of water and soil nutrients, increased erosion, and reduced productivity of native vegetation. These effects reduce habitat quality for sagebrush-associated species including: pronghorn, mule deer, elk, greater sage-grouse, and sagebrush passerines. Ecological function deteriorates as hydrological processes are impacted, litter accumulation and organic matter breakdown decreases, and soil surfaces become denuded of native plants and biotic soil crusts. Once invasive plant species become established, a seed source is developed for invasive species to expand into adjacent habitats such as riparian areas.

Cheatgrass (*Bromus tectorum*) is a growing threat for Wyoming sagebrush habitats. Disturbance events, such as wildfire or prescribed fire, can result in a cheatgrass invasion, and it has been a major issue across the entire Bridger-Teton. Cheatgrass fundamentally alters fire

and vegetation patterns in sagebrush habitats by creating a bed of continuous, fine fuel that readily carries fire. Among other impacts on wildlife, increased fire frequency can decrease spring insect availability for birds. Where cheatgrass invaded the Snake River Plains of Idaho, the natural fire cycle shortened from 30–100 years to 3–5 years (WGFD 2017a). Because sagebrush may take several years to mature before producing seed, repeated fires can entirely eliminate sagebrush and may result in type conversion from sagebrush steppe. Cheatgrass dominance eventually creates uniform annual grasslands, perpetuated by large, frequent fires and void of any patches of native plant communities (WGFD 2017a).

Leafy spurge (*Euphorbia esula*), Nodding plumeless thistle aka musk thistle *(Carduus nutans*), spotted knapweed (*Centaurea stoebe*), Canada thistle (*Cirsium arvense*), gypsyglower aka houndstongue (*Cynoglossum officinale*), black henbane (*Hyoscyamus niger*), Dyer's woad (*Isatis tinctoria*), whitetop (*Cardaria draba*) and Dalmatian toadflax (*Linaria dalmatica*) are other invasive species that pose a threat to sagebrush communities. Invasive plant invasions often originate in areas of disturbed or bare soil.

Currently, insects and disease that affect sagebrush do not seem to be a major driver or stressor on the Bridger-Teton, but there is evidence of western tent caterpillars (*Malacosoma californicum*) invading this ecosystem and completely defoliating antelope bitterbrush shrubs on certain sites along the Wind River Front. This outbreak was isolated and not witnessed in other areas of the Bridger-Teton or in higher elevations. It is possible that with climate change, grasshopper and Mormon cricket (*Anabrus simplex*) outbreaks may impact this ecosystem. Shrubs that are stressed from: drought, high summer temperatures, excessive browsing or soil compaction are less able to fight off insect outbreaks.

Pure sagebrush stands are found in areas with deeper soils and less topographic relief, but they are also common on slopes with a gradual shift to a mixed, mountain shrub community on steeper slopes and in drainages. Precipitation ranges from 12-20 inches/year. Soils are deep and well drained. Soil moistures are udic (not dry for as long as 90 cumulative days) and soil temperatures cryic (very cold soils in the Rocky Mountain Region). This ecosystem contains a variety of legume species that serve as nitrogen fixers that benefit other plant species and can lead to higher diversity. Soil orders typically associated with this ecosystem are Inceptisol and Mollisol.

Montane sagebrush steppe is dominated by mountain big sagebrush (*Artemesia tridentata* ssp*. vaseyana*), but it can host more than 130 other species of plants. This vegetation type may occur as inclusions within forested types, especially on the ecotone border with montane forest and quaking aspen. There is a frequent presence of other evergreen shrubs that are critical for elk, pronghorn, and mule deer winter range including antelope bitterbrush and rubber rabbitbrush. Other species of sagebrush in this ecosystem include prairie sagewort aka fringed sage (*Artemisia frigida*) and threetip sagebrush (*Artemisia tripartita*).

The sagebrush steppe understory is made up of an extremely diverse variety of perennial bunchgrasses and sedges including: bluebunch wheatgrass (*Pseudoroegneria spicata*), Idaho fescue (*Festuca idahoensis*) basin wildrye (*Leymus cinerus*) and sandberg bluegrass (*Poa secunda*). Herbaceous cover is moderate to abundant ranging from 40-85 percent hosting a lush array of hundreds of wildflower species including: arrowleaf balsamroot (*Balsamorhiza sagittata*), sticky geranium (*Geranium viscosissimum*), green gentian (*Frasera speciosa*), hooded phlox (*Phlox hoodii*), and hundreds more. A continuous grass and forb understory is believed to be a major pre-settlement vegetation type, although the exact composition of the

community greatly varies across the Bridger-Teton. The ecosystem also hosts many berry producing shrubs including: mountain snowberry (*Symphoricarpos oreophilus*). wild rose (*Rosa woodsii*), chokecherry (*Prunus virginiana*) and serviceberry (*Amelanchier alnifolia*), which are important food sources for wildlife.

Sagebrush-associated vegetation types provide habitat for approximately 87 species of mammals; 297 species of birds; and 63 species of fish, reptiles, and amphibians (WGFD 2017a). Sagebrush ecosystems in Wyoming not only support crucial habitats for some of the largest migratory populations of ungulates in North America, but also offer the best chance to sustain healthy populations of sage-grouse and other sagebrush dependent species (WGFD 2017a). In Wyoming, sagebrush obligates include the: sage sparrow, Brewer's sparrow, sage thrasher, sage-grouse, pygmy rabbit, sagebrush vole, and sagebrush lizard (WGFD 2017a).

Sagebrush itself is a keystone plant. Sagebrush ecosystems provide important food and cover, especially winter habitat, for big game species and other wildlife. The protein level and digestibility of sagebrush are typically greater during winter than other shrub and herbaceous plants (WGFD 2017a). During this time, sagebrush is commonly the only green vegetation that rises above the snow. Elk, mule deer, and pronghorn are the primary wild ungulates that utilize sagebrush habitat. Pronghorn antelope attain their highest population densities in these ecosystems. Wyoming big sagebrush is also regarded as a crucial food item for sage-grouse, and mature sagebrush cover is important for sage-grouse broods.

Invertebrate communities in sagebrush are not well understood, but they may be critical to its effectiveness as wildlife habitat. Invertebrates represent high-protein forage, especially in spring and early summer, when plant protein is not yet available, and vertebrates are generally protein-starved. Insect forage is known to be key to survival of sage-grouse chicks during the first few weeks after hatching, which in turn is key to increasing sage-grouse populations. Similar scenarios likely apply to other sagebrush-occupying wildlife. In addition to the numerous vertebrate and invertebrate animal species that depend on sagebrush for food and cover, there are several plant species primarily found only in association with sagebrush.

Grazing management can be used as tool to maintain or improve ecological integrity in this ecosystem. Best management practices that adjust the intensity, interval, and season of use for grazing can have significant impacts on ecosystem health. Grazing can influence sagebrush density, canopy cover, and re-establishment rates as well as herbaceous composition (WGFD 2017a). Grazing also may reduce fine fuels and alter fire regimes (WGFD 2017a). Spring developments, water pipelines, and fencing can affect how livestock and wildlife use areas. Grazing that is not adaptively managed can lead to a loss or alteration of forbs and shrubs, interfere with ecological process, increase the spread and establishment of invasive plant species, and reduce habitat quality for wildlife. Adaptively managing the timing and intensity of grazing is particularly important for retaining residual grass cover, which has a strong influence on nesting success for sage-grouse and ground-nesting birds by providing cover to hide nests and hatchlings from predators.

As directed in the 2015 Sage Grouse Plan Amendment (USDA 2015), livestock grazing on the Bridger-Teton would be managed to maintain residual perennial grass height in nesting and brood rearing habitats.

Off-road vehicle use is increasing in sagebrush habitats. Driving vehicles off established roads can enhance the spread of invasive species, especially spotted knapweed and cheatgrass (WGFD 2017a). Illegal off-road activity can crush sagebrush, create new routes, and damage

biological soil crusts. Areas of shallow soils are particularly susceptible to erosion and “crusting”, which can create gullies and washouts after heavy rain events.

Many areas of the Bridger-Teton that make-up this ecosystem are considered big game winter range. Additionally, this ecosystem provides suitable and capable acres for livestock grazing. Those ecosystem services will likely continue and, depending on the impact of climate change and fire return interval, could expand into nearby forested areas. Water, air quality, erosion, and natural hazard regulations could all be negatively impacted through large and frequent wildfire events that become more common with climate change and the subsequent flush of invasive annual grasses in this ecosystem following fire. Recreation and aesthetics could be negatively impacted if large wildfires, drought, and invasive plants change this shrub community to one that is considered less desirable by humans.

Sagebrush has been identified as one of eight priority habitats to enhance or maintain within the WGFD SHP. The purpose of the SHP is to strategically guide WGFD habitat improvement and protection activities. Regional priority areas for conservation work are identified including crucial areas necessary for maintaining terrestrial and aquatic wildlife populations, and enhancement areas where there is the potential to enhance or improve important wildlife habitats that have been degraded. Narratives for both crucial and enhancement areas describing the location, boundaries, values, issues, species, and solutions/actions are available on the WGFD website, User Guide to Habitat Priority Areas.[2]

The degree the Bridger-Teton can affect change in this ecosystem is high for the near-term and high for the long-term.

Subalpine Forb Ecosystem

Key Takeaways

The current level of ecological integrity for this ecosystem is moderate. This is the result of historic overgrazing by domestic sheep and recreational activities, which resulted in vegetation alteration and soil loss at localized subalpine forb sites combined with the subsequent changes to current day management that have improved conditions over the past 30 years. The long-term trend (to 2050) for the integrity of this ecosystem is also considered moderate based on current trend monitoring, which shows that a majority of sites are stable or in an upward trend in response to current management efforts, but there are still a small proportion of sites trending downward. There is a moderate ability of the forest to positively affect ecological integrity in the near term through invasive species treatments, managed grazing, seed collection and planting, and managing recreation impacts.

Summary

Unique among the forest and rangeland ecosystems in the western United States is one broadly referred to as the subalpine forb ecosystem, which includes a complex of 15 identified subalpine forb community types (Gregory 1983), including a unique subset of plant community types broadly referred to as “tall forb” community types (Baigas 2009). Tall forb community types

[2] The WGFD website is accessible at: https://wgfd.wyo.gov/Habitat/Habitat-Plans/Habitat-Priority-Areas#:~:text=Three percent20sets percent20of percent20habitat percent20priority,areas percent20and percent20 percent22connectivity percent22 percent20areas.

occur in subalpine areas of the Bridger-Teton, primarily in the Wyoming, Salt River, and Gros Ventre Ranges. Tall forb plant communities are exemplified by high plant diversity and a wide variety of luxuriant wildflowers (Winward 1998), and they are arguably some of the most important types within the subalpine forb ecosystem and on the Bridger-Teton because when healthy, they store water and contribute to watershed health (Zobell et al. 2023). Situated in the upper portions of watersheds, their condition affects the entire downstream ecosystem. Intact tall forb communities provide hydrologic services including water retention, storage, and slow runoff release from spring snowmelt and intense summer thunderstorms (Winward 2011) which in turn support aquatic habitat. In addition, plant biomass contributes to soil formation, air quality, and erosion control as well as proper nutrient cycling. Healthy soils and ground cover, temperature, precipitation, and snowpack within the NRV that maintain tall forb sites in their Reference State contribute to a high integrity system.

The subalpine zone of the Bridger-Teton is generally between 6,000-10,000 feet elevation and exhibits incredibly diverse flora. Subalpine forb community types are unique from other cover types in that successional processes on these sites reach their potential by supporting a vast array of colorful flowering forb species while the surrounding lands support a variety of trees, shrubs, and/or graminoids. Subalpine forb habitats may occur as small openings in forests or large open parklands in the subalpine zone. According to the Bridger-Teton's most recent vegetation data, there is a total of 72,102 acres, or approximately 2 percent of the Bridger-Teton, classified as subalpine forb community types. Although minor on the landscape, their ecological importance is disproportionately high because of the ecosystem services they provide, including: wildlife and pollinator habitat, watershed function, biodiversity, and biomass. Many plant species that occur on these sites are important to indigenous peoples, and plant communities contribute to the seedbank and biodiversity. Forb sites provide forage for wildlife and hunting opportunities for upland game species. The wide variety of forbs, which bloom from early summer until fall, have an aesthetic value that appeals to recreationists.

Common species of the subalpine forb ecosystem on the Bridger-Teton, as described by Gregory (1983) include: white marsh marigold (*Caltha leptosepala*), tall fringed bluebells (*Mertensia ciliata*)*, false hellebore (*Veratrum californicum*), spearleaf arnica (*Arnica longifolia*), fireweed (*Chamerion angustifolum*), goldenrod (*Solidago* spp.)*, cutleaf balsamroot (*Balsamorhiza macrophylla*)*, fern-leaf licorice-root (*Ligusticum filicinum*)*, western coneflower (*Rudbeckia occidentalis*)*, showy goldeney (*Heliomeris multiflora* var. *multiflora*), nettleleaf giant hyssop (*Agastache urticifolia*)*, common cowparsnip (*Heracleum maximum*)*, arrowleaf balsamroot (*Balsamorhiza sagittata*), mule-ears (*Wyethia amplexicaulis*)*, tall larkspur (*Delphium x occidentale*)*, oneflower helianthella (*Helianthella uniflora*)*, owl's-claws aka sneezeweed (*Hymenoxys hoopesii*), silvery lupine (*Lupinus argenteus*)*, Virginia strawberry (*Fragaria virginiana*), and tobacco root (*Valeriana edulis)** (Gregory 1983). Other species include: sticky purple geranium (*Geranium viscosissimum*)*, alpine leafybract aster (*Symphyotrichum foliaceum*)*, thickstem aster (*Eurybia integrifolia*)*, western sweetroot (*Osmorhiza occidentalis*)*, Engelmann's aster (*Eucephalus engelmannii*), Columbian monkshood (*Aconitum columbianum*)*, aspen fleabane (*Erigeron speciosus*)*, stickseed (*Hackelia* spp.)*, Porter's licorice-root (*Ligusticum porter*i)*, lousewort (*Pedicularis* spp.), tall cinquefoil (*Potentilla arguta*)*, slender cinquefoil (*Potentilla gracilis*)*, groundsel aka ragwort (*Senecio* spp.)*, meadow-rue (*Thalictrum* spp.), and western valerian (*Valeriana occidentalis*)*. Certain grass and sedge species occur as a minor component of subalpine forb communities, particularly mountain brome (*Bromus marginatus*) (Gregory 1983), Raynolds sedge (*Carex*

raynoldsii), slender wheatgrass (*Elymus trachycaulus*) and oniongrass (*Melica* spp.) (Zobell 2023; USDA 2023e; Gregory 1983; Winward 1998).[3]

Historically, domestic sheep stocking rates on the Bridger-Teton were approximately 4-5 times current levels. Range allotment files document historic resource concerns of soil erosion, mainly associated with trailing, and excessive utilization of subalpine forb communities. These documented concerns, in addition to changes in wool markets post-World War II, resulted in decreased stocking and changes in management over time. For example, allotments and grazing permits were implemented beginning in the early 1900s, livestock numbers reduced from hundreds of thousands of domestic sheep in the 1930s to less than 40,000 currently permitted, and current day sheep grazing on subalpine forb areas does not occur until July, reducing the negative effects of early foliar cover removal. Since 1990, the Bridger-Teton has significantly reduced stocking levels and employed grazing management that controls intensity, frequency, duration, and distribution is employed to minimize soil loss and maintain appropriate utilization levels. Once-over and rotational grazing practices replaced season long grazing and best management practices have been implemented through annual operating instructions and allotment management plans.

The Wyoming Range Allotment Complex (WRAC) and Triple Peak Forage Reserve (TPFR) were established in 2004 and 2008 to address concerns with overlap of bighorn sheep core area (WRAC) and to improve watershed health in Colorado River Cutthroat Trout (CRC) critical areas (Sublette County Conservation District 2019a, 2019b). Three of the allotments in the WRAC are a result of the permittee waiving the permit back to the Forest Service without preference and remain vacant while the remaining allotments are closed to grazing. Closed allotments are closed to scheduled grazing and require a National Environmental Policy Act (NEPA) analysis to open them to any grazing while vacant allotments allow for a temporary permit and require NEPA analysis to obtain a 10-year permit.

Herbivory continues to be a potential driver for ecological dynamics that requires continued careful management. Another aspect of subalpine forb ecological dynamics is the common occurrence of native pocket gophers, which create burrow systems, eskers, and mounds in the upper 8-10 inches of the soil profile (Zobell et al 2023). While the role of pocket gophers is not completely understood, they can provide benefits to properly functioning communities through the aeration of soil. However, there is evidence to suggest that they may also influence species composition and the amount of ground cover (Zobell et al. 2023).

Status and Trends

Forest Service guidelines to evaluate the current status and trends of upland rangelands include presence of invasive plants, species composition, and ground cover, which is defined by the forest service as basal vegetation, litter, moss/lichen, and rock greater than ¾-inch diameter (USDA 2005b). The minimum ground cover for proper functioning of tall forb cover types was determined to be 80% in *Indicators of Rangeland Health and Functionality in the Intermountain West* (O'Brien 2003). However, guidelines allow for a deviation from this standard if more site-specific information is available (USDA 2005b). However, the Bridger-Teton does not currently have more site-specific guidance, and there are not guidelines for subalpine forb community types that are not considered tall forb communities. Individual allotment management plans utilize standard guidance of 80% ground cover or identify other objectives, including but not

3 Denotes species dominant or associated with tall forb community types (Gregory 1983; Winward 1998).

limited to utilization levels, bare ground, frequency, species composition (cover), and species richness. Trend information is based on a combination of the above metrics and repeated photo points.

Objectives for the WRAC and TPFR include 80% ground cover for all tall forb community types and 5% canopy cover for at least one listed key plant species (sticky purple geranium, fernleaf licorice-root, oneflower helianthella, tobacco root, or mountain brome) (Sublette County Conservation District 2019a, 2019b). There are 11 monitoring locations in the WRAC and TPFR, where domestic sheep grazing was removed over 20 years ago, with 55% of sites showing a stable or upward trend, defined as similar or increasing ground cover over the monitoring timeframe of 1983 to 2019 (Sublette County Conservation District 2019a, 2019b). Most sites (82%) met the objective of 5% or greater cover of at least one of the identified key plant species. None of the sites meet established ground cover objectives of 80 percent. However, mean ground cover for all sites is 63 percent, with all but three sites exceeding Forest Service guidance indicating 60 percent ground cover required to protect soil resources (O'Brien 2003). Mean bare ground for all sites is 12 percent, and all but one site has less than 20 percent bare ground. Mean foliar cover for all sites is 79 percent, and all but two sites have greater than 60 percent foliar cover, an indicator of soil protection from rain events (Sublette County Conservation District 2019a, 2019b). A significant number of sites (45%) show a downward trend since grazing was removed from the area, indicating variables other than livestock grazing affecting these sites. However, long-term trend compared to the 1950s and 1960s is upward. In addition, Colorado River Cutthroat Trout (CRC) have responded positively, with re-establishment in Mule and Silver Mine creeks since the establishment of the WRAC (Rhea 2016).

There are 30 active sheep allotments that intersect subalpine forb community types on the Bridger-Teton, and their management objectives include providing livestock forage, roads, trails, and driveways to manage livestock grazing, meeting or exceeding state water quality standards, providing suitable and adequate habitat for game and fish, protecting sensitive plant and animal species, retaining or improving forage and range conditions, retaining or enhancing riparian areas, coordinating livestock management with recreation, preventing human interference with livestock operations, controlling the spread of noxious weeds, and implementing predator-control programs where intolerable losses to livestock are demonstrated (USDA 1990).

Range staff have established hundreds of subalpine forb monitoring studies in grazed allotments where various sampling methods described above are used to determine condition and trend. Based on a sample size of 13 allotments representing 72% of the monitoring locations, approximately 30% of the allotments are upward, 60% apparently stable, and 10% downward trending. Mean ground cover as defined by the Forest Service is 53% for sample size of 45 monitoring locations (n = 45), while mean ground cover as defined by the *Monitoring Manual for Grassland, Shrubland and Savanna Ecosystems Volume II: Design, supplementary methods and interpretation* (Herrick etal 2009), which includes vegetation foliar cover in addition to litter, moss/lichen, and rock greater than ¾-inch diameter, is 81 percent (n = 96). Mean foliar cover is 70% and mean bare ground is 14% (n = 137) and species richness is 25 (n = 117). Sampled locations (n = 25) average 18% utilization with less than 3% of sites exceeding established utilization objectives. In addition, there are many photo points illustrating trend over time and highlighting a reduction in soil loss and stabilization in gullies with fewer active gullies compared to conditions prior to 1990. Best management practices used to manage domestic sheep grazing include once over grazing, one night per bedding ground, open herding, and placement of mineral locations.

Analysis and discussion of condition and trends point to several key issues when setting realistic objectives, selecting monitoring locations and methods, and analyzing the data. The currently identified community types for the forest occur on a variety of soils, aspects, slopes, landscape positions, and precipitation and elevation ranges. They include tall forb as well as subalpine forb community types not considered tall forb sites. Therefore, the site potential in terms of species composition, foliar and ground cover, and productivity likewise vary. Even the subset of community types considered “tall forb” types occur on sites with different effective moisture which affects their site potential. When setting objectives, there is a need for more site-specific guidance that considers site potentials. Therefore, the Bridger-Teton is working toward utilizing the Ecological Site Description (ESD) framework to describe important site concepts that occur on the forest.

The USDA defines an ecological site as a distinctive kind of land with specific soil and physical characteristics that differs from other kinds of land in its ability to produce distinctive kinds and amounts of vegetation and in its ability to similarly respond to management actions and natural disturbances (Caudle et al 2013). Unlike other vegetation classification systems, ecological site descriptions (ESDs) use: climate, soil, geomorphology, hydrology, and vegetation potential to describe the ecological potential and dynamics. ESDs describe ecological processes, called states, resulting in various plant communities, described as plant community phases, on the same ecological site as a result of natural processes (i.e. disturbance regimes such as fire) or management actions. Once developed, ESDs will provide expected species composition, foliar and ground cover, and productivity for the dominant ecological sites and their Reference State (site potential), alternate States (process-based) and plant community phases (plant dominance-based). ESDs are not prescriptive of the Desired Plant Community (DPC), but they provide descriptions of plant communities that are possible given the existing ecological processes on the site for managers to choose from as their DPC on a site-specific basis.

When selecting monitoring locations, it is important for managers to choose sites representative of the dominant ecological sites that occur and are described on the forest, and monitoring methods will need to conform to the metrics described in the ESD. When analyzing the data, using metrics identified in the objectives and described in the ESD will ensure consistency that is currently lacking for the Bridger-Teton range monitoring program.

In addition to vegetation monitoring, the Bridger-Teton is monitoring other resources on the forest that rely upon subalpine forb communities. In response to a 1997 properly functioning condition (PFC) Assessment of the Bridger-Teton, which indicated some sensitive, disjunct or isolated colonies of butterflies are at risk of disappearing (USFS 1997), baseline monitoring has been established with nearly 200 species/genera of pollinators documented to date (DeLong unpublished). Once a baseline is established, the Bridger-Teton can monitor pollinator trends into the future.

Threats to floral resources include changes in precipitation and temperature that impact nutrient cycling, soil formation and primary production, which may negatively impact pollinator habitat as well as water and air quality and erosion. Other potential threats include unmanaged grazing and impacts from recreational activities, mainly roads, trails, and the introduction of invasive species. Activities currently used to address threats to the subalpine forb ecosystem include invasive species treatments as well as managed grazing and recreation. Seed collection and planting has not been used for these systems in recent years but remains a viable restoration activity if appropriate plant materials are used for existing soil conditions.

Alpine Ecosystem

Key Takeaways

The current status of the ecological integrity of this ecosystem is moderate and the long-term trend (to 2050) for ecological integrity is considered low, primarily due to increasing recreation impacts and climate change. Available management actions on the Bridger-Teton have little to no influence on the climate trajectory. However, the Bridger-Teton can manage recreation impacts.

Summary

Alpine ecosystems occur above treeline and they are characterized by: forbs, grasses, sedges, mosses, lichens, dwarf shrubs, and stunted krummholz trees. They may be densely vegetated to almost entirely barren rock. In most cases where vegetation exists, total ground cover is high. The alpine forbs are perennial evergreen cushion plants that grow as green mounds of vegetation and flower in late summer. They maintain low profiles to withstand snow and wind and shallow roots that cling to rocky habitats; in many cases these plants can live for hundreds of years. Species and community diversity is shaped by harsh growing conditions such as strong winds, cold temperatures, and ultraviolet radiation. Vegetation structure rarely exceeds 4 inches in height with occasional low-growing shrubs 2-3 feet in height. This ecosystem is found on: gentle to moderate slopes, flat ridges, valleys, and basins where the soil is stabilized enough to support communities and the water supply is constant, or in smaller microsites, sometimes on the steepest of peaks or sheer cliffsides.

Although much of the alpine habitat on Bridger-Teton is protected by wilderness or sheer remoteness, the alpine ecosystem faces new threats from: climate change, wildfire, pathogens, and increased recreation.

Mountain ecosystems, similar to arctic tundra, are disproportionally affected by climate change compared to other habitats and, therefore, are at risk of conversion. Many mountain ranges are rich biodiversity hotspots, harboring endemic species restricted to a single range. As the climate warms, cold adapted alpine species are forced to move upslope, but such movement is constrained by elevation and substrate of the summit, resulting in diminishing and fragmented populations, and possible local extinctions.

Historically, the mean fire return interval of the alpine has been 300-1,000+ years depending on elevation, topography, and vegetation; but with climate change fires are moving into higher elevations at greater frequency and intensity. Increased wildfire will compound the direct effects of climate change on alpine taxa in North America. Under a moderate climate scenario, the Middle Rockies Ecoregion is projected to lose up to 43-74 percent of suitable high alpine habitat by 2050 driven by climate and wildfire (Bloom et al. 2018).

Alpine ecosystems provide important services such as recreation. This ecosystem plays an important role in water collection and storage, mostly through snow accumulation and melting, which is slowly released into Wyoming’s streams and rivers throughout the summer. In addition, this ecosystem is an important source of insects, which contribute to the forage base for vertebrate wildlife and provide pollination services.

Although the avifauna of the alpine tundra is small compared to those of other habitats, these species (e.g., black rosy-finch and American pipit) are typically specialized and endemic and

they are not found in other habitats during the breeding season. Black rosy-finches are Wyoming Species of Greatest Conservation Need (SGCN) and they breed above timberline in barren, rocky, or grassy areas, including: cirques, talus slopes, and alpine areas that have cliffs, snowfields, or glaciers nearby. The American pika and the wolverine are SGCNs that also are found in this ecosystem. Alpine areas are used by bighorn sheep, primarily in the summer, but also in the winter by the Absaroka, Jackson, Targhee, and Whiskey Mountain herds. Any reduction in available forage could result in negative impacts to bighorn sheep, whether that is over-winter survival or reduced reproductive output.

Key ecosystem characteristics when the system exhibits high integrity include areas where human use or pressures from recreational activities are limited and where the thin soils are healthy and intact. Climate, in particular: temperature, wind, precipitation, glacier extent, and snowpack duration that are within the NRV, contribute to a high integrity system.

The Bridger-Teton has a larger proportion of alpine than is typically found in other areas of the region. Alpine exists at high elevations of the: Bridger, Gros Ventre, and Teton Wildernesses, Wyoming Range, with smaller pockets in the Salt River Range (USDA 2023a). The alpine ecosystem is mapped at approximately 8 percent (~277,188 acres) of the Bridger-Teton.

Status and Trends

The Alpine Ecosystem encompasses three different, but similar biophysical settings: (1) Rocky Mountain Alpine Dwarf-Shrubland, (2) Rocky Mountain Alpine Turf, and (3) Rocky Mountain Alpine – Mountain Sparsely Vegetated Systems. There is no description in Landfire (USDA 2023d) for the “Sparsely Vegetated Systems,” but it primarily consists of high-elevation rocky outcrops above timberline with little vegetation.

This widespread ecological system occurs above upper timberline throughout the Rocky Mountain cordillera, including alpine areas of ranges in: Colorado, New Mexico, Arizona, Utah, Nevada, Idaho, Montana, Wyoming and north into Canada. In Wyoming, roughly 98 percent of alpine ecosystems are publicly owned, and 72 percent are in wilderness areas (WGFD 2017a). Important human uses of alpine ecosystems include: recreational hiking, hunting, fishing, photography, rock climbing, camping, skiing, and horse-packing. This ecosystem plays an important role in water collection and storage, mostly through snow accumulation and melting.

In general, lower elevation alpine communities tend to contain more vegetation cover than those found in higher elevations. The Wind River Range is composed of granitic material, the mountains of the Teton Wilderness are comprised of volcanic material, the Gros Ventre is made up of dolomite and limestone, and the Salt River Range, which has lesser amounts of alpine, is part of the Overthrust Belt, which is composed of mixed sedimentary bedrock. These differences in parent materials, along with elevation and aspect, have contributed to the large variability in the species diversity and density found among alpine communities on the Bridger-Teton (USDA 2023a).

Alpine soils can be very dry as a result of: severe cold, persistent strong winds, intense ultraviolet radiation, low vapor pressure at high altitudes, and reflective solar radiation from snowbanks. These conditions can impair photosynthesis and limit growth of woody vegetation (WGFD 2017a). Alpine tundra is more diverse than the lower elevation mountain grasslands. Alpine plants tend to have more root and rhizome biomass than shoots, leaves, and flowers. This feature not only aids in water and nutrient absorption, but also plays a very important role in over-winter carbohydrate storage (WGFD 2017a). Vegetation structure rarely exceeds 4

inches in height with occasional low-growing shrubs 2-3 feet in height. Large, woody debris is scarce, but lichens, mosses, and biotic soil crusts are common and diverse.

Vegetation in these areas is controlled by snow retention, wind desiccation, permafrost, and a short growing season. Dense tuffs of graminoids and scattered forbs occur. Dominant vegetation includes: dwarf krummholz whitebark pine (*Pinus albicaulis*) and subalpine fir (*Abies lasiocarpa*), arctic willow (*Salix arctica*), netleaf willow (*Salix reticulata*), Western moss heather *(Cassiope mertensiana*), entireleaf mountain-avens (*Dryas integrifolia*), eightpetal mountain-avens (*Dryas octopetala*), Pink mountain heath (*Phyllodoce empetriformis*), huckleberry and blueberry (*Vaccinium spp*.), fleabane (*Erigeron* spp.), asters (*Aster* sp.), spotted saxifrage (*Saxifraga austromontana*), boreal sagebrush (*Artemisia arctica*), blackroot sedge (*Carex elynoides*), dryspike sedge (*Carex siccata*), northern singlespike sedge (*Carex scirpoidea*), spike sedge (*Carex nardina*), curly sedge (*Carex repestris*), tufted hairgrass (*Deschampsia beringensis*), and alpine fescue (*Festuca brachyphylla*).

The alpine ecosystem on the Bridger-Teton contains many at-risk species. These include the federally threatened whitebark pine (*Pinus albicaulis*) and wolverine, along with many of the potential plant species of conservation concern, including: Payson's draba (*Draba paysonii var paysonii*), arctic alpine fleabane (*Erigeron humilis*), Woolly fleabane (*Erigeron lanatus*), and Pink campion (*Silene repens*).

Key ecosystem characteristics when the system exhibits high integrity include areas where human use or pressures from recreational activities are limited (Cole and Monz 2002). Accelerated erosion is the main concern. Biotic soil crusts, which can have a combination of : lichens, cyanobacteria, moss, green algae, fungi, and bacteria, can be important components of alpine ecosystems. They can prevent: erosion, retain moisture, cycle nutrients and contribute to soil formation. They are fragile and do not hold up well to disturbance such as recreation. Recovery after disturbance in alpine tundra is long, due to a very short, cold growing season and extremely slow soil formation.

The fire return interval is approximately 500 years or more, though it might be as high as 2,000 years as there is little evidence of spreading fire in this system. Ignitions are often limited to a single snag or small group of trees. Yet fires are increasing in the alpine due to climate change, with the potential to shift vegetation communities (Bloom et al. 2018).

Ground cover within the NRV provides shade, erosion control and food for wildlife. Vegetated areas provide natural erosion control and reduce the threat of slumping or landslides. The soils that are associated with alpine ecosystems are primarily Entisols and Inceptisols.

Drivers and stressors in this ecosystem are primarily climate driven. Herbivory and the subsequent soil impacts that result from ungulates moving through and utilizing alpine sites contribute to high integrity conditions if those actions are within the NRV and they do not negatively impact vegetative cover and soil conditions. Native herbivores (Rocky Mountain bighorn sheep, mule deer, elk, and pika) are common in the alpine, but probably do not greatly affect vegetation cover because animals frequently move in this environment.

Climate change is a significant stressor/driver, and it can impact: plant structure, survivability, phenology, reproduction and growth yield with rising temperatures, extended drought, and precipitation extremes. Additionally, climate change scenarios likely will exacerbate the current decline in pollinators (specifically western bumblebee) in this ecosystem, and lead to increased

occurrences of temporal mismatch between plants and pollinators. Both these issues can lead to loss of plant biodiversity and seed banks needed to recover from disturbances.

In Wyoming, the greatest increases in annual temperature during the past 50 years occurred at high elevations in the: Wind River, Gros Ventre, Absaroka, Wyoming, and Salt Ranges (WGFD 2017a). If temperatures fluctuate and warming trends continue to move upward, this could result in the snowpack melting-out earlier. If there is no follow-up precipitation after that melt-off, soil moisture would be reduced and soil temperatures would increase at the expense of the plant species trying to survive in this high elevation environment. Rising global temperatures may lead to drier environmental conditions in these habitats could cause shifts in species composition and the loss of high elevation wet meadows, which function as important natural water storage features and hydrological flow regulators. Dry summers associated with major drought years (mean return interval of 100 years) favor grasses over forbs, whereas wet summers cause a more diverse mixture of forbs and graminoids. Warming surface temperatures are expected to be most pronounced at high elevations and latitudes. Changes in species diversity may be most apparent in alpine landscapes as warmer conditions encourage lower elevation species to expand their range upward in elevation and northward in latitude (WGFD 2017a).

Melting glaciers directly impact those species that depend on glaciers for their survival. Glaciers typically hold a higher concentration of chemicals than perennial snowpack. Glaciers that were cored in the Wind River Range contained concentration of nitrates that corresponded with the industrial revolution. As these glaciers melt, they release stored chemicals into the systems downhill. Alpine lakes that are glacially fed usually have a different chemistry and pH than adjacent alpine lakes fed by perennial snowpack.

In alpine systems air pollution and climate can affect crustose lichens, macrolichens growing on soil, and biotic soil crusts. Crustose lichens on rocks are part of the weathering cycle and contribute to soil formation. Deposition from air pollution typically increases with elevation. Excess nitrogen tends to give an edge to the sedges, especially Carex species at the expense of forbs.

Recreational activities such as: camping, hiking, biking, horse-packing, and off-trail travel can degrade mountain grasslands and alpine tundra, especially in areas with shallow soils (WGFD 2017a). Recreationists may: trample plants, compact the soil, increase soil erosion, and contribute to the establishment of invasive plant species. Expanded trail networks, both system and user created, contribute to increases in bare ground. However, alpine tundra and subalpine areas tend to be more resistant to noxious weed invasion due to harsh growing conditions and fewer vectors. Recreational livestock use also can have detrimental localized effects through soil compaction and concentrated grazing. Trampling alpine vegetation and rock lichens along with soil erosion associated with recreation trails and camping activity is of most concern in the Wind River Range. Any disturbance above treeline may have lasting effects because of long recovery times caused by the harsh growing conditions and low productivity. Motorized vehicles, including motorcycles, ATVs and snowmobiles, can have significant impacts on plant communities. The main areas of concern regarding motorized use in this ecosystem are in the Wyoming and Salt Ranges. Recreation and aesthetics could be negatively impacted if changes to the system result in landscapes that are considered less desirable by humans. Nutrient cycling, soil formation and primary production may be impacted as a result of climate change, which may in turn affect the shrubs, forbs, and grasses in this ecosystem critical in holding the soil in place in this extreme environment.

Soils are susceptible to erosion and “crusting” in this ecosystem, which can create gullies and washouts after heavy rain events. Saxicolous crustose lichens, small lichens that adhere to rocks, exude chemicals that break down rocks over time. They also provide housing and food for small insects.

Status

The current status of the ecological integrity of this ecosystem is moderate. Overall, the hydrologic functioning of alpine communities seems to be intact. There is concern that if recreation use continues to increase it could impact the shallow soil structure characteristic of this ecosystem. The ecosystem is still functioning across much of its range in a good condition, but there are issues compromising it, especially in the Wind River Range due to the ever-increasing numbers of recreationists stressing the system.

High-elevation ecosystems are disproportionally affected by climate change in something known as elevation dependent warming. Essentially warming occurs faster at higher elevations. As temperatures rise, the amount of available alpine habitat in the Rocky Mountains will decrease resulting in potential local extinctions of plant species. In addition to the direct effects of climate-driven habitat loss, high elevation plants also must respond to indirect effects, such as changes in disturbance regimes. One notable shift is the increase of wildfire frequency in regions where fire was previously rare or absent, including the alpine (Bloom et al. 2018).

The long-term trend (to 2050) for ecological integrity is considered low. This rating is based on the likely continued increase in recreational activity in the future and the impacts that result from that activity. Climate change impacts will continue to stress the system. Air pollution deposition of nitrogen plus longer growing seasons could increase the number of waterbodies that experience cyanobacteria blooms.

The degree the Bridger-Teton can affect change in this status is moderate for the near-term and moderate for the long-term. Management actions that can provide benefits to the ecosystem include managing recreation impacts.

Aquatic, Wetland, and Riparian Ecosystems

Introduction

In this chapter, status and trends of ecological integrity are described and evaluated for the following ecosystems:

1. Riverine: Rivers, streams and associated riparian areas
2. Palustrine: Wetlands, ponds and groundwater dependent ecosystems (GDEs)
3. Lacustrine: Lakes and reservoirs

Aquatic, wetland and riparian ecosystems comprise less than 5 percent of the total plan area, yet they provide a disproportionately large portion of the total ecosystem services, supporting diverse wildlife habitat and recreational opportunities. Predominant information sources for this Assessment include published scientific articles, publicly available datasets including the National Hydrology Dataset (NHD) and National Wetland Inventories (NWI), and local knowledge of the Bridger-Teton staff. Primary stressors to these ecosystems include climate change, transportation infrastructure and livestock grazing. Despite the presence of these

stressors, nearly all key ecosystem characteristics are functioning within their natural range of variation on the Bridger-Teton (Smith et al., 2020). Additional information on aquatic, wetland and riparian ecosystems is discussed in the Water Resources Report including a: more detailed discussion of water quality, groundwater resources, impacts of water use infrastructure and the influence of beaver populations.

In March 2023, a group of Bridger-Teton and regional experts conducted a series of aquatic ecosystem workshops (USDA 2023b) to assess the ecological integrity of aquatic ecosystems on the Bridger-Teton. The Aquatic Ecosystem Workshops and Integrity Report is included in this document as Appendix C.

Riverine: Rivers, Streams, and Associated Riparian Areas

Key Takeaways

- There is high certainty about the ecological integrity of these ecosystems. Currently, the integrity is moderate. Projected future integrity (2050) is low. Surveys are needed to better understand the conditions and trends of these ecosystems. There is a combination of highly functioning riverine ecosystems and highly impacted riverine systems in the plan area, which leads to an overall moderate integrity ranking for the plan area.
- Climate change is one of the most significant stressors on the integrity of these systems. Models predict a shift in the hydrology of these ecosystems, which will disrupt established and historical water availability and ecological services of these ecosystems (Halofsky et al. 2018). Climate change also will increase water use needs. Other stressors include: recreation, roads and trails, livestock grazing, water uses, land use development and non-native and invasive species.

Summary

There are an estimated 5,548 miles of perennial streams and 6,268 miles of intermittent streams within the Bridger-Teton's boundaries (Smith et al., 2020). The Bridger-Teton lies within five river basins: 1) Upper Snake-Columbia Basin, 2) Upper Green-Colorado Basin, 3) Upper Yellowstone-Missouri Basin, 4) Upper Bear-Great Basin, and 5) North Platte-Missouri Basin. River and stream ecosystems are characterized by single and multi-thread channels, adjacent riparian habitats, and associated floodplains. Dimensions, patterns and profiles of riverine systems vary extensively and are primarily driven by geology and precipitation. Rivers and streams are also heavily influenced by their surrounding watershed. Healthy, proper functioning watersheds typically contain healthy rivers and streams. Riparian integrity along channels prevents channel destabilization and mitigates flood damage through floodplain interaction, sediment capture, and groundwater recharge. These ecosystems and corridors facilitate: gene flow of fish populations, habitat connectivity for all life stages of fish, crucial spawning and rearing habitats, terrestrial migration corridors, terrestrial bird nesting habitats, and diverse aquatic and terrestrial species assemblages.

The geomorphology and parent material of valleys and floodplains drive potential aquatic and riparian habitat. Watershed scale erosional and depositional processes produce fluvial and morphological features that are the building blocks of stream channel dimension, materials and floodplain vegetation (Rosgen 1996). Valley bottom types and characteristics vary across the plan area. Steep, colluvial valleys with some bedrock presences are typically associated with

higher elevation headwaters, but they also occur in lower elevations across the Bridger-Teton such as Snake River Canyon above Alpine and the canyon area immediately downstream from Lower Slide Lake. Steep gradients and presence of bedrock substrate limit floodplain width and complexity. Moderately steep valleys with alluvial terraces, dynamic floodplains and more sorted channel substrate typically exists between steep headwater valleys and lower elevation, flatter valley types. An example of moderately steep valleys in the plan area include the Hoback River valley from Bondurant downstream to the Granite Creek confluence. Yellowstone Meadows is an example from the plan area of a wide, low elevation valley with a broad, extensive floodplain and gentle valley slope. The geology, geomorphic, and biotic processes all integrate differently depending on the: valley type, climate, location across the plan area and level of human/management development. Geomorphic processes and parent material of valley bottoms are generally outside of the scope of management influence and they are relatively stable. Landslides and mass wasting, such as the Gros Ventre Slide, are natural, ecological processes that influence change in valley bottom function.

Rivers and streams are dynamic systems; their shape, size and condition are primarily driven by flow regimes and sediment inputs. Other drivers include: geology, watershed condition, large wood inputs, riparian vegetation and beaver activity. River and stream channels are typically at their full potential for supporting ecosystem functions and integrity when they are in a stable state. According to Rosgen (1996), stream channel stability is achieved when a stream has a stable dimension, pattern, and profile that over time maintains channel features. This occurs when the sediment load and other eroded material is in balance with the stream's capability to transport it through the watershed. Channel instability occurs when the sediment supply exceeds the stream's capacity to transport it (deposition and aggradation) or the stream's energy exceeds the sediment supply (erosion and degradation). Surface disturbance such as roads, channel alteration or major vegetation changes in the watershed can alter sediment regimes and potentially trigger changes in stream channel stability. Natural disturbance including fire, floods, and landslides are another source of channel instability. When a stream channel experiences changes in flow or sediment regime from any type of disturbance, it evolves or proceeds to go through successional stages. Relatively small-scale disturbances or natural disturbances such as natural wildfire regimes, smaller floods, fuel reduction treatments or sustainable grazing often trigger small scale successional changes that increase habitat complexity by introducing pulses of large wood or substrate into streams. However, large scale disturbances or disturbances that are a continual source of sediment loading often destabilize or shift channel succession to a degree that ecological integrity of the system is impacted. The rate of evolution of stream channels back to a stable state following disturbance is dependent upon the: rate of vegetative recovery in the watershed, degree of floodplain connectivity, human influence and the extent and vigor of riparian vegetation.

Aquatic habitat complexity is indicative of high integrity and it is driven by a range of physical, chemical and biological characteristics. These include: a) healthy riparian vegetation that provides stream shading and temperature regulation while stabilizing stream banks; b) stable, undercut banks that provide overhead cover for fish; c) coarse in-channel woody debris that impounds water, creates scour pools and sorts sediment; d) a diversity of substrate sizes from boulders that create scour pools and provide low velocity resting areas for fish, to small gravel that provides spawning habitat for fish; and e) a diversity of habitat types including pools (fish wintering and rearing habitat), pool tail-outs (spawning habitat), and riffles (macroinvertebrate food production for fish), and runs. Collectively, these features provide productive aquatic

habitat that supports all life stage requirements for fish and other aquatic organisms while maintaining a thermal regime within the historic range of variability.

Riparian areas can be difficult to spatially delineate due to the heterogeneity of riparian vegetation and flood patterns. Naiman and Décamps (1997) and Cooper and Merrit (2012) define riparian areas as the portion of the stream channel occurring between the low and high-watermarks and adjacent terrestrial areas extending from the high-watermark toward the uplands where vegetation may be influenced by elevated water tables or flooding. A key, distinguishing element of riparian areas is a hydrologic and geomorphic connection between a flowing river or stream and the riparian area (Cooper and Merrit 2012). The composition and the structure of riparian vegetation are influenced by: surface flows, groundwater, soils, and floodplain features. In turn, riparian vegetation influences water quality, surface water and groundwater fluctuations, and fluvial valley bottom dynamics (Griffin et al. 2014; Pollock et al. 2009; Winward 2000). Smith et al. (2020) delineated seven dominance groups of riparian vegetation community types that reflect differences in structure and wildlife habitat. They include: (1) coniferous tree, (2) tall deciduous tree, (3) low deciduous tree, (4) tall willow, (5) low willow, (6) nonwillow shrub and (7) herbaceous.

Coniferous tree-dominated community types are associated with a variety of valley and stream types. They also have been identified adjacent to springs and fens. Common overstory species include: subalpine fir (*Abies lasiocarpa),* Engelmann spruce *(Picea engelmannii),* blue spruce *(Picea pungens),* lodgepole pine *(Pinus contorta),* thinleaf alder *(Alnus incana* ssp. *tenuifolia),* quaking aspen *(Populus tremuloides),* and narrowleaf cottonwood (*Populus angustifolia)*. Dominant understory species include: water birch *(Betula occidentalis),* redosier dogwood *(Cornus sericea),* shrubby cinquefoil *(Dasiphora fruticosa)*, willows (*Salix* spp.) and a number of mesic forbs and graminoids. The majority of coniferous tree-dominated community types on the Bridger-Teton are stable and indicative of a late-seral riparian vegetation guild. However, some types may have resulted from encroachment by conifers into sites previously dominated by: graminoids, willows, cottonwoods and other riparian plants. Composition of coniferous tree-dominated community types are typically stable in the absence of valley or channel disturbances (Smith et al. 2020).

Tall deciduous tree-dominated community types are characterized by an overstory that contains cottonwoods (*Populus angustifolia*, *Populus fremontii*, *Populus balsamifera*), aspen (*Populus tremuloides*), and/or Scouler's willow (*Salix scouleriana*). Valley bottoms tend to be wider with a shallower gradient compared to valley bottoms with coniferous-dominated community types. Aspen-dominated community types have been associated with springs, but no tall deciduous tree-dominated types have been associated with fens (Smith et al 2020). Maintenance of tall deciduous tree-dominated community types, particularly cottonwood-dominated communities, is reliant upon ecological stressors for establishment and maintenance. Cottonwood galleries rely on regular flooding and complex floodplain roughness to maintain a diverse age class. Scouring during floods removes dead or decadent trees along banks and overflow channels, depositing them into channels and increasing aquatic habitat complexity. Flooding also creates sediment deposition on floodplains, which is critical for cottonwood seed germination. Aspen-dominated community types rely on disturbance from fire for regeneration and maintenance of a diverse age class. Tall deciduous tree-dominated community types also rely on connection to a shallow groundwater alluvial aquifer. Anthropogenic stressors that reduce flooding or that alter natural hydrologic or fluvial processes, such as dams, dikes or water uses, have the potential to impact tall deciduous tree-dominated community types.

Low deciduous tree-dominated community types on the Bridger-Teton include stands of *Alnus incana, Betula occidentalis*, and other deciduous trees (Smith et al. 2020). These community types are found on channels and valley bottoms of various widths and gradients, and they are also associated with springs. None are associated with fens (Smith et al. 2020). Low deciduous tree-dominated community types are often found following floods and in some areas are successional to late-seral types or coniferous tree-dominated types.

Numerous tall willow-dominated community types exist in a variety of settings. The most dominate tall willow species on the Bridger-Teton include: *Salix geyeriana, Salix boothii, Salix melanopsis, Salix drummondiana, Salix exigua,, and Salix lasiandra. Salix geyeriana, Salix boothii* and *Salix melanopsis* are more commonly found in wide valley types and along channels that experience very little scouring and deposition. Types dominated by *Salix drummondiana*, *Salix exigua*, and *Salix lasiandra* occupy active fluvial areas with recent clearing and sediment deposition in narrow and wide valleys at a range of stream gradients (Hansen et al. 1995). (See Smith et al. (2020) for additional information on tall willow-dominated community types.)

Low willow-dominated community types are typically located in broad valley bottoms, but they are also found near springs and fens. Dominant overstory species include: *Salix eastwoodiae*, *Salix glauca*, *Salix planifolia*, and *Salix wolfii*. Frequent understory species are *Carex aquatilis*, *Carex utriculata*, and *Deschampsia cespitosa*. (See Smith et al. (2020) for additional information on tall willow-dominated community types.)

Nonwillow shrub-dominated community types exist in a variety of settings including springs. Many of these community types are dominated by *Cornus sericea*, which is an early seral species that colonizes stream bars and bare banks. *Dasiphora fruticosa* and *Artemisia cana* dominate nonwillow shrub types in moderate to broad valley bottoms adjacent to sagebrush, mountain brush, and forested uplands. These are typically late-seral types that transition into drier upland communities (Smith et al. 2020).

Herbaceous-dominated community types consist of forb-dominated types and graminoid-dominated types. Forb-dominated types often occur in more narrow, steeper valley types surrounded by coniferous forest. They also can be associated with springs, but none are associated with fens. Graminoid-dominated types are more often found in broad valleys along meandering channels and wet meadows. Graminoid-dominated community types are also found adjacent to springs and fens. Sedge species including *Carex utriculata, Carex aquatilis, Carex nebrascensis* are often found in the wettest areas and form dense root mats that are very effective at stabilizing banks. Other sedges, rushes and most grasses are associated with drier portions of riparian areas. Some herbaceous-dominated community types are dominated by historically introduced species including: *Agrostis stolonifera*, *Bromus inermis*, *Poa pratensis*, and *Phelum pratense*. These species colonize recently disturbed sites and withstand high levels of grazing, facilitating their displacement of *Calamogrostis canadensis*, *Deschampsia cespitosa*, and other native graminoids (Smith et al. 2020).

Status and Trends

Smith et al. (2020) compiled existing data and literature on seven indicators to estimate the natural range of variability of channel and floodplain dynamics. The indicators used were:

- Large woody debris presence
- Channel shape and function

- Percent of functional riparian area
- Streambank erosion
- Aquatic habitat complexity
- Floodplain acres per stream mile
- Percentage of floodplain impacted by moderate fire severity.

For this analysis, the Bridger-Teton was divided into four geographic units: Wind River, Gros Ventre, Kemmerer and Wyoming. The Gros Ventre, Kemmerer and Wyoming units exhibit a moderate departure from reference condition for bank erosion. Indicator data also suggest that the number of floodplain acres per stream mile in the Kemmerer unit is moderately departed from reference condition and riparian function in the Wyoming unit is moderately departed. Overall, channel and floodplain dynamics have been resistant and resilient to multiple, interacting stressors. Despite some indicators being moderately departed from reference condition in select parts of the Brider-Teton, Smtih et al. (2020) considered all indicators and concluded that channel and floodplain dynamics across the Bridger-Teton are within NRV.

Smith et al. (2020) combined data from several sources to describe the composition and structure of riparian ecosystems in the plan area. There were 117 riparian community types associated with streams and likely present in the Bridger-Teton that were further grouped into five riparian dominance groups: 1) coniferous trees, 2) deciduous trees, 3) willows, 4) non-willow shrub and 5) herbaceous. Percent cover of each dominance group was used to quantify riparian plant composition within each of the four geographic units.

Riparian plant composition was within the natural range of variability in all four geographic units, but evidence suggest moderate alteration in the Gros Ventre, Wyoming, and Kemmerer units (Smith et al., 2020). Changes in composition within some riparian reaches include conifer and upland plant encroachment, which may be caused by fire suppression or hydrological changes such as reduction in beaver activity. Reduction in willow and aspen recruitment was noted at several locations, particularly sites that were heavily grazed or located near winter feed grounds for elk (Bridger-Teton 2017; Gruell 1980). There are weak positive correlations between upland encroachment and floodplain road miles, grazed acres, and actively grazed acres. Weak positive correlations were observed between: conifer encroachment and floodplain road density, watershed trail miles, floodplain trail miles, and timber harvest acres. Spatial data show little evidence of conversion to invasive species, but field reports indicate that herbaceous species, including bull thistle and Canada thistle, have invaded riparian areas in several parts of the Bridger-Teton. Potential avenues of invasion include roads, recreation sites, and livestock grazing (Smith et al., 2020).

Current Forest Plan guidance on streambank stability and bank alteration, as it relates to ungulate grazing, is contained in the Streambank Stability Guideline, which states

> At least 90 percent of the natural bank stability of streams that support a fishery, particularly [TES] and all trout species, should be maintained. Stream bank vegetation should be maintained to 80 percent of its potential natural condition or an HCI rating of 85 or greater. Stream bank stability, vegetation and fish numbers and biomass should be managed by stream type.

The guideline proved difficult to interpret and in 2008, the Forest Supervisor directed district rangers to apply the Streambank Stability Guideline using direction contained in Simon (2008).

Simon (2008) directs the Multiple Indicator Monitoring (MIMs) (BLM 2011) protocol be used, more specifically, the streambank alteration indicator. Maximum acceptable amounts of streambank alteration vary between 15 and 25 percent (depending on stream type) where channel types are known and 20 percent where channel type is unknown (Simon 2008). The MIMs protocol and direction from Simon (2008) has been applied to 29 of the 133 active grazing allotments. However, the MIMs protocol is designed for stream scale assessments and applying the results to a landscape scale assessment is not a direct correlation. Table 18 describes the extent of MIM monitoring and the number of allotments that had greater than or equal to 20 percent alteration during their most recent monitoring period. MIM monitoring is time consuming and requires extensive training by practitioners. Due to the time-consuming nature of MIM monitoring and staffing levels, MIM site distribution is not extensive enough to make inferences about the status or trend of riverine ecosystems.

Literature suggests that stubble height (along the riparian greenline) remaining after grazing is an indicator of: 1) the effect of grazing on the physiological health of the individual plant, and 2) the ability of the vegetation to provide streambank protection during high flows. Stubble height is not a resource objective and is not appropriate for use as a prescriptive standard in land use plans. It is appropriate for use in annual operating plans (AOPs) as an indicator for changing annual management (Bryant et al, 2006). The current Bridger-Teton National Forest (BTNF) Forest Management Plan does not prescribe a standard for stubble height measured along the riparian greenline, however some AOPs on the forest do contain riparian stubble height thresholds, typically 4 inches. Collaborative monitoring efforts between BTNF and SCCD collected stubble height data on 17 allotments from 2020 through 2024. These sites are located in Sublette County, with the Pinedale and Big Piney Ranger Districts. Of these 17 sites, all were above the 4 inch threshold. The maximum stubble height measured was 19.5 inches and the minimum was 4.5 inches. The minimum height was measured within the Blucher Creek Allotment. The average measurement was 9.4 inches and the median was 8.1 inches. Similar to MIM monitoring, stubble height measurements are appropriate for stream scale assessments and should not be used for landscape scale assessments.

It is the professional opinion of Bridger-Teton staff that the majority of riverine ecosystems are not impacted by ungulate grazing to an extent they are on a downward trend. However, there are some stream networks, primarily in lower elevation, broader valley types, adjacent to private ranches and near elk feedgrounds, that have been historically and are presently being impacted by ungulate grazing. Additional MIM data is needed to more precisely quantify the impacts of ungulate grazing across the Bridger-Teton. Unmanaged livestock grazing can have negative, site-specific impacts to aquatic, riparian and wetland habitats that can include loss of channel stability, decreased water quality, increased sedimentation, soil compaction, and altered or diminished herbaceous vegetation, along with nonnative, invasive weed expansion. Livestock also tend to favor water crossings at stream reach breaks, typically the exact locations of spawning cutthroat trout, which can result in redd trampling during the months of June, July, and August.

Table 18. Summary of MIM monitoring on the Bridger-Teton

District	Active Allotments	Active Allotments with MIM Sites	Percentage of Active Allotments with MIM Sites	Allotments with one or more MIM sites measuring ≥20% Alteration
Kemmerer	35	5	14%	1
Big Piney	13	2	15%	1
Greys River	34	5	15%	1
Jackson	13	4	31%	1
Black Rock	2	0	0%	Not applicable
Pinedale	36	13	36%	3

Systematic stressors of riverine ecosystems include climate change, invasive species, altered fire regimes. Other anthropogenic stressors include: roads and trails, dispersed and developed recreation camping, land use and development, water use, beaver trapping, livestock grazing, and wildfire suppression (Appendix C).

Palustrine: Wetlands, Ponds and Groundwater Dependent Ecosystems

Key Takeaways

- There is moderate certainty about the ecological integrity of these ecosystems. Currently, the integrity is moderate. Projected future integrity (2050) is low. Surveys are needed to better understand the conditions and trends of these ecosystems.
- Climate change is the largest contributing influence on the integrity of these systems. Models predict a shift in the hydrology of these ecosystems, which will disrupt established and historical water availability and ecological services of these ecosystems. Other stressors include invasive species, water use, roads, trails, livestock grazing and recreation.
- GDEs can be hotspots for biodiversity in an increasingly dry climate. Management activities should focus on limiting the amount and duration of water diversions, protecting sites from heavy ungulate trampling and herbivory and decommissioning roads adjacent to or within wetlands.

Summary

Wetlands are ecosystems “that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support . . . a prevalence of vegetation typically adapted for life in saturated soil conditions” (Federal Interagency Committee for Wetland Delineation 1989). The wetlands addressed in this chapter are dominated by trees, shrubs, and emergent herbaceous vegetation, in addition to unvegetated ponds less than 20 acres in size and less than 6.6 feet maximum depth. Ponds of this size are classified as palustrine systems according to the Cowardin classification (Cowardin et al. 1979).

Wetlands encompass highly diverse and unique ecosystems with a wide range of vegetation, soil, and hydrological characteristics. They are supported by surface water, groundwater, and precipitation or frequently a combination thereof. The composition of these wetlands changes along gradients related to the availability of water, including water table elevation and length of inundation or saturation. Smith et al. (2020) summarized the dominant riparian and wetland

plant communities on the Bridger-Teton as follows: (1) coniferous tree (2) tall deciduous tree, (3) low deciduous tree, (4) tall willow, (5) low willow, (6) non-willow shrub, and (7) herbaceous.

GDEs are “communities of plants, animals, and other organisms whose extent and life processes are dependent on access to or discharge of groundwater” (USDA 2012a). These ecosystems occur at aquifer discharge locations and include special habitats such as springs, fens, and karsts. Many perennial streams and lakes are also supported by upwelling groundwater. The distribution of GDEs is influenced by: underlying geology, terrain, climate, and anthropogenic activities. The geologic units in the Bridger-Teton are igneous, sedimentary, and metamorphic. Granitic and metamorphic rocks are dominant in the Wind River Range, sedimentary rocks are dominant in the Wyoming Range, and a mix of volcanic, granitic, and sedimentary rocks form the Gros Ventre Range and areas in the North Zone of the Bridger-Teton (USDA 2001a, 2004; Gruell 1980; Wells et al. 2015). Mountain ranges in the Bridger-Teton originated through various geological processes, with subsequent glacial periods crafting the landforms that currently exist in the landscape (Cooper and Andrus 1994). Following these periods, valley bottoms and low elevation floodplains were filled with glacial outwash and alluvial deposits, which provide groundwater storage and transport. Porous, fractured, and dissolved geologies of mountain ranges allow recharge of groundwater and they are additional drivers of GDE distribution at lower elevations. High elevation glacial activity influences GDE distribution in areas such as the Wind River Range (Smith et al. 2020).

Springs are ecosystems entirely supported by groundwater. They form at the contacts, joints and faults of disparate geologies. Groundwater reaches the surface at springs by moving through: low-permeability rock, geologic fissures, through large cavities or at fault line scarps (Whiting and Stamm 1995). Various types of springs occur within the plan area, each with features that promote regional biodiversity (Springer and Stevens 2009). Springs with surface pools provide lentic habitat for plants, vertebrates, and other biota. Spring runout channels provide unique lotic habitats due to relatively uniform water temperatures and low oxygen concentrations (Springer and Stevens 2009). These channels increase connectivity across the landscape for organisms associated with surface water systems. Runout channels may connect with streams or may terminate to subsurface flow while still supporting aquatic and riparian species. Spring mounds composed of calcareous minerals, peat, and other substrates provide specialized habitat features as well. Vegetation communities sustained by springs often have greater structural diversity and, therefore, high value as wildlife habitat. Springs are also a critical source of drinking water for wildlife and livestock (Smith et al. 2020).

Fens are wetlands supported by groundwater with an accumulation of peat (1 foot (30 centimeters) thick or more). These systems are characterized by low oxygen and nutrient availability, and they are exceptionally stable ecosystems in the absence of disturbance (Chadde et al. 1998). They are relatively uncommon in the Intermountain Region, and they support a distinctive flora with a high concentration of rare species restricted to these extreme environmental conditions. Fens occur in historically glaciated features, such as cirques and outwash channels (Chadde et al. 1998). Two major types were identified in the Rocky Mountains: 1) valley peatlands and 2) subalpine peatlands (Bursik 1990; Heidel et al. 2017). Valley fens form around lakes and ponds at relatively low elevations in major river valleys. Subalpine peatlands are more common and they tend to occur along low-gradient subalpine streams (Chadde et al. 1998; Smith et al. 2020).

Karst systems and bedrock aquifers form where permeable rock allows the infiltration, storage, and transport of water. Karst systems are subterranean passages dissolved into limestone,

dolomite, or other soluble bedrocks with large passageways often occurring at fault zones (Mills 1989). Epikarst occurs in solution-enlarged fractures and cavities that temporarily store and transport groundwater without recharging regional aquifers. Pseudokarst systems transport water through passageways of noncarbonate bedrock such as volcanic deposits and piped sandstone. Bedrock aquifers form in layers of sandstone, limestone, and other permeable rocks, and they are often confined by impermeable units such as shales and crystalline rocks (Mills, 1989; Smith et al., 2020). (Additional information on karst systems is included in the Geologic Resources section.)

GDE distribution is also driven by regional climate and local weather patterns, particularly annual variation in snowpack and snow water equivalent. Their continued existence relies on discharge from groundwater and recharge to these groundwater systems depends on the following: distribution, amount and timing of precipitation, evapotranspirative losses, snow cover thickness, snowmelt characteristics, and land use/land cover (Klove et al. 2014). Areas with high precipitation, particularly areas that accumulate slow melting snow, are important sources of recharge, and they are influential to the water table depth. Typical climate patterns that include low humidity and prolonged dry periods on the Bridger-Teton significantly limit the development of fens, which require specific hydrology to allow the accumulation of peat (Bedford and Godwin 2003; Chadde et al. 1998). The distribution of springs in the Gros Ventre Range is highly reliant on precipitation for groundwater recharge (Mills 1989; Smith et al. 2020).

Ponds are extremely varied and their characteristics primarily depend on depth and duration. These factors are subject to the following: local topography, geomorphology, snowmelt, precipitation, and water table fluctuation. Some ponds have open water and others are dominated by emergent vegetation, still other ponds may seasonally vary from open water dominance to emergent vegetation dominance and then become completely dry.

Status and Trends

NWI mapping for the Bridger-Teton shows 66,372 acres of palustrine wetlands and ponds, which amount to less than 2 percent of the plan area (See Table 19). The majority of wetlands are either emergent or shrub dominated. Emergent wetlands are dominated by herbaceous plants while shrub wetlands are typically dominated by willows and other woody vegetation. In 2018, Smith and Lemley utilized NWI mapping, aerial photography and topographic maps to predict the presence of fens. Most potential fen locations were found in saturated emergent and saturated shrub wetlands, but fens also were predicted in areas mapped by the NWI as ponds and seasonally saturated. A total of 13,717 acres were mapped as potential fens in the plan area. Fens were predicted to be across the plan area, but the majority of fens were predicted to be within the Pinedale Ranger District. Notable fens in the plan area include a rare type of fen known as a floating mat fen. Two hundred and thirty-eight potential fens (267 acres) were identified as potential floating mat fens.

The NHD reports a total of 136 springs in the Bridger-Teton. This data layer typically underestimates the true number of springs. In 2022, Bridger-Teton staff surveyed 25 additional GDE sites, 8 of which exhibited characteristics of fen wetlands. The number of springs is the best indicator available to document the currently known occurrence of groundwater dependent ecosystems around springs. Many more springs and GDEs likely exist, including those that directly discharge into a perennial stream, but they are not yet mapped.

Table 19. NRAS wetlands by NWI category on the plan area

Wetland Type	NWI Code	Acres	Percent of Plan Area
Palustrine (Total)	P	66,372	1.92%
Emergent	PEM	31,585	0.91%
Forested	PFO	1,954	0.06%
Shrub	PSS	26,673	0.77%
Pond	PAB, PUB, PUS	6,187	0.18%
Potential Fen	Not applicable[1]	13,717	0.40%

1 Known fens are typically represented by NWI code PEM. However as stated above these identified “potential fens” were mapped under various NWI codes that include: PSS, PAB, PUB, and PUS.

One of the 25 sites surveyed in 2022 was KWS on the Pinedale Ranger District. KWS is unique because it is the only habitat for the KWS dace, which is currently the only TEPC fish species in the plan area. KWS flows at 85 °F from its sources for 984 feet at an average of 7 cubic feet per second (cfs) before spilling over a 15-foot waterfall into the Green River. The waterfall is a barrier to aquatic movement from the Green River to KWS isolating the dace from the Green River. The KWS dace is endemic to KWS, exists in no other ecosystem, and its entire habitat occurs on land administered by the Bridger-Teton. KWS dace conservation efforts have included a: closure order preventing public entry into the warm spring; replacement of mid-system culverts with a bridge; livestock exclosure; non-native watercress removal; and habitat and population monitoring.

Stressors to wetlands, ponds and groundwater dependent ecosystems include changes in surface or subsurface water runoff, water diversions and lowering of the groundwater table. Climate change and invasive species also are significant systematic stressors. Spring boxes and other infrastructure that diverts water from these systems can have detrimental effects. Other stressors include: roads and trails, livestock grazing, recreation, and water use.

There is moderate certainty about the ecological integrity of these ecosystems. Currently, the integrity is moderate with climate change being the largest contributing influence on the integrity of these systems. Projected future integrity (2050) is low. Service delivery is expected to decline in these fragile ecosystems. Climate change projections are expected to shift the hydrology of these ecosystems and disrupt established and historical water availability. Increased recreation impacts also will continue.

Lacustrine: Lakes and Reservoirs

Key Takeaways

- There has been little data collected on the biological and physical condition of lakes and reservoirs in the plan area. Currently, lakes and reservoir ecosystems are considered to have a moderate ecological integrity. Climate change is considered to be the most significant threat to ecological integrity. Introduction of aquatic invasive species is also considered to be a significant threat.
- A unique characteristic of the Bridger-Teton is the relatively large number of high elevation alpine lakes present in the Bridger Wilderness; this is a recreational draw to the area and impacts from camping, lakeshore use, and human waste around alpine lakes are increasing.

Summary

NHD data records 11,984 waterbodies including lakes, ponds and reservoirs in the plan area. Of these, 344 are named lakes and five are named reservoirs. It should be noted that there is overlap between waterbodies recorded on the NHD and acres of wetland ponds recorded in NWI data. The majority of the 11,984 waterbodies are palustrine pond wetlands.

A unique characteristic of the Bridger-Teton is the relatively large number of high elevation alpine lakes present. Most of these lakes are found within the Wind River Range on the Pinedale Ranger district (over 1,500 lakes across 428,416 acres) (Ganz et al. 2021). Much of the plan area is mountainous with high-elevation lakes generally deep, cold, and low in nutrients (oligotrophic), however, many high elevation lakes have increased nutrient status over the years and they are in a medium nutrient status (mesotrophic). Lakes with low nutrient status are more easily influenced by: groundwater, air pollution and dust deposition, snowmelt and in some cases glacial inputs. (Water chemistry and nutrient status of high elevation lakes are further described in the Air Quality section.) High elevation lakes can be rich in aquatic bugs such as zooplankton, macroinvertebrates, and insects as well as they provide habitat for amphibians, and waterfowl.

The narrow ring of relatively shallow water along the shoreline where sunlight supports algal growth and some rooted emergent/submergent plants (littoral zone) tends to have the highest abundance of aquatic species. High-elevation lakes typically do not naturally contain fish. Colorado River Cutthroat Trout were one of the first species introduced to the Bridger Wilderness area in 1907. A considerable amount of the fish stocking occurred between 1924 and 1935 with the stocking of Lake Trout, Golden Trout, cutthroat, Brook Trout, Brown Trout, and Rainbow Trout. Kokanee Salmon and Grayling were introduced primarily in the 1940s (Hudelson et al 1980) WGFD continues to stock select lakes in the plan area, and they have ceased to stock other naturally fishless lakes to support a variety of recreational experiences and ecological conditions. The majority of high-elevation lakes in the plan area are located in designated wilderness and they have little to no development along shorelines. However, dispersed recreational use proximal to alpine lakes is increasing and it may impact nutrient inputs into high elevation lakes.

Middle- to low-elevation lakes (approximately < 9,000 ft. elevation) have larger drainage areas and receive more water from stream input and overland flow. When combined with longer growing seasons at lower elevation, these factors generally contribute to higher nutrient availability that support moderate levels of algae/plant productivity (mesotrophic). Mesotrophic lakes typically have a larger littoral zone around the shoreline and support a greater amount of vegetation and aquatic life. Fish naturally occur in some of these systems and include native species like cutthroat trout as well as non-native species like: brook trout, rainbow trout, kokanee and lake trout. The topography surrounding these lakes is relatively flatter and more conducive to withdrawals for water use. These lakes are generally more accessible and they have boat ramps, campgrounds and hiking trails.

The outflow of several natural lakes in the plan area have been anthropogenically dammed so the water holding capacity is increased and outflows can be controlled for irrigation purposes. These systems and man-made reservoirs exhibit similar characteristics to middle and low elevation lakes. Water levels may have more extreme fluctuations due to water use, which could impact littoral and shoreline habitat. These lakes and reservoirs are typically located closer to communities and they have the most amount of recreational use.

Status and Trends
There has been little data collected on the biological and physical condition of lakes and reservoirs in the plan area. (Water quality information is discussed in the Water and Air Resources reports.) Lakes and reservoir ecosystems currently are considered to have a moderate ecological integrity. Climate change is considered to be the most significant threat to ecological integrity. Aquatic invasive species is also a significant threat to lakes and reservoirs, particularly those lakes and reservoirs that provide recreational opportunities. Please see the Invasive Species Section under Ecosystem Drivers and Stressors.

The timing of precipitation events and amount of runoff may shift due to climate change and compromise the integrity of these systems. Earlier ice-off and warmer than average summer temperatures also affect nutrient cycling in these lentic systems leading to potential fish kills, increased benthic algae growth, or blooms of harmful cyanobacteria. Algae and cyanobacteria blooms are naturally occurring, but density and distribution have been increasing over the last decade due to more favorable growing conditions including: increased water temperature, longer growing seasons, elevated phosphorus and nitrogen inputs from dust deposition and soil nutrient cycling and decreases in precipitation. Other stressors to lakes and reservoirs include: recreation, altered fire regimes, livestock grazing, and both terrestrial and aquatic invasive species.

Watersheds

Key Takeaways

- Based on the latest Watershed Condition Framework (WCF) analysis for the 171 watersheds on the Bridger-Teton, 157 watersheds are rated as properly functioning and 14 are rated as functioning at risk. No watersheds are rated as impaired.
- Most watersheds are rated functioning for: water quality, water quantity, aquatic habitat, riparian wetland vegetation and soils.
- Watersheds were most commonly rated as impaired for the indicators aquatic biota, forest cover, and rangeland vegetation. Watersheds were most commonly rated as functioning at risk for the indicators roads and trails, fire regime and terrestrial invasive species.

Summary

- The majority of the watersheds within the Bridger-Teton form the headwaters of the major rivers in the western United States including the Snake-Columbia, Yellowstone-Missouri and Green-Colorado. Smaller portions of the Bridger-Teton lie within the Upper Bear-Great Basin and the North Platte-Missouri Basin.
- In 2010, sixth-level watersheds (typically 10,000 to 40,000 acres) across all National Forest Systems lands were classified using the national WCF (USDA 2011b). A watershed condition was assigned following an assessment of existing data, knowledge of the land, and professional judgment. WCF ratings for the Bridger-Teton were updated in 2021 to reflect impacts from watershed restoration efforts and wildland fires since the initial assessment in 2010.
- The WCF reports that: water quantity, water quality, aquatic habitat, and soil conditions across the Bridger-Teton are generally in good or proper functioning condition; however, stressors such as climate change, invasive species, and wildfire regime changes threaten

the integrity of watersheds, both currently and in future projections (See Aquatic, Wetland and Riparian Ecosystems section). The current forest plan does little to address climate change, invasive species, and wildfire regime considering the best available science.

- Although general watershed conditions on the Bridger-Teton are good, there are opportunities to improve watershed conditions. The current forest plan does not provide sufficient guidance for land managers to use while prioritizing watersheds for restoration.

Status and Trends

Setting

River basins in the United States are delineated into a nested hierarchy represented by Hydrologic Unit Codes (HUCs) numbered with 2 to 12 digits, which are then categorized with names from largest in size to smallest that include: regions (2-digit HUC), sub-regions (4-digit), basins (6-digit), sub-basins (8-digit), watersheds (10-digit), and sub-watersheds (12-digit) (USGS et al. 2013). The Bridger-Teton lies within five river basins: 1) Upper Snake-Columbia Basin, 2) Upper Green-Colorado Basin, 3) Upper Yellowstone-Missouri Basin, 4) Upper Bear-Great Basin, and 5) North Platte-Missouri Basin. These basins are then divided into 11 sub-basins, 75 watersheds and 171 sub-watersheds (See Figure 18).

Average annual precipitation across the Bridger-Teton varies from approximately 17 inches at lower elevations to over 57 inches at higher elevations. Most of the precipitation across the Bridger-Teton comes as snow in the winter. Summer brings thunderstorms that produce high intensity, short duration precipitation events. Streamflow is predominantly driven by annual snowmelt runoff starting in March, peaking in late May to early June, and tapering off to baseflow levels in late August to early September. Summer thunderstorms can increase streamflow for short periods in localized areas. There can be considerable variability in the shape of a stream's hydrograph and peak flows from year to year depending on local and regional meteorological and climatic conditions.

Watershed Condition Class

In 2010, sub-watersheds (6th level 12-digit HUC, typically 10,000 to 40,000 acres) were used to assess and prioritize areas for restoration across all national forests using the national WCF (USFS 2011). The WCF was used to assign a watershed condition rating following an assessment of existing data, knowledge of the land, and professional judgment.

Watershed condition is the state of the physical and biological characteristics and processes within a watershed that affect the soil and hydrologic functions supporting aquatic and terrestrial ecosystems. Watershed condition reflects a range of variability from natural pristine (functioning properly) to degraded (impaired). The Forest Service Manual classification defines watershed condition in terms of "geomorphic, hydrologic and biotic integrity" relative to "potential natural condition." In this context, integrity relates directly to functionality. Integrity is evaluated in the context of the natural disturbance regime, geo-climatic setting, and other important factors within the context of a watershed (USFS 2011).

The WCF considers 12 indicators to assign watershed condition class ratings. The indicators are grouped into four process categories: 1) Aquatic, Physical; 2) Aquatic, Biotic; 3) Terrestrial, Physical; and 4) Terrestrial, Biota. The first three categories each constitute 30 percent of the total framework rating each. The fourth category constitutes the remaining 10 percent.

Indicators are evaluated using a defined set of attributes as shown in Figure 17. (For a more detailed explanation of the WCF, please refer to Watershed Condition Framework – A framework for assessing and tracking changes to watershed condition (USFS 2011a)).

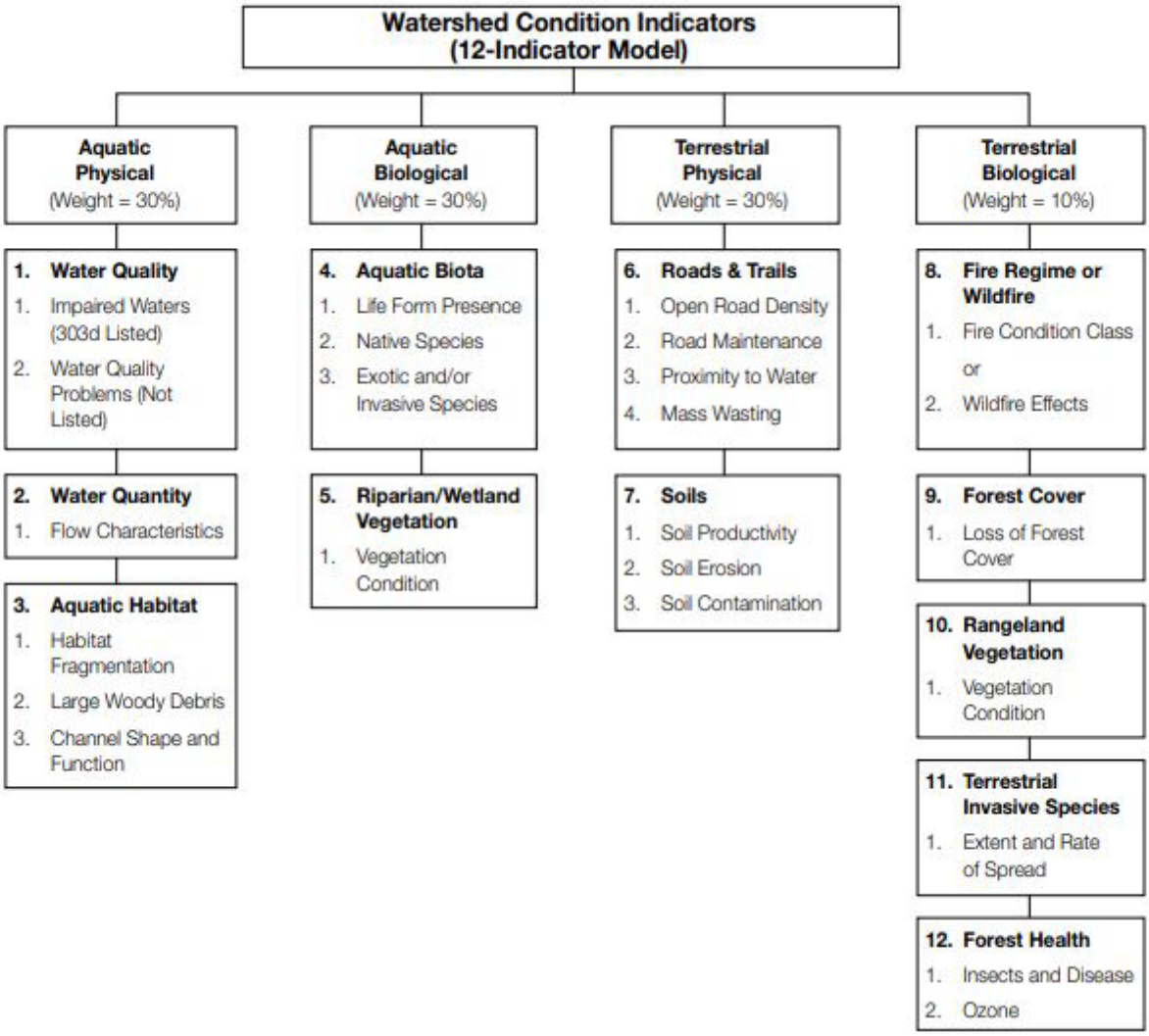


Figure 17. Process categories and indicators of the Watershed Condition Framework

For each watershed, attributes within each indicator are individually rated as “good” (Class 1), “fair” (Class 2), or “poor” (Class 3) according to existing data, knowledge of the land and professional judgement. The attribute scores are then averaged to give a score for each indicator. The indicator scores are then averaged to give a rating of Class 1 (functioning properly), Class 2 (functioning at risk) or Class 3 (impaired function) for each process category. The Process Category scores are then combined based on a weighting factor to determine a score for each watershed. A watershed is functioning properly (Class 1) if the physical attributes are appropriate to maintain or improve biological integrity, i.e., the watershed is functioning in a manner like natural wildland conditions (USFS 2011). Class 2 and Class 3 watersheds have impaired function because some physical, hydrological, or biological thresholds have been exceeded. Class 2 watersheds exhibit moderately impaired functions and Class 3 watersheds exhibit severe impairments. This can occur due to natural processes, such as wildland fire or

large slope failures, but they are more typically caused by human related disturbance, such as: roads close to streams, overgrazing by domesticated animals, invasive species, recreational activities or presence of aquatic non-native species.

The Bridger-Teton has 171 watersheds. Of these, 157 are functioning properly, 14 are functioning at risk and no watersheds are impaired (See Figure 18). Across the Plan area, indicators most prominently rated “good” are water quality, aquatic habitat, and riparian/wetland vegetation (See Figure 19). Indicators most commonly rated as “fair” are fire regime/wildfire, roads and trails, and terrestrial invasive species. Indicators most commonly rate as “poor” are aquatic biota, rangeland vegetation and forest cover.

System Stressors and Drivers Contributing to Watershed Degradation

System stressors for watershed condition include climate change, invasive species and altered wildland fire regimes. Other stressors include: livestock grazing, recreation, land use development, air pollution, insects and disease, water use, roads and trails, and timber harvest.

Invasive Species

The Terrestrial Invasive Species indicator is rated “good” in 65 percent of the watersheds, “fair” in 32 percent of the watersheds and “poor” in 4 percent of the watersheds. Terrestrial invasive species have become established on the Bridger-Teton and they are continuing to emerge as a system stressor.

Wildland Fire Regimes

The Forest Service’s WCF was used to assess the fire regime and effects of wildfire in the Bridger-Teton. The Fire Regime indicator is included within the Terrestrial Biological set of indicators along with: Forest Cover, Rangeland Vegetation, Terrestrial Invasive Species, and Forest Health. Fire Regime is rated “fair” in 78 percent of sub-watersheds and “good” in the remaining watersheds.

Issues in the Broader Landscape

Issues that extend beyond the plan area that are pertinent to how the USFS manages watersheds in the future include: 1) population growth and its demand on forest resources and 2) climate change, which could fundamentally alter watershed processes that lead to sustainable natural and human communities. As both local and regional populations increase, there will be greater demand for ecosystem services originating on USFS lands, these include, but are not limited to, the following: water supplies, carbon sequestration, food supplies, fiber, and recreation. As discussed in the water resources report, stressors and drivers impacting water resources on USFS lands have the potential to directly impact users downstream of the plan area.

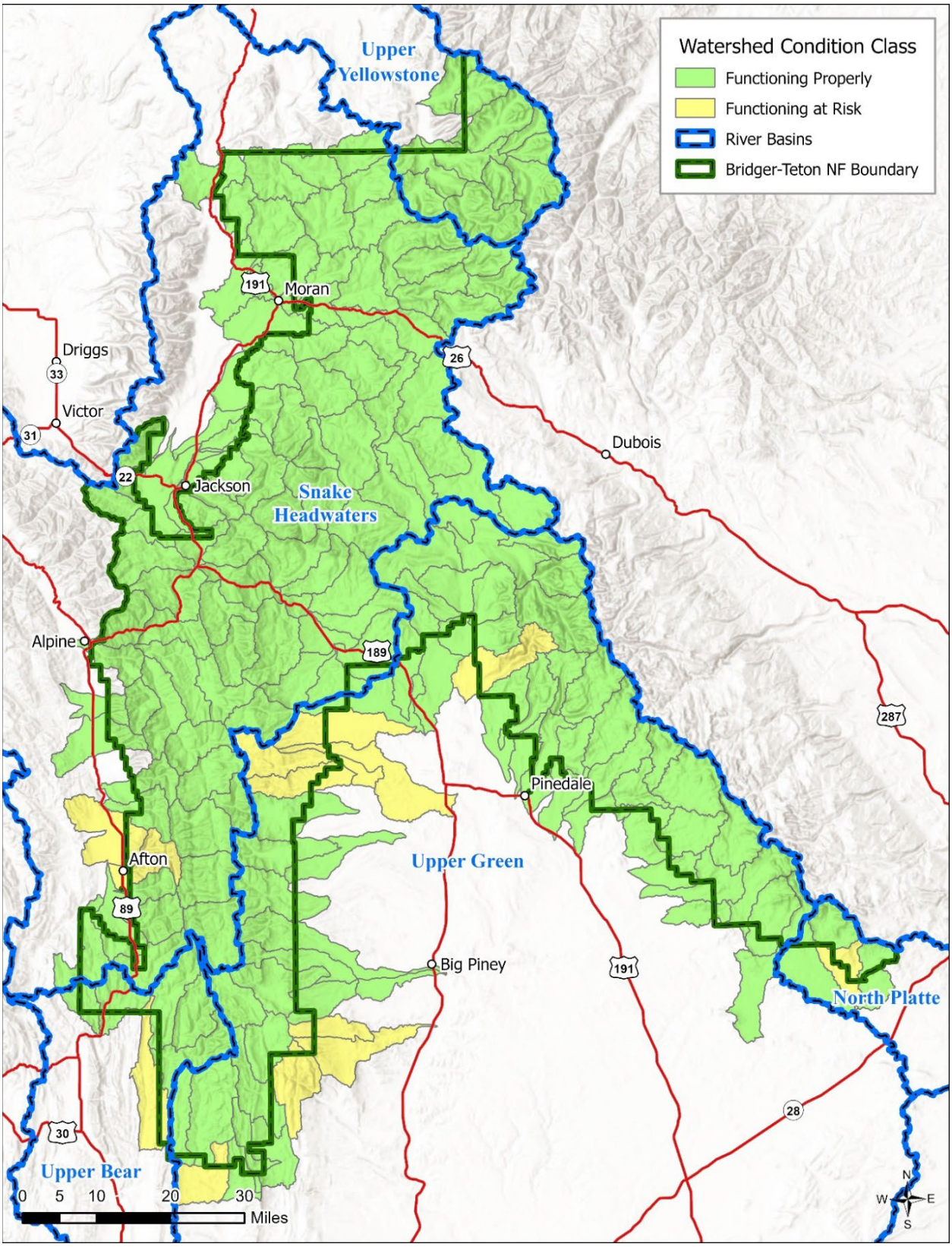


Figure 18. River basins and Watershed Condition Class Ratings

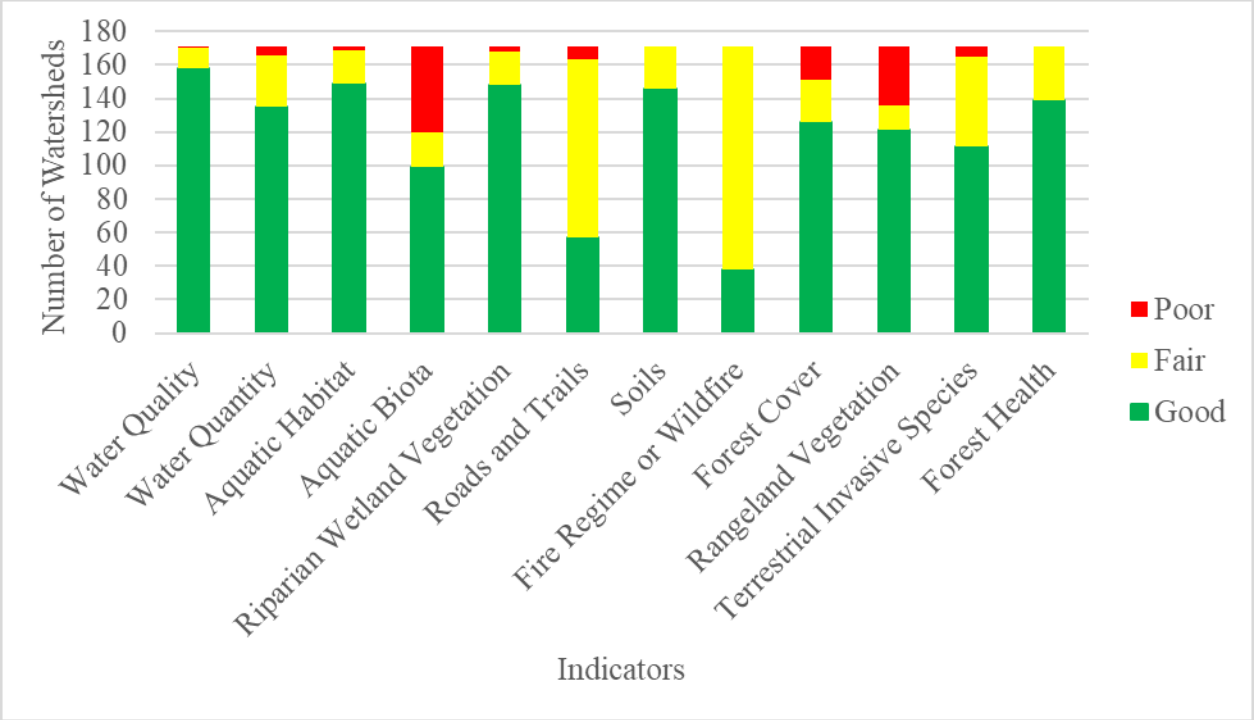


Figure 19. Watershed Condition Framework Indicator rating for watersheds across the plan area

As regional climate change influences natural resource conditions downstream of the Bridger-Teton, additional stress and demand on resources within the plan area likely will increase. As water supplies downstream of the plan area decrease, there will be a greater demand for water originating on USFS lands. As summer temperatures increase and recreational water supplies decrease across the region, recreational use on the Bridger-Teton will increase as recreationalists seek cooler summer temperatures and water-based recreation.

Air, Soil, and Water Resources and Quality

Air Quality

Key Takeaways

Clean air is essential to ecological, social, and economic sustainability. On the Bridger-Teton, pollutants associated with acid rain (mainly sulfates and nitrates) have decreased in recent decades. Ground-level ozone concentrations have overall decreased since the peak over a decade ago. An increased trend in air temperature and wildland fire smoke in the summer may increase future ozone concentrations. Current air quality issues and concerns include smoke impacts from wildland fire and atmospheric deposition of: ammonium, calcium, phosphorus, microplastics, and other pollutants deposited through dry and wet deposition. The current management plan lacks direction for management actions that contribute to air pollution and management of resources affected by air pollution. Monitoring is essential to evaluate air pollution and associated effects.

Air Pollution as a Driver to Ecosystems

An increase in nutrient deposition from air pollution and increased dust events can add nitrogen and phosphorus to an ecosystem, acting as a stressor and adversely affecting: soil health, lichens, mycorrhizae, native terrestrial and aquatic plant communities, invasive species colonization, water quality cyanobacterial and algal bloom risk in surface water, and snowpack retention. Nutrient deposition from air pollution has been shown to favor sedge growth in alpine ecosystems (Bowman et al. 2012). Additionally, air pollutants stress trees, making them more vulnerable to insects or diseases and adversely impacting the growth rate and decadal survival of certain species. Dust also contains microplastics and chemicals, such as pesticides; the ecological effects of which are currently unknown.

Current Forest Ecological Condition Contributions to Air Quality

Trees and other flora on the Bridger-Teton can absorb or trap air pollutants and GHGs and release oxygen, all of which contribute to cleaner air quality. However, when the following: drought, insect infestation, disease, tree cutting, and other stressors kill trees, they no longer remove carbon dioxide, nutrients, and air pollutants from the atmosphere.

The amount and type of fuel loading affects the intensity and duration of a wildland fire and the amount of smoke that is released (Long et al. 2017, Nanus et al. 2022). Smoke contains many different air pollutants that can pose significant health risks to humans (USEPA 2016c). Particulate matter (PM), a composite of various pollutants, is commonly measured during fires. PM is measured in two size cuts, 2.5 or 10 microns. At 2.5 microns or smaller PM is small enough to penetrate deep into the lungs, enter the bloodstream and contribute to health issues. Smoke also affects visibility on roads and at scenic vistas that can be a safety concern for drivers and may negatively impact the visitor experience (Wetterberg et al. 2021, Wilson et al. 2020).

Growth of invasive plants, such as cheatgrass, can also change fire regimes and thus corresponding air pollutants released (Balch et al. 2013). Plants, such as sagebrush, release high amounts of volatile organic compounds, which is one of the precursor emissions for ozone formation. Ozone, like PM, is regulated by USEPA under the National Ambient Air Quality Standards (NAAQS) within the Clean Air Act.

Drought can also increase localized dust on roads, thereby contributing to increased PM levels, poorer visibility and negative health effects.

Air Quality Effects on Social and Economic Sustainability

Clean air is valued for contributions to physical and mental health and unobscured vistas by communities and tourists in and around the Bridger-Teton. Good air quality is essential for clean water and healthy ecosystems, which are directly tied to ecosystem benefits. Sulfur dioxide (SO_2) and nitrogen oxides (NO_x) air pollution and deposition have decreased across the country, including in Wyoming and on the Bridger-Teton primarily due to the Clean Air Act amendments in the 1990s (Nopmongcol et al. 2019, Hand et al. 2020). The decrease in key air pollutants resulted in an increase in the number of clear days and visible distance seen across the Bridger-Teton, particularly in winter months (See Appendix D: Air Quality, IMPROVE Visibility Graphs).

Though reductions in anthropogenic – or human-caused – emissions have improved air quality, smoke from wildland fires has increased in duration, intensity, and frequency, most notably between July and September in recent years ([Nanus et al. 2022], Appendix D – Air Quality: IMPROVE Visibility Graphs, Appendix D – Environmental Protection Agency State of Wyoming Emissions Inventory). Most of the smoke-impacted days experienced on the Bridger-Teton are caused by upwind off-forest fires. Likewise, fires on the Bridger-Teton may impact air quality in downwind areas off-forest. Smoke from wildland fires contains many different chemical compounds, including known carcinogens and other hazardous air pollutants. Concentrations and composition of chemicals found in smoke vary depending on several factors including fuels burned, distance to fire, and fire severity and intensity. High smoke concentrations can negatively impact: human and wildlife respiratory, cardiovascular, and autoimmune health, mental health, wildlife vocalizations, and animal behavior, such as movement USEPA 2016c, Sanderfoot et al. 2022). Wildland fire smoke also can obscure visibility, including night sky viewing, and have a negative impact on economies with a large tourism base (USEPA 2016c, Socioeconomic baseline report 2022). (See Fire Management section.)

The communities and parts of the Bridger-Teton that lie within the Upper Green River Basin (UGRB) marginal ozone nonattainment area may experience short durations of moderate to high ozone levels. In the past three years the NAAQS for ozone protective of human health has not been exceeded. High ozone formation is most likely to occur in late winter and early spring, on sunny days with high reflectance off snow. If ozone exceedance occurs, it is possible that local populations and tourists may experience symptoms such as coughing and difficulty breathing (https://www.epa.gov/ground-level-ozone-pollution/health-effects-ozone-pollution).

Air Quality Effects on Ecological Sustainability

Air pollution deposited from the atmosphere can act as a nutrient or an acid and alter the health of various terrestrial and aquatic ecosystem components (McMurray et al. 2021). Deposition can occur through precipitation, fog, and dry fallout, including dust storms. Ammonium deposition has increased on parts of the Bridger-Teton with most emissions coming from agricultural areas in Idaho and Utah (Zhang et al. 2018). Dust events also have increased, which increases nutrient loading to aquatic and terrestrial systems (Clow et al. 2016). Deposition of ammonium and phosphorus boosts primary productivity in surface waters and this can lead to increased risk for harmful algal and cyanobacteria blooms (Paerl et al. 2014). See the Water Resources section for more information on harmful algal and cyanobacteria blooms. Excess nitrogen deposition has been linked to increases in invasive species and changes in: diatom, lichen, forb, and grassland communities and decreases in tree species growth rate and probability of survival over 10 years (Nanus et al. 2022, McMurray et al. 2021). Dust-on-snow events can increase snowmelt rates on both glaciers and perennial snow fields (Clow et al. 2016), which can decrease availability of water supplies downstream in late summer and fall. Dust often contains microplastics and sometimes pesticides, pesticide derivatives, and other chemicals. The ecological effects of microplastic and pesticide deposition on the Bridger-Teton are unknown.

Ground level ozone (O_3) concentrations can damage human, animal, and plant cells on contact (Nanus et al. 2022). Current ozone standards for human health are not sufficient to prevent damage in sensitive plant species (CASAC 2014). Examples of common ozone-sensitive plants on the Bridger-Teton include: quaking aspen, serviceberry, snowberry, huckleberry, and willow (Sullivan 2016). Days with high ozone concentration on the Bridger-Teton typically occur in the UGRB during late winter when most herbaceous plants are covered by snow and trees and

shrubs are considered dormant. It is not understood if current ozone levels affect dormant trees and shrubs on the Bridger-Teton.

Sensitive Air Designations

On the Bridger-Teton, the term ‘airshed’ aligns with federally designated Class I and II wilderness areas. The 1977 Clean Air Act amendments direct Federal land managers to “preserve, protect, and enhance the air quality” in 156 mandatory class I national parks and wilderness areas (42 U.S.C. 7470 et seq.). Class I areas are wilderness areas that were designated before August 7, 1977 and they are larger than 5,000 acres. All other land managed by Federal land managers are designated Class II. There are three wilderness areas on the Bridger-Teton including the Bridger Wilderness (Class I), Teton Wilderness (Class I), and Gros Ventre (Class II). Neary 30 percent of the Bridger-Teton or over 1 million acres is within a Class I airshed.

In addition to wilderness areas, part of the Bridger-Teton lies within the UGRB area. This area was designated by USEPA in 2012 as “marginal nonattainment” for the 2008 8-hour ozone. In 2016 the EPA issued a determination of Attainment confirming that the UGRB met the 2008 NAAQS for three consecutive years. This allowed The Wyoming Department of Environmental Quality (WDEQ) to initiate the process in 2024 with EPA to redesignate the UGRB back to attainment for the 2008 ozone NAAQS.

Until the UGRB is redesignated to attainment, all Bridger-Teton initiated projects must comply with the general conformity provisions of the Clean Air Act (section 176[c]), which prohibits Federal agencies from taking any action within a non-attainment area that causes or contributes to a new or existing violation of the standards or delays the attainment of a standard. This includes any project that triggers an environmental assessment (EA) or an environmental impact statement (EIS) and some categorical exclusion (CE) projects. In the UGRB, volatile organic compounds (VOCs) and NO_x, the precursors of tropospheric ozone formation, must be documented for projects within the Bridger-Teton. In addition, the WDEQ may issue ozone action days when: private entities, industries, Federal agencies (such as the USFS), and the public are asked to minimize emissions. Ozone action days typically occur in the late winter and early spring and may affect USFS activities such as prescribed fire burns. Class I Wilderness areas are also Class I Airsheds, as shown in Figure 20, and they are afforded special protection under the Clean Air Act. All other land on the Bridger-Teton is considered Class II. The UGRB is included in the Figure 20 marginal nonattainment area for the 2008 ozone standard.

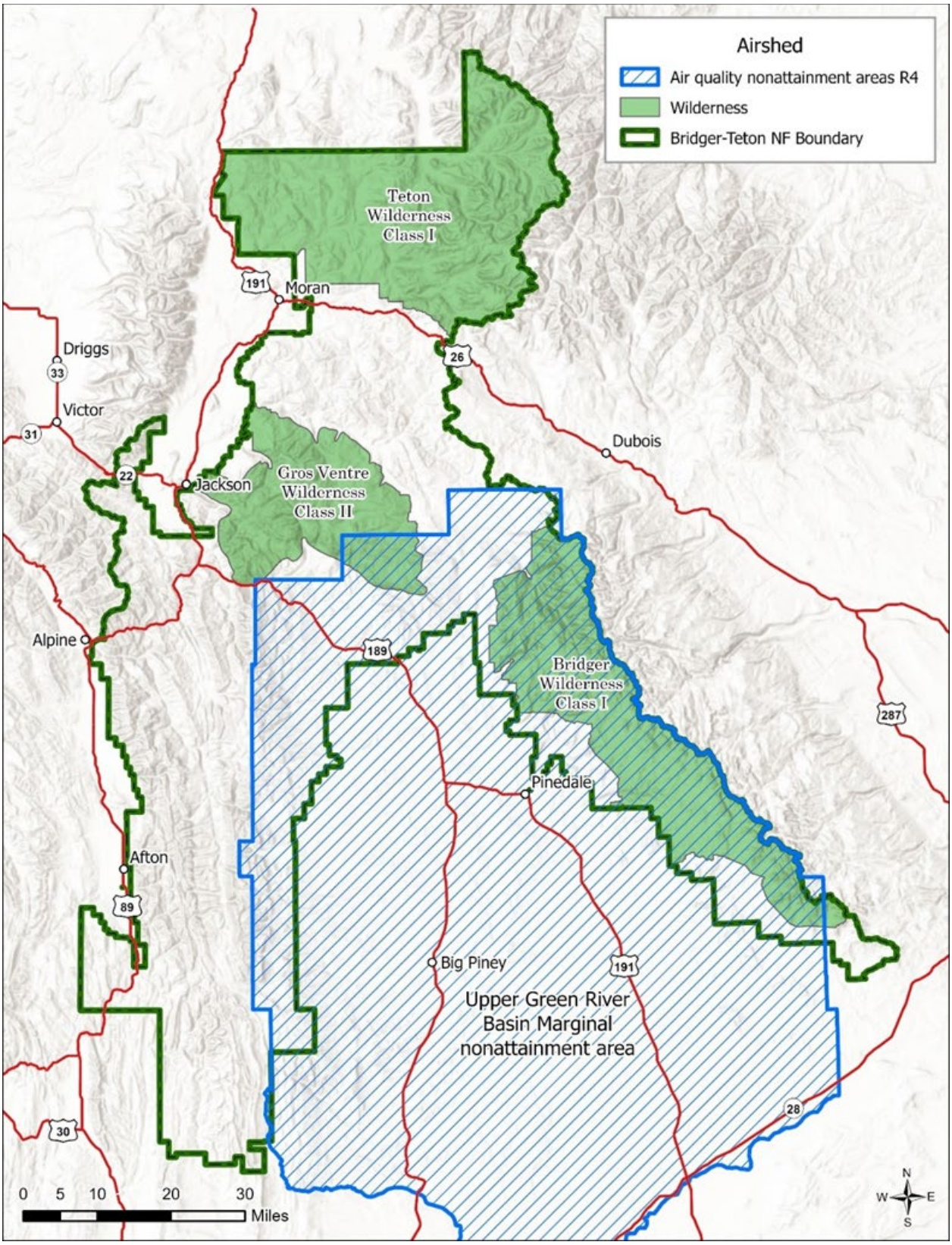


Figure 20. Distribution of airsheds in the plan area and the broader region

Status and Trends

Current Condition and Trend of Air Quality in the Plan Area and the Broader Region of Influence

Pre-industrial loading of total nitrogen (N) (nitrate-N + ammonium-N) deposition in the Rocky Mountains prior to the industrial revolution is estimated as low as 0.9-1.0 kg. N ha.-1yr-1 (Sverdrup et al. 2011, Holland et al. 1999). Nanus et al. (2017) estimated total nitrogen (TN), including nitrate, ammonium, and organic N, ranged from 2.20 to 4.79 kg-N ha-1yr-1 on the Bridger-Teton. The Total Deposition Model (TDEP) (2015-2017) estimates that N deposition on the Bridger-Teton, not including organic N, ranges from 2.4 to 6.8 kg-N ha-1 yr.-1 (USDA 2021a). Field measurements of total N deposition on the Bridger-Teton are measured in precipitation, dry deposition, and snowpack. When combined, the estimates of total measured N deposition (USDA 2021a) align with the Nanus et al. (2017) estimates. Nitrogen oxides and sulfur dioxide pollution and deposition have drastically decreased since the mid- to late 90s nationwide (Nopmongcol et al. 2019, Hand et al. 2020, USDA 2021a). Most of the emission reductions are credited to the 1990 Clean Air Act amendments and the 1999 Regional Haze Rule (RHR). These trends are reflected in precipitation and snowpack samples collected on or near the Bridger-Teton (USDA 2021a). Ammonium deposition increased on parts of the Bridger-Teton (USDA 2021a) due in part to an increase in emissions related to agriculture and wildland fire from both regional and long-distance transport (Zhang et al. 2018). Calcium deposition increased in snowpack samples and lake water chemistry samples (Ingersoll et al. 2016, unpublished analysis), likely influenced by an increase in dust events associated with drought conditions including lack of wintertime snowpack holding soil in place (Clow et al. 2016).

In accordance with the Regional Haze Rule, each Class I Wilderness Area is monitored with a goal of improving visibility degraded by anthropogenic emissions towards background conditions by 2064. Both the Bridger Wilderness and the Teton Wilderness Areas are meeting the targeted glidepath towards an estimated background conditions of 4.0 deciview (the standard measure for haziness, with a higher deciview meaning more haze) by 2064 with visibility improving particularly in winter months (See Appendix E). The Gros Ventre Wilderness is not a Class I Wilderness Area because it was not designated wilderness until 1984. While it is not part of the RHR program, it benefits from it. Although wildland fire smoke is usually not considered controllable within the RHR, the number of smoke-impacted days and the concentration of haze increased over the last two decades during summer months (USDA 2021a, Appendix E).

As snowpack melts, a pulse of phosphorus, nitrogen, and other nutrients enters surface waters on the Bridger-Teton (Ganz et al. 2021). Total phosphorus (TP) measurements in lake water and snowpack began in 2020, thus trend data are unavailable. However, increasing trends in TP concentrations have been documented at other lakes in the Rocky Mountains (Scholz and Brahney 2022).

Lake cores in the Bridger Wilderness have shown shifts in diatom communities related to increases in dust and associated nitrogen and phosphorus deposition since the 1940s (Brahney et al. 2015).

High levels of mercury have been found in birds, fish, and dragonfly larvae in Yellowstone National Park (YNP), suggesting mercury deposition and cycling is of concern in the Greater Yellowstone Ecosystem (Nanus et al. 2022). Mercury sampling has occurred in fish across

Wyoming and on or close to the BTNF and consumption advisory's have been issued by the Wyoming Department of Health as a result of that sampling. Advisory information can be found on the WGFD website (https://wgfd.wyo.gov/fishing-boating/fish-consumption-advice) and site-specific sampling results are held by the WGFD. The Bridger-Teton installed a wet deposition mercury monitor in 2021 and trends are not yet available. However, a mercury monitor in YNP at Tower Falls provides relevant data. Wet deposition of mercury at Tower Falls and other sites in the Rocky Mountains increased between 2005-2013 (Weiss-Penzias et al. 2016). Mercury concentration in snowpack chemistry samples in and around the Bridger-Teton (eight sites) declined or show no trend in the last 8-12 years, except for Teton Pass where the trend in mercury concentration increased since 2013 (https://co.water.usgs.gov/projects/RM_snowpack/html/snowpack_map.html).

Microplastics, pesticides, and other air pollutants are depositing on the Bridger-Teton, but the USFS lacks long-term data for trend analysis and knowledge on ecological implications (Brahney et al. 2020, McMurray et al. 2021, unpublished data 2023).

Critical Load Exceedances and Trends

A CL is a science-based threshold that identifies the amount of pollutant deposition below which significant ecological harm to an ecosystem component is not expected to occur (Nilsson 1988a, Nilsson 1988b). CLs are used to simplify complex scientific information and communicate the effects and risk of air pollution deposition to Federal land managers, policy makers, and the public (Blett et al. 2014, Burns et al. 2008, and Burns et al. 2011). Information about CLs and CL exceedances on the Bridger-Teton is available for: lake water acidification, surface water eutrophication, lichen species richness and abundance, and tree species growth rate and probability of survival over 10 years. Critical load estimates based on studies near the Bridger-Teton are available for alpine sedges and conifer-associated mycorrhizae. When pollution deposition exceeds the CL, the risk for negative ecological effects increases (e.g., eutrophication and decreases in tree growth rate).

Lake Water Acidification and Eutrophication CLs and Exceedances

Nitrogen (N) and sulfur (S) deposited from the atmosphere can act as an acid or nutrient. High elevation aquatic ecosystems on the Bridger-Teton are more sensitive to acid inputs and nutrient enrichment effects because steep topography and shallow rocky soils with sparse vegetation combine to make a poor buffering environment for deposition of ions from the atmosphere. Deposition often increases with elevation so the mountain ranges of the Bridger-Teton are more impacted than communities in the valleys (Nanus et al. 2017, 2022). Rapid snowmelt during runoff season releases a pulse of chemicals stored in the snowpack (Nanus et al. 2017).

The acid neutralizing capacity (ANC) of a waterbody (buffering capacity) indicates how sensitive the waterbody is to acidic inputs. Many high alpine lakes on the Bridger-Teton, particularly in the Bridger Wilderness, have low buffering capacity and they are sensitive to additional acidic inputs. Modeled lake chemistry data from 203 lakes sampled over the last decade on the Bridger-Teton showed 61 lakes (30 percent) at risk for acidification due to excess N deposition above the CL (McMurray et al. 2021). Risk for acidification is highest during spring runoff due to the concentrated addition of chemical compounds (Ganz et al. 2021).

Deposition from acidic pollutants, such as NO_x and SO_x, decreased in the last few decades (Nopmongcol et al. 2019, Hand et al. 2020). Dust events containing cations, such as calcium, which can increase buffering capacity, increased (Clow et al. 2016). Calcium concentrations increased in some alpine lakes on the Bridger-Teton[4]. These two trends combined may, overtime, decrease the risk for acidification at high alpine lakes.

Excess nutrient N deposition can increase the risk for a waterbody to become more eutrophic, which is a condition that occurs when excess nutrient leads to dense plant growth, which eventually leads to reduced dissolved oxygen in the water, sometimes to the point where aquatic biota, such as fish, cannot survive. As waterbodies eutrophy there is an increase in algal and cyanobacteria abundance, lake productivity, and changes in native diatom communities which may cause shifts in the foodweb. Modelled surface water eutrophication risk showed N deposition rates high enough to exceed CLs over 90 percent of the Bridger-Teton. The highest magnitudes of exceedance were in the Teton and Bridger Wilderness Areas and the southwest portion of the Bridger-Teton (McMurray et al. 2021).

A CL exceedance does not mean a lake will become eutrophic or experience algal or cyanobacteria blooms. Nitrogen is just one variable that influences probability for surface water eutrophication, other variables include: another essential macronutrient-phosphorus, length of growing season, water temperature, air temperature, sunlight, and other climatic variables. Lake water eutrophication monitoring should continue on the Bridger-Teton.

Lichen Species Richness and Forage Lichen Abundance

Lichens are important organisms, particularly in forested ecosystems, and they support various ecosystem functions and services such as providing food, nesting material, and housing for a myriad of animals and insects (https://www.nps.gov/articles/lichen-and-our-air.htm). Lichens that grow on trees and shrubs (known as epiphytic) are often sensitive to air pollutants, including N and S deposition, in part because most of their nutrients are absorbed from the atmosphere (Munzi et al. 2010, Geiser et al. 2019) developed nationwide CLs for lichens. Total N deposition exceeded CLs for lichen species richness over 80 percent and forage lichen abundance for 100 percent of the Bridger-Teton (McMurray et al. 2021). The highest predicted declines in lichen species richness were in the Teton Wilderness and the southwest portion of the Bridger-Teton. Predictions for declines in forage lichen abundance were widespread throughout the Teton, Gros Ventre, and Bridger Wilderness Areas as well as throughout the Wyoming Range (McMurray et al. 2021). Due to CL development methods and model evaluation, it is likely that the magnitudes of the CL exceedances are overestimated, thus any management focus and or monitoring should start with the highest exceedance areas.

Critical Load for Tree Species Growth Rate and Probability of Decadal Survival

CL exceedances of nitrogen for various tree species growth rate and probability of survival over 10 years was based on national research (Horn et al. 2018). Three tree species included in this research occur on the Bridger-Teton: 1) Douglas-fir (*Pseudotsuga menziesii*) (survival CLs), 2) balsam poplar (*Populus Balsamifera*) (growth and survival CLs), and 3) quaking aspen *(Populus Tremuloides*) (growth and survival CLs). Modeled N deposition suggests CLs for survival are exceeded for Douglas-fir in 82 percent (390 m^2 or 1,010.8 km^2) of the current modeled habitat and CLs for growth are exceeded for balsam poplar in 50 percent (0.3 m^2 or 0.8 km^2) of the

[4] Unpublished data on file at the Bridger-Teton Supervisor's Office, 340 N. Cache, Jackson, WY 83001.

modeled habitat (McMurray et al. 2021). These exceedances were modeled to have <5 percent decline effect on survival and growth. While this level of decline is considered minor compared to drought, disease, and infestations that affect tree species, it is worth considering the cumulative effect and continuing to monitor these CLs as new information becomes available.

Other Critical Loads

The CL to protect natural alpine plant community composition in Rocky Mountain National Park was estimated at 3.0 kg (6.6 lb) N ha-1 yr.-1 (Bowman et al. 2012). Areas on the Bridger-Teton with N deposition above 3.0 kg (6.6 lb) N ha-1 yr-1 may see shifts in alpine community composition with sedges having a competitive edge over alpine forbs. Shifts in alpine forb communities to sedge dominate would affect pollinators and other species that consume or rely on alpine forbs. Alpine plant community composition is not monitored on the Bridger-Teton.

The CL to protect ectomycorrhizal or fungal associations with conifer roots is estimated to be around 5.0 kg (11.0 lb) N ha-1 yr.-1 [Lilleskov et al., 2019]. Areas on the Bridger-Teton with N deposition above 5.0 kg (11.0 lb) N ha-1 yr-1 may see the following: shifts in mycorrhizal fungal communities; declines in biomass and forest floor decomposition; associated changes in nitrogen; and phosphorus cycling (Lilleskov et al. 2019). Mycorrhizal associations also are critical to alpine plant establishment and survival (Cripps and Eddington 2005). Mycorrhizal communities are not monitored on the Bridger-Teton.

Natural Resource Management and Air Quality

Most of the mineral development in the region, including oil and gas, are not within the plan area. Currently, the Bridger-Teton has 13 active petroleum wells (See minerals/geology section) and no mining or foreseeable proposed mining activity that would substantially affect air quality in the plan area.

Prescribed fire is a useful management tool that can aid in maintaining and restoring ecosystem health on the Bridger-Teton. Prescribed fire also is used to reduce fuels in the WUI and thus reduce the risk of impacts to communities that live in fire prone areas. Smoke management is integral to the prescribed fire management program. All prescribed burns in the project area must meet the Wyoming State Smoke Management Standards and Regulations. Prescribed fire within the UGRB marginal nonattainment area is considered an “exceptional event”, but it may have special considerations depending on the burn circumstances. Smoke from prescribed fire is unavoidable, but it is episodic, monitored and managed, and it does not pose a continuous health concern to the public. Many considerations go into a burn prescription to reduce the impacts of smoke. Because prescribed fire reduces fuel loading in a more controlled setting than wildland fire, smoke from prescribed fire results in lower pollutant impacts than if a large and high intensity wildland fire were to occur within the area (Long et al. 2017).

Pesticides are used to manage invasive and unwanted species on and off the BTNF. On the BTNF herbicides are the predominant form of pesticide used. including both aerial and ground application where appropriate. Treatment of invasive plant species on the Bridger-Teton is evaluated in the Invasive Plant Management Final Environmental Impact Statement for the Bridger-Teton National Bridger-Teton (2020).

Pesticides may enter the atmosphere through direct application, wind drift during aerial application from nearby locations, volatizing into the atmosphere after application, or during long-distance transport from dust deposition events. Many commonly used pesticides are toxic

to pollinating and non-pollinating insects, plants, mycorrhizae, and aquatic organisms. Currently, the Bridger-Teton is engaged in a pilot project to understand what pesticides, if any, are deposited from long-distance and regional transport in the atmosphere. (Pesticides also are briefly discussed in the Rangeland Management and Water Resource sections.)

Human-Related Threats and Stressors to Air Quality

Zhang et al. (2018) investigated the contribution of nitrogen air pollution to the GYA by both source sector and source region in 2011. At the time, the agricultural sector was the largest single source contributor to N deposition in the GYA, contributing 34 percent of N deposition on an annual basis, with 74 percent of agricultural emissions attributed to the Snake River Valley in Idaho. Agricultural emissions that contribute to nitrogen deposition also may include phosphorus and other chemicals, such as pesticides associated with agricultural production and operations. Contributions of N deposition from the oil and gas sector were small and primarily located near the Wind River Range (10 percent in the winter). N deposition from wildland and prescribed fire contributed to 18 percent of total deposition. Other emissions were grouped with the additional primary source locations being: California, Wyoming, northern Utah, and international (Zhang et al. 2018). It is important to note that this study was from 2011 and emission regimes changed including an increase in: frequency, severity, intensity, duration, and acres burned from wildland fires, fertilizer application, and dust events.

As tourism and recreation increase, so does on- and off-road vehicle and snowmobile use and associated emissions of NO_x, SO_2, VOC, and HAPs within and near the Bridger-Teton boundaries. Increased vehicle use on dirt roads also increases dust emissions. Unpublished emission data from Yellowstone National Park indicates there is valid concern over, and a need to further investigate, the air quality impact from the emissions of millions of vehicles visiting the Yellowstone National Park and GYA each year.

Recreation management actions affect the number and types of motorized vehicles that travel on roads and motorized trails on the Bridger-Teton, as well as what kinds of permitted events may occur. This may affect local pollution emissions and increased dust from motorized travel on dirt roads and trails.

There is growing concern over the impact of microplastic pollution on aquatic and terrestrial ecosystems world-wide (Dissanayake et al. 2022). On the Bridger-Teton, Brahney et al. (2020), estimated the mean plastic deposition rate over the Wind River Range was 68 ± 6 microplastics m^{-2} day^{-1} with plastic quantity estimated to be between 9.3-22.3 metric tons (75.0 ± 6.6 tons) per year, depending on the identification technique used. The largest source of microplastics on the Bridger-Teton is long-distance and local transport associated with dry deposition of fibers (Brahney et al. 2020). Other sources include recreationists who shed fibers from synthetic clothing and equipment and roadways (Brahney et al. 2021). The Bridger-Teton conducted a pilot project with the U.S. Geological Survey (USGS) to test seven snowpack sites on or near the Bridger-Teton that are part of the Rocky Mountain Regional Chemical Snowpack Monitoring Program (https://www.usgs.gov/centers/colorado-water-science-center/science/rocky-mountain-regional-snowpack-chemistry-monitoring) for microplastics. A total of 17 samples were analyzed between 2016-2019. Microplastics were found at each site. Microplastics pieces per liter ranged from 1.62-17.24 (0.42-4.55 gallons). Most studies on the ecological effects of microplastics focused on marine organisms. Currently, the Bridger-Teton staff does not understand the ecological effects, if any, of microplastic deposition on the Bridger-Teton.

Impacts of System Stressors on Air Quality and the Relationship to Ecological Sustainability

Changes in: drought conditions, temperature, plant disease and insect outbreaks that affect wildland fire regimes towards larger more frequent fires can contribute to hazardous levels of PM and other air pollutants lasting for several days and even weeks. Wildland fires also emit large amounts of GHGs, carbon monoxide, and deposition of atmospheric pollutants, which may affect the health and productivity of aquatic and terrestrial ecosystems.

Ozone formation occurs more rapidly with warmer temperatures (Moghani and Archer 2020). Increasing temperatures associated with climate change trends has been linked to an increase in harmful ozone production and an increase in airborne allergen exposure (Moghani and Archer 2020). However, a decrease in ozone precursors, such as nitrogen oxides in the atmosphere, may negate ozone formation caused by increases in temperature. If increases in temperature decrease snowpack, wintertime ozone formation also may decrease.

Current Land Management Plan Direction and Air Quality

The current plan mentions that “activities on the Bridger-Teton are planned to protect the quality of basic watershed resources, including air. Air values are protected to retain pristine wilderness characteristics, and the potential effects of air pollution upon the air quality related values (AQRVs) of Class I Wilderness will be evaluated during project analyses.” The only direction pertaining to smoke management is “prescribed fires will not be ignited during predicted periods of atmospheric inversions.” Other factors in addition to inversions are considered when planning prescribed burns and assessing smoke impacts. These strategies are outlined in the Wyoming Smoke Management Plan (SMP). New information on managing smoke in communities during prescribed burns could be incorporated into a revised Forest Plan.

Addressing key air quality issues in the management plan is difficult because most air pollution originates from outside of the planned area. Regardless, some AQRVs in Class I Wilderness Areas on the Bridger-Teton are being impacted by air pollutants, highlighting the importance of AQRV monitoring.

(More detailed information on air quality monitoring can be found in the most-recent Bridger-Teton National Forest Monitoring Plan and Biennial Monitoring Report (USDA 2021a).)

Issues, Concerns, or Opportunities that Extend Beyond the Plan Area

There is opportunity for collaboration with the following: state, county, local officials, and private sector partners to reduce emissions that are impacting the Bridger-Teton. This level of collaboration takes persistence, enduring support, and a vast amount of volunteer and employee time. The primary emission sources of concern are from agricultural pollutants that are currently acting as a fertilizer to aquatic and terrestrial systems. Microplastic pollution can be reduced at the local and county levels. Increased planning around tourism can reduce vehicle emissions.

The Projected Future Status of Air Quality if Existing Plan Direction and Stressors Remain in Place

Anthropogenic air pollution and deposition from nitrogen oxides, sulfur oxides, and mercury are expected to decrease or remain stable. Nitrogen oxides are a precursor to ozone, so reductions in this pollutant are needed to reduce ozone. However, ozone formation is known to increase

with an increase in surface temperature. Moghani and Archer (2020) modeled the impacts of climate change and climate change plus predicted emissions reductions on future ozone concentrations for 2050. Even with predicted emission reductions, modeled levels of ozone at Grand Teton National Park show violations of the current ozone standard by 2050 (Moghani and Archer 2020).

Smoke and associated pollutants from wildland fire are expected to increase across the project area in the next decade, with organic aerosols predicted to increase in the West up to 40 percent by 2050 (Hallar et al. 2017, Spracklen et al. 2009). Nitrogen and phosphorus deposition from agricultural practices (i.e., intense livestock, dairies, poultries, grains and vegetable production) are expected to increase on downwind landscapes including parts of the Bridger-Teton if the trend in agricultural use of fertilizers, feedlot practices, and dust events increases.

Plastic production is on the rise nationally and deposition of microplastics will continue to occur across the Bridger-Teton. The Bridger-Teton can reduce plastic use internally, educate visitors, and work with surrounding communities to reduce microplastic pollution from local sources.

Air pollution deposition will continue to act as an additive stress to ecosystems alongside other stressors such as: drought, climate change, invasive species issues, and insect and disease infestations.

Soil Resources

Key Takeaways

Soil is the foundation of ecosystem function and the food web. It acts as a growth medium and it: provides nutrients for vegetation, stores and filters water, cleans air, provides habitats for vertebrate and invertebrate species, is the foundation for human infrastructure, and is a long-term storage reservoir. Sustainable forest management has a direct relationship with maintaining long-term soil productivity. The existing forest plan lacks direction for management and monitoring that will ensure land and soil productivity will be maintained/thrive.

Summary

Soils are a dynamic resource that support physical, chemical, and biological activities of ecosystems. They are products of natural processes and consist of: minerals, organic matter (both dead and alive), water, and air. They are formed from the interactions over time between: parent materials, climate, organisms, topography, and vegetation communities. No single factor is responsible for all soil characteristics. All factors act together at different rates to form each individual soil type. The diversity of soils on the Bridger-Teton reflects the various landscapes and soil-forming factors.

The soils in the Wind River Range primarily formed from granitic material and generally have medium to coarse textures due to a slower weathering rate. Different ages of glacial till in the Wind River Range have different degrees of soil development. Soil derived from Bull Lake till (200,000 and 130,000 years ago) had longer to develop compared to soils that formed from the Pinedale age glacial till (30,000 to 10,000 years ago). Soils that formed on Bull Lake moraines generally have thicker surficial horizons (A and B), higher illuvial clay and finer soil textures compared to Pinedale age glacial till. The Absaroka mountains on the north of the Bridger-Teton are comprised of volcanic material deposits of: andesite lava, ash, mud and debris flows. The Gros Ventre mountains are primarily formed from dolomite, limestone and layered sedimentary

rocks. Soils formed on limestone and dolomite tend to have finer textures and they are alkaline because of a high calcium content of these parent materials. The Wyoming and Salt River Ranges are part of the Overthrust Belt, which is composed of sedimentary material. Soils formed on shale or siltstone weather more quickly than sandstone and will have finer textures than the more resistant sandstone parent material.

The soils on the Bridger-Teton are classified according to the Soil Taxonomy of the National Cooperative Soil Survey, USDA. This system of soil classification has six levels. The broadest category is called an order and five orders cover most of the forest including: Entisol, Inceptisol, Mollisol, Alfisol, and Histosol.

Existing Information

Soil resources on the Bridger-Teton have been described, characterized, and classified in three different soil inventories including 1) Teton National Forest (1985), 2) Bridger National Forest West (1993), and 3) Bridger National Forest East (1997). The Bridger National Forest East and West Terrestrial Ecological Unit Inventory (TEUI) have been converted to a Natural Resources Conservation Service (NRCS) Soil Survey, and they have been published on Web Soil Survey (WSS). The Teton Wilderness Areas within the Teton National Forest TEUI has been converted to a Soil Survey published by NRCS on WSS. The NRCS expects to publish the non-wilderness portions of the Bridger-Teton area draft Soil Resource Inventory by the end of 2024. Soil surveys help identify areas of the Bridger-Teton that are best suited for various land uses and land management practices.

The Bridger-Teton is collaborating with Lincoln, Star Valley, Sublette and Teton County Conservation Districts and NRCS to develop Ecological Site Descriptions (ESDs) for the Subalpine Forb ecological sites. The Bridger-Teton expects to develop additional ESDs for other ecological sites (a conceptual division of the landscape defined by its recurring patterns of soil, landform, geology, climate and ability to support a specific kind and amount of vegetation). ESDs are part of an ongoing effort to systematically collect, organize, and share knowledge about ecosystems and the relationships between their biological communities and physical surroundings. ESDs provide land managers the information needed for evaluating the land as to suitability for various land uses; capability to respond to different management activities or disturbance processes; and ability to sustain productivity over the long-term.

Current soil surveys and inventories provide useful data for land and resource management but often lack the detailed information needed in high-use areas on the forest. Updating the soil surveys and expanding ESDs would improve decision-making and support adaptive management for current and future land management challenges and resource conditions.

Current Forest Management Direction

The National Forest Management Act states that management activities will not produce substantial and permanent impairment of productivity. Since 1999, physical soil disturbance has been the focus of soil management on National Forest System (NFS) lands. FSM Chapter 2550 Soil Management and Region 4 supplement define criteria for measuring and managing soil quality and it provides direction for maintaining soil quality.

The direction provided by the current forest plan can be paraphrased as described below.

- Maintain or improve long-term soil productivity and soil hydrologic function.

- Control the risk of human caused soil erosion, mass wasting and sedimentation.
- Maintain the desirable condition of watersheds and integrity of associated ecosystems.

Status and Trends

Soil quality is the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries; to sustain plant and animal productivity; to maintain or enhance water and air quality; and to support human health and habitation and ecosystem health. A decrease in soil quality could affect the ability of the Bridger-Teton to: sustain recreation opportunities, wildlife habitat and populations, domestic livestock populations, timber production, plant and fungal biodiversity and quality of water for aquatic ecosystems and human uses. Soil functions are assessed by soil quality indicators. Soil functions include: soil biology, soil hydrology, nutrient cycling, carbon storage, soil stability and support, and filtering and buffering. Soil is the foundation of the ecosystem; to provide multiple uses and ecosystem services in perpetuity, these six soil functions need to be active.

1. Soil Biology: The presence of roots, fungi, and microorganisms in the upper sections of the soil. Having a diverse community of soil organisms is a key component of healthy soils and ecosystems. Healthy soils have an increased capacity to: decompose organic matter, cycle nutrients, form stable aggregates, direct and absorb moisture, regulate temperature, and promote both root growth and healthy plant communities. Quality indicators include: root distribution, soil structure, porosity, soil and canopy cover and plant community composition. Soil erosion, compaction, loss of soil structure, invasive species, severe or frequent burns and climate change can alter the diversity and abundance of soil biota.
2. Soil Hydrology: The ability of the soil to absorb, store, and transmit water, both vertically and horizontally. Changes in: soil bulk density, soil chemistry, soil structure, soil pores and ground cover can alter soil hydrology. Quality indicators include: surface soil structure and porosity, water infiltration rate, available water, and subsurface flow. The main impacts to soil hydrology on forests are: compaction, loss of soil structure, erosion, mass wasting, loss of vegetation cover and hydrophobicity from severe burns. Road interception also affects soil hydrology.
3. Nutrient Cycling: Soil stores and moderates the release of macro and micronutrients into the soil solution. During these biogeochemical processes, analogous to the water cycle, nutrients can be transformed into plant-available forms, held in the soil, or even lost to the atmosphere or water. Soil organism decomposition is at the center of the transformation and cycling of organic and inorganic nutrients through the environment. Quality indicators include: presence of surface organic layer, depth and presence of the A horizon, both fine and coarse woody material, and nutrient availability. The major impacts to nutrient cycling are: loss of organic matter and topsoil, mixing of soil layers, compaction, loss of soil structure, mass movement, changes in soil temperature and moisture.
4. Carbon Storage: The ability of the soil to store carbon. The amount of carbon stored in soils is often greater than the amount stored aboveground in living and dead plant biomass. Soils with higher clay content are generally associated with larger soil carbon storage. Carbon has more opportunities to adhere to clay particles because of the larger surface areas and numerous absorption sites. Carbon storage is a function of the percent of rock fragments, organic matter content and bulk density of the soil. Compaction, loss of organic matter, soil structure, and topsoil all affect a soil resource’s ability to function as a sink.

5. Soil Stability and Support: Soil has a porous structure to allow passage of air and water, withstand erosive forces, and provide a medium for plant roots. Soils also provide anchoring support for human structures and protect archaeological treasures. Inherent soil properties, such as soil texture and particle size distribution, play a major role in physical stability. Soil quality indicators include surface erosion by wind or water, site stability and soil deposition. The main forest impacts to structure and stability are mass wasting, erosion, and loss of organic matter and vegetation.
6. Filtering and Buffering: Soil can act as a filter to protect the quality of water, air, and other resources. Toxic compounds or excess nutrients can be degraded or otherwise made unavailable to plants and animals. Microorganisms in the soil degrade some of these compounds; others are held safely in place in the soil, preventing contamination of air and water. Wetlands' soils specially function as nature's filters. Main impacts to the filtering and buffering function include the same impacts as discussed above for soil hydrology and biology.

Soil productivity is a part of soil quality that is measured and monitored during forest plan implementation. Soil productivity is the ability of the soil to support vegetation depending on the physical, chemical, and biological properties of soil. The amount of nutrients and water the soils contain and can release to plants are determining factors in vegetation productivity. The nutrient exchange capacity and the available water holding capacity of soils in turn depend on several factors including: soil depth, texture, pH, and soil organic matter and clay content. Soil properties are used as indicators of changes to soil productivity and overall soil quality.

Forest Management Soil Disturbance

Forest management for multiple uses can cause disturbances that effect soil quality and functions. There are many soil functions intertwined, making it difficult to separately discuss them. Various degrees of soil disturbances result from management activities, but ecologically sustainable land stewardship can minimize adverse effects on soil quality. Soil disturbances and impacted functions can recover toward a natural condition either naturally or through restoration activities. The reduction of effects, coupled with increased time and soil restoration activities, should result in a sustainable or possibly even increased soil capacity to support multiple uses and ecosystem services.

Most soil disturbance is short-lived, but some disturbances are persistent or irreversible. Detrimental soil disturbance is defined in Region 4 as: soil displacement, soil compaction, soil puddling, and severely burned soil.

- Detrimental soil displacement includes areas where 3.3 feet by 3.3 feet or larger exhibits the loss of either 2 inch of humus or enriched topsoil (A horizon), whichever is less.
- Detrimental soil compaction is the soil density increase (weight per unit volume) and strength that restricts: root growth, alters soil structure, reduces soil aeration, and inhibits water movement.
- Soil puddling is the water infiltration reduction and permeability causing water to remain on the soil surface. It can alter local groundwater hydrology and wetland function and provide conduits for runoff. Soil puddling may occur in conjunction with detrimental compaction. Soil puddling visual indicators include clearly identifiable ruts with berms on the soil surface.

- Severely burned soil guideline applies to prescribed and wildland fires. Severely burned soils are identified by fire severity ratings and the effects to the soil. A severely burned soil is generally soil that is within a High Fire Severity burn as defined by the Forest Service Burned Area Emergency Rehabilitation Program (FSH 2509.13) and Debano et al. (1998). Soil humus losses, structural changes, hydrophobic characteristics, and sterilization are potential severely burned soil effects.

Detrimental soil disturbance due to management actions can be avoided through best management practices and design of forest management treatments. Where detrimental soil disturbance does occur, specific mitigation treatments can be applied to bring the soil back to a productive and functioning condition. Some areas of the Bridger-Teton have historic soil disturbances that may not have the capability to return to pre-management conditions. Current management direction provides protection of existing soil quality and direction to improve soil quality, where possible, in areas with historic disturbances.

Livestock Grazing

In localized areas on the Bridger-Teton, historical heavy livestock grazing along mountain ridges, hillsides, and alpine meadows led to: soil displacement, gullies, deep rills, accelerated sheet erosion, soil compaction, plant pedestaling, sparse vegetative cover, and/or large monocultures of undesired vegetation. Due to the amount of erosion and soil displacement, some of these areas may not return to the original vegetative community. Although there is a reduction of livestock populations from historical grazing and vegetative cover has improved, the effects can still be observed today where soil quality and productivity has been impaired (Davis 2007). Bridger-Teton specialists observed vegetative recovery trends are not uniform across the Bridger-Teton. Areas within allotments that have adaptive grazing practices to improve range condition or are in higher elevations, are recovering better than sites located in lower elevations. This is due to the climate and vegetative community differences of the areas. Areas of livestock trailing and corridors between allotments generally receive greater livestock traffic.

Bridger-Teton specialists observed stream channels and riverbanks baring the signature of livestock grazing. When soils are not adequately vegetated, accelerated erosion occurs and drainageways can become clogged with detached soil material. This loose soil material eventually becomes sediment that is deposited into stream channels. Continuous soil erosional processes caused a downward trend of spawning cutthroat in some riparian areas in the Bridger-Teton. In addition, downcutting and erosion of some stream and river channels on the Bridger-Teton disconnected channels from their floodplains. When floodplains become disconnected from their streams or river channels, it causes a change in vegetation communities, increases downstream erosion, and reduces the soil's ability to regulate temperature and filter and store water.

Positive trends have been observed and documented in Bridger-Teton Soil Resource Reports, indicating soil conditions improved in livestock grazing allotments. One example is East Sagebrush Creek allotment. In 1957 the ground cover in this allotment was about 40 percent compared to 97 percent ground cover measured in 2006. This allotment appears to have fully recovered from the impact of historic grazing (Winthers 2006, Soils Report: Sweetwater, Blucher, East Sagebrush Allotments). Multiple livestock grazing allotments had soil health determinations indicating that some plots within allotments were impaired, but allotments were within Region 4 Soil Quality Guidelines (Soil Reports: Winthers 2006, Winthers 2007, Winthers 2008).

Timber Harvest

Three known soil disturbance monitoring projects were completed where timber activity had occurred or within fuel management project boundaries on the Bridger-Teton. Types of soil disturbance observed were: rutting, soil displacement, erosion, and the combination of soil displacement and compaction. Causes of the disturbances were associated with ground-based harvest techniques used for piling slash and skidding of trees. Scorching of soil was also documented that resulted from the burning of slash piles. The majority of units monitored in 2010 and 2011 did not exceed soil disturbance for Region 4 soil quality standards. Areas monitored on the Big Piney (Hams Fork Soil Disturbance Monitoring Data 2010) and Kemmerer (LaBarge Soil Disturbance Monitoring Data 2010) Ranger Districts in 2010 had no observation of detrimental soil disturbance. Detrimental soil disturbance was observed to have exceeded Region 4 soil quality standard in the Phillips Bench Unit 3 within the boundary of the Teton to Snake Fuels Management Project during monitoring in 2011. The soil disturbance in this Phillips Bench Unit 3 was due to old roads and skid trails, some soil displacement also was present. No ground-based treatment was planned to occur in this Phillips Bench Unit 3, hand thinning and hand piling and burning was planned in this Phillips Bench Unit 3. Following implementation, including project design features, this Phillips Bench Unit 3 was not expected to exceed its current levels of detrimental soil disturbance. Any soil disturbance is not expected to be a substantial or permanent impairment (Burgoyne 2012).

Coarse, woody debris is dead organic materials such as: plant stems, branches, roots, and logs in all stages of decay with a diameter greater than 3 inches. Coarse, woody debris is material above the soil surface. Included are both natural and management induced material. Dead, woody material left after logging provides material for microbes to feed upon and, typically, microbial populations increase after forest harvests due to the input of logging residues. As dead, woody material gradually decomposes following harvest, microbial populations decline and slowly release the nitrogen to growing vegetation. Coarse, woody debris amounts met recommendations throughout the Bridger-Teton to the Snake Fuels Management Project area, except in units Phillips Bench 3 and Singing Trees 1. For these forest types, 5-10 tons per acre of large, woody material (greater than 2.8 in.) is recommended; these units are below 5 tons/acre. The monitoring data completed for Big Piney and Kemmerer Ranger District indicate coarse, woody debris is present in all units, but not enough data is present in the project record to determine tons per acre (Hams Fork Soil Disturbance Monitoring Data 2010, LaBarge Soil Disturbance Monitoring Data).

Recreation

Recreation impacts can degrade soil resources when heavy use and poor trail placement result in the trail tread becoming rutted or multiple treads are created due to wet soil conditions. Additional detrimental soil disturbance is created when erosion along a trail cuts into previously undisturbed soils or where user-created non-system trails are established. Multiple auxiliary disturbances can occur associated with trail erosion, drainage of adjacent moist meadows, and advance of noxious weed infestations along trail corridors. The same can be said for user-created four-wheel drive routes and the unauthorized use of motorcycles, ATVs, and trucks off designated roads and trails. Motorized vehicles in areas of sensitive soils have the potential to effect soil erosion and soil productivity potentials. The hydrologic functioning of soils that store large quantities of water within the landscape can be disrupted by trails that cause excessive drainage of water in these areas. User-created recreation trails lack adequate design to shed

storm water, and they are often created on steep grades prone to erosion. During the summer and fall seasons, some roads and trails on the Bridger-Teton experience significant vehicle and ATV traffic. Detrimental soil disturbance also is created at large, dispersed campsites and staging areas.

As recreation increases within the Bridger-Teton's wilderness boundaries, so have observations of human waste and discarded toilet paper. Digging holes for waste disposal can be very ineffective within alpine areas that have sparsely vegetated shallow lithic soil because these soils cannot assist with decomposition of organic matter as would be expected from a moderately deep or deeper soil. In addition, decomposition rates of organic matter in cold, dry climates of alpine regions are much slower when compared to areas where soil temperature and moisture is higher. These two characteristics of alpine soils causes the discarded waste to persist longer than recreation users may expect. Even though decomposition of organic matter is slower in alpine regions, the release of nutrients does occur. The additional nutrients to these nutrient poor areas may cause localized adverse effects by creating nutrients and microbial population imbalances within soil, riverine and lacustrine ecosystems.

Noxious Weeds

Another source of soil disturbance prevalent on certain areas of the Bridger-Teton is noxious weed species infestation on lands. When weed seed becomes prevalent in surface soil horizons, it has the potential to reduce land productivity and restrict management options. Strong correlations have been found on the Bridger-Teton, especially on certain soil-landscape types, between past soil disturbance and the occurrence of noxious weeds. These infested sites then become source areas for the spread of noxious weeds into adjacent, non-disturbed areas. Noxious weed spread can follow disturbance because weeds have opportunistic traits and they can exploit disturbed soil conditions (Williamson and Harrisburg 2002, Norton et al. 2007, James et al. 2010). The expansion of weed infestations into new areas can alter nutrient regimes and organic matter levels in the soil, which shifts the competitive balance on a site away from desired native species (Wolf and Klironomos 2005, Steinlein 2013). Management options and plant growth potential are both reduced when weed infestations exceed thresholds where restoration becomes difficult, creating new novel plant assemblages (Seastedt et al. 2008).

Once a noxious weed becomes a co-dominant species on a site, whether in a grassland area or as a forest understory plant, changes to the soil and reduced site potential are consistent with the concept of "permanently degraded" as used in the NEPA (1970) and the National Forest Management Act (1976). Without management action to reverse the negative effect of noxious weed infestation these areas can become permanently degraded.

Management Implications

Although the current guidance is useful, the Bridger-Teton Forest Plan needs to be updated to reflect best available science, current best management practices, and regional guidance. Some additions to the revised plan should include the following:

- desired future conditions for land productivity;
- more specific management direction for land and soil productivity;
- land productivity monitoring question that incorporates all land management activities;

- monitoring elements for land productivity added to the monitoring plan; and
- incorporating soil quality standards and guidelines for land management actions including, but not limited to, detrimental disturbance guideline for ground-based machinery vegetation management, and ground cover guidelines for rangeland.

Water Resources

Key Takeaways

Water resources are at the core of sustainable socioeconomic development, healthy ecosystems and human survival. The most significant water resources stressor on the Bridger-Teton and in the broader region is climate change. While stream flows on the Bridger-Teton are projected to be more resilient to warming temperatures than other areas in the region, the demand for water is not expected to decrease in the future. Water resources on the Bridger-Teton will become more critical to meeting future water demands in the broader region. The current land management plan does not address climate change, nor does it establish goals to increase resilience of water resources to projected changes in precipitation and temperature.

Summary

- Water is a foundational component of the world we live in. Both terrestrial and aquatic ecosystems on the Bridger-Teton depend on an adequate supply of high-quality water. One reason Congress established the USFS in 1905 was to provide quality water for the nation's benefit. The Bridger-Teton sits at the headwaters of our Nation's most relied upon river systems, the Snake-Columbia, Green-Colorado and Yellowstone-Missouri Rivers. The Bridger-Teton is also a recharge area for many local and regional aquifers.
- Water resources on the Bridger-Teton provide many services to the public including drinking water, irrigation, and water for livestock. Water resources also provide world class recreational opportunities on the Bridger-Teton including fishing, boating, and wildlife viewing. Many campers, hikers and hunters are also drawn to water resources on the Bridger-Teton for their scenic or other cultural values.
- Much of the local and regional economy surrounding the Bridger-Teton is driven by agriculture, which depends on water from the Bridger-Teton. Most of the water in the Upper Snake River Basin is used for crop production in southeastern Idaho. The Upper Green River flows into the Colorado River, which provides drinking water to approximately 40 million people and irrigates 5.5 million acres of land across seven U.S. states.
- The types of demand for water resources are much the same today as they historically have been on the Bridger-Teton: drinking water, irrigation, stock water, and recreational or spiritual uses. While often less-explicitly recognized, ecological needs for water indirectly support systems that provide multiple other human benefits from fish to clean air. The quantity of water needed to meet all these uses and needs significantly increased and will continue to increase with rising populations.
- Infrastructure influencing water delivery on the Bridger-Teton includes the following: reservoirs, diversion structures, irrigation ditches, pipelines, stock water developments, and groundwater wells. Infrastructure on USFS lands is permitted through special use authorizations from the Bridger-Teton.

Status and Trends

Water resources on the Bridger-Teton are contained within one of five basins (Figure 18). Most of the Bridger-Teton lies within the Upper Snake-Columbia Basin or the Upper Green-Colorado Basin. Smaller portions of the Bridger-Teton lie within the Upper Yellowstone-Missouri Basin, Upper Bear-Great Basin or North Platte-Missouri Basin. (Further descriptions are contained within the Watershed section.) The prominent values sustained by water originating on the Bridger-Teton include drinking and agricultural water supplies, recreational values, and ecological needs.

Surface water resources vary tremendously across the Bridger-Teton and they include: rivers, streams, wetlands, ponds, lakes and reservoirs. Groundwater resources include aquifers and GDEs, which include springs, fens, and karst systems. (A more detailed description of these aquatic resources and their ecological integrity is included in the Aquatic, Wetland and Riparian Ecosystem section.) This report focuses on water quality and anthropogenic water uses.

Water Rights and Drinking Water

In Wyoming, water rights are like those of many western states where the right is based on priority or prior appropriation; that is, whoever first put the water to beneficial use has the priority right to the water. Water rights in Wyoming are regulated by the State Engineer. The USFS reviews and permits access to state granted water rights on NFS lands through special use authorizations, which are legal documents (e.g., permit, term permit, lease, and easement) that allow occupancy, use, or privileges on National Forest lands. The implementing regulations that guide how the Forest Service administers special use authorizations can be found in 36 CFR Parts 25, 261, and 295. Most water rights on the Bridger-Teton are for: stock water, domestic use, irrigation, or municipal use. To date, there are just over 700 active water rights on the Bridger-Teton with: 47 located on the Kemmerer District; 80 on the Big Piney District; 160 on the Greys River District; 179 on the Jackson District; 96 on the Blackrock District and 145 on the Pinedale District.

Forty-nine of the state-granted water rights on the Bridger-Teton provide drinking water to Public Water Systems (PWS). PWS are defined as a system that serves water to at least 15 service connections or an average of 25 people per day for a period of at least 60 days (WDEQ-WQD 2023). Wyoming is the only state that does not have primacy over the Safe Drinking Water Act; the USEPA retains primary enforcement authority over the Safe Drinking Water Act and PWS in Wyoming. In 2004, the WDEQ completed a source water assessment (WDEQ-WQD 2004) that identified areas contributing water to a PWS well or intake and that have the potential to affect water quality at PWS. Three protection zones were identified for each PWS. Zone 1 is located within a 100 ft. radius of a well or intake, and it has the highest potential for contaminants to affect PWS water quality. Zone 2 and Zone 3, moving outward from the well, have decreasing potential for contaminants to impact water quality.

In the State's 2004 assessment, 21 Zone 1 protection areas were identified on the Bridger-Teton, with the majority occurring along the Star Valley Front. Included in these 21 PWS, are systems that service the Cities of Alpine, Pinedale, and Afton. Other PWS on USNFS lands service guest ranches, subdivisions, campgrounds and summer camps. Each Zone 1 area on NFS lands has an associated larger Zone 2. Additional areas classified as Zone 2 on the NFS lands protect intakes or wells located downstream from NFS lands. Large swaths of NFS lands along the Star Valley Front, Wyoming Range, and Wind River Range are classified as Zone 3.

The WDEQ- Water Quality Division (WQD) is planning to revise the 2004 Source Water Assessment Report in the next 1 to 2 years to establish protection zones for PWSs that came online after 2004 (Kim Parker WDEQ, personal communication March 28, 2023).

Wyoming water law allows the State of Wyoming to hold water rights for instream flow. Instream flow water rights are issued to maintain a minimum amount of water in perennial streams and rivers for maintenance of fisheries habitat. Most of these instream water rights are junior to other traditional water rights, which means that if there is a shortage of water, senior water rights will take priority. Currently, the State of Wyoming holds 29 segments of instream water rights on the Bridger-Teton. (More information, including the location of these 29 segments, is available at: https://wgfd.wyo.gov/Fishing-and-Boating/Instream-Flow-XStream-Angler/Instream-Flow-Map.)

The Omnibus Public Lands Management Act (Public Law [P.L.] 111-11) designated Snake River Headwaters waterways as wild and scenic rivers and mandated the establishment of Federal reserved instream flow water rights to protect the free-flowing condition and outstandingly remarkable values of the designated segments. The Omnibus Public Lands Management Act set a priority date for these water rights as of March 19, 2009. Flow data continues to be collected at this time to provide a basis for a future filing of water rights under Wyoming state law as required in the Omnibus Public Lands Management Act. Federal reserved instream water rights will be held by the USFS.

Water Use

Increases in population, development, and visitation have increased the overall demands on water resources resulting in water use being a major stressor. Of particular concern are consumptive water uses, which on the Bridger-Teton include: irrigation, stock water, domestic, and municipal uses. These water uses can alter the timing, magnitude and duration of natural flows, and they also may interfere with interactions between groundwater and surface water systems.

Water rights associated with irrigation comprise 125 of the 707 water rights on the BTNF. Irrigation withdrawals on the BTNF typically utilize diversion structures on stream channels and ditches that carry water from the stream to the point of use. Water is diverted away from natural stream channels, which reduces the amount of water available for downstream aquatic, riparian and wetland ecosystems. The amount of water that can legally be diverted is dependent upon state administered water law and is outside of the control of USFS. Depending on the amount of water diverted, downstream channel morphology is often altered due to reduced flows and altered sediment regimes. Riparian corridor extent and species diversity can be reduced. Water temperatures downstream of diversions can become elevated due to decreased flow rates, which can stress fish and other aquatic species. Accurate data on the amount of water used for irrigation purposes on the BTNF is not available due to the lack of instrumentation installed at diversion structures. Irrigation diversions can also impede aquatic organism movement, including spawning. Entrainment occurs when fish swim through diversion structures and become trapped in irrigation ditches; this typically leads to direct mortality. Excess irrigation water sometimes flow back into natural streams. This is called return flows and often contributes water quality contaminants and elevates stream water temperatures.

Dams are another type of water use infrastructure on the forest that can impact aquatic, riparian and wetland ecosystems. Dams impound water for various uses including municipal, irrigation, stock water, recreation and hydropower. Dams directly eliminate riverine ecosystems and

replace them with lacustrine ecosystems. Dams are often a barrier to aquatic organism movement and fragment aquatic habitat. Depending on the type of outflow, dams can impact downstream aquatic ecosystems in a myriad of ways. Downstream water temperature and sediment regimes are typically altered. Larger, more sophisticated dams regulate water releases in an attempt to meet water use needs while still mimicking natural hydrographs and providing for recreational opportunities downstream of the dam. Jackson Lake Dam is an example. Other dams, such as those built for stock ponds may completely dry up the downstream channel and only allow flow to pass through when the pond is full. All dams present unique challenges in providing for permitting water use while still allowing adequate flow for aquatic ecosystem function.

BTNF staff are already working with partners to minimize the effects of irrigation and other consumptive water use on aquatic and riparian ecosystems. Existing diversion infrastructure is being upgrading or retrofitted to be more efficient while reducing the likelihood of entraining fish and other aquatic organisms. Multi-agency cooperative meetings are routinely held to capture input on reservoir management and to identify opportunities for aquatic enhancement. As the timing, magnitude and duration of natural flows are altered due to climate change, collaborative management amongst all water users will become more critical in providing for ecosystem services and multiple uses.

Special Designations

Wyoming State Regulations (020-1 Wyo. Code R. §§ 1-4) define Class 1 waters as “Outstanding Waters” and those surface waters in which no further water quality degradation by point source discharges other than from dams will be allowed. Nonpoint sources of pollution shall be controlled through implementation of appropriate best management practices. Water quality and uses of Class 1 waters are to be maintained. Class 1 waters on and downstream of the BTNF include:

- All surface waters located within the boundaries of national parks and congressionally designated wilderness areas as of January 1, 1999 (See the Designated and Special Areas section);
- The main stem of the Snake River through its entire length above the U.S. Highway 22 Bridge (Wilson Bridge);
- The main stem of the Green River, including the Green River Lakes from the mouth of the New Fork River upstream to the wilderness boundary;
- The main stem of the Sweetwater River above the mouth of Alkali Creek;
- All waters within the Fish Creek (near Wilson, Wyoming) drainage;
- The main stem of Granite Creek (tributary of the Hoback River) through its entire length;
- Fremont Lake;
- Wetlands adjacent to the above listed Class 1 waters (WDEQ-WQD, 2001).

In 2009, the passage of the Craig Thomas Snake Headwaters Legacy Act (P.L. 11-111) added all or segments of 13 rivers and 25 separate river segments totaling 414 miles in the Snake River Headwaters to the National Wild and Scenic Rivers System. See the Designated and Special Areas section. In 2014, the BTNF finalized a Comprehensive River Management Plan (CRMP) (USDA-USFS, 2014b), which is required by the Wild and Scenic River Act. The CRMP

establishes overall management direction for designated wild and scenic river segments within the BTNF. Along with establishing management direction, the CRMP also served to document the status of water quality for each segment at the time of designation. Water quality descriptions were derived from available data sources at the time and were developed for each designated segment. All designated segments are considered to have very good water quality. Elevated sediment because of wildfire was noted at Granite Creek and Pacific Creek. Detailed water quality data for each segment is available in the CRMP.

In addition to state water quality standards and protections afforded by the Clean Water Act, designated wild and scenic river segments have additional management mandates to protect water quality. Section 7 of the WSR Act (16 U.S.C § 1278(b)) prohibits federal assistance for water resources projects that would adversely affect WSR values, including water quality. Section 10(a) (16 U.S.C § 1281(a)) includes direction for river managers to not only protect but also to enhance or improve WSR values, including water quality (IWSRCC, 2024).

Water Quality

Water quality on the Bridger-Teton is generally considered to be in good condition. The WDEQ-WQD establishes regulatory surface water quality standards for all waters in Wyoming including within the BTNF. As directed by the Clean Water Act, determinations of surface water quality standards attainment are compiled into Wyoming's Integrated 305(b) and 303(d) Report (IR). The latest IR (WDEQ-WQD 2025) identifies 22 streams where a water quality assessment has been completed on the BTNF. Twenty of these streams are supporting at least one beneficial use. Clarks Draw is located on the Big Piney District and is a tributary to the Hoback River. A water quality assessment was completed; however, data is insufficient to determine if beneficial uses are being met on Clark's Draw. Fish Creek, which primarily flows through private lands near Wilson, WY, flows over a relatively short section of the BTNF near the Anchor Ranch. Fish Creek is listed as impaired due to elevated levels of total nitrogen, total phosphorus and E. coli.

Table 20. Impaired streams downgradient of Bridger-Teton

Waterbody Name	River Basin	Impairment	Identified Pollutant
Crow Creek	Salt	Recreation	E-coli
Hams Fork River	Green	Cold water game fish, aquatic life other than fish	pH
Big Sandy River	Green	Recreation	E-coli
Little Sandy River	Green	Cold water game fish, aquatic life other than fish	Sedimentation
Sweetwater River	North Platte	Recreation	E-coli
Lander Creek	North Platte	Recreation	E-coli
Fish Creek	Upper Snake	Aquatic life other than fish, recreation	Total nitrogen, total phosphorus, E-coli
Flat Creek	Upper Snake	Cold water game fish, aquatic life other than fish, recreation	Physical substrate, habitat alteration, E-coli

The IR (2025) does list six impaired perennial streams located outside of the BTNF that have tributaries originating within the BTNF (See Table 20). These segments flow through land managed by other agencies or private landowners after leaving the Bridger-Teton. Reasons for impairment are not attributed to management actions taken on the Bridger-Teton.

The National Aquatic Resource Surveys (NARS) are collaborative programs between the USEPA (Environmental Protection Agency), states, and tribes designed to assess the quality of the Nation's coastal waters, lakes and reservoirs, rivers and streams, and wetlands using a statistical survey design. The National Rivers and Streams Assessment Surveys (NRSA) and the National Lakes Assessment Surveys (NLA) are components of NARS. Since 2007, they included randomly selected locations on the Bridger-Teton to collect physical, chemical, and biological data on surface water. The data suggests that the most widespread chemical water quality stressors are elevated nitrogen and phosphorus levels. Most sites on the Bridger-Teton were ranked “good” with a few sites ranked “fair” for total nitrogen and total phosphorus (USEPA 2010, USEPA 2016a, USEPA 2016b, USEPA 2020, and USEPA 2022). (See Table 21 for information on NARS sites located on the Bridger-Teton.) (Additional information related to NARS is available at: https://www.epa.gov/national-aquatic-resource-surveys.) (Potential sources of nitrogen, phosphorus and other pollutants is discussed in the Air Quality Assessment report.)

Table 21. Total nitrogen and total phosphorus concentrations from National Aquatic Resource Survey sites on Bridger-Teton

Location	Site ID	Year	Total N Microgram/Liter (µg/L) (ranking)	Total P [µg/L] (ranking)
Greys River, south of Forest Park (NRSA Sites)	14550	2009	62 (Good)	19 (Fair)
Greys River, south of Forest Park (NRSA Sites)	1002869	2013	66 (Good)	24 (Fair)
Greys River, south of Forest Park (NRSA Sites)	2013865	2019	94 (Good)	14.7 (Good)
Greys River, north of Box Y (NRSA Sites)	1002870	2013	91 (Good	25 (Fair)
Greys River, north of Box Y (NRSA Sites)	2013864	2018	104 (Good)	117.7[1]
Greys River, north of Box Y (NRSA Sites)	2014004	2019	22 (Good)	14.9 (Good)
Cottonwood Cr, tributary to Gros Ventre River (NRSA Sites)	1002882	2013	81 (Good)	12 (Good)
Cottonwood Cr, tributary to Gros Ventre River (NRSA Sites)	2013471	2018	108 (Good)	6.8 (Good)
Unnamed tributary to Donald Creek (NRSA Sites)	1004331	2014	120 (Good)	14 (Good)
Unnamed tributary to Donald Creek (NRSA Sites)	2013454	2018	120 (Good)	5.2 (Good)
Hoback River, near Riverbend Ranch (NRSA Sites)	1002881	2013	49 (Good)	17 (Good)

Location	Site ID	Year	Total N Microgram/Liter (µg/L) (ranking)	Total P [µg/L] (ranking)
Hoback River, near Camp Creek conf. (NRSA Sites)	2013866	2019	163 (Fair)	37.4 (Fair)
Unnamed tributary to East Fork Sagebrush Cr. (NRSA Sites)	2013849	2018	108 (Good)	6.8 (Good)
Black Lake (NLA Sites)	NLA06608-0090	2007	252 (Good)	11 (Good)
Black Lake (NLA Sites)	NLA06608-0090	2007	350 (Fair)	15 (Fair)
Freemont Lake (NLA Sites)	NLA06608-0794	2007	91 (Good)	3 (Good)
Freemont Lake (NLA Sites)	NLA06608-0794	2007	69 (Good)	1 (Good)
Freemont Lake (NLA Sites)	NLA12_WY_103	2012	50 (Good)	12 (Good)
Freemont Lake (NLA Sites)	NLA17_WY-10021	2017	140 (Good)	0.9 (Good)
Willow Lake (NLA Sites)	NLA06608-0970	2007	140 (Good)	3 (Good)
Willow Lake (NLA Sites)	NLA12_WY_R02	2012	141 (Good)	12 (Good)
North Fork Lake (NLA Sites)	NLA06608-1818	2007	90 (Good)	7 (Good)
Star Lake (NLA Sites)	NLA12_WY_116	2012	306 (Fair)	31 (Fair)
Star Lake (NLA Sites)	NLA17_WY-10006	2017	276 (Fair)	14.9 (Good)
Green River Lakes (NLA Sites)	NLA12_WY_120	2012	88 (Good)	18 (Good)
Hidden Lakes (NLA Sites)	NLA12_WY_125	2012	269 (Fair)	29 (Good)
Temple Lake (NLA Sites)	NLA12_WY_133	2012	59 (Good)	14 (Good)
Temple Lake (NLA Sites)	NLA17_WY-10009	2017	80 (Good)	6.3 (Good)
Sauerkraut Lakes (NLA Sites)	NLA17_WY-10012	2017	109 (Good)	7.4 (Good)
Unnamed, near Wall Lake (NLA Sites)	NLA17_WY-10031	2017	125 (Good)	7.7 (Good)

1 Outlier.

The USGS (2009) completed baseline groundwater sampling for pesticide contamination at sites across the State of Wyoming. There were no sites sampled on the Bridger-Teton. However, there were 40 sites sampled down-gradient of the USFS lands. Three of those sites tested positive for pesticides at concentrations greater than a common assessment level (CAL) of 0.07 micrograms per liter (µg/L). There was one site located near the Town of Jackson, one site near the Town of Pinedale, and one site near the Town of Cokeville. All of them detected pesticides that were smaller than USEPA drinking water standards or applicable health

advisories. All sites sampled were at risk of influence from urban and/or agricultural pesticide use. Repeat sampling was completed in 2008-2010 on a subset of sites from the initial baseline sampling (USGS 2013). Only one site downgradient of the Bridger-Teton was included in the repeat sampling; it is located near Daniel Junction. Pesticide concentration at this site had increased since baseline sampling. All detected pesticides were measured at concentrations smaller than USEPA drinking-water standards or health advisories where applicable (many pesticides did not have standards or advisories).

HCBs are dense concentrations of cyanobacteria, commonly referred to as blue-green algae, that pose a health risk to people, pets, and livestock. The WDEQ is working with the Wyoming Department of Health (WDH), land management agencies, and other stakeholders to address HCBs in Wyoming surface waters. There have been anecdotal reports of HCBs in lakes in the Bridger Wilderness. In September of 2022, there was confirmed HCB presence in V Lake, which prompted the WDH to issue an advisory for V Lake. HCBs were also confirmed at Little Soda Lake, Twin Lakes 2, Meeks Lake, and V Lake in 2024, resulting in the issuance of Bloom Advisories. However, Toxin Advisories were not issued for these waters because cyanotoxin concentrations were below toxin advisory thresholds. In 2024, cyanobacteria were documented in Murphy Lake though did not exceed density thresholds for the issuance of an HCB advisory. Advisories are issued to inform the public of potential health risks when cyanobacteria blooms are present (WDEQ 2024). The presence and frequency of HCBs on the Bridger-Teton are expected to increase due to warming temperatures. (For more information on HCBs in Wyoming, See www.wyohcbs.org.)

Stressors on Water Resources

System stressors include climate change, invasive species and altered wildland fire regimes. Human activities and multiple uses that impact water resources in the Bridger-Teton include: water uses, transportation, and recreation. Consumptive water uses on the Bridger-Teton include: irrigation, stock water, domestic, and municipal uses. Non-consumptive water uses include recreational and ecological uses. Instream flow is the use of water to sustain watershed function and integrity of riparian and aquatic ecosystems. Coordinating water uses, particularly reservoir releases, so that the needs of irrigators, recreationists and ecological systems are being met is becoming increasingly challenging. Collaboration and coordination between irrigation districts, state, federal and local governments is essential to ensuring all resource needs are met.

In 2024, Teton County produced a Water Quality Management Plan (WQMP) that inventoried potential stressors to water quality within Teton County (Teton County, 2024). Three primary categories of pollutants were identified: wastewater, point sources and nonpoint sources. Centralized wastewater treatment plants are effectively treating wastewater effluent. The WQMP also looked at large capacity septic systems in the county and concluded that there are areas within the county which are likely affected by wastewater sources, primarily septic systems. Most of these septic systems occur on privately owned land, however they could impact downstream water quality on NFS lands (Teton County, 2024).

There are only two permitted point source discharge locations within the BTNF: Grante Hot Springs and Astoria Hot springs. Both are permitted through WDEQ-WQD and are monitoring for permit compliance on a monthly basis.

Teton County's WQMP found that the primary water quality stressor within the county stems from nonpoint source sources. Point sources are actively permitted and monitored through state permits, while there is little to no oversight on nonpoint sources. Nonpoint source pollution occurs when contaminants that are dispersed across the landscape are carried into waterways by rainfall or snowmelt. Nutrients and pathogens are the nonpoint source contaminants of greatest concern in Teton County. Nonpoint sources of discharge include parks, lawns, golf courses, agriculture and urban areas (Teton County, 2024). Nonpoint sources of these pollutants occurring on the BTNF include pet waste along popular hiking trails, elk feed grounds and livestock grazing.

Reasonably Foreseeable Water Resources Projects

Reasonably foreseeable water use projects on the Bridger-Teton include the construction of new reservoirs and the modification of existing reservoirs to extend their life and increase storage capacity. The use of large reservoirs allowed the development of present-day irrigation and agricultural practices; however, damming rivers to create reservoirs alters fundamental hydrologic and geomorphic processes of natural waterways, which eliminates or adversely impacts many ecological riverine processes, species habitats and populations of both native aquatic species and non-native sport fish.

Water Resource Issues Extending Beyond the Bridger-Teton

Stressors and drivers impacting water quantity, quality, timing, and duration of water resources in the Bridger-Teton have the potential to impact water users far downstream of the Bridger-Teton boundary. If water quality is degraded through activities occurring on NFS lands, downstream users could experience higher water treatment costs and/or higher infrastructure maintenance costs. Increased peak flow quantities resulting from wildfires and/or climate change can cause flooding, which could damage private property and transportation infrastructure downstream of NFS lands. Conversely, stressors that decrease streamflow quantities from NFS lands effect water users, including users who may seem distant from the Bridger-Teton but who rely on water from the Bridger-Teton.

The Green River is one of the principal tributaries of the Colorado River. The Colorado River Basin is experiencing the worst drought in its recorded history, posing unprecedented new challenges throughout the Colorado River Basin and in areas that rely on water from the basin (USGS 2023). Recent studies suggest that when compared to other subbasins within the Colorado River Basin, streamflow in the UGRB is projected to be more resilient to warming temperatures than other basins within the Upper Colorado River Basin (Hoerling et al. 2019, Whitney et al. 2023). Water supply reliability and resiliency from the UGRB may become increasingly crucial for Upper Basin states to meet their obligated water delivery to Lower Basin states.

Water stored in Grassy Lake, Jackson Lake, and Palisades Reservoir are crucial for irrigation in southeastern Idaho. The Pacific Northwest Region of the Bureau of Reclamation (BOR) manages releases from these reservoirs. Coordinating releases so that the needs of irrigators, recreationists, and ecological systems are being met is becoming increasingly challenging as stressors, such as climate change, decrease the amount of runoff flowing into these reservoirs. Working groups consisting of state and Federal agencies as well as local governments and organizations collaborate with BOR to increase understanding of recreational and ecological needs of water releases; however, water rights held by irrigators are typically older than any in-

stream water rights related to fisheries or Wild and Scenic Rivers and would take precedent when water shortages occur.

Current Land Management

The current land management plan does very little to affect the quantity, timing, and distribution of water resources in the plan area and broader region. Dominant drivers for these variables include climate and geology and are mostly beyond management's scope of influence. Many of the goals set forth in the existing forest plan seek to address present day water resources issues and concerns, however, many of the standards and guidelines are vague and ineffective. In recent years, issues and concerns have been addressed through project-specific design or mitigation features, developed from best available science.

Diversity of Plant and Animal Species

At-Risk Species

Introduction

In accordance with the 2012 National Forest System Land Management Planning Rule (2012 Planning Rule) and further guidance from the Forest Service Land Management Planning Handbook (FSH), at-risk species are identified within the forest plan revision process, relevant to the plan area and planning process. At-risk species consist of two groups: 1) federally recognized threatened, endangered, proposed, and candidate species (TEPC) and 2) species of conservation concern (SCC).

Threatened and endangered species are federally designated by the USFWS (terrestrial species) under the (ESA) of 1973. This ESA was created to protect critically imperiled species from extinction and to identify a path towards their recovery. A proposed species is a species being evaluated in detail to determine if they should be listed as a threatened or endangered species under the ESA. A candidate species is one where there is sufficient information to warrant listing, but it is precluded by higher priority species. For some threatened or endangered species, critical habitat is important to the recovery of the species that also has been identified. Similarly, proposed species may have proposed critical habitat identified.

SCC are species other than a federally recognized: threatened, endangered, proposed, or candidate species known to occur in the plan area and the Regional Forester determined the best available scientific information indicates substantial concern about the species' capability to persist over the long-term in the plan area (36 CFR § 219.9).

How At-Risk Species Inform Revision of the Forest Plan

The 2012 Planning Rule requires plans to use a complementary ecosystem and species-specific approach to provide for the diversity of plant and animal communities and to maintain the persistence of all native species in the plan area, regardless of any special status, listing, or designation. At-risk species play a role in all three phases of the forest plan revision process described below.

- Assessment – Identify species listed under the ESA that occur in the plan area and develop potential SCC.

- Plan Revision – The Regional Forester identifies SCC for the plan area derived from the potential species identified during the assessment phase and after consideration of public comments. Plan components are developed to maintain ecosystem integrity, with incorporation of species-specific plan components, when needed, to provide for species whose specific habitat needs may not be fully met under the ecosystem-level plan components.
- Monitoring – Periodically observe monitoring indicators to determine whether the revised plan is providing ecological conditions necessary to contribute to maintaining a viable population of a species. For select at-risk species, a select set of ecological conditions, including habitat, is monitored.

Federally Recognized Species

On the Bridger-Teton there is one federally recognized plant species with a status of threatened; there are five federally recognized threatened, endangered, proposed, or candidate terrestrial wildlife species that occur on or in proximity to the Bridger-Teton; and there is one federally recognized aquatic species with a status of endangered (See Table 22).

Table 22. Federally recognized species and designated critical habitats

Species Common and Scientific Name	Federal Status	Critical Habitat within Action Area	Recovery Plan
Whitebark pine (*Pinus albicaulis*)	Threatened	No	No
Canada lynx (Lynx canadensis)	Threatened	Yes	Yes
Grizzly bear (Ursus arctos horribilis)	Threatened	No	Yes
Yellow-billed cuckoo (*Coccyzus americanus*)	Threatened	No	No
Wolverine (*Gulo gulo*)	Threatened	No	No
Monarch butterfly (*Danaus plexippus*)	Proposed Threatened	No	No
Kendall Warm Springs dace (Rhinichthys osculus thermalis)	Endangered	Yes	Yes
Suckley's Cuckoo Bumble Bee (*Bombus suckleyi*)	Proposed Endangered	No	No

Federally Recognized Terrestrial Wildlife

Of the five federally recognized: threatened, endangered, proposed, and candidate terrestrial wildlife species, only two, the grizzly bear and wolverine, commonly occur in the plan area. The yellow-billed cuckoo has only been documented adjacent to the Bridger-Teton. Canada lynx has not been documented on the Bridger-Teton since 2010. One unconfirmed 2022 Canada lynx sighting northeast of Bondurant was reported in 2024. The Monarch butterfly only has one documented observation of four individuals on the Bridger-Teton in 2016. Furthermore, their habitat is rare to non-existent on the Bridger-Teton with only two milkweed specimens collected in the 1990s. One specimen was documented in the Greys River drainage and the other adjacent to the Narrows Campground road near New Fork Lake. In general, milkweed is not native to habitats found on the Bridger-Teton.

The current Bridger-Teton Land Resource Management Plan (LRMP) does not contain specific plan components for wolverine, yellow-billed cuckoo, or monarch butterfly.

One of the federally recognized: threatened, endangered, proposed, and candidate species' populations (grizzly bear) are increasing (IGBST 2023). Canada lynx and wolverine have unknown trends on the Bridger-Teton and in the broader region (USFWS 2023a, USFWS 2023b). Both the yellow-billed cuckoo and Monarch butterfly have large declining trends in Wyoming and beyond.

Grizzly Bears

A generalist species, the grizzly bear can be found in all ecosystems in the northern portion of the Bridger-Teton, roughly north of Highway 189/191. Grizzly bear conservation on the Bridger-Teton has been successful. Regulating human-caused mortality through habitat management and conflict prevention are effective approaches, as evidenced by increasing grizzly bear populations in the GYE. An effective habitat management tool for reducing grizzly bear mortality risk on public lands is managing motorized access to ensure grizzly bears have secure areas away from humans. Another important measure to reduce human-bear conflicts is requiring people in grizzly bear habitat to store their food, garbage, and other attractants so that they are inaccessible to bears.

Since 2005, the U.S. Fish and Wildlife Service has made multiple attempts to designate the Greater Yellowstone Ecosystem (GYE) grizzly bears population as a Distinct Population Segment (DPS) and remove (delist) it from the Federal List of Endangered and Threatened Wildlife. Legal challenges repeatedly overturned these attempts, citing concerns about whitebark pine decline, regulatory mechanisms, and genetic health (USFWS 2024a). In 2022, the State of Wyoming petitioned to establish and delist the GYE DPS of the grizzly bear (WGFD 2022b), but in its January 2025 12-Month Finding, the Service found that the GYE grizzly bears do not qualify as a distinct population segment (DPS) under ESA. As a result, the petition was deemed unwarranted. Currently, the Service is evaluating the status of the grizzly bear in the lower-48 States as part of a settlement agreement tied to Idaho's petition to delist the species, with a rulemaking decision expected by January 31, 2026 (90 CFR 3763).

In anticipation of the delisting of GYE grizzly bears, Federal and State agencies developed a conservation strategy for managing GYE grizzlies in 2003, which was updated in 2007, 2016 again in 2024 (Yellowstone Grizzly Bear Coordinating Committee 2024). The conservation strategy identifies secure habitat, developed sites, livestock grazing allotments, and key food sources as the habitat elements most likely to influence grizzly bear persistence in the GYE. So long as the Greater Yellowstone grizzly population is listed under the Endangered Species Act, plan components adopted from the conservation strategy apply within the recovery zone as delineated in the Grizzly Bear Recovery Plan (USFWS 1982, revised 1993). If the grizzly bear (GYE or in the lower-48 States) are delisted under the ESA, the Forest Service will consider the grizzly bear as a potential species of conservation concern as required by Forest Service Handbook 1909.12 Ch. 10, 12.52(d)(2)(b). Legal status of the grizzly bear affects the terminology used to describe the specific area to which plan components apply. If the grizzly bear is successfully delisted, the term "primary conservation area" replaces the term "recovery zone" to reflect the change in management paradigm from a focus on achieving species recovery to conservation of a recovered population. Regardless of the terminology used, the spatial extent to which the plan components apply will be the same, because the boundary for the primary conservation area is the same as the boundary for the recovery zone.

Wolverines

Wolverines exist at low densities on the Bridger-Teton, and they are primarily found in alpine areas, though they could be found ranging in all ecosystems on the Bridger-Teton.

Canada Lynx

Conditions for Canada lynx on the Bridger-Teton are naturally marginal. The Bridger-Teton's ability to support a persistent resident Canada lynx population is questionable, both currently and historically. It is uncertain whether resident Canada lynx historically occurred in the Greater Yellowstone Area (GYA) or whether the GYA only ephemerally hosted dispersing Canada lynx (USFWS 2023a). Although the Bridger-Teton has intensively managed and surveyed for Canada lynx since they were listed under the ESA in 2005, surveys and research-related trapping efforts have failed to detect Canada lynx on the Bridger-Teton since 2010, or elsewhere in the GYA since 2013 (USFWS 2023a). Most verified records of Canada lynx in the GYA after 2000 were animals that had been released in Colorado and dispersed to and through the GYA (USFWS 2023a). The Bridger-Teton amended its forest plan in March 2007 to provide for conservation and recovery of the Canada lynx. The amendment incorporated management direction found in the Lynx Conservation Assessment and Strategy. Conservation and recovery measures will be updated to reflect the latest scientific information (Olsen et al. 2021, Interagency Western Lynx Biology Team 2022).

Canada lynx populations in the Lower-48 states occur at the southern periphery of the species' range and only represent approximately 2 percent of the species' entire distribution. Current temperature conditions for Lower-48 states Canada lynx likely already approach upper thermal thresholds for maintaining the snow conditions, forest climatic and vegetation structural characteristics, and prey populations capable of supporting resident Canada lynx populations (USFWS 2023a). Because Canada lynx remain widespread and abundant throughout most of its historical range and it does not appear to have suffered range loss or population decline and because no acute, widespread threats to Canada lynx have been identified, the International Union for Conservation of Nature designated it a species of least concern. Range-wide, even in a warming climate, the species is not considered to be at risk of extinction (USFWS 2023a). Conversely, the GYA lacks habitat capable of supporting persistent occupancy by resident Canada lynx populations and it is uncertain whether it did so historically. As a result, the USFWS scored GYA Canada lynx as "not resilient/functionally extirpated"; note that this may be its typical historical condition (USFWS 2023a).

By definition, the Bridger-Teton is "sink" habitat for Canada lynx (Pulliam 1988, Jansen and Yoshimura 1998, McKelvey et al. 1999). The Bridger-Teton has not recently supported, and does not currently appear to support, resident Canada lynx or a breeding population (USFWS 2023a). Successful Canada lynx recruitment on the Bridger-Teton has not been documented.

[5] No evidence of Canada lynx was found in the study area over three winters of effort on a 1.9-million-acre survey grid including: approximately 4,000 miles of 195 independent snowmobile and ski-based track surveys; 54 cameras that were active for a total of 37,500+ camera nights; analysis of a subset of 374 DNA samples; and after review of over 230,000 trail camera photographs of wildlife. While there exists high quality Canada lynx habitat in the GYA, these habitats are patchy. The probabilities of detection certainly varied over the survey area due to field reality. The survey effort was closely aligned with well-established Canada lynx and other mesocarnivore detection protocols. The lack of detections strongly suggest that Canada lynx are not present in the areas surveyed (USDA 2021a).

One female in the Wyoming Range produced four kittens in 1998 and two in 1999, though none of the kittens survived to independence, and the female died of starvation in March 2000. Continued climate warming and associated impacts are likely to further diminish the Bridger-Teton's already questionable ability to support resident Canada lynx. The USFWS concludes the GYA is very unlikely to support a persistent resident population through 2025, even less likely that it will do so at mid-century (2050), and highly improbable that it will support resident Canada lynx by the end-of-century (2100). Even under the least impactful climate and future conditions' scenarios, the USFWS concludes Canada lynx will remain "not resilient/functionally extirpated" in the GYA at mid-century and end-of-century (USFWS 2023a).

Under the Endangered Species Act, approximately 2,731,000 acres on the Bridger-Teton have been designated as critical habitat for Canada lynx. In November 2024, a proposed rule outlining revisions to the critical habitat map was published, identifying 657,000 acres as proposed critical habitat within the Bridger-Teton (89 CFR 94656). The final rule is expected to be published by November 2025.

Monarch Butterfly

Occurrence of the Monarch butterfly in Wyoming is limited and scattered. They typically occur at lower elevations (<6,560 feet or <2,000 m), meaning the majority of mountainous habitat on the Bridger-Teton is unsuitable for them. Western Wyoming is likely one of the furthest points the western populations of Monarch butterflies reach in the summer months, and their presence in this region is, therefore, shorter in duration and lower in abundance than in other parts of its range.

Yellow-Billed Cuckoo

The Yellow-billed Cuckoo is extremely rare on the Bridger-Teton, with only a few documented observations near the Forest boundary and none within the boundary. No detections have been recorded along the five Breeding Bird Survey (BBS) routes within the plan area. No designated critical habitat located within the plan area. This species prefers to nest in open woodlands with a densely vegetated understory, especially near water. Nest placement requires dense patches of broad-leaved trees. In Wyoming, its habitat is restricted to riparian woodland: greater than 37 acres in size, with at least 7 acres of closed canopy, a canopy height of 16 to 98 feet, and a vegetated understory 3 to 20 feet in height. As of 2020, the Bridger-Teton contains 83 cottonwood habitat patches, with a mean patch size of 5 acres (range: 0.5-30 acres) and a total of 399 acres of habitat (USDAFS 2021a).

Suckley's Cuckoo Bumble Bee

Suckley's cuckoo bumble bee has been observed near or within the Bridger-Teton, though sightings are rare. Throughout its range, the species has been collected in various habitat types at elevations ranging from 2 to 3,200 meters (6 to 10,500 feet). However, this species has not been documented within the contiguous United States since 2016. As an obligate social parasite, Suckley's cuckoo bumble bee relies on social bumble bees in the genus Bombus to reproduce. It is classified as a semi-specialist parasite and is confirmed to usurp the nests of Western bumble bees (Bombus occidentalis) and Nevada bumble bees (Bombus nevadensis). Other potential hosts within the subgenus Bombus may also support this species across its range (USFWS 2024b).

Key Risk Factors

The most important stressors and threats to federally recognized: threatened, endangered, proposed, and candidate wildlife species in the plan area are climate change (habitat degradation and fragmentation, drought, increasing temperature, and diminishing snowpack); human-caused mortality; destruction, degradation, and fragmentation of riparian habitats: and insecticides. Some of these threats are within the authority of the USFS to address, such as providing secure habitat for grizzly bears, human-bear conflict prevention, and protecting riparian corridors; some are not, such as climate change and use of insecticides off Bridger-Teton.

Wolverines are particularly vulnerable to climate change through loss and degradation of their habitat. Wolverines, already low in numbers, could be significantly affected by declining snowpack in its preferred high-elevation forest and alpine habitats. A growing issue for wolverine conservation is the increasing use of alpine areas for winter recreation, including increasing requests for heliskiing across the Bridger-Teton. The Bridger-Teton would profit from a deliberate strategy to address this issue.

The biggest threat to grizzly bears is human-caused mortality. Thus, the objective for grizzly bear management continues to be to reduce or to mitigate the risk of human-caused mortality and displacement. An effective habitat management tool for reducing grizzly bear mortality risk on public lands is managing motorized access to ensure grizzly bears have secure areas away from humans. Unmanaged motorized access increases human interaction and potential grizzly bear mortality risk; increases displacement from important habitat; increases habituation to humans; and decreases habitat where food requirements can be met. In addition, grizzly bears opportunistically prey on livestock, which also contributes to human-caused mortality. This is a source of continuing concern, controversy, and litigation on the Bridger-Teton.

Managing motorized access on public lands helps ameliorate these impacts. Other habitat management tools that minimize displacement and reduce grizzly bear mortality risk include regulating livestock allotments and developed sites on public lands. Implementing food storage orders on public lands also reduces mortality risk for both humans and grizzly bears. Requiring users and recreationists in grizzly bear habitat to store their food, garbage and other bear attractants in bear-proof, inaccessible ways reduces human-grizzly bear conflicts. The Bridger-Teton is a partner with other local, state, and federal agencies in keeping bears wild and people safe (BearWise Jackson Hole 2025). In addition, encouraging users and recreationists to carry bear spray, and know how to use it, helps reduce the potential for injury to people and bears. The Bridger-Teton does a good job of mitigating the threat of human-caused grizzly mortality.

The primary threat to the North American wolverine is from habitat and range loss due to climate warming. Wolverines inhabit habitats with near-arctic conditions wherever they occur. Wolverines are dependent on deep, persistent snow cover for successful denning, and they concentrate their year-round activities in areas that maintain deep snow into spring and cool temperatures throughout summer. Climate changes are predicted to reduce wolverine habitat and range by 23 percent over the next 30 years and 63 percent over the next 75 years, rendering remaining wolverine habitat significantly smaller and more fragmented. Other threats are minor in comparison to the primary threat of climate change; however, they could become significant when working in concert with climate change if they further suppress an already

stressed population. These secondary threats include inadequate regulatory mechanisms to protect against human recreational disturbance.

The primary issue for Canada lynx on the Bridger-Teton is that the plan area functions as a population sink and is likely inherently ephemeral. Canada lynx habitat generally can be described as moist boreal forests that have cold, snowy winters and a high-density snowshoe hare prey base. Without high densities of snowshoe hares, Canada lynx are unable to sustain populations despite utilizing a multitude of other prey. The GYA apparently does not contain the snowshoe hare numbers to sustain resident Canada lynx. Recent research showing warming-mediated northward contraction of snowshoe hare distribution suggests the likelihood of further declines in the Canada lynx's primary prey in the GYA. Other stressors to Canada lynx are vegetation management, fire management and habitat fragmentation (USFWS 2023a).

The most significant threats to Monarch butterflies come from the loss of habitat for breeding, migrating, and overwintering. In addition, indiscriminate use of pesticides to control insects and weeds are detrimental to pollinators such as Monarch butterflies. One group of insecticides of particular concern is neonicotinoids (https://monarchjointventure.org/monarch-biology/threats, accessed 12/22/23). Climate change is also a main threat (USFWS 2021).

The primary threat to Yellow-billed Cuckoo is the degradation and fragmentation of riparian forest habitats.

The primary threat to Suckley's Cuckoo Bumble Bee is the decline of its host Species. As a parasitic bee, Suckley's Cuckoo Bumble Bee depends on certain bumble bee species to survive. The decline of its hosts, such as the Western bumble bee (Bombus occidentalis), directly affect its population. Additional threats contributing to its decline include the introduction and spread of pathogens via managed bees, competition for resources, competition for resources, habitat conversion and fragmentation and shifts in temperature and precipitation patterns that disrupt the ecosystems where this species and its hosts thrive (USFWS 2024b, 89 CFR 102074).

Management Implications

Effective management for: threatened, endangered, proposed, and candidate species provides multiple healthy, resilient ecosystems distributed across a broad geographic range to be redundant and withstand catastrophic events. Except for grizzly bear and wolverine, the Bridger Teton's overall role in: threatened, endangered, proposed, and candidate species conservation is low, mostly because Canada lynx, cuckoo, and Monarch butterfly rarely occur in the plan area. The primary concern for: threatened, endangered, proposed, and candidate species on the Bridger-Teton is habitat degradation and fragmentation, and climate change effects; for grizzly bear it is human-caused mortality. Potential impacts to wolverine from winter recreation activities on the Bridger-Teton, particularly in modeled denning habitat, need to be analyzed and mitigated. No inadequacies in the current management approach have been identified, although there is no information on abundance, distribution, or population trends for Monarch butterflies in the plan area. Thus, there is currently insufficient information to identify concerns for Monarch butterflies on the Bridger-Teton.

Federally Recognized Aquatic Species

The Kendall Warm Springs (KWS) dace is currently the only threatened or endangered fish species on the Bridger-Teton. Within the plan area, there are currently no relevant candidate or proposed species for Federal listing.

Kendall Warm Springs Dace

The Kendall Warm Springs dace (*Rhinichthys osculus thermalis*) is the only federally listed fish species known to occur on the Bridger-Teton. The KWS dace was federally listed as endangered in 1970, with recognition that it was an imperiled species pre-dating the ESA, listed under the Endangered Species Preservation Act of 1966. The water in Kendall Warm Springs originates from a series of thermal springs and seeps (USFWS 2015a) that likely come from thousands of feet below the earth's surface.

The Kendall Warm Springs dace geographic distribution is limited to a single warm spring. Numerous conservation measures have been employed to help conserve the species, but monitoring suggests a declining trend in relative abundance. The USFS is leading habitat and monitoring efforts to evaluate causes of the apparent population decline. Preliminary results indicate habitat changes associated with shifts in the vegetation community are contributing to these declines. Long-term management of non-native watercress and potential shifts in ungulate use along with withdrawal of the groundwater recharge area from oil and gas development will be necessary to maintain and/or recover species habitat and population stability.

Kendall Warm Springs flows at 85 °F from its sources for 984 feet at an average of 7 cfs before spilling over a 15- foot waterfall, isolating the Kendall Warm Springs dace from the Green River in Sublette County, Wyoming. The Kendall Warm Springs dace is endemic to Kendall Warm Springs, it exists in no other system, and its entire habitat occurs on land administered by the Bridger-Teton. KWSs dace conservation efforts included: a closure order preventing public entry into the warm spring; replacement of mid-system culverts with a bridge; livestock exclosure; non-native watercress removal; and habitat and population monitoring. Although the range of this species is very limited in scale, an area of 21,000 acres (33 square miles) would need to be withdrawn from oil and gas development to protect the aquifer supplying the spring. The withdrawal would protect ecological sustainability, but at the cost of reduced potential for economic development (oil and gas) in the groundwater recharge area.

Status and Trends

The Kendall Warm Springs dace (*Rhinichthys osculus thermalis*) is the only ESA listed fish species known to occur on the Bridger-Teton. The Kendall Warm Springs dace is endemic to only one stream, Kendall Warm Springs, that originates from a series of thermal springs and seeps (USFWS 2015a), then flows 984 feet to a waterfall at its confluence with the Green River. Aquatic habitat within the spring is primarily comprised of shallow, relatively fast water over cobble and gravel substrate interspersed with emergent aquatic vegetation mats and shallow (less than 1 inch) areas along the margins.

The species has been assigned a Recovery Priority Number of 12C indicating that it is a subspecies with a moderate degree of threat, low recovery potential, and may conflict with development projects. The number of fish present in the population has never been accurately estimated. However, catch per unit effort trapping data indicate a possible decline in relative abundance from 1997 to present.

A recovery plan revised in 2015 provides a review of: species status, population trends, threats, recovery objectives, recovery criteria, and recovery actions. Primary threats at the time of ESA listing included limited distribution, habitat change/manipulation, and small population size. Additional threats identified since the time of listing are potential catastrophic habitat loss due to manipulation or pollution of the aquifer that supplies the springs; habitat degradation from potential oil and gas development; and potential non-native species introductions. The trend of increased recreational traffic on the road crossing the spring elevates potential for introduction of nonnative species and habitat degradation including chemical spills. Because habitat is extremely limited, any loss of habitat or change in habitat conditions may result in extinction of the species, which includes changes in: width/depth ratio, type and extent of aquatic vegetation, thermal regime, water table, flow, water quality, and water chemistry.

Livestock grazing has been excluded from Kendall Warm Springs for many years. There is information to suggest lack of ungulate hoof action to maintain a high width to depth ratio resulted in narrowing and deepening of the channel, which provides suboptimal habitat for Kendall Warm Springs dace. Therefore, implementing an experimental grazing regime designed to benefit Kendall Warm Springs dace habitat may be desirable.

The current U.S. Forest Service Bridger-Teton Land and Resource Management Plan, approved in 1990, covers the known population of KWS dace (USDA 1990). The Forest Plan contains general standards and guidelines for the maintenance and enhancement of the Kendall Warm Springs dace habitat, such as establishing the spring as a Special Interest Area and establishing protection of Kendall Warm Springs as a management objective. Prior to the 1990 plan, 160 acres surrounding Kendall Warm Springs were withdrawn from mineral entry under the mining law by Public Land Order 2765 (DOI 1962). The U.S. Fish & Wildlife Service Kendall Warm Springs Dace Revised Recovery Plan states that additional mineral withdrawal and an oil and gas leasing availability buffer are among the criteria necessary for reclassification from Endangered to Threatened (USFWS 2015a).

Key Risk Factors

The Kendall Warm Springs dace may be negatively affected if there is a reduction in discharge from the warm spring or by a significant change in water temperature. According to Mattson (1998), the consistent warm temperature of the Kendall Warm Springs is indicative of a deep regional groundwater flow system, which may be as deep as 0.5 miles (900 m). Groundwater residence times for deep regional flow systems with long, slow flow paths may be centuries to millennia. Therefore, climate induced changes in Kendall Warm Springs discharge and temperature would likely occur very slowly relative to hydrologic changes in shallower springs.

A significant threat to Kendall Warm Springs dace associated with climate change is likely the expanding ranges of non-native species. Both aquatic and terrestrial species' ranges will shift over time and the threat of plants and animals through impacts to habitat, competition or predation are all of concern.

Additionally, the increased risk of wildfire across the area, including the Green River floodplain, may introduce a threat to the species that has not existed in the past. Threats from both fire as well as increased firefighting operations will likely increase with shifting fire regimes.

This species appears to have a relatively extreme thermal tolerance range, which may provide some resistance to climate change. Kendall Warm Springs evolved from cold-water adapted river speckled dace to survive exposure to fairly constant 85 °F water for most of the year, as well as progressively cooler temperatures in the downstream channel margins. However, given

that the geographic distribution of the species is extremely limited, this single population may be vulnerable to unforeseen climate change impacts.

Other At-Risk Aquatic Species Outside Plan Area

The western glacier stonefly (*Zapada glacier)* is listed as threatened under the ESA. It has been documented at six sites in Grand Teton National Park, which borders the Bridger-Teton, but the species has not been documented on the Bridger-Teton. Suitable habitat is likely present on the Bridger-Teton, but no surveys for the species nor their habitat have occurred.

The Bridger-Teton staff must analyze any potential impacts to water quality and quantity in both the Platte and Colorado River Basins; this relates to habitat for federally listed fish in both Basins. The Bridger-Teton staff must consult with the USFWS if water withdrawals exceed thresholds for: pallid sturgeon (*Scaphirhynchus albus*) in the Platte River system and bonytail chub (*Gila elegans*), humpback chub (*Gila cypha*), Colorado pike minnow (*Ptychocheilus lucius*), and razorback sucker (*Xyrauchen texanus*) in the Colorado River System.

Federally Recognized Plant: Whitebark Pine

On the Bridger-Teton, there is one federally recognized plant species, whitebark pine (Pinus albicaulis), with a status of threatened under the U.S. ESA.

Status and Trends

Whitebark pine (*Pinus albicaulis*) generally occur on cold and windy, rocky, high-elevation sites, growing in both geographically isolated stands at high elevation (Arno et al. 1989) and in mixed conifer stands throughout its elevational range. On the Bridger-Teton, stands usually occur at elevations above 6,900 feet. There are approximately 380,000 acres of known or predicted whitebark pine vegetation types on the Bridger-Teton where whitebark pine is either dominant or co-dominant. Whitebark pine is a long-lived species taking over 50 years to produce viable cones with individuals reaching ages of 1,000 years and older. The whitebark pine provides vital ecosystem and hydrological services. It is considered a keystone species and a critical food source for many species of birds and mammals, including the threatened grizzly bear (*Ursus arctos horribilis*) and an obligatory relationship with the Clark's nutcracker (*Nucifraga columbiana*) because whitebark seedlings sprout almost exclusively from nutcracker seed caches (Macfarlane et al. 2023). Although these hydrological processes are a logical extrapolation of known mechanisms, the role of treeline whitebark pine communities should be substantiated by empirical data, but it can be assumed it serves an important role. Additionally, whitebark pine is of cultural importance to indigenous peoples in the area as a traditional food source.

Widespread mortality of whitebark pine has been documented across the Bridger-Teton. From 1999-2018, there was an unprecedented decline resulting in 43 percent mortality across the GYE with instances of 95 percent mortality in certain stands (Macfarlane et al. 2023). The key threats to whitebark are: climate change, increased MPB (*Dendroctonus ponderosae*) outbreaks, white pine blister rust (*Cronartium ribicola*) - a non-native invasive fungal infection - and frequent and intense wildfires and climate-induced drought, and the synergistic effects of climate change (Macfarlane et al. 2023, USFWS Species Status Assessment 2021).

Key Ecological Characteristics Needed to Support Species

Intact, functioning subalpine ecosystems with healthy soils and microbial communities are required for whitebark pine (*Pinus albicaulis*) to persist over the long-term.

Key Risk Factors

Like other subalpine species, climate change poses a substantial risk to whitebark pine as there is likely little opportunity for species migration upslope or north. High-elevation plants are disproportionally affected by climate change. As temperatures rise, the amount of available alpine habitat in the Rocky Mountains will decrease resulting in potential local extinctions of plant species. In addition to the direct effects of climate-driven habitat loss, high elevation plants must also respond to indirect effects, such as changes in disturbance regimes. One notable shift is the increase in wildfire frequency in regions where fire was previously rare or absent, including the alpine (Bloom et al. 2018). Mean annual air temperature in the GYE warmed by 2.3 °F (1.3 °C) at a rate of 0.34 °F (0.19 °C) per decade between 1950 and 2018, with the greatest rates of warming in the winter and spring seasons and at higher elevations (Macfarlane et al. 2023, Bloom et al. 2022).

The largest insect and disease threats to whitebark pine in North America are a combination of white pine blister rust (C*ronartium ribicola)* and periodic MPB (*Dendroctonus ponderosae*) outbreaks that are exacerbated with episodic or sustained droughts (Keane and Parsons 2010, USFWS 2011). Climate change has also been directly and indirectly linked to whitebark pine mortality by predisposing trees to insect and pathogen attacks and enabling the geographic expansion of rusts and shifts in bark beetles to higher elevations (Millar et al. 2012).

Wildfires in declining whitebark pine forests can be both a benefit and a threat (Keane 2018). Altered fire regimes as result of fire suppression could result in a change in fire intensity or frequency affecting this long-lived species. Although whitebark pine is fire-adapted, there is uncertainty surrounding the specifics of these adaptations, including the species' susceptibility to damage from fires of differing intensity, the role of low-severity fire, and how fire suppression interacts with fire return intervals to affect forest succession across the range of whitebark pine (USFWS 2021). In some places, successional replacement of whitebark pine with shade-tolerant conifers as result of fire suppression contributed to the species' decline. Yet a more direct impact from wildfire is seen with the increase of fire frequency and intensity at high elevations resulting in stand-replacing fires that can decimate whitebark pine populations especially if the fire return interval becomes less than 50 years or the time it takes a tree to grow and reproduce viable seeds. Therefore, it may be important to protect key stands of whitebark pine, especially those with known rust-resistance, from wildfire, while using fire as a tool in other instances (Tomback et al. 2023).

Management Implications

For federally listed species, projects are generally designed to maintain or enhance habitat and to avoid or mitigate potential negative effects to individuals to comply with the ESA. This can increase the time and cost for project planning if species inventory is needed, or if additional work is needed to assess habitat conditions before making a project decision. In addition, procedures to ensure appropriate regulatory oversight by the USFWS are factored into project level planning when federally listed species could be affected; this can impact the rate and pace for designing and implementing projects aimed at ecological restoration. The current

management plan lacks direction for federally listed plant species, as none were listed at the time of plan development.

Species of Conservation Concern

SCC are species known to occur on the Bridger-Teton that the Regional Forester determines, using best available scientific information, is a substantial concern about their capability to persist over the long-term in the plan area. (A detailed process to identify the potential SCC is provided in the proposed Forest Service Handbook directives (USDA 2013, proposed FSH 1909.12 Section 12.5) and described in Figure 21). A total of 91 non-plant species and 101 plant species were evaluated. The list of potential SCC (See Table 23 and Table 26) may be modified based on the best available scientific information and public input during the planning process before approval of the final land management plan.

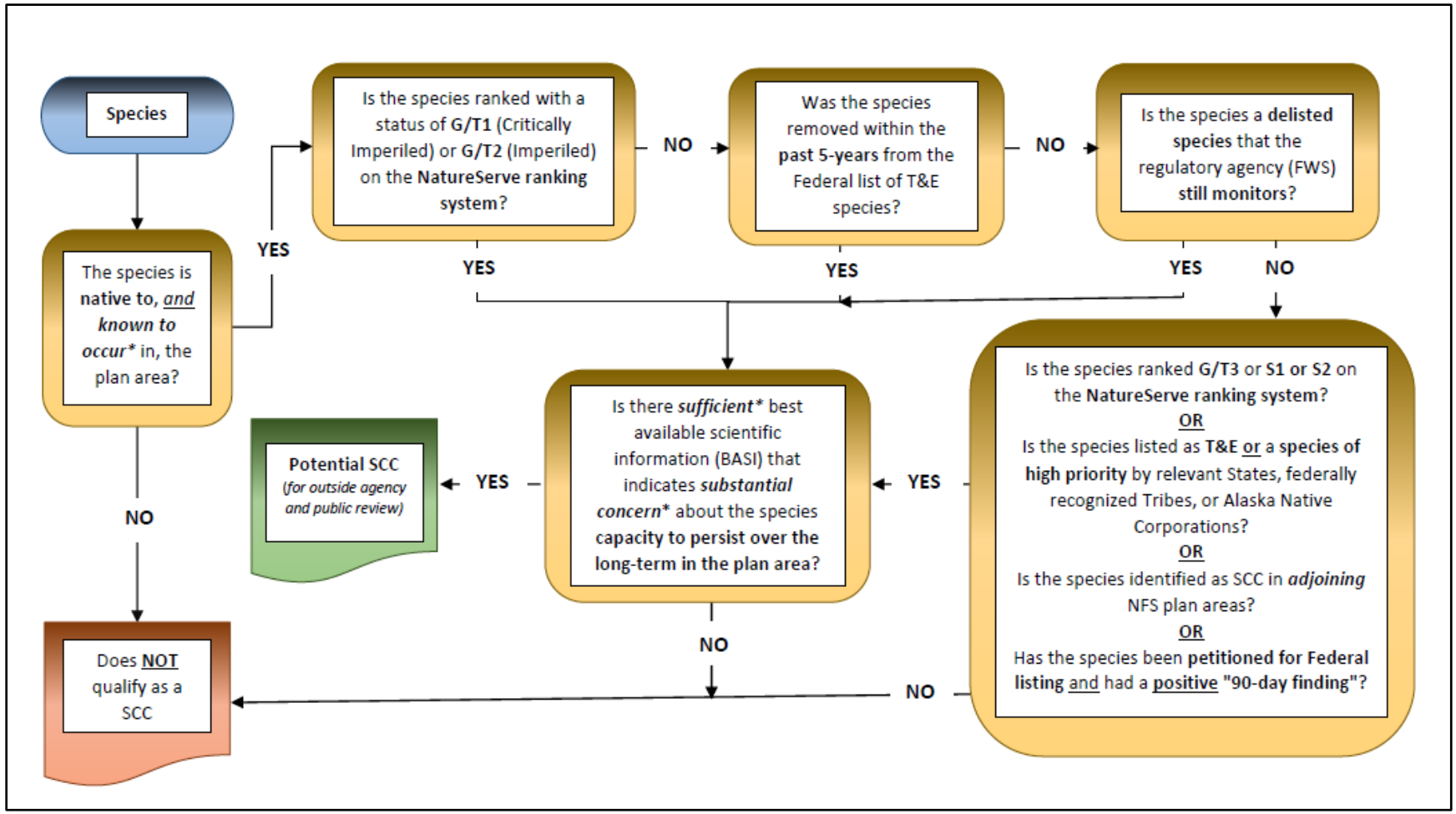


Figure 21. Directive-based process used for determining potential species of conservation concern under the 2012 Planning Rule (FSH 1909.12, Chapter 10, Section 12.52c)

The purpose of identifying SCC is to aid in developing land management plan components that maintain the diversity of plant and animal communities and provide for the persistence of native species in the plan area (36 CFR 219.9). Most species will be maintained by plan components (desired conditions, objectives, standards, guidelines, and suitability of lands) that provide for broad ecosystem integrity and ecosystem diversity. Some species may require additional species-specific plan components for maintaining or recovering SCC and federally recognized species or where the species requires unique and specific ecological conditions that are best addressed with more focused plan components.

Additionally, the 2012 Planning Rule recognizes that it may not be possible to maintain a viable population of some at-risk species within the plan area due to circumstances beyond the authority of the USFS or due to limitations in the inherent capability of the land. Examples might be migratory species where viability is primarily affected in other locations; temperature sensitive species affected by warming temperatures; or where the plan area has limited ecological capacity to provide sufficient habitat to sustain the species.

Potential Plant Species of Conservation Concern

Key Takeaways

This list of potential plant SCC highlights 14 species that are important to the ecosystem of the Bridger-Teton and at risk of population decline (See Table 23). The greatest threats include: climate change, recreation, development, and increased competition from invasive species. Native plants exist in complex relationships with other local flora and fauna; are highly adapted to their environments; and provide a host of benefits within the context of their ecosystems. These benefits may include: stabilizing soil, filtering water, supporting wildlife, and increasing the biodiversity that helps ecosystems build resilience to environmental stresses such as droughts, floods, and wildfires. The natural bounty of native plants is used as: food, medicine, textiles, and shelter by the indigenous people who have been present in this landscape for at least 13,000 years. Protection of native species and their habitats can translate into indirect economic value, such as decreased costs for cities to purify drinking water, increased recreation activities, and improved wildlife habitat.

The current management plan lacks direction related to the management of plant SCC, nor does it include direction for management actions that may affect plant SCC.

Table 23. Potential plant species of conservation concern

Common Name	Species Name	Key Risk Factors	Status and Trends	Habitat
Payson's milkvetch	*Astragalus paysonii*	Succession in the absence of disturbance especially fire, herbicide application, and invasive plant species (Heidel 2013).	Thirty-seven populations. Tallies of a limited number of populations in 1993 and 2013 show an overall decline in numbers by 12-33%. Threats to suitable habitat include succession caused by lack of disturbance and competition by invasive species, which favor disturbance processes. G3 - Vulnerable; S2 Imperiled; WY Species of Concern; R4 Sensitive species	Coniferous forests and margins, primarily in disturbed areas, usually on sandy soils with low cover of forbs and grasses.
Scalloped moonwort, aka crenulate moonwort	*Botrychium crenulatum*	Road construction and maintenance, grazing, herbicide application, recreational activities, structure construction, timber harvest, changes to disturbance regime, grazing effects, invasive plant species, and climate change.	Wide range (11 states). Three populations across the forest representing 51 individuals. All located in active grazing allotments. Population trends difficult to estimate due to limited survey data. Could be subject to anthropogenic disturbances. G4, S1, WY species of concern, and USFS sensitive species.	Moist, open montane habitats, marshes, damp meadows, and riparian areas.
Peculiar moonwort aka puzzling moonwort	*Botrychium paradoxicum*	Road construction and maintenance, herbicide application, recreational activities, structure construction, timber harvest, changes to disturbance regime, grazing effects, invasive plant species, and climate change.	Six populations representing at least 55 individuals known on the forests with high threats of grazing, recreation, and climate change. G3G4, S2, and WY Species of Concern and R2/R4 Sensitive Species.	Moist, open montane habitats, marshes, damp meadows, and riparian areas.
Low northern sedge, aka beautiful sedge	*Carex concinna*	Loss of habitat due to pack animal and horse grazing and climate change, trampling due to recreation activities. Probable future effects of climate change including drying up of groundwater.	Single occurrence in wilderness along a popular trail and lakeshore, known from eight states. G5, S1 in WY and CO, WY Species of Concern. Sensitive Species on the Medicine Bow National Forest as well as the Thunder Basin National Grassland.	Moist to dry meadows, riverbanks, thickets, floodplains, conifer, and deciduous woodlands, usually on calcareous substrates; moist soils bordering spring-fed streams, spruce swamps, and on seeps.
Fragile rockbrake, aka slender cliff-brake	*Cryptogramma stelleri*	Proximity to highway, recreation, invasive plant species, loss of microsite habitat. It is also likely present at other fragile limestone sites on the Bridger-Teton, such as caves and other developed	This is a critically imperiled species and a Regional Sensitive to R2 and R3. Only two occurrences on the Bridger-Teton, including on a popular ski resort, known from eight states. G5, S1 in WY and CO, WY Species of Concern. Sensitive Species on the	Sheltered calcareous cliff crevices and rock ledges in coniferous forest at middle and upper altitudes.

Common Name	Species Name	Key Risk Factors	Status and Trends	Habitat
		climbing areas - tied to snowpack. Subject to disturbance along cliffsides (climbing, caving, etc.).	Medicine Bow National Forest as well as the Thunder Basin National Grassland.	
Mountain tansymustard, aka Wyoming tansymustard	*Descurainia torulosa*	Habitat loss due to erosion.	Populations on the Bridger-Teton are fluctuating, but they remain stable. Recent surveys indicate the population may be suffering from a short-term decline. Currently, a USFS R4 SS and only known to occur on the Bridger-Teton in R4. The species is endemic to Wyoming and restricted to Absaroka Range and Rock Springs Uplift with limited number of populations and individuals on the Bridger-Teton. G2 imperiled; S2 - imperiled, WY species of concern; and R4 sensitive species. Formal proposal for listing at T and E denied.	Ledges, talus slopes, and cliff bases composed of volcanic breccia or sandstone with sparse vegetation, in the mountains and on basin escarpments.
Woolly fleabane	*Erigeron lanatus*	Main threat identified climate change related warming and habitat loss.	Seven collection records; population estimated at 1,000-1,400 individuals; populations are stable based on observations from 1990 to 1994. G4 – apparently secure, S1, WY Species of Concern, and R4 Sensitive Species.	Open rocky alpine and subalpine habitats; often limestone boulders and talus with cryptogrammic crust.
Fourpart dwarf gentian	*Gentianella propinqua*	Invasive plants, hiking, recreation, and wildfire. Immediate threats are not known due to low population numbers.	One collection 2006. No abundance, population, and trend data. Ranked G5/T5-secure; S1; WY species of concern.	Meadows, slopes, and streambanks at high elevations.
Vasey's rush	*Juncus vaseyi*	Climate change, trampling from recreation, invasive species. It has declined in the Rocky Mountains due to the conversion of mountain wetlands to hay meadows. It is likely populations have experienced moderate to high levels of impacts from both natural disturbances (non-native plants and wildfire) and anthropogenic activities (grazing and roads). Habitat trends are slightly declining and may be exacerbated by climate change.	Three occurrences. Species may be declining in vulnerable disjunct localities where it often occupies very restricted habitat. In Wyoming, populations are suspected to be stable based on the resurvey of two populations over time. Population trends on the Bridger-Teton cannot be assessed due to lack of data. G5; S1; WY species of concern; no other listing.	Marshes, damp thickets, meadows, and margins of bogs; depressions along sandy lakeshores and low sandy ground with pines, wet prairies, lakeplain wet prairie, and other intermittently wet ground; lakeshores with sandy and gravelly glacial till and in hummocky wet meadows with rich organic soils.

Common Name	Species Name	Key Risk Factors	Status and Trends	Habitat
Pale monardella, aka mountain wild mint	*Monardella glauca*; syn. *Monardella odoratissima* var. *glauca*	Recreation, climate change, and invasive species. Analysis suggests habitat has likely experienced moderate to high effects from natural and anthropogenic disturbances, and trends may be declining on theBridger-Teton. Climate change effects could exacerbate declining conditions.	Four occurrences. Population trends unknown. Known populations are small. G3; S1; WY species of concern; and no other listing.	Open, wet, or dry, often rocky places; floodplains and valley toe slopes growing on well-drained, often gravelly slopes, flats, and openings.
Greenland primrose	*Primula egaliksensis*	Grazing, trampling, road development, recreation, and climate change.	One occurrence near a high use area. Population trend data is very minimal. Abundance numbers from 2 different years, it can be assumed the population is stable. Further studies need to be conducted to determine the long-term trend of habitat. Ranked G4; S1; WY species of concern; R2 and R4 Sensitive.	Fens, marl hummocks, and wetlands.
Pink campion	*Silene repens*	Logging, recreation, grazing, invasive species, and climate change. Analysis suggests habitat has likely experienced moderate to high effects from natural and anthropogenic disturbances, and trends are likely stable or declining on the Bridger-Teton. Climate change effects could exacerbate conditions.	Two occurrences; scarcity of occurrences suggest the species' distribution on the Bridger-Teton is sparse and isolated. Abundance, trends, populations unknown. G5; S1; WY species of concern; no other listing.	Rocky slopes and ridges, alpine screes and fellfields, and timberline meadows on a variety of bedrock cushion plant communities.
Teton wirelettuce	*Stephanomeria fluminea*	Closely tied to a hydrologic regime that could be modified by activities such as gravel extraction or water diversion for irrigation. Natural influences seem to impose minimal, if any, negative impact. Plants show little evidence of herbivore or insect damage due to the strong odor emitted. Recreational poses moderate risk to populations. Invasive plant encroachment, including cheatgrass and sweet yellow clover, are a major concern.	Regional endemic to only a handful of watersheds in Grand Teton and Northern Bridger-Teton that are highly impacted by recreation and invasive species, especially being choked out by sweet yellow clover. Eleven locations on the Bridger-Teton. Locally abundant. Population trends unknown. G2 imperiled; S2 - imperiled, WY species of concern.	Cobble floodplains, shifting gravel and sand bars along major rivers and streams.

Common Name	Species Name	Key Risk Factors	Status and Trends	Habitat
		Habitat may be threatened by the effects of climate change.		
Largeflower Triteleia	*Triteleia grandiflora*	Habitat loss, fragmentation, and degradation caused by human recreation, livestock grazing, resource development (timber and mineral), and invasive non-native plant species are potential threats to long-term persistence. Invasive plants have been identified as a major threat.	Several occurrences on the Bridger-Teton are in high use areas. Known from eight states. G4; S2; WY Species of Concern; R2 Sensitive. S1 in Colorado. S4 in MT. Sensitive Species in Grand Teton National Park, which is adjacent.	Meadows, grasslands, sagebrush, pinyon-juniper woodlands, aspen woodlands, pine forests, and scattered woodlands.

Please see USFS 2025 Proposed Species of Conservation Concern List for Bridger-Teton National Forests with supporting documentation and rationale for more information. The information in this table is based on information from the USDA Plants, Wyoming Natural Diversity Database, Wyoming Plant Species of Concern, the Rocky Mountain Herbarium, the Consortium of Pacific Northwest Herbaria, and Bridger-Teton records. Rankings based on Global Ranking (Imperiled to Secure - G1-5), State Ranking (Imperiled to Secure S1-S5), WYNDD Species of Concern, and Forest Service Regional Sensitive Species updated July 2024.

Status and Trends

Systematic inventories to document the contemporary presence or absence of most at-risk species are limited. Historic distribution and historic population estimates are not known for most species, although more data generally exists for federally listed species. General accounts from the last 100 years from naturalists and studies from recent decades allow extrapolation of abundance and distribution. This information gap must be considered in the context of the current and admittedly altered, drivers and stressors. In many cases, restoration to historic species distributions and population levels cannot be realistically attained due to human encroachment into the wildlands; permanent or semi-permanent alteration of habitats due to land use changes; fundamental alteration of drivers and stressors, such as wildfire and climate change. Similarly, key life history information is lacking or has not been synthesized into a readily available format for some species. Climate change is a key risk factor for many potential SCC. It is particularly important for SCC in high elevation, alpine and subalpine areas, as well as those dependent on seeps, springs, and other wet areas, and seasonal rainfall. The effects of climate change are exacerbated at high elevations resulting in rapid degradation of suitable habitat for high elevation plants – highlighting the need to conserve existing populations. Anticipated rising temperatures, extended drought, precipitation extremes with high variability, early snowmelt timing, and shifts in phenology are likely to serve as a significant risk that may impact plant structure and survivability, reproduction, and growth yield. Changes in relative humidity outside the normal range can affect: soils, plants, lichens, and seedling survival.

Introduction and spread of non-native invasive plant species are also listed as key risk factors for most of the potential plant SCC. Invasive plants can outcompete native species, or in some cases such as with cheatgrass *(Bromus tectorum*), shift the fire regime to increased frequency of fire resulting in decreased native plant diversity and richness. Plants face a unique challenge in that populations can be fragmented by localized impacts; as such, a risk factor is roads bisecting populations. Recreation trails are also identified as a risk factor both as a means to bisect populations, but also for direct impacts to plants from recreation users. Ski area development also may pose a unique risk to plant species already facing direct threats from climate change. Livestock grazing is also listed as a key risk factor for many species; however, due to limited distributions for most plant species, specific risks cannot be addressed in this course of an Assessment as the risks would depend on the phenological timing of the plant along with the timing and extent of livestock grazing at those sites.

The variable ability of plants to disperse also makes it more uncertain how species that rely on specific soils or habitat conditions may react to climate change if temperature or precipitation patterns change. For example, the ideal climate conditions for a high elevation species may shift upslope, but there are not suitable soils in that area, or the plant is physically limited by its ability to disperse. Special substrates, including: limestone, sandstone, glacial till, calcium ate, and volcanic breccia are important for some species. Additionally, increased nitrogen deposition is a risk factor to SCC; in areas of high nitrogen deposition, levels may have negative effects on mycorrhizae, alpine communities, and sensitive plant species. The additional presence of nitrogen and phosphorus in the environment also may give invasive plant species a higher competitive ability. (For more information on increased nitrogen and phosphorus deposition, please see the Air Quality section of the Assessment.) Regardless of general conditions and trends, conditions and trends for each species should be evaluated in the context that several potential SCC have limited ranges or specific habitat requirements and low population numbers.

This level of detail is not readily available for consideration in this Assessment, but it will be considered, as appropriate, during later plan revision phases.

The presence of potential SCC affects management decisions. The presences of potential plants SCC can be used as an indicator for sustainability of forests related to the conservation of biological diversity. Maintaining intact, functioning ecosystems will be important to ensuring the continued existence of the potential plant SCC.

Potential Aquatic Species of Conservation Concern

Key Takeaways

Aquatic SCC on the Bridger-Teton influence ecological sustainability in many ways. Stable native Cutthroat Trout populations are indicators of good water quality and watershed health, and they support regionally important recreational fisheries. Presence of stable native nongame sucker and chub populations are indicative of high habitat quality and aquatic ecosystem function because they fill important ecological niches.

Issues, concerns, and conservation opportunities vary across the nine potential SCC based on their distributions, habitat requirements, and land uses. However, common issues and concerns include: nonnative fish species (competition, hybridization, and predation), habitat fragmentation, channel dewatering, climate change (altered flow and temperature regimes), and overgrazing.

Opportunities for conserving and restoring potential SCC include: improved livestock grazing management, implementing strategies to conserve instream flows, removing nonnative fish species, and removing migration barriers where they do not serve a conservation purpose (e.g., preventing the incursion of non-native fish species or aquatic invasive species). Some populations at risk of climate change effects may benefit from process-based restoration projects that restore floodplain connectivity, increase base stream flows, and increase resilience of riparian areas to wildfire.

Summary

Five potential SCC fish have been identified in the plan area. Species were evaluated based on: a) NatureServe status, WDGF species of greatest conservation need, Wyoming Natural Diversity Database, USFS and the BLM sensitive species designation, and International Union for Conservation of Nature status; b) known distribution and abundance on the Bridger-Teton; and c) known threats to Bridger-Teton populations. The subspecies considered as potential SCC are limited to those that are “native” (i.e., present in a particular ecosystem as a result of natural migratory or evolutionary processes and not as a result of an accidental or deliberate introduction) (FSH 1909.12 Zero Code).

Recent taxonomic revisions to Cutthroat Trout have been adopted by the American Fisheries Society (Page et al. 2023) and by NatureServe (2025). The plan area overlaps with what is now considered Rocky Mountain Cutthroat Trout (*Oncorhynchus virginalis*) (Page et al. 2023). There is ongoing systematic research and revision on Cutthroat Trout taxonomy (e.g., Trotter et al. 2018, Markle 2018, Kokkonen 2024). For the purpose of this assessment, Cutthroat Trout were evaluated following the subspecies recognized by NatureServe (2025), which is also consistent with how WGFD currently manages the species: Colorado River Cutthroat (*Oncorhynchus virginalis pleuriticus)* and Snake River Fine-spotted Cutthroat (*Oncorhynchus virginalis behnkei)*.

Within the Snake River Basin flowing to the Columbia River, Snake River Fine-spotted Cutthroat Trout are native above Palisades Reservoir. Colorado River Cutthroat Trout are native to portions of the Colorado River drainage, including the Upper Green River drainage in the plan area.

Northern Leatherside Chubs (*Lepidomeda copei)* are native to the Bear and Snake River drainages in Wyoming, and there is genetic evidence that two small populations are native in the UGRB (Blackney et al. 2014). Within the plan area, Leathersides occur in a handful of streams. Recent genetic evidence suggests that most Leatherside populations are isolated from one another with much less gene flow between populations than historically occurred (Blackney et al. 2013). Roundtail Chub (*Gila robusta)* on the Bridger-Teton occur in the Upper Green River Drainage. The Bridger-Teton has the only lentic populations of Roundtail Chub and those population are currently threatened by non-native trout and proposed impoundments.

These species all contribute in some way to ecological sustainability in the plan area. First, each species fills an important ecological niche based on its: geographic distribution, habitat requirements, aquatic community interactions, and position in the food chain. For example, Cutthroat Trout eat drifting aquatic macroinvertebrates, many of which feed on photosynthetic algae. A variety of avian and wildlife species prey on cutthroat trout. In this way cutthroat trout form an important link in the food chain. An intact native fish assemblage is an indicator of aquatic ecosystem function, health (including good water quality), and sustainability. Nongame fish play a small role in social and economic sustainability, but due to the unique niches they fill, they disproportionally contribute to ecological sustainability.

Managing for widely distributed and stable native fish SCC populations contribute to a wide variety of ecosystem services including: recreation, tourism, water supply, water quality, erosion prevention, and climate regulation. This is because healthy fish populations are a product of watershed, floodplain, and riparian function upon which these ecosystem services depend. As an example, providing clear, cold water for cutthroat trout preserves the sustainability and quality of municipal water sources. Moreover, Cutthroat Trout are an important food source for charismatic megafauna such as bears, eagles, and wolves and they provide a critical link in the food chain. A large segment of the public appreciates the intrinsic value of native aquatic species and the variety of ecosystem services they support. In fact, viewing native fish through snorkeling or at known spawning areas is not uncommon.

Status and Trends

Table 24 summarizes the conservation status, abundance, distribution, population trends, and threats within the plan area and broader region. All potential SCC fish species are considered to have experienced downward trends in habitat quality and quantity in the plan area relative to historical conditions, given the introduction and expansion of non-native species, habitat alteration, fragmentation, water developments and diversions, etc. These threats and trends are further described in the individual species evaluations. Over the past 20 years, a substantial amount of habitat has been restored by state and federal agencies and non-governmental organizations. Despite such efforts, there continue to be abundant opportunities for additional restoration projects to continue to improve aquatic and riparian habitat within and beyond the plan area.

Table 24. Status, trend and threat summary for potential fish species of conservation concern. Population trends are described both within the plan area and broader region based on WGFD (2017a) and NatureServe (2025).

Species/sub-species	NatureServe, SWAP Rankings	Bridger-Teton Abundance and Distribution	Pop. Trends	Threats
Colorado River Cutthroat Trout	T3/S1-Critically Imperiled, Tier 2	Rare-distribution and abundance restricted	Historical declines across its range; short-term trends are unknown but likely stable to decreasing	Hybridization and competition with nonnative trout; habitat degradation and fragmentation; reduced beaver persistence; climate warming.
Snake River Fine-spotted Cutthroat Trout	T1/S1-Critically Imperiled, Tier 2	Common within a limited range	Historical declines across its range; short-term trends are unknown but likely stable or possibly increasing	Habitat degradation and fragmentation (altered flow regimes, channel stabilization, and floodplain modifications); hybridization and competition with nonnative trout; climate warming.
Flannelmouth Sucker	G3/S3-Vulnerable, Tier 1	Rare-distribution and abundance greatly restricted	Historic declines across its range, with ongoing declines in Wyoming	Hybridization and introgression with other sucker species; competition with and predation by nonnative species; water developments, drought, loss of migratory corridors and habitat degradation.
Northern Leatherside Chub	G3/S1-Critically Imperiled, Tier 2	Rare-limited and isolated	Historic declines across its range, including extirpations; ongoing declines are suspected along with declining genetic purity	Population fragmentation; habitat degradation, modification, and fragmentation; competition and predation from nonnative fish.
Roundtail Chub	G3/S3-Vulnerable, Tier 1	Rare- greatly restricted in numbers and distribution	Historic declines across its range, including extirpations; recent trends are uncertain but probably relatively stable or slowly declining	Competition and predation from nonnative fish; habitat degradation (e.g., dewatering, loss of connectivity).

Flannelmouth Sucker

The current State Wildlife Action Plan (WGFD 2017a) classifies Flannelmouth Sucker as Tier 1 Imperiled. Flannelmouth Sucker populations have declined throughout their historic range. They currently occupy about 55 percent of their historically occupied habitat in the Upper Colorado River Basin (WGFD 2017a). Flannelmouth Sucker are probably still continuing to decline (NatureServe 2025). Flannelmouth Sucker populations in the Green River drainage have declined since the 1960s due to impoundments in the mainstem Green River in Wyoming (Flaming Gorge and Fontenelle Reservoir) (UDNR 2009). Population trends on the Bridger-Teton, which are part of this drainage, have likely declined as well.

Flannelmouth sucker can generally be characterized as “big-river fishes,” although they can also occupy smaller tributary streams and occasionally lakes. Their ecological condition requirements include dynamics flow regimes, varied habitats to support all life history stages, connectivity for dispersal and to access spawning sites, and freedom from impoundments (Bezzerides and Bestgen 2002). The most insidious threat to the continued persistence and integrity of Flannelmouth Sucker in the plan area is hybridization with non-native suckers (WGFD 2017a). Hybridization is occurring between native suckers and non-native White Sucker (*Catostomus commersoni*), Longnose Sucker (*Catostomus Catostomus*), and Utah Sucker (*Catostomus ardens*) Some combinations sucker hybrids are fertile and will lead to introgression, which reduces the genetic purity of populations (WGFD 2017a).

Chub Species of Conservation Concern

The current State Wildlife Action Plan (WGFD 2017a) classifies Roundtail Chub as Tier 1 Imperiled and Northern Leatherside Chub as Tier 2 Imperiled. The two species have different habitat requirements, which are further described in the individual species evaluations. Roundtail Chub occupy large rivers and lakes, and occasionally small streams, while Northern Leatherside Chub occupies sluggish pools and backwaters of creeks and small to medium rivers. Their ecological condition requirements include a natural flow regime, varied habitats to support all life history stages, in-stream cover and channel complexity (e.g., woody debris), habitat connectivity, and freedom from competition and predation from native and non-native fish.

Both chub species are considered rare on the Bridger-Teton with population trends being variable (declining to stable). Leatherside Chub populations have declined relative to historical observations and now appear to be extirpated in some systems. Current populations in Wyoming are extremely limited and isolated. Population size is variable with populations in some areas declining or vulnerable, while others appear stable (WGFD 2017a). Roundtail Chub have been extirpated from approximately 45 percent of historical habitat in the Upper Colorado River Basin and decline has been observed in remaining populations (Bezzerides and Bestgen 2002; WGFD 2017a). This species was once common in many waters around Pinedale and Green River. Current distribution on the Bridger Teton has been reduced to several lakes on the west slope of the Wind River Mountain Range and the Upper New Fork River within the Green River Basin (e.g., New Fork Lake, Willow Lake, Fremont Lake, Halfmoon Lake, Little Halfmoon Lake, Burnt Lake, and a recently introduced population in Meadow Lake).

Cutthroat Species of Conservation Concern

The current State Wildlife Action Plan (WGFD 2017a) classifies both subspecies of Cutthroat Trout as Tier 2 Imperiled. Cutthroat Trout prefer gravel-bottomed creeks and rivers as well as lakes. Their ecological condition requirements include relatively clear, complex, coldwater habitats; connectivity for expression of fluvial life history strategies (where applicable); freedom from hybridization, predation and/or competition with non-native salmonids.

The distribution and abundance of both cutthroat subspecies significantly declined from historic levels. Colorado River and Snake River Cutthroat Trout currently occupy only about 13 and 48 percent of their historic native range, respectively (Hirsch et al. 2013, WGFD 2017a). There are 217 miles of occupied Colorado River Cutthroat Trout habitat out of 807 historic miles of habitat on the Bridger-Teton. Populations in the northern part of the Upper Green River GMU only persist in the Wyoming Range (Eastern drainages) and the Green River– Big Twin Creek watershed. The existing conservation populations associated with the Bridger-Teton are isolated, resident populations and primarily restricted to high elevation streams within their

range (USFS 2019a). North Piney Lake also supports a lentic population of Colorado River Cutthroat, and several other stocked lakes on the Bridger-Teton support angling opportunities for the various subspecies of cutthroat. Snake River Cutthroat Trout populations remain widely distributed in the Snake River drainage with 300 known populations across 2,495 miles of riverine habitat. On the Bridger-Teton, Snake River Cutthroat Trout are widely distributed with conservation populations present in 1,338 of 1,461 (92 percent) historically occupied stream miles. These conservation populations in the plan area substantially contribute to the number of stream miles in Wyoming (63 percent) and across the species five-state historic range (31 percent).

Table 25. Comparison of current and historical habitat occupancy for cutthroat trout sub-species in the plan area

Cutthroat Subspecies	Occupied Stream Miles on the Bridger-Teton	Historically Occupied Stream Miles on the Bridger-Teton	Bridger-Teton Percent Contribution to Occupied Stream Miles in Wyoming	Bridger-Teton Contribution to Occupied Stream Miles Range-wide
Colorado Cutthroat	217	807	33%/650 WY	3,022/7%
Snake River Cutthroat	1,338	1,461	63%/2,112 WY	4,292/31%

Key Ecosystem Characteristics, Drivers, and Stressors

Key ecosystem characteristics (KEC) for potential fish SCC include properly functioning floodplains, riparian areas and river/stream channels with flow and temperature regimes, sediment delivery, and transport rates within the natural range of variability. If these characteristics are provided for, instream habitat features (pools, riffles, runs, off channel habitats, etc.) and aquatic habitat complexity are generally maintained at their full potential. Population stability is dependent upon connectivity between spawning, rearing and overwintering habitats such that life history requirements are met.

Potential fish SCC stressors include any anthropogenic disturbance that directly, indirectly, or cumulatively affects these KECs. Water developments, such as dams and irrigation diversions, are a major stressor for all nine potential fish SCC. These developments impact habitat for lentic populations of native fish species; alter the timing and magnitude of peak spring flows; decrease base flow; increase water temperature; interrupt sediment transport; entrain fish; and fragment aquatic habitat. Therefore, potential fish SCC concern in the plan area can be negatively affected by water developments either upstream or downstream from the Bridger-Teton boundary.

Undersized and perched culverts can fragment potential SCC fish populations, which can prevent access to important upstream spawning, rearing, or overwintering habitats. Moreover, undersized crossing structures create velocity barriers to fish passage, and they are prone to failure during flood events. Also, the eroding road fill can contribute an excessive amount of fine sediment to sensitive spawning habitats.

Livestock grazing of an intensity and duration that exceeds the ability of streambanks and streambank stabilizing vegetation to recover can negatively affect aquatic habitat and fish populations (e.g., Young 2008, Dauwalter et al. 2014, WDGF 2017a, Dauwalter et al. 2018). Many riparian plant species have binding root masses that reduce streambank erosion during

high flow periods. When streambank vegetation is overgrazed and banks are broken down by hoof shear, streams typically become shallow and over-widened. This condition is often associated with the following: increased fine sediment accumulation in spawning habitats; decreased stream shading; decreased pool depth; decreased undercut bank cover; and increased stream temperature. Other actions that decrease the composition, extent, and vigor of riparian vegetation and streambank stability, such as improperly managed timber harvest, riparian road construction, and unrestricted off-road vehicle use, also can compromise floodplain and stream channel function to the detriment of SCC habitat.

Nonnative fish pose a major threat to all potential SCC through competition for food and space along with hybridization or predation. Cutthroat Trout populations are susceptible to extirpation from hybridization with other species in the *Oncorhynchus* genus and competition or predation from other trout species. Native suckers are also threatened by hybridization of nonnative suckers and nonnative predators pose a threat to Roundtail Chubs in lentic systems.

The plan area is critically important for maintaining potential SCC because it includes the headwaters of the: Snake, Yellowstone, Colorado, and Bear River Basins. Maintaining water quality and quantity downstream to the Bridger-Teton boundary promotes the conservation of these species within the plan area and beyond. Increased stream temperatures alter precipitation patterns, and changes in the timing, magnitude, and duration of spring runoff from climate change can interact with all the stressors within and beyond the boundaries of the plan area to cumulatively degrade SCC habitat. Cutthroat Trout have a relatively narrow thermal tolerance, although some have adapted to tolerate warmer water temperatures than others (Wagner et al. 2001, WDGF 2017a). Because of their thermal sensitivity, Cutthroat Trout are vulnerable to increased stream temperatures from climate change. High elevation habitats that are resistant to climate warming are essential to the long-term conservation of cutthroat trout by providing thermal refugia.

Potential Terrestrial Wildlife Species of Conservation Concern

Key Takeaways

SCC on the Bridger-Teton influence ecological, social and economic sustainability in many ways. For example, amphibians are good indicators of watershed health. Pollinators are critical for successful reproduction and seed set for approximately 85 percent of globally flowering species (Hatfield et al. 2012). The annual benefits of native pollinators to crops in the United States is valued at ~ $3.3 billion. This is especially evident for farmlands located adjacent to national forests and other natural areas. Fruits and seeds derived from insect pollination are a major part of the diet for approximately 25 percent of all birds and mammals ranging from red-backed voles to grizzly bears.

Summary

Six potential wildlife SCC were identified in the plan area (See Table 26). Western toad, Gillette's Checkerspot, Western bumble bee, and Black Rosy Finch have experienced severe declines across their range, including Wyoming (WGFD 2017a, NatureServe 2025) Greater Sage-grouse is in moderate decline. Columbia spotted frog appears relatively stable in most of its range with some declines documented in portions of its range (WGFD 2017a, NatureServe 2025).

Table 26. Potential wildlife species of conservation concern

Species Name	Current Status[1]
Greater Sage Grouse	S4— Apparently Secure
Western Toad	S1— Critically Imperiled
Columbia Spotted Frog	S3— Vulnerable
Black Rosy Finch	S1— Critically Imperiled
Gillette's Checkerspot	G3—Vulnerable (State status- unranked)
Western Bumblebee	G3—Vulnerable, S3-Vulnerable

1 Current status source is NatureServe Wyoming State Status (https://www.natureserve.org/).

Sagebrush steppe, aspen forests, riparian areas, wet meadows, alpine areas, and flower-rich meadows are the ecosystems and habitats most important for supporting potential SCC in the plan area. Multiple uses, such as grazing and recreation, that degrade these habitats and spread invasive species, negatively affect potential wildlife SCC in the plan area. The main threats to potential wildlife SCC on the Bridger-Teton include degradation, fragmentation, and loss of their habitats; chytrid fungus, climate change, overgrazing, invasive species, *Vairimorpha bombi* (a parasite to bumblebees), and pesticides.

Sage-grouse will face significant challenges from climate change, and they are expected to be vulnerable to population declines from degraded habitat caused by wildfire-induced mortality of mature sagebrush; increased spread of invasive annual grasses; and possible effects of West Nile virus. As alpine specialists, Black Rosy Finches are most vulnerable to climate change impacts to their summer breeding habitat. Western toads and Columbia spotted frogs are sensitive to chytrid fungus, alteration and fragmentation of aquatic habitats, and the timing and duration of water availability. Livestock activity can negatively, positively, or neutrally influence amphibians and their habitat via many potential pathways, and effects can also vary by life history stage (aquatic larvae vs terrestrial adults) (Barrile et al. 2021, 2022). Climatic conditions such as drought, warmer temperatures, and reduced snowpack may affect amphibian population dynamics and viability, although spotted frogs will probably be resilient in areas with reliable water sources (McCaffery and Maxwell 2010, McCaffery et al. 2012). Increased drought and extreme temperatures may impact pollinators already under stress from insecticides, loss of flower-rich habitat, and the spread of nonnative plants.

Status and Trends

Greater Sage-Grouse

In Wyoming, greater sage-grouse are considered "Apparently Secure" by NatureServe (See Table 26). Currently, greater gage-grouse occupy 56 percent of its historic North American range, inhabiting portions of 11 states and 2 Canadian provinces. In Wyoming, 91 percent of potential historic greater sage-grouse range is currently occupied; this is 70 percent of the State and 26 percent of North America's occupied greater sage-grouse range. Wyoming contains 37 percent of North America's population of greater sage-grouse. The Bridger-Teton is generally located outside the range of greater sage-grouse and suitable nesting and brood-rearing habitat is isolated on the Bridger-Teton. On Bridger-Teton, sage-grouse populations are considered to be in decline.

The greater sage-grouse is highly vulnerable to threats since the species: has specific sagebrush habitat requirements; has limited ability to disperse; has a relatively low fecundity; is predisposed to West Nile virus mortality, and is sensitive to habitat fragmentation, degradation, and disturbance (Nature Serve 2017, USFWS 2013, WGFD 2017a). Threats in Wyoming are primarily from degradation, fragmentation, and loss of sagebrush steppe habitats. Invasive annual grasses represent a significant threat to sagebrush habitats, primarily from increased fire frequency. Greater sage-grouse avoid areas due to human activities, even though sagebrush remains intact resulting in functional habitat loss and contributing toward habitat fragmentation. Other threats include herbivory of sagebrush by elk and bison near winter feeding operations and conifer encroachment (WGFD 2017a). While improperly managed livestock grazing (Defined as: "Grazing at an intensity or in ways that impair ecosystem functions"; USFWS 2015b) was identified as a threat, there are data to support both beneficial and detrimental aspects of grazing (Beck and Mitchell 2000, Boyd et al 2014), suggesting that the risk of livestock grazing to sage-grouse is dependent on site specific management (75 FR 13998). Short-term trends in statewide populations are believed to be largely weather related. In the late 1990s, 2004-05, and again in 2014-15, timely precipitation resulted in improved habitat conditions allowing greater numbers of sage-grouse to successfully reproduce. Drought conditions throughout this decade are believed to have caused lower grouse survival leading to population declines (WGFD 2025d).

Sage-grouse breeding and brood-rearing habitats on the Bridger-Teton are limited, comprising less than 1.5% and 0.5% of the plan area, respectively. These habitats are critical to the persistence of the species on the Bridger-Teton. Sage-grouse leks within the Bridger-Teton are somewhat isolated with only four known. The Ollie's Draw lek and the Clark Draw lek are part of the Upper Green River Conservation Area as of 2024 season, while the Breakneck Flat and Dry Cottonwood leks in Gros Ventre belong to the Upper Snake River Basin Conservation Area.

Results from Upper Green River Conservation Area lek monitoring in 2024 showed the average number of males/lek for all active leks increased to 38 in 2024, compared to the past two years of 25 in 2023, and 24 in 2022. This results in a 56% increase from 2023 but 31% lower than the last peak in 2016. The Ollie's Draw lek was likely discovered as a potential lek in either 2014 or 2015 from aircraft or a transmitted bird. Number of leks has been relatively small and fluctuating, but the 2024 had the highest male count. The Clark's Draw lek has been monitored since 2010. The 2024 lek count showed an increase from 2023 but lower than the peak in 2015.

The Gros Ventre sub-population is particularly concerning because these birds breed on only two known leks (Breakneck Flats and Dry Cottonwood). The Dry Cottonwood lek was last active in 2016. The Breakneck Flats lek had a high of 34 males in 2016, but since then has steadily declined, with only 4 males observed in 2024 (WGFD 2025d).

The Bridger-Teton incorporated standards and guidelines for the conservation of greater sage-grouse into the forest plan in 2015. These standards and guidelines are intended to reduce human disturbance occurring in sage grouse habitat and to limit the duration, timing, and location of human activities to best protect greater sage-grouse during all its life stages. Livestock grazing on the Bridger-Teton is managed to maintain residual perennial grass height to provide for adequate sage grouse nesting cover to increase the likelihood of successful nests. During the breeding and nesting season, perennial grass height should be allowed to grow to at least or maintained at a height of 7" to provide essential concealment cover. After eggs hatch, 4" of perennial grass cover should be maintained in the uplands throughout the summer and into the fall. During the brood-rearing season as upland vegetation dries out in

mid/late summer, broods move to riparian/mesic areas that are rich in forbs and insects. When grazing occurs during the brood-rearing/summer season, an average of 4” of herbaceous vegetation should be retained in riparian/ mesic meadows. During 2016 and 2017, the Bridger-Teton measured droop and stubble heights in allotments across sage grouse habitat on the Bridger-Teton. Sampling occurred on 163 sites. Where sampling occurred, data indicate that management of livestock grazing based on the 2015 Sage Grouse Plan Direction provides for the stated droop height and stubble height provisions (USDA 2017a, USDA 2017b, USDA 2017d, USDA 2018a, USDA 2018d).

Following the issuance of the Sage Grouse Plan Amendment in 2015, some researchers examining greater sage-grouse suggested that previous studies may have overlooked potential biases in linking nest success to grass height. Since then, several publications have explored the influence of plant phenology and the timing of grass height measurements, indicating that earlier estimates may have overstated the significance of grass height as a factor in nesting success (Gibson et al. 2016, Sage Grouse Initiative 2017, Smith et al. 2017).

Western Toad and Columbia Spotted Frogs

In Wyoming, Western Toads (formerly “Boreal” Toad) are considered “Critically Imperiled” (S1) in the state of Wyoming by NatureServe (2025) (See Table 26). The WGFD State Wildlife Action Plan classifies the species as “Aa,” which means that the population is imperiled and limiting factors are extreme; thus, extirpation is possible (WGFD 2017a). Western toads were formerly widespread and common, but they have dramatically declined in the last three decades in many portions of their range in western North America (USFS 2019a). Western toads are considered “extremely rare” in Wyoming (WGFD 2017a) and are also rare in the plan area, occupying ~5-15% of surveyed sites (Wallace and Tronstad 2019, RMAP 2025). Current occupancy is highest in the Gros Ventre and adjacent northwestern portion of the Wind River range (Wallace and Tronstad 2019). Preliminary results from the Rocky Mountain Amphibian Project in the Bridger-Teton do not show a consistent trend in species occupancy since 2014 (RMAP 2025), but their distribution and abundance has substantially declined in Wyoming since the 1970s (WGFD 2017a, NatureServe 2025).

Columbia spotted frogs are considered “Vulnerable” (S3) in the state of Wyoming by NatureServe (2025). The WGFD State Wildlife Action Plan classifies the species as “Bb,” which means that the population is vulnerable and limiting factors are severe (WGFD 2017a). The Columbia spotted frog is moderately common in the plan area, occupying ~15-30% of surveyed sites in the plan area; their occupancy is greater in the Teton and Gros Ventre mountain ranges than the higher-elevation wetlands in the Wind River Range (Wallace and Tronstad 2019, RMAP 2025). Population declines were documented in the states surrounding Wyoming (WGFD 2017a). However, like Western Toads, preliminary results from the Rocky Mountain Amphibian Project in the Bridger-Teton do not show a consistent trend in species occupancy since 2014 (RMAP 2025).

Chytrid fungus was first discovered in northwest Wyoming on the National Elk Refuge in 2000 (Keinath and Bennett 2000). It is thought to be the primary reason for recent mass die-offs and population declines. Use of chemical piscicides, such as rotenone and antimycin, can pose risks to larval amphibians, but these impacts depend on concentration, treatment timing, field conditions, etc. (Skarr et al. 2017). Fungal disease, *Saprolegnia ferax*, is a fish pathogen associated with hatchery fish that has been found to cause very high mortality to Western toads (Blaustein et al. 1994, Maxell 2000).

Amphibians face multiple potential stressors including disease, climate change, habitat alteration, and invasive species. Environmental stressors can also be interactive. Given these risk factors, coupled with relatively low occupancy and reduced distributions, the viability of these species and their persistence on the Bridger-Teton over the long-term are of substantial concern.

An extensive list of Conservation Goals and Potential Conservation Actions are detailed in the "Bridger-Teton National Forest Sensitive Species Conservation Assessment: Western Toad and Columbia Spotted Frog" (USDA 2019a).

Black Rosy-Finch

In Wyoming, NatureServe considers Black Rosy-Finches to be "Critically Imperiled" (See Table 26). Most of the Black Rosy-Finch distribution in the U.S. is on the Bridger-Teton and Shoshone National Forests. This species is showing robust decline in the Bridger-Teton (Shivik 2024) based on a broad-scale monitoring of bird communities known as Integrated Monitoring in Bird Conservation Regions (IMBCR).

Partners in Flight documents a 95 percent loss in the global population of this species from 1970-2014 (Rosenberg et al. 2016). The WYNDD classification is bifurcated between breeding and non-breeding season with a critically imperiled status for the breeding season when these birds are concentrated on high-elevation alpine patches on the Bridger-Teton. Black Rosy-Finch is restricted to high alpine slopes located above timberline (above 10,000) and appears to be tightly linked to both tundra and persistent snowpack (Brown et al. 2018). While the magnitude and character of habitat change is unknown, breeding habitat losses are expected. Changes in the timing of snowmelt could be detrimental to breeding success if this is a cue indicating optimal forage availability. It is unknown if other habitats will continue to support the energy requirements of broods and reproducing adults. Given the apparent global decline, negative trends in the Bridger-Teton (Shivik 2024), the fact that the Bridger-Teton provides a significant share of the breeding habitat for this species while their habitat requirements are restricted to high-elevation patches, and changes occurring on its summer breeding habitat, there is a substantial concern for the persistence of Black Rosy-Finches over the long-term on the Bridger-Teton.

Gillette's Checkerspot

Globally, Gillette's Checkerspot are considered to be "Vulnerable" by NatureServe (See Table 26). It is rare throughout its range (USDA 2019c). Although there is no abundance data for the Bridger-Teton, the species is also likely rare on the Bridger-Teton. Occurrences of Gillette's Checkerspot were recorded in multiple areas and ranger districts across the Bridger-Teton as well as surrounding areas. Many of these occurrences are historic, but at least five have been recorded on the Bridger-Teton since 1990.

The Gillette's Checkerspot is found in localized areas in the central and northern Rocky Mountains. It has experienced dramatic declines over the past 30 years. Range-wide surveys showed that 7 of 14 populations in the central and northern Rocky Mountains were extirpated between 1982-1984 and 2002-2006, including two of the largest known populations in the 1980s. Although there is no population data for the Bridger-Teton, the species is likely rare and experiencing similar declines here as well. The Gillette's Checkerspot inhabits a variety of damp habitats in mountains including: open, moist conifer forests, moist meadows, and streamsides. Habitat is sometimes unstable and prone to disturbance.

Based on its low abundance, declining populations, and vulnerabilities related to its habitat requirements, there is substantial concern for the capability of the Gillette's Checkerspot to persist over the long-term on the Bridger-Teton. Major threats to Gillette's Checkerspot habitat on the Bridger-Teton include potential overgrazing, invasion of noxious weeds, and global climate change.

Isolation of colonies makes species vulnerable to permanent local extirpation from any kind of temporary habitat disruption including browsing by large ungulates. Populations could be very quickly (one season) eradicated if grazing were severe enough. While adherence to rangeland management plans will limit the chance of overgrazing, there is potential for impacts to Gillette's Checkerspot and its habitat to occur.

Climate change also may pose a threat to Gillette's Checkerspot and its habitat. The loss of populations in the central and northern Rocky Mountains is attributed to conspicuous changes in vegetation due to the drying of meadow habitat (USDA 2019c, NatureServe 2020). Lower elevation and more southerly populations were more likely to become extirpated, further emphasizing the threat of climate change.

Alpine communities on the Bridger-Teton may be affected by climate change effects. Alpine communities have a high sensitivity to climate change, a low adaptive capacity, and very high vulnerability to climate change (Halofsky, et al. 2018). Changes in temperature and precipitation may lead to greater variability in forb flowering, which could create an asynchronistic effect with native pollinator emergence (Warziniack et al. in Halofsky et al. 2018, Bloom et al. 2022), leading to decreased reproduction in native plants. Because pollinators are critical for successful reproduction and seed set for approximately 85 percent of globally flowering species (Hatfield et al. 2012), this asynchronistic effect may have profound implications.

Overall, Gillette's Checkerspot is likely moderately to highly vulnerable to threats due to its rarity and isolated distribution. The nature of some threats, such as isolated populations and climate change, are beyond Bridger-Teton control.

Western Bumblebee

Globally, Western bumblebees (*Bombus occidentalis*) are considered to be "Vulnerable" by NatureServe (See Table 26) and was petitioned for listing as Threatened or Endangered under the Endangered Species Act (USFWS 2016). The Western bumblebee is widely distributed across western North America and it has experienced dramatic declines in the past 20 years. Although it has only been recorded in a few locations on the Bridger-Teton, available habitat is well distributed throughout the Bridger-Teton. The USFSW is currently conducting a species status review to determine if the Western bumblebee should be proposed for listing under the ESA.

Western bumblebees inhabit a wide variety of habitats, although species richness tends to peak in flower-rich meadows of forests and subalpine zones (USDA 2019c). Western bumblebees require habitats rich with floral resources and continuous blooming from spring to fall. In particular, the availability of floral resources late in the season may affect species fitness because this is the time when Western bumblebee communities produce reproductive bees. The species appears to be able to disperse several miles during nest establishment.

Major threats to Western bumblebee habitat on the Bridger-Teton include invasive species and global climate change. High variability in reproductive success, recorded low reproduction, reduced genetic diversity, and competition with honeybees all increase the vulnerability of

Western bumblebee populations. Infection by pathogens and parasites (e.g., the microsporidian [*Vairimorpha bombi*]), presumably introduced by escaped bees from commercial colonies, appear to be a major driver in Western bumblebee declines. Insecticides and some herbicides also pose serious threats to Western bumblebees. Neonicotinoid insecticides, which have toxins that are extraordinarily persistent and are expressed in the nectar and pollen of plants, exert both lethal and sublethal effects on Western bumblebees; they are of particular concern (NatureServe 2019, USDA 2019c). Neonicotinoids are widely used in production agriculture, but not on the Bridger-Teton. Changes in temperature and precipitation may lead to greater variability in forb flowering, which could create an asynchronistic effect with native pollinator emergence (Warziniack et al. in Halofsky et al. 201, Bloom et al. 2022) leading to decreased reproduction in native plants.

Based on its low abundance, declining populations, susceptibility to disease, and numerous vulnerabilities related to its habitat requirements, life history, and demographics, there is substantial concern for the capability of the Western bumblebee to persist over the long-term on the Bridger-Teton.

Native pollinators such as: bees, butterflies, moths, flies, bats, and beetles substantially contribute to the food production systems of the United States, the economic vitality of the agricultural sector, and the health of our environment. Pollination by these species adds $3.3 billion in value to agricultural crops in the United States each year (Losey and Vaughan 2006, Calderone 2012). Pollinators pollinate more than 80 percent of wild flowering plants in temperate latitudes, thereby enhancing biodiversity and supporting stronger and more resilient ecosystems. However, the health of pollinator population has been impacted over recent decades by a variety of factors: the loss, degradation, and fragmentation of habitat; diminished quantity and quality of food sources; reduced availability of sites for mating, nesting, and migration; exposure to pesticides; and increased adverse effects from pathogens, arthropod pests, and parasites. Invasive plant species have been implicated worldwide in the disruption of native pollinator processes and alteration of habitats that support native pollinators.

On June 20, 2014, a memorandum was issued directing the heads of executive departments and agencies to create a Federal strategy to promote the health of pollinators. The memorandum directs future land management activities, including restoration, rehabilitation, and revegetation projects, to consider the needs of pollinators.

Other Highlighted Species

Aquatic Highlighted Species

Key Takeaways

Other highlighted aquatic species (OHAS) in the plan area influence ecological, social and economic sustainability in many ways. These organisms fill important ecological niches and contribute to the integrity and viability of native species assemblages. From alpine headwaters to large rivers, managing for widely distributed and stable OHAS populations contribute to a wide variety of ecosystem services including: recreation, tourism, water supply, water quality, erosion prevention, and climate regulation. This is because OHAS populations are a product of watershed, floodplain, and riparian function upon which these ecosystem services depend. Maintaining water quality and quantity and habitat connectivity within the: Upper Snake, Upper

Colorado, Upper Missouri, and Upper Bear River Basins is essential for sustaining these species within and beyond the plan area.

Issues, concerns, and conservation opportunities vary across the highlighted aquatic species described below based on their distributions, habitat requirements, and land uses. However, common issues and concerns include: habitat fragmentation, channel dewatering, climate change (altered flow and temperature regimes), and overgrazing.

Opportunities for conserving these native aquatic species populations include: improved livestock grazing management; implementing strategies to conserve instream flows; moderating stream temperature; removing migration barriers; and preventing the invasion and establishment of nonnative species. Some populations may benefit from process-based restoration projects that: restore floodplain connectivity, increase base stream flows, moderate water temperature, and increase riparian area resilience to wildfire. All of the OHAS would benefit from additional sampling, using emerging tools like eDNA, to refine distribution at the plan area scale and to establish a baseline for presence-absence monitoring.

Summary

OHAS fill important ecological niches and serve as barometers for ecosystem health and contribute to social and economic sustainability. OHAS include native nongame fish species of Mountain Whitefish, Mottled Sculpin, Paiute Sculpin Mountain Sucker and Green Sucker; Native game fish species of Yellowstone Cutthroat Trout and Bonneville (Bear River) Cutthroat. In addition, western pearlshell mussel is recognized as a species of both cultural and ecological importance.

Native Nongame Fish

Mountain Whitefish (*Prosopium williamsoni*), Mottled Sculpin (*Cottus bairdii*), Paiute Sculpin (*Cottus beldingii*), Mountain Sucker (*Pantosteus platyrhynchus),* and the newly recognized Green Sucker *(Pantosteus virescens)* are important members of the native cold-water fish assemblage on the Bridger-Teton. Land management practices designed to protect native salmonid habitats (e.g., the potential SCC subspecies of Cutthroat Trout) are generally expected to also benefit these species.

Mountain Whitefish (*Prosopium williamsoni*) prey on a variety of aquatic and terrestrial invertebrates and often compose a large portion of the biomass present within streams and lakes and, therefore, substantially contribute to ecosystem processes (e.g., nutrient cycling). Although Mountain Whitefish are not the salmonid species sought out by most anglers, they often provide fly fishermen the opportunity to catch fish when trout are not biting. Because their flesh is light and mild tasting but bony, whitefish are targeted by anglers for smoking. Because they provide a food source for piscivorous fish and many carnivores including: eagles, osprey, bears, otter, and mink, they form an important link in the food chain. Mountain Whitefish are sensitive to stream temperature increases, decreased water quality, and habitat degradation, and they are a good indicator of ecosystem health (Brown 2022, Paragamian 2002, Brinkman et al. 2013). Therefore, managing riverine habitats for healthy Mountain Whitefish populations ensures the preservation of numerous ecosystem services.

Mottled and Paiute Sculpin are benthic (bottom-dwelling) fish adapted for life in clear, cold, fast-flowing streams with gravel and cobble beds. They feed on insects and invertebrates in shallow riffle habitats that are less preferred by other native fish species. Sculpin are an important food

source for piscivorous gamefish, and they are an important link in the food chain. Anglers recognize this and routinely cast sculpin-imitating flies and lures in pursuit of large fish. Maintaining sufficient instream flows to inundate riffle habitat is essential for conserving sculpin populations, aquatic invertebrate production, and overall ecosystem stability.

Mountain Sucker are also benthic feeders but can occupy more varied habitats. They can exploit both lotic and lentic conditions, can inhabit water conditions ranging from clear to turbid, and are associated with a wide range of substrates (Belica and Nibbelink 2006). In stream systems, Mountain Sucker are most common in low gradient segments that consist of a mix of riffles, pools, and runs. Presence of cover (e.g., exposed tree root masses, undercut banks, logs, and boulders) is their primary microhabitat factor (Belica and Nibbelink 2006). Maintaining the availability of diverse stream habitats is important for the continued persistence of the species.

Bluehead Sucker (formerly *Catostomus discobolus*) has recently been split into two species based on morphological and genetic evaluations: Bluehead Sucker (*Pantosteus discobolus*) and the newly recognized Green Sucker (*Pantosteus virescens*) (Page et al. 2023, Suchomel et al. 2024). The BTNF supports populations of Green Sucker in the Snake River and Bear River drainages (Suchomel et al. 2024). There have been numerous observations of Green Sucker in the plan area, including in the Snake River, Hoback River, and Gros Ventre River. Both the Snake River and the Gros Ventre have populations of the species that utilize habitats on the BTNF year-round. Many other streams within the BTNF are utilized seasonally by Green Sucker.

Western Pearlshell Mussel

Western pearlshell mussels (*Margaritifera falcata*) are found in cold-to-cool streams with low-to-moderate gradient and stable sand or gravel substrates. They are primarily filter-feeders, and they can clean large volumes of water by straining organic matter out of the water column (Howard and Cuffey 2006). They also provide nutrients to benthic organisms (Vaughn and Hakenkamp 2001). They are an important food source for terrestrial wildlife, such as: raccoons, skunks, bears, and shorebirds. For millennia, indigenous people have utilized freshwater mussels as food and they used their shells for making buttons, jewelry, and tools.

Native Game Fish

Two Cutthroat Trout subspecies are distributed in the plan area, but their current distributions include many artificially introduced populations. Yellowstone Cutthroat Trout (*Oncorhynchus virginalis bouvieri*) are native to the Snake, Yellowstone, Bighorn-Wind and Tongue River drainages. Bonneville (Bear River) Cutthroat (*Oncorhynchus virginalis utah*) are native to the Bear River drainage of the Great Basin. Several other stocked lakes on the Bridger-Teton support angling opportunities for the various subspecies of cutthroat.

The majority of remaining habitat for the Cutthroat Trout subspecies exist in higher elevation, headwater portion of their historic ranges, predominantly on National Forest land. The Bridger-Teton's Cutthroat Trout subspecies are readily sought out by resident and visiting anglers who value fishing for native trout in their historically occupied habitats. According to Briceno et al. (2023), anglers fishing Wyoming national forests annually contribute $156 million dollars to local economies through: lodging, restaurant, gas, fishing gear, licenses, and other purchases. Fishing accounts for 12 percent of all Bridger-Teton recreation expenditures including: hiking, camping, hunting, and wildlife viewing (Briceno et al. 2023). The WGFD oversees the Wyoming

Cutt-Slam, whereby anglers are recognized for their fishing accomplishment. Activities like the Wyoming Cutt-Slam help promote the social and economic value and stability of native fish in the plan area and the broader region.

Status and Trends

Native Nongame Fish

The four highlighted species of nongame fish (Mountain Whitefish, Mottled and Paiute Sculpin, and Mountain Sucker) are considered secure in Wyoming: all are ranked as "S5," which indicates the species is "at very low or no risk of extirpation in the jurisdiction due to a very extensive range, abundant populations or occurrences, with little to no concern from declines or threats" in the state (NatureServe 2025). Green Sucker is currently unranked by NatureServe since the species is newly recognized (NatureServe 2025). Because these species are not popular sportfish and can be challenging to survey, there are limited data to assess the status and trend of individual populations in the plan area. However, a study by Edwards (2014) did establish baseline population estimates for Mountain Whitefish in several streams on and near the Bridger-Teton. Overall, Mountain Whitefish populations in the plan area appear robust and secure, with densities similar to wild trout populations in the sampled streams (Edwards 2014). The plan area provides high quality riverine habitats in the Upper Snake, Upper Yellowstone, Upper Green, and Bear River Basins that are important for the long-term conservation of native nongame species. For example, the portion of the Upper Snake that overlaps the plan area is characterized by relatively high biological integrity with fish assemblages indicative of quality, cold-water habitat (e.g., Maret and Mebane 2004). Population trends of Green Sucker are uncertain since the species has only recently been recognized.

As small, bottom-dwellers, sculpin are especially susceptible to habitat fragmentation from perched road culverts or irrigation diversion structures. Although it is not fully known what types of in-stream features might impede Mountain Sucker movements, construction of passage barriers is considered a general threat to the species via population and habitat fragmentation (Belica and Nibbelink 2006). Both species of sculpin tend to occupy riffle habitats, which are the most prone to dewatering from climate change and irrigation withdrawals. Mountain Sucker are also reliant on riffle habitat for spawning, but during non-breeding are more common in pools and pool-run edge habitats (Belica and Nibbelink 2006). Maintaining water quality, quantity and habitat connectivity within the headwaters of the Snake, Upper Colorado, and Bear River Basins will promote the long-term conservation of native nongame fish species within and downstream of the plan area.

Native Game Fish

On the Bridger-Teton, the distribution of Bonneville Cutthroat Trout in the plan area is restricted but there are still a relatively large number of stream miles (about 90) that remain occupied in the Smiths Fork and Thomas Fork drainages and 6.2 miles of habitat in Poler Creek and in Lake Alice. The distribution of Yellowstone Cutthroat is also limited, occurring only in the Northeastern part of the Plan Area. Although there are climate change, pathogen, nonnative species, and habitat degradation threats to Yellowstone Cutthroat and Bonneville Cutthroat Trout, currently most populations are relatively stable.

Western Pearlshell Mussel

The western pearlshell mussel has the broadest distribution and longest lifespan of the western U.S. freshwater mussel species. Within Wyoming, western pearlshell mussels occur in the Snake, Green, and Bear River Basins. They are classified by NatureServe as (S3) Vulnerable (At moderate risk of extirpation in the jurisdiction due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors). Wyoming counties where the species has been documented include: Lincoln, Sublette, Teton, and Uinta (Beetle 1989). Western pearlshell are cryptic organisms that burrow into the streambed and they have shells that, to the untrained eye, resemble rocks. Water depth, velocity, and turbidity can further complicate detecting mussels with visual surveys. Therefore, the distribution of this species in the plan area is not entirely known. They can live a very long time, with an average lifespan of 60 to 70 years and a maximum lifespan exceeding 100 years. Given their longevity, western pearlshell presence in a stream is not necessarily indicative of population viability. This is because some populations dominated by older individuals are at risk of extirpation from stochastic events and unsuitable reproduction conditions. Therefore, population trends within the plan area are relatively unknown.

Key ecosystem characteristics of western pearlshell habitat include: clean, cold, connected, low-moderate gradient streams and rivers with stable sand, gravel, and cobble bottoms. Successful reproduction and dispersal depend on the presence of a salmonid fish host. WPM glochidia (larvae) attach to the gills of a host fish and develop for several weeks before detaching. Threats and stressors include actions that degrade: water quality, quantity, habitat connectivity, channel stability, and host-fish abundance (especially native salmonids). Specifically, water developments for irrigation and hydropower may alter natural flow regimes and fragment habitat for mussels and their salmonid hosts. Land uses, such as livestock overgrazing, that elevate nutrients, sediment, and stream temperature may contribute to extirpation of populations (e.g., Stagliano 2023). Not only is climate change a concern due to stream warming, but also because changes in the timing and magnitude of runoff can destabilize otherwise stable channels.

Within the plan area, instream structures, such as irrigation diversions and perched stream crossings, that fragment habitat present opportunities for habitat restoration. Stream warming from climate change and irrigation are threats that can be mitigated to some extent through increased water delivery efficiency, instream water reservations, and large-scale process-based restoration. Channels degraded from livestock overgrazing or recreation impacts can be adaptively managed to restore western pearlshell habitat.

The plan area provides high quality stream and riverine habitats in the Upper Snake, Upper Green, and Bear River Basins that are important for the long-term conservation of the species. Ensuring a supply of clean water, highly connected habitat, and robust native fish populations promotes western pearlshell population viability within and beyond the plan area.

Terrestrial Wildlife Highlighted Species

Key Takeaways

- Beavers are a keystone species, meaning they have a disproportionately large effect on their environment relative to their abundance. Beavers play a critical role in watershed health by improving and maintaining the structure of the surrounding ecological community.

- The Bridger-Teton provides important habitat for the four large bighorn sheep (BHS) core herds (herds that have never been extirpated, then reestablished via transplants) in the northwest corner of the State that account for over 85 percent of Wyoming's statewide total and represent some of the largest meta-populations of BHS throughout its range.
- The Bridger-Teton also provides crucial habitat for many large elk, mule deer, moose, bison and pronghorn antelope herds.
- The Path of the Pronghorn became the first federally designated migration corridor in the United States in May 2008 when the Bridger-Teton amended its forest plan to protect the 47,000-acre ungulate travel corridor.

Summary

Other highlighted species are species of interest commonly enjoyed and used by the public for: hunting, trapping, observing, or sustenance, including cultural or tribal uses. State fish and wildlife agencies manage many of these species through hunting regulations. The following species are valued for their social, cultural, and economic benefits to visitors of the Bridger-Teton: bighorn sheep, mule deer, elk, moose, bison and pronghorn antelope. The most important issues for these species are degradation and fragmentation of habitats, diseases such as pneumonia and CWD, and motorized recreation.

Because of their popularity and wide distribution, bighorn sheep, mule deer, elk, and antelope are some of the most economically and socially important animals in western North America. For example, as Wyoming's second-largest industry, tourism relies heavily on wildlife experiences. The number one reason people travel to Wyoming is to view wildlife. Wyoming's economy and tourism industry benefit greatly from this. In 2021, big game license sales generated $29.2 million for WGFD for conservation activities (WGFD 2021). Big game hunting generated a total of over 92,000 hunter days and contributed $15.5 million to local economies in 2015, while Teton County generated over 42,000 hunter days with hunters spending $8.4 million in the county during the same year (Taylor and Foulke, 2017).

Residents of the counties surrounding the Bridger-Teton, as well as our national stakeholders, value wildlife and non-motorized recreation more than commodity production on the Bridger-Teton (Clement and Cheng 2011). For example, 75 percent of respondents value the Bridger-Teton because it provides a variety of fish, wildlife, and plant life, whereas 49 percent of respondents value the Bridger-Teton because it provides timber, minerals, and/or tourism opportunities such as outfitting and guiding. Survey conducted in 2009 showed that the majority of hunters (61 percent) supported efforts by Federal land management agencies to regulate the use of off-road vehicles (WGFD 2009), but this question has not been asked in the recent surveys.

Status and Trends

Beaver

In Wyoming, beaver is considered "apparently secure" (NatureServe 2025) and their populations are considered stable after historic declines. Today, beaver may occupy only one-third of their original range in the State. While the overall status and trend of beaver in the plan area and the broader region of influence is unknown, beaver have significantly increased in portions of the GYE since the early 20th century (Smith and Tyers 2012).

Beavers inhabit permanent sources of water of almost any type in their range, but riparian ecosystems are most important for supporting beaver. Habitat suitability is largely determined by food availability, particularly aspen trees, which are extensively used for dam building and preferred forage (Jenkins and Busher 1979). In Wyoming, beaver distribution is closely tied to the distribution of aspen, though they also inhabit riparian areas with willow and cottonwood. Key ecosystem characteristics include permanent, relatively stable water sources and streams with gradients less than 15 percent; the optimum stream gradient appears to be 6 percent or less. The availability and accessibility of forage are important factors limiting beaver colonization. A 40 to 60 percent tree or shrub canopy cover within 165 ft. of the water's edge of preferred beaver forage species is considered optimum for beaver establishment. Generally, beaver require a minimum of 0.5 mile of stream channel.

There are few threats to beaver. Historic extirpation from large areas of their range and riparian habitat degradation are the biggest issues for this species. Riparian degradation can be caused by a variety of factors, singly or in combination, including: over-browsing of aspen, cottonwood and willow by large concentrations of wild ungulates, fire suppression, conifer encroachment into aspen stands, drought, development, increased erosion, formation of gullies, or natural events that have resulted in loss of vegetation.

Beaver ponds stabilize watersheds by moderating high flows and reducing downstream flooding; maintaining more constant summer flows; and storing water during flooding and releasing water during droughts. Ponds retain sediment and organic matter, thus improving fish habitat, and the increase in water surface area produces a corresponding increase in total aquatic productivity. These ponds also provide important pool habitat for certain fish species, additional recreational opportunities (fishing, wildlife viewing, etc.), and diverse scenery. Restoring beaver to appropriate areas on Bridger-Teton would help improve the health of riparian ecosystems in a natural, cost-effective manner. Beavers improve riparian and aquatic ecosystems by expanding wetlands and elevating water tables resulting in subirrigation of adjoining areas. Subirrigation into the floodplain encourages plant growth that stabilizes streambanks. The increase in vegetation provides additional forage and cover for livestock and wildlife.

Beavers are a keystone species and an ecosystem driver, because they have a disproportionately large effect on their environment relative to their numbers. Beavers play a critical role in watersheds by maintaining the structure of the surrounding ecological community. By constructing dams and ponds, beavers exert a considerable influence on the geomorphology, hydrology, and composition of aquatic and riparian ecosystems. Beavers create dynamic habitats, such as willow stands and herbaceous-dominated wetlands. Beaver dams increase the storage capacity of catchments by absorbing and retaining water during high flows. Discharge is then released slowly, leading to higher base flows during late summer. In some areas, beaver dam complexes maintain perennial flows in what are otherwise intermittent streams (Pollock et al. 2014), increasing the extent of riparian and aquatic habitats and the amount of water available for groundwater recharge. Beaver ponds and their dams enhance the depth, extent, and duration of inundation during flooding and elevate the water table during both high and low flows (Westbrook et al. 2006). Significant beaver populations within a drainage can make water resources, including quantity and quality, more resistant and resilient to the effects of drought and climate change (Pollock et al. 2014, Rosell et al. 2005). In the absence of beaver, willow, non-willow shrub, and herbaceous riparian vegetation are confined to stream margins or disappear altogether as the water table declines (Chadde and Kay 1991).

Riparian habitats provide the greatest overall value to wildlife of any habitat type in Wyoming, and the benefits of beaver-modified riparian habitat to wildlife are even more significant. For example, total bird density in some beaver-occupied riparian habitat has been found to be three times that of adjacent riparian habitat. Beaver-occupied riparian habitat provides: resting, feeding, nesting, and brood-rearing habitat for waterfowl. Sandhill cranes seek out beaver ponds for nesting, and both trumpeter swans and Canada geese have been found to nest on beaver lodges. Moose are attracted to aquatic vegetation found in beaver ponds. Muskrat and otter will sometimes take up residence in abandoned beaver dwellings. The presence of muskrat and fish in beaver ponds may attract mink. Beaver ponds are especially critical to the continued survival of native cutthroat trout species.

Beavers often have a detrimental impact to nearby: roads, culverts, trails and recreational areas used by humans. Flooding caused by beaver dams is often a costly and time-consuming maintenance issue. Beaver populations are often removed, translocated or their dams destroyed to alleviate nuisance flooding. Beaver extirpation, beaver removal, or beaver absence degrades aquatic ecosystems by: disrupting sediment management, reducing groundwater recharge, diminishing river and stream interaction with associated floodplains, and limiting the extent and vigor of riparian vegetation. In recent years, Bridger-Teton staff along with partners have worked to develop projects to alleviate flooding without removing resident beaver. The results have been promising, but more development and implementation is needed.

Bighorn Sheep

In Wyoming, BHS are considered “imperiled/vulnerable” (NatureServe 2025) and their populations are considered stable after historic declines (WGFD 2017a). Wyoming has approximately 20 percent of the total number of BHS in the contiguous United States and 15 percent of the total range-wide estimate of BHS (including Canada). In 1960, there were estimated to be 2,000 BHS in Wyoming, restricted entirely to the northwest corner of the State. By 1990, this estimate rose to over 7,000 and it has ranged between 6,000 and 7,000 since that time. The four core native herds (herds that have never been extirpated, then reestablished via transplants) in the northwest corner of the State account for over 85 percent of Wyoming’s statewide total and represent some of the largest meta-populations of BHS throughout its range. These core native herds are the: Absaroka, Targhee, Jackson, and Whiskey Mountain herds. Between 2017 and 2023, populations in the Jackson and Absaroka herds experienced some fluctuations but remained within population objectives (WGFD 2023f, WGFD 2023g). Since 2018, insufficient demographic data has been collected on the Whisky Mountain herd to produce an accurate population estimate. However, indications suggest the population continue to languish far below objective and is currently estimated at around 500 bighorn sheep (WGFD 2019e) and continued to decline in 2023 (WGFD 2023f). Although the exact population size on the Bridger-Teton is unknown, individual herd size ranges from ~60 to ~900 animals. The Darby Herd in the Wyoming Range is considered a “non-emphasis area”, meaning it is among the lowest priority areas for BHS management. Since 2016, three-year trend counts for the Darby Mountain herd have remained below the population objective, except for the 2018–2020 average (WGFD 2023g).

In northwest Wyoming, alpine tundra and areas of associated rocky escape terrain are used during summer. In winter, lower elevation, grassy benches and southerly slopes are used, with some herds or population segments wintering on wind-swept ridges at high elevations (WGFD 2017a). Open areas with high visibility for predator detection and communication among individuals are typically used as foraging habitat, and ideal habitat typically includes a

juxtaposition of visibility, escape terrain, and abundant, continuous forage. Nearly 50 percent of the Bridger-Teton is classified as summer ranges for BHS. Approximately 20% of summer ranges are currently occupied by BHS. Preferred habitat includes areas with slopes between 31–85 degrees and <30 percent forest cover. Threats include: disease, fire suppression, mountain goats, human disturbance, and climate change. WGFD is actively conducting research and implementing test and remove protocols, to better understand and actively manage threats to bighorn sheep herds on the Bridger-Teton. These management activities may require permitting to conduct work in Wilderness Areas to be successful.

BHS are highly susceptible to diseases that can be carried and transmitted through contact with domestic sheep and goats. The Final Report and Recommendations from the Wyoming State-wide Bighorn/Domestic Sheep Interaction Working Group (2004) outlines strategies for managing interactions between bighorn and domestic sheep. It emphasizes disease prevention, habitat management, and stakeholder collaboration to balance conservation efforts with livestock operations. The report also highlights research priorities and economic considerations, aiming to support both wildlife and agricultural interests in Wyoming. The Bridger-Teton has significantly reduced the number of active sheep allotments over the last 20 years. As part of the BHS/Domestic Sheep-Risk Management Strategy (USDA 2018b), the Bridger-Teton staff conducted a risk assessment of sheep allotments in relation to BHS herd home ranges. There are currently no active sheep allotments with a “high” risk of contact (ROC), those are all vacant, closed or forage reserves. There are only four allotments with a “moderately high” ROC, all located on the Greys River Ranger District, and they have associated a mitigation measure to reduce that risk (USDA 2018b). There is one allotment with a “medium” ROC and the rest of the allotments are all considered “low”. However, it should be noted that a “low” category is assigned for ROC results that pertain to the Darby herd, regardless of the ROC model results, to reflect the fact that the Darby herd is in a non-emphasis area (USDA 2018b). Domestic goats can also carry pathogens that, if transmitted to bighorn sheep, can develop into diseases that are harmful to wild sheep. Besser et al. (2017) found that the severity of disease that developed after exposure to domestic goats was milder than impacts to bighorn sheep resulting from disease transmitted by domestic sheep. However, disease transmission from recreational use of domestic pack goats is still a potential threat to bighorn sheep.

Fire suppression degrades BHS habitat by allowing conifer encroachment. The expansion of non-native mountain goats on the Bridger-Teton has the potential to adversely affect BHS in core herds, particularly through competition for forage and space on high elevation winter ranges and the transmission of disease such as pneumonia (WGFD 2017a).

Human disturbance (e.g., snowmobiling, backcountry skiing, and heli-skiing on and near winter ranges and off-trail recreation on summer ranges) and human presence near lambing sites may be detrimental (USDA 2018b). Human disturbance on the Bridger-Teton is primarily a concern for the Targhee herd, which is mostly located in Grand Teton National Park. However, winter recreation activities have also been increasing in the Teton Wilderness affecting the Absaroka Herd and in the Gros Ventre Wilderness affecting the Jackson Herd. Due to habitat loss from development, this sheep herd clings to existence in rugged high country, enduring brutal winter conditions above timberline in the alpine ecosystem. A primary threat includes the loss of crucial winter range due to recreational (skier and snowmobile) disturbance. Backcountry skiing, snowboarding, and mountaineering are popular winter pursuits in the Teton Range; both visitor numbers and the spatial extent of their footprint have increased over time during the winter. Human activity now frequently extends into habitats that are critical to wintering BHS in this area. In some cases, sheep have effectively lost up to 30 percent of the available winter habitat

in their home range because of displacement by skiers. In other places, sheep are forced to move to avoid skiers, burning precious energy during winter, which can result in poor reproduction and starvation. A working group made up of biologists, conservationists and land managers developed a strategy to address these issues (Teton Range Bighorn Sheep and Winter Recreation Strategy).

Climate change could negatively influence forage quantity and quality on existing ranges. The effects of warming on the distribution and abundance of invasive species, such as cheatgrass, also may negatively impact BHS habitat (WGFD 2017a). Fluctuations in precipitation may affect the availability and timing of spring forage. Changes in precipitation patterns, including rain-on-snow events, and temperature shifts that increase freeze-thaw cycles, could make movement more costly and limit access to forage (Aycrigg et al. 2020). BHS on the Bridger-Teton may be more resilient to reduced forage availability because the landscape provides diverse habitat types and few barriers (Halofsky 2018). Studies indicate that avalanches-related fatalities will continue to pose a threat to bighorn sheep as temperatures warm and may increase if the frequency of extremely wet events rises (Bair 2024).

One key ecosystem characteristic (KEC) for BHS is the lack of active sheep grazing allotments near their range. Sheep grazing on the Bridger-Teton has changed significantly over time. In 1990, there were 81 sheep allotments and approximately 60,000 sheep grazing on the Bridger-Teton (USDA 1990). Since then, many of these allotments have been closed, vacated or put into a forage reserve status. These changes have been influenced by various factors, including land management decisions and wildlife considerations. Currently, there are 33 active domestic sheep allotments that are authorized for 24,500 sheep. All are located in the southern part of the Bridger-Teton, within the Greys River, Kemmerer and Pinedale Ranger Districts (USDA 2018b).

Plains Bison

In Wyoming, Plains Bison are considered “critically imperiled” (NatureServe 2025). Bison historically ranged throughout most of North America, including the Greater Yellowstone area surrounding Jackson hole (Boyd 2003; USFWS et al. 2007). The Plains bison were most abundant across the grasslands of the Great Plains extending east toward the Great lakes regions, south to Florida, and westward toward Nevada and the Rocky Mountain region. Present day Bison distribution across North America consists of remnant and re-introduced herds, occupying less than 1.2% of their original range (Sanderson et al. 2008 in Aune et al 2017).

Currently, bison occupy a small, isolated area of northwest Wyoming, located within the Greater Yellowstone Ecosystem. This includes the Yellowstone and Jackson herds. The Jackson bison herd comprises one of the largest concentrations of bison in North America. The Jackson bison herd migrates across several jurisdictions including Grand Teton National Park and the National Elk Refuge, with some crossing into the Bridger-Teton National Forest and onto state and private lands in Jackson Hole. Plains bison has very low distribution across the Forest and are more commonly known to occupy lands near the Forest boundary.

The Jackson bison herd is not as abundant on the BTNF as they are on the adjacent Grand Teton National Park and National Elk Refuge. The Jackson herd averaged 773 individuals from 2011 to 2015, 546 individuals in 2016, and the proposed estimated population for 2017 was 504 individuals (WGFD 2016). The state of Wyoming has implemented bison hunting to regulate the Jackson population and reach the desired population objective. According to Wyoming Game

and Fish, the bison herd objective for the Jackson population is 500 individuals. The Jackson herd has remained within its population objective for the past seven years, maintaining stability. WGFD considers this is a long-standing population objective that is working well under current management (WGFD 2023e).

Bison are primarily grazers and forage in grassland and meadow communities. They can persist in arid regions and in colder climates that experience deep snow cover. Grasses and sedges form the mainstay of the annual diet in all regions (Aune et al. 2017). However, diets in the summer and fall may vary, including flowering plants, woody plant leaves, and lichens, in addition to grasses and sedges.

Existing threats to Plains bison includes habitat loss, disease, reduction in genetic diversity, hybridization, and the threat of depopulation as a management response to infection (Aune et al. 2017; Boyd 2003).

Mule Deer, Elk, Pronghorn Antelope and Moose

In Wyoming, mule deer, elk, and pronghorn antelope are considered “secure”, and moose is considered “apparently secure” (NatureServe 2025). Even it is considered “secure”, mule deer populations have declined throughout Wyoming since 2000. Populations appear to be responding in a density-dependent fashion to decreasing habitat availability and/or quality. After the 2022 hunting season, the WGFD estimated a total population of 242,500 mule deer in the State. Mule deer herds overlapping the plan area include Upper Shoshone, Dubois, Wyoming Range, and Sublette, all of which have been below population objectives in recent years. The Wyoming Range mule deer herd experienced severe winter mortality in 2022–2023, reducing its population to an estimated 10,300 deer post-hunt in 2023 which is an historic low (WGFD 2023e). In contrast, winter mortality in the Sublette, Dubois, and Shoshone herds during the same period was less severe. The Dubois herd has been in decline for over a decade but has stabilized since 2019 (WGFD 2023f). The Sublette Deer Herd has only neared its population objective three times since 1993, with severe winter conditions typically leading to above-average mortality following population peaks (WGFD 2023g).

Conversely, in 2021, there were an estimated 110,200 elk in Wyoming, almost 30 percent above WGFD’s population objectives for the species. Most elk herds overlapping the Bridger-Teton have populations within or above objectives, with stable or increasing trends. However, Chronic Wasting Disease (CWD) remains a growing concern in and around the Bridger-Teton. Some elk have tested positive for CWD, including a GPS collared elk from the Piney herd in 2023 (WGFD 2023g). During the winter of 2024-2025, several additional CWD cases were detected on or near the Bridger-Teton, affecting locations such as the Dell Creek feeding ground on the FS, Black Butte, Scab Creek and Horse Creek feeding grounds near the FS boundaries.

Since the early 1900s, supplemental feeding of elk has been conducted in northwestern Wyoming. Feedgrounds were established for multiple reasons, including concerns over winter mortality, reducing wildlife damage, supporting higher elk populations for hunting opportunities, mitigating loss of winter range due to human development (WGFD 2004), and reducing brucellosis transmission to livestock (WGFD 2025c). However, feedgrounds may also contribute to the spread of infectious diseases such as Chronic Wasting Disease (CWD) and brucellosis (Cook et al. 2023).

On the Bridger-Teton, the WGFC is authorized under Special Use Permits to operate the feedgrounds at Dog Creek, Fall Creek, Fish Creek, Muddy Creek, and Green River Lakes

through 2028 for their elk management activities; while Alkali Creek feedground was permitted for emergency use only through 2024 and then was closed. The permits include both authorization for use and site-specific stipulations. Currently, the Bridger-Teton is working on an Environmental Impact Statement (EIS) to evaluate the proposal for continued authorization of winter elk management at Dell Creek and Forest Park.

Wyoming is home to roughly half of the world's pronghorn antelope population; in 2021, WGFD estimated there to be 388,500 pronghorn antelopes in the State, 9 percent below the objective of 429,200. Indications are that over the winter of 2022/2023, the pronghorn antelope that winter in the Green River Basin, but summer in Grand Teton National Park, the National Elk Refuge and along the Gros Ventre River lost up to 75-87 percent of their number due to pneumonia and severe weather. The Sublette herd saw population growth and met its objective in 2021 and 2022, but in 2023, numbers dropped by over 50%, falling well below the objective (WGFD 2023d).

Moose are present throughout the plan area, though no parturition sites have been identified in the plan area by WGFD. Their crucial winter ranges are limited to lower elevations along rivers and streams. Moose may make long distance movements across landscapes relatively devoid of suitable habitat, allowing demographic and genetic interchange among populations. The Jackson herd has remained well below its population objective but has been stable. The 2023 trend count was low due to mild winter conditions, which caused moose to disperse into side drainages and forested areas, making them difficult to locate. Despite overall low numbers, calf-to-cow ratios have steadily increased in recent years (WGFD 2023e). The Sublette herd has remained just below its population objective but stable. While spring mortalities have occurred within the herd, the causes and significance of these deaths are not yet well understood (WGFD 2023g).

Mule deer and elk thrive in all ecosystems on the Bridger-Teton, from low altitude shrublands to alpine areas. Mule deer are particularly associated with sagebrush steppe for winter and transitional range habitat. Mule deer are primarily browsers, with much of their diet comprised of forbs and the leaves and twigs of woody shrubs. Instead of eating large quantities of low-quality feed like grass, mule deer must select the most nutritious parts of plants. Because of this, mule deer have more specific forage requirements than larger ruminants like cattle and elk. Elk have one of the most variable diets of any big game species. While grass, forbs, and woody browse are all consumed by elk, grass species seem to be preferred where they are available. Pronghorn antelopes are commonly associated with grasslands and sagebrush communities. Moose use a variety of forest types where cover and browse are present, requiring thermal cover in summer because they are particularly vulnerable to heat stress. Moose may use clearcuts, recently burned areas, or other areas where forest canopy has been disrupted or removed, and shrub species used for forage are abundant. Mature conifer or aspen forest habitat types may be important, however, in providing forage and both thermal and hiding cover.

KECs for mule deer, elk, pronghorn antelope and moose include disturbance regimes within the NRV, which maintain shrubs and other vegetation types in healthy, vigorous conditions within appropriate succession classes; unimpaired traditional migration corridors between seasonal ranges; areas free from human disturbance; and adequate amounts of healthy undisturbed winter range. The current status of the integrity of terrestrial ecosystems are described under the Terrestrial Ecosystems section.

Factors that impact or limit mule deer, elk, pronghorn antelope, and moose populations include the following described below.

1. Long-term declines in productivity and nutritional quality of many summer and winter ranges.
2. Altered fire intervals, invasive plants, and competition with other ungulates (both wild and domestic).
3. Habitats converted and fragmented by: expanding human populations, increasing recreational activity, mineral and energy development, invasive plant species, and other intensive uses of the land.
4. Climatic extremes, such as drought and severe winters, impact quality and quantity of habitat and lower recruitment.
5. Diseases, such as chronic wasting disease (CWD), which may cause significant substantial mortality in mule deer and elk and *Mycoplasma.bovis*, which could cause significant localized mortalities in pronghorn antelope (WGFD no date). Cervids (mule deer, white-tailed deer, elk, and moose) and pronghorn are all susceptible to adenovirus hemorrhagic disease (AHD); however, mule deer appear to be more severely affected (WGFD no DateA).
6. Off-highway vehicles, including ATVs and snowmobiles, which can displace mule deer, elk, and pronghorn antelope from preferred habitats, increase stress, and cause increased energy expenditure.
7. Vehicle-wildlife collision which have been occurring at an average of more than 7,600 cases per year in Wyoming, leading to wildlife losses.

In 2008, the Bridger-Teton officially designated “the Path of the Pronghorn” to conserve the pronghorn antelope that summer in Jackson Hole and annually migrate between there and wintering areas in the Green River Basin. Documented round trip migration distances from 175 to 330 miles make this the longest known terrestrial animal migration in the 48 contiguous states.

Geologic Resources and Hazards

This chapter describes and evaluates geologic resources and hazards on the Bridger-Teton. Information used to conduct the assessment includes public documents and data produced by: Federal and State agencies, internal USFS documents and studies, peer-reviewed scientific literature, company profile websites, U.S. Geologic Survey Maps, Federal regulations, USFS manual direction, and personal communication with professionals considered to be knowledgeable in their respective fields.

Geologic Resources

This section discusses two congressionally recognized geologic resources (caves and paleontological resources) as well as glaciers, a geologic resource per USFS direction.

Key Takeaways

The Bridger-Teton contains significant caves, the potential for scientifically important paleontological resources, and glaciers that are substantial in the context of the Lower-48 states. The most important local issues regarding these are: limited USFS inventory and knowledge to inform management actions; recharge area protection for karst aquifers (See

Water Resources Management section); potential for management actions or public users to impact significant caves; possible loss of paleontological resources due to ground disturbance; and cascading effects of glacial retreat on Bridger-Teton resources.

The Forest Plan provides no management guidance for caves, paleontological resources, or glaciers. Ongoing resource inventory and limited management actions are guided by Federal law, regulation and USFS-wide policy.

There is opportunity for continued inventory of geological resources per these general USFS directives. There is also opportunity for a revised land management plan to recognize the presence of geological resources and include a list of best management practices and/or standard permit conditions to be considered while planning management actions.

Introduction

Congress has required Federal land management agencies to consider and protect significant caves and scientifically important paleontological resources. USFS direction outlines inventory of geologic resources, any geologic feature or area that has important scientific value or that is significant to natural resource management, such as glaciers. The Bridger-Teton contains a substantial amount of alpine karst landscapes with varying degrees of cave development, sedimentary bedrock with high potential to host paleontological resources, and two of the larger glaciers in the lower-48 states.

Caves are a feature of karst landscapes and they can contain sensitive resources, be ecological niches, provide important scientific information and be recreation sites for cavers. Most caves are found in limestone bedrock, especially that of Paleozoic age, which outcrops throughout the Bridger-Teton. Caves on the Bridger-Teton tend to be: cold, wet (flowing water at least seasonally), vertically oriented, lacking showy formations such as stalactites, and have limited bat populations.

Beyond caves, the Bridger-Teton’s karst landscapes are ecologically, aesthetically, and even socioeconomically important (See also Water Resources Management Section). For example, Periodic Spring is a karst groundwater feature that provides municipal water to the Town of Afton, Wyoming.

A thick section of sedimentary rock covering ages from Cambrian through Quaternary outcrops across much of the Bridger-Teton, including formations known to contain scientifically important fossils at other locations (e.g., Morrison Formation at Dinosaur National Monument).



Figure 22. Caver at lower right mapping a designated significant cave on the Bridger-Teton

Status and Trends

A handful of caves in the area have been widely known for decades and new caves have been regularly mapped since the beginning of USFS inventory work in 2018. During cave mapping, baseline information, such as presence of bats and evidence of public use, is recorded. To date, not enough information has been gathered to assess trends in cave condition over time.

Caves are not considered in the forest plan, but they are managed according to the 1988 Federal Cave Resources Protection Act, 36 CFR 290 and USFS-wide directives. Current land management actions on the Bridger-Teton are not known to negatively impact caves. The level of recreational use appears to be low and the trend stable, but these are not well understood. There does appear to be regular recreational use of several well-known and easier-to-access caves. There is also periodic concerted cave exploration by avid caving organizations (over the last 5 years and previously in the 1990s). The Bridger-Teton staff do not intensively manage cavers due to the low use level and lack of known impacts (i.e., caves are not gated and permits are not required). However, the Bridger-Teton staff do coordinate mapping efforts with organized cavers, both informally and through agreements.

One of the more important concerns regarding karst (a landscape generally underlain by limestone with features and landforms resulting from dissolution) is the relatively short residence time of groundwater from infiltration at the surface to discharge at a spring or well (i.e., less water purification). As a result, surface management activities in the recharge area of a karst aquifer have an increased likelihood of impacting down-gradient groundwater quality. Additionally, surface management activities within karst can be susceptible to, or aggravate, karst collapse (i.e. sinkholes), The current forest plan does not consider karst beyond its aesthetic importance to National Natural Landmarks, Wilderness and Wild and Scenic River designations. The Forest Plan does, however, outline management areas for protection of municipal watersheds, at least one of which is a karst spring. It is not known if these boundaries were drawn in consideration of the differences between surface water and groundwater flow paths.

Although there is high potential for paleontological resources on the Bridger-Teton, little paleontological research has been done and only one locally prolific Cretaceous age geologic formation has been identified. The Bridger-Teton has approved a handful of paleontological research permits since 2016. The land management plan provides no guidance on paleontological resources. Management is instead informed by the Paleontological Resources Preservation Act, 36 CFR 291 and general USFS policy.

The Bridger-Teton contains 15 glaciers; mostly located in the Wind River Range. They have been retreating since the industrial revolution, consistent with the trend of mountain glaciers worldwide, and may disappear or turn into rock glaciers because of human-caused warming. The future of these glaciers has an important nexus with other resources on the Bridger-Teton (See Alpine Ecosystem, Air Quality, and Cultural Resource sections).



Figure 23. Wildfire smoke encroaching on Sourdough Glacier and 13,114' Klondike Peak (August 21, 2021)

Geologic Hazards

Geologic hazards are geologic processes or conditions, either naturally occurring or altered by humans, that are a potential danger to public health and safety, infrastructure, and resources.

Key Takeaways

Geologic hazards are a part of the local ecosystem and affect social and economic sustainability to a moderate degree on the Bridger-Teton.

Landslides and other mass slope movements, including avalanches, are the primary hazards (WSGS 2025). Landslides commonly impact forest road infrastructure and public access. The impacts can be substantial at individual locations over a timeframe of months with less severe effects continuing for years. For example, the Porcupine Landslide totally blocked access along the Greys River Road and temporarily impounded the Greys River in 2018 and it continues to creep today (Lincoln County 2019). Avalanches impact state highways traversing the Bridger-Teton throughout the winter and take the lives of backcountry recreationists almost every year. They have minimal serious impact on USFS roads and other infrastructure. Another widespread hazard is expansive soil, which can exacerbate landslides and has detrimental impacts on infrastructure (WSGS 2025).

The current plan broadly addresses landslides, saying that earth moving and logging on potentially unstable slopes needs special design consideration and/or may be off-limits. This sort of slope stability analysis is not always implemented in practice. Avalanche hazard is briefly considered in the plan, which notes that known hazard zones should be avoided for infrastructure and winter trail siting. Although not spoken to in the plan, the general public is well informed of avalanche hazards by the Bridger-Teton Avalanche Center’s daily winter forecasts. The current plan does not directly address expansive soil as a geologic hazard, although it does speak to soil extensively and contains guidelines relevant to expansive soil. There is potential to directly address the expansive soil hazard in the new plan.

Introduction

Geologic hazards that occur on the Bridger-Teton are directly related to the climate, geology, soil type, geomorphology, and topography. Mass movements of rock, soil and snow on unstable or steep slopes are the geologic hazards that most frequently occur in the region. Although most mass wasting events occur in remote areas, there have been recent examples where an increased risk of flash flooding, impacts to public access, and infrastructure security have occurred. Some of these geologic instabilities are small scale features, affecting less than 100 cubic yards, but others are large scale affecting thousands of cubic yards of material. Mass wasting and snow avalanches are best mitigated by keeping infrastructure and Bridger-Teton visitors away from steep cliffs, known areas of slope failure and avalanche paths.

Snow avalanches are the downward movement of snow due to the instability of the snowpack. They occur most frequently on slopes between 30º and 45º. Avalanches can quickly reach speeds up to 100 mph. They vary in destructive power from harmless to large enough to destroy mature forests or flatten municipalities. Avalanche types are used to classify avalanches based on physical, objective, and easily observable characteristics. Earthquakes are known to trigger avalanches, but the most common mechanism is an increase in weight of the snowpack, due to accumulation of snow or rain from storms, and human activities such as: snowmobiling, snowboarding, skiing, or snowshoeing. The additional weight causes the instability of the snowpack along a weak snow layer. Every year human activity triggers snow avalanches on the Bridger-Teton and some incidences have resulted in fatalities.

Landslides are a type of mass wasting process of downslope movement of soil and/or rock by gravity that occur on natural and engineered slopes. The movement of earth includes: flowing, sliding, toppling, falling, or spreading, and many exhibit a combination of different types of movements at the same time or during the lifetime of the landslide (Cruden and Varnes 1996, Hungr et al. 2013, Petley 2012). Natural slopes throughout northwest Wyoming are extensively mantled by landslide deposits that widely range both in genesis and age (See Figure 24). In this region, landslides occur so frequently that they affect engineering developments and land use (Bailey 1971). Landslides are likely to occur in areas near where they have occurred in the past or as reactivation of older mass wasting. In many cases, the landscape features provide evidence of past and ongoing landslide activity. The most significant factors that contribute to landslide activation or reactivation are steepness of the original slope angle, weak soil and/or geologic material, undercutting of the toe of the slope by erosion or excavation, and saturation of the slope (Jones et al. 1961; Highland and Bobrowsky, 2008).

Expansive soils—those that swell when wetted and shrink when dried—can also exacerbate slope instability and have a detrimental impact on roads, building foundations, and other infrastructure. On its online Wyoming Geologic Hazards Map, the Wyoming State Geological Survey has mapped geologic units considered to be regionally susceptible to expansive soil formation throughout the BTNF. These geologic units, primarily Cretaceous age shales, are prevalent in the Wyoming Range, Greys River Valley, and Gros Ventre River Valley.

Status and Trends

Various factors influence the stability of slopes and cause landslides and other mass movements, including: precipitation, snow melting, temperature change, earthquake shaking, volcanic activity, bedrock characteristics, slope angle, slope undercutting and various human actions (Gariano and Guzzetti 2016). The Bridger-Teton has multiple geologic units and geographic regions that are prone to landslides. The Wyoming State Geologic Survey

delineates 483,688 acres (approximately 14 percent of the land surface) of inactive or active landslide within the administrative boundary of the Bridger-Teton (See Landslide Map of the Bridger-Teton National Forest) and has further described and mapped landslide susceptibility across the forest (Wittke and Staford, 2019). Landslide prone areas on the forest commonly contain weakly cemented, easily weathered, and/or poorly drained clay-rich plastic strata (claystone and shale) where the bedding planes dip steeply with the slope. When poorly drained subsurface soil horizons or geologic units are overlayed by porous material, formation of water saturated zone between the layers can cause slope failure and earthflow (Highland and Bobowski, 2008). Geographic regions that have glacially steepened valley sides and slopes undercut by stream erosion with joints or bedding planes dipping valleyward are the most favorable combinations for the release of rock and soil debris. Vertical or overhanging cliffs and very steep rock walls with blocks or plates loosened by weathering also periodically drop away under the influence of gravity. Soil that has developed on slopes between 34 and 46 degrees often approach or exceed the angle of internal friction of natural soil materials. The balance between slope stability and failure is critical on these slopes (Bailey 1971).

Climate variations influence some of the conditions leading to mass wasting events; for example, during a wet spring the moisture from snowmelt and spring rains can initiate landslides and rockfalls (Bailey 1971). The Porcupine Landslide along the Greys River was triggered in February 2018 by a warm precipitation event coupled with an earthquake. There is high confidence that changes in heat waves, glacial retreat, and/or permafrost degradation will affect slope instabilities in high mountains, and medium confidence that temperature-related changes will influence bedrock stability (Parry et al. 2007). The surface soil can migrate under the influence of cycles of freezing and thawing, or hot and cold temperatures, inching its way toward the bottom of the slope (Jones et al. 1961). The presence of vegetation can increase slope stability by stabilizing shallow soils, delay water infiltration and remove pressure from shallow groundwater (Bailey 1971). Climate-driven changes in forest health, vegetative cover, and species composition (and associated root strength and surface roughness) can cause hillslopes to rapidly unravel, exhibiting accelerated rates of surface erosion and mass wasting (Halofsky, et al. 2018). In addition, areas where vegetation has been removed or killed by recent fires are typically more prone to landslides and debris flows (Bailey 1971, USGS 2018).

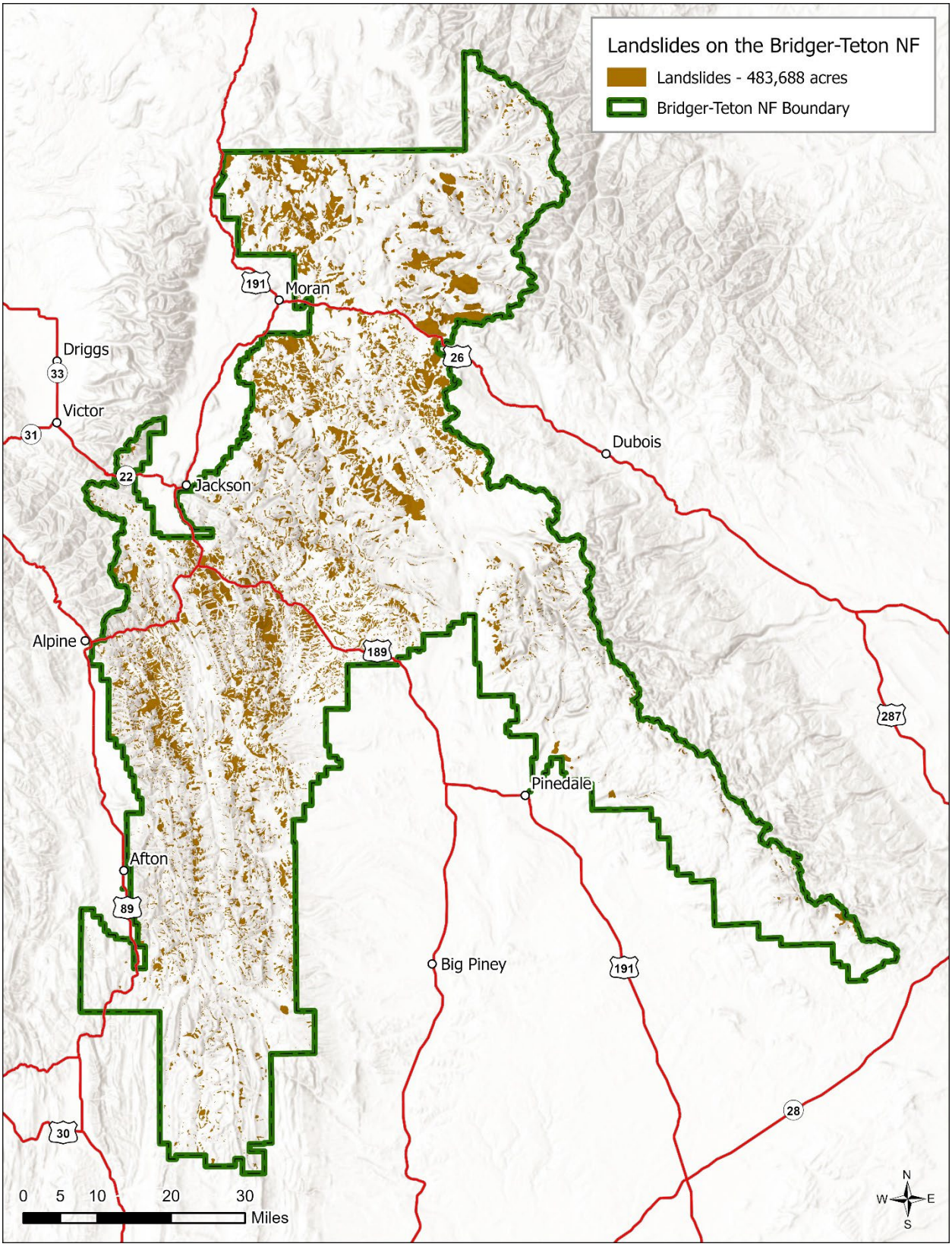


Figure 24. Landslides within the Bridger-Teton
Source: Wyoming State Geological Survey.

Current Management Actions

Advancement in remote sensing technology has made it easier to highlight areas vulnerable to slope instability, though we still cannot predict when a landslide will occur. Slope failure only lacks a trigger. That triggering force can be many things, including removal of vegetation, excavation for roads, and increased moisture. The Forest Plan states that a geotechnical evaluation or slope-stability assessment will be conducted prior to earth moving activities and manipulation of vegetation on marginally stable, unstable, and landslide areas. These guidelines need to be more consistently applied to future projects in areas of slope instability. Mapping identifying high risk areas for both landslides and expansive soils can be updated and improved to facilitate this.

Carbon Stocks and Pools

Introduction

Over the course of the last century, increasing GHG emissions produced from industry and other human activities have led to warmer temperatures and more variable climate conditions (IPCC 2023). The bulk of these emissions occur in the form of CO_2, methane, and other GHGs. Forests can play an important role in mitigating the impacts of climate change because trees have the potential to store large amounts in their trunks, leaves, and roots. Forests in the United States are currently sequestering more carbon than they are emitting, making them a key influence on the carbon cycle at the national scale (Pan et al. 2011a).

Atmospheric CO_2 is a critical requirement for photosynthesis, the process in which plants synthesize water, sunlight, and CO_2 to produce food and energy needed to grow and reproduce. During photosynthesis, plants convert carbon from the atmosphere to biomass where it can be stored within the ecosystem for periods spanning weeks/months (e.g. deciduous leaves) to centuries (e.g. tree stems) depending on how carbon is allocated during plant growth. This process is an important control that regulates the transfer, or flux, of CO_2 to the atmosphere and it can help mitigate climate change effects. The status of forest carbon stocks and storage is typically described by an interconnected network of carbon stocks or pools. These pools include living and dead trees, below ground sources like roots and soil, and carbon in the atmosphere.

Forests are dynamic systems and the carbon balance can shift depending on disturbance frequency and intensity, human influences, and other changing conditions. The movement or transfer of carbon from one carbon pool to another is referred to as the flux (USDA Forest Service 2023l). Carbon fluxes can vary in magnitude and carbon pools are generally described as carbon sinks or sources depending on the flux. A carbon source, indicates more carbon is being emitted to the atmosphere from an ecosystem than is being created through vegetation productivity. A carbon sink is the inverse of source and it indicates the rate of carbon sequestration exceeds the rates of carbon emission. A carbon sink can fluctuate or transition to a source when carbon is emitted back into the atmosphere via decomposition, decreased net primary productivity, or disturbance.

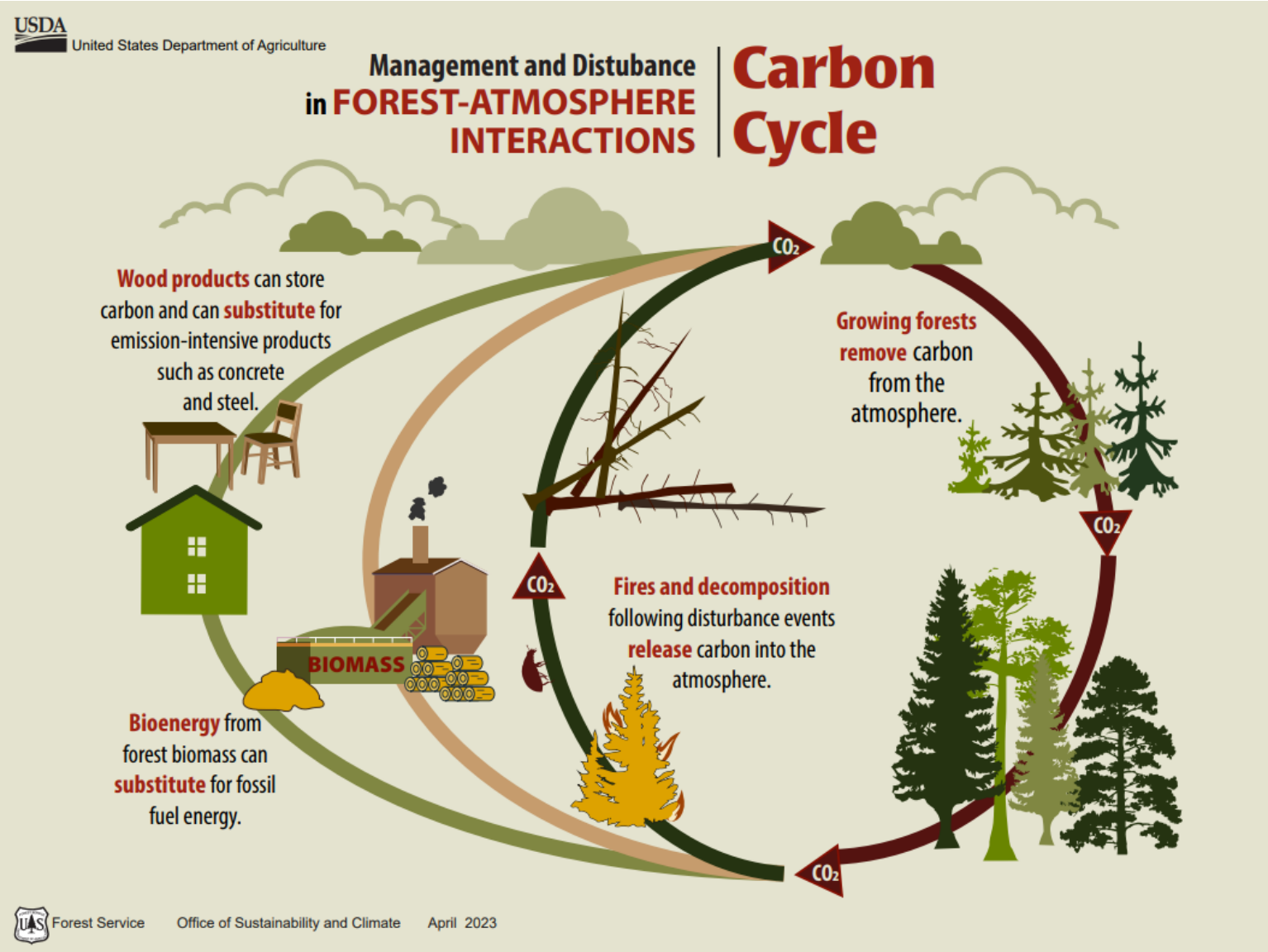


Figure 25. A schematic diagram of the carbon cycle. The carbon flux from one carbon pool to another is depicted by the arrows (USDA Forest Service 2023x).

Assessing forest carbon stocks helps scientists and land managers determine the current amount of carbon stored; the Bridger-Teton's status as a potential carbon source or sink; and important drivers influencing the carbon balance. Insects and disease, fire, harvest, and climate are all issues that can negatively impact the balance of a forest. Understanding the carbon dynamics of a forest, and the disturbances that may threaten it, can inform decision-making to best manage forests and the ecosystem service of carbon storage they provide.

Discussion of Bridger-Teton carbon in this assessment refers to a report (i.e. carbon whitepaper) that assesses historical status and trends of carbon drivers and stocks in the Bridger-Teton as well as regional projections of possible future carbon dynamics (See Appendix F) (USDA 2024). According to the most recent data from 2023, forest carbon stocks in the Bridger-Teton remained stable over the past two decades, suggesting that the Bridger-Teton may be a modest carbon sink. Most forest carbon is stored in the soil, aboveground biomass, and forest floor, each storing around a quarter of the total and totaling approximately 75 percent of total carbon storage (See Appendix F).

Status and Trends

Disturbances that Impact the Stocks

There are many factors that can influence the status of a forest as a carbon source or sink. Historical climate, disturbance regimes, and land management practices have driven the current distribution and composition of forest types on the Bridger-Teton. The legacy of land use on the Bridger-Teton includes: logging, agriculture, mining, and wildfire suppression. In the Bridger-Teton and the western United States more broadly, fire exclusion and subsequently large wildfires have affected current forest conditions and structure. Similarly, insect disturbances also have been a significant factor on the forest carbon stocks, particularly in recent decades (See Appendix F).

Factors that may increase carbon sequestration in the Bridger-Teton include long growing seasons in cooler, higher elevation forests. However, warmer temperatures could increase drought vulnerability in drier, water-limited ecosystems. Continued regeneration of younger tree age classes with higher productivity rates following disturbance also may provide some increase in total carbon accumulation across the Bridger-Teton.

While deforestation is the leading threat to forests worldwide (Pan et al. 2011a), insects, followed closely by fire, are responsible for the largest forest carbon reductions in the Bridger-Teton, (See Appendix F). Insect outbreaks in the Bridger-Teton have affected the largest extent of forested area of all disturbance types, with slightly under 20 percent of the Bridger-Teton experiencing insect damage over the past two decades (See Appendix F). Because insects can result in swift, immediate mortality of a forest, the carbon shifts can occur relatively quickly. However, it is important to note that dead trees on the landscape can still continue to store carbon on the landscape for years following disturbance events.

Fires are another disturbance type that can quickly impact the balance of the Bridger-Teton. For example, the fires in 1988 burned over 1.2 million acres in the GYE, which released a large amount of forest carbon to the atmosphere over a short period. Currently, less than 3 percent of the Bridger-Teton has been impacted by fire in the recent decade. Fires are not a leading cause of carbon loss, but it is important to continue to evaluate the threat of fire on the landscape, given fires have been growing in intensity in the American West in recent years (Iglesias et al.

2022). Additionally, fire suppression across the west has led to dense stands and high fuel loads in many forest ecosystems, further increasing fire risk and potential shifts in carbon from forests to the atmosphere in the future (Halofsky et al. 2018).

When timber is harvested, carbon from the resulting wood products is not simply released into the atmosphere. The wood products store carbon for their lifetime, more effectively than alternative construction materials like steel or concrete. In the Intermountain West, the 1940s through the 1970s were the peak harvesting period. In 2013, harvested wood products represented less than 1 percent of the total forest storage for the USFS Intermountain Region. Timber harvests on the Bridger-Teton have been small and infrequent, and they do not greatly impact the balance of Bridger-Teton. Timber harvesting was more prevalent from the 1940s to the 1970s, but it has since declined in frequency. In recent history, timber harvesting disturbed less than 0.21 percent of the Bridger-Teton (See Appendix F).

Current research indicates that younger trees actively store carbon at a greater rate than older trees. Forests are most productive at a younger age and productivity generally plateaus as trees age. Most of the Bridger-Teton is middle aged; however, there appears to be a strong layer of regeneration, likely due to regrowth following disturbance like fire. As these younger age classes grow, they will positively contribute to the overall balance for Bridger-Teton.

Rangelands

Rangelands are also an important component of the ecosystem carbon in the Bridger-Teton. Like forests, rangelands also can be carbon sinks, but a vast majority of carbon is stored in the soil. Much smaller amounts of carbon are stored in aboveground biomass pools and roots relative to carbon stocks in forests. Soils in rangelands can retain stocks for long periods of time if soils are stable and organic matter continues to accumulate in the system through growth and decomposition of rangeland vegetation. Drought and variable temperatures due to climate change may impact the potential storage of these rangelands. Invasive species, like cheatgrass, also can alter the composition, microbial processes, and balance of a rangeland.

Fens

Mountain fens are vital ecosystems for: habitat, biodiversity, water and carbon cycling, but there is little comprehensive information on their distribution, abundance or condition in any region of the western U.S. (Chimner et al. 2010). In the southern Rocky Mountains of the United States, all peatlands are classified as fens, supported by groundwater input and not solely by direct precipitation (Cooper and Andrus 1994). The Bridger-Teton contains a rich resource of fen wetlands (Smith and Lemley 2018). Smith and Lemley (2018) mapped 9,503 potential fens covering nearly 14,000 acres. Fen distribution was analyzed by elevation, surficial geology, and watershed. The vast majority of mapped potential fens occurred between 8,000 to 11,000 feet. This elevation range contained 89 percent of all potential fen locations and 94 percent of likely fen locations. Four watersheds in particular have very high numbers of likely fens. North Fork of Silver Creek had 302 likely fens, Upper Boulder Creek had 290 likely fens, Upper Pole Creek had 231 likely fens, and Washakie Creek-East Fork River had 208 likely fens. The Bridger-Teton is methodically field verifying fen distribution based on this guidance document.

Future Forest Conditions

Climate change has the potential to greatly impact forest carbon stocks and dynamics (Vose et al. 2018). Models indicate that increased CO_2 concentrations may provide a fertilization effect

leading to increased forest productivity, but the effect diminishes over time and it may be offset by other factors like drought (Zhu et al. 2016). Furthermore, warmer temperatures may favor the growth of some tree species, while reducing the growth of others. Growing season length may increase with future warming potentially increasing vegetation growth in areas where water is not limited. However, the effects of increasing drought, wildfire, and precipitation variability may exceed any potential benefits associated with climate change. Warmer temperatures also could make conditions more favorable for insects and make it more difficult for species to regenerate following disturbance events leading to shifts in species composition and future carbon sequestration capabilities (Davis et al., 2023).

Chapter 3. Assessment Findings: Socioeconomic Elements and Multiple Uses

This chapter presents the social elements, economic considerations, and multiple uses for the Bridger-Teton. Each section contains key takeaways and a summary that provides background information and context, followed by a more detailed discussion of the existing conditions and status and trends, which includes descriptions of key interactions and system drivers and stressors. This information provides the context necessary to understand the existing conditions and current management framework.

Social and Economic Conditions

Key Takeaways

- There are five counties within the Bridger-Teton. While these counties are directly influenced by forest management, adjacent counties and Wyoming's economy are indirectly influenced, largely through recreation and tourism activity. Within the five-county area, the population has grown 43 percent since 1990, primarily through in-migration with growth projected to continue increasing.
- Communities have deep connections to the Forest associated with the following: ancestral tribal practices, multi-generational livelihoods, gathering activities (firewood, hunting, fishing, and berries), recreation, health, and spiritual values. Key ecosystem services and benefits received from the Forest include: diverse recreation opportunities, wildlife and fish habitat, forest and plant products, forage for livestock, healthy watersheds, and support for human health, learning, and art.
- Bridger-Teton programs directly accounted for 2.3% of the total jobs and $116M in labor income in 2019. For these jobs, the distribution is as follows: recreation activity generates the most jobs at 56 percent, agency operations contribute 18 percent, livestock grazing and mineral extraction contribute 11 percent each, USFS payments to the state and counties contribute 3 percent, and forest products contribute 1 percent. Within the three counties with large acres of Bridger-Teton land, construction activity dominates the labor sector and real estate is a notable contributor within the service sector. The importance of both real estate and construction sectors underscore the value of public lands in supporting amenity-rich lifestyles that typically draw new residents to the area, generating economic activity. Despite the minor influence on local economy, the forest products industry is crucial to continue active management, achieve forest management objectives, and provide forest products.
- The region encompassing and surrounding the Bridger-Teton is undergoing significant transformation socially and economically. This is especially true of Sublette and Lincoln Counties, which have endured economic boom and bust cycles since the 1980s associated with energy and timber markets. Many counties are moving from a commodity-driven economy (producing raw materials for production and trade) to an amenity-driven economy (providing services). As economies diversify, access to forest and rangeland products will continue to be important along with the availability of forest land for water, sites for

communication infrastructure, and opportunities for a wide diversity of guided and non-guided recreation.

Overview

The 2012 planning rule for National Forest land management planning recognizes that ecological, social, and economic systems are interdependent and, thus, all three systems must be considered in planning for a sustainable future. While no one system has priority over another, the planning rule recognizes that national forest management cannot ensure social and economic sustainability, only influence it. This is because many social and economic factors are outside the control and authority of the Bridger-Teton. For this reason, the planning rule requires that plan components contribute to social and economic sustainability rather than guarantee it. An assessment is required covering topics such as: existing social, cultural, and economic conditions and trends, benefits people obtain from the National Forest (ecosystem services), and the contribution of multiple uses on the Bridger-Teton to local, regional, and national economies (36 CFR 219.10).

To prepare the Assessment, Bridger-Teton staff worked with an independent contractor to describe existing socioeconomic conditions and trends; describe the connection between the Bridger-Teton and local economies; and identify preliminary ecosystem services and benefits provided by USFS lands and resources. Complete results, methods, and data source references are contained in a 2022 Socioeconomic Baseline Report for the Bridger-Teton National Forest, available in the project record. This report was bolstered by county-level data from the Economic Profile System maintained by Headwaters Economics (https://headwaterseconomics.org/apps/economic-profile-system/) as well as data from the Wyoming Economic Analysis Division, and a dashboard of economic information compiled by the USFS (Forest Level Economic Contributions Dashboard – 2019 | US Forest Service (usda.gov). To gain insight to people's connection with the Bridger-Teton, information from engagement efforts was compiled and some interviews were held with individuals representing diverse interests. These efforts were supplemented by a statistically valid survey of residents within the five counties encompassing the Bridger-Teton. In addition, an online survey was conducted that focused on recreationists. (Final reports from both surveys are available in the project record.)

Socioeconomic Area of Influence

The primary area of influence for the socioeconomic assessment is where forest management substantially affects social, cultural, and economic conditions. Biological and administrative designations (for example, watersheds or state boundaries) do not necessarily correspond with socially and economically meaningful units. Typically, counties are the primary scale for the social and economic analysis. For the Bridger-Teton, this includes the five counties within the boundaries of the Bridger-Teton (Lincoln, Sublette, Teton, Fremont and Park Counties). Adjacent counties indirectly influence the Bridger-Teton, typically through recreation or obtaining forest products like firewood or Christmas trees (e.g. Sweetwater and Unita counties in Wyoming, Teton and Bonneville counties in Idaho) with the forest attracting recreation use from a much larger region. The socio-economic area of influence includes recognition that tribal nations were the first people of these lands and they hold treaty rights not only on nearby reservations (Fort Hall and Wind River), but also on ceded lands that encompass the entire Bridger-Teton and beyond. Additional information about the five counties encompassing the Bridger-Teton follows.

Lincoln County

Lincoln County forms the western portion of the Forest containing the mountain ranges of the overthrust belt, high desert lands, and prominent river corridors such as the Greys and Hams Fork. Approximately 32% of the county lies within the Bridger-Teton National Forest. Overall, 73.3% of the county is federal land, most of which is managed by the BLM. The county extends 110 miles north to south with the county seat Kemmerer at the south end, Afton in the center, and Alpine at the north end with many other small communities such as Cokeville, Thayne, and Star Valley Ranch. The environmental contrast, between an agricultural, partly forested north and a mostly treeless, industrial south, makes Lincoln County one of the most diverse in the state. Five county-wide plans contain relevant information as updated forest plan direction is developed. These plans include the Comprehensive Plan (2006 and 2021), the Natural Resource Management Plan (2021), the Lincoln County and Star Valley Conservation District Long-Range Plans (2021 and 2022), and the Community Wildfire Protection Plan (2015). The goal for public lands within the Comprehensive Plan states that the County will "actively participate in all public land management decision-making processes and anticipates federal agency participation in county planning efforts and activities". In particular, the county expects to coordinate efforts on wildlife, grazing, access, economic, social, and cultural issues to "promote and support public land uses consistent with the orderly development and efficient use of renewable and non-renewable resources". The Natural Resource Management Plan and other county plans contain specific policies covering the full breath of topics covered in this assessment.

Economically, the county was historically rooted in mining and ranching, notably coal mining in the Kemmerer area and dairy/cheese production in the Afton area. Today, construction, retail trade, real estate and government jobs dominate the labor market, but mining and ranching jobs are still important components (US BEA 2023). With the decline in coal mining, the county has faced economic hardship over the past few decades. However, the arrival of a natrium power reactor in Kemmerer and tremendous growth in Alpine as people working in Teton County seek more affordable housing, indicate a changing economy that may see a revival of the energy market and more emphasis on recreation opportunities. Socially, many families are oriented around the Latter-Day Saints church. Multi-generational families maintain strong connections with the land tied to ranching, logging, dairy/cheese production, gathering firewood, hunting and fishing. The 2023 social survey found that residents' preferences for the future of the Bridger-Teton were comparable with residents of Sublette County but differed from residents in Teton, Park, and Fremont counties. Residents identified recreation as the top value attributed to the Forest and expressing higher levels of support for off-road vehicle use, snowmobiling, commercial wood products, grazing, and utilities than other counties. Residents also express less support for special protections such as wilderness, wild and scenic rivers, expanded winter wildlife habitat, and watershed protection than other counties (Western 2024).

Sublette County

Sublette County forms the eastern portion of the Forest and is ringed by the Wind River Mountains to the east, the Wyoming Range to the west, and the Green River Basin and Gros Ventre Wilderness to the north. The central portion of the county is dominated by sagebrush-steppe. Approximately 37% of the county lies within the Bridger-Teton National Forest. Overall, 76.7% of the county is federal land, most of which is managed by the BLM. Geographically isolated from railroads and population centers, the county retained its frontier culture for longer than many areas of Wyoming and the West, and it remained one of the least densely populated

areas in the state well into the 20th century. It is still the least populated of the five counties within the Forest but is growing rapidly. The county contains three incorporated towns – the county seat of Pinedale, Big Piney, and Marbleton. Smaller communities include Boulder, Bondurant, Cora, and Daniel. Historically, Sublette County is known for its important role during the fur trade era of the early 1800s with six rendezvous held near the confluence of the Green River and Horse Creek. Five county-wide plans contain relevant information as updated forest plan direction is developed. These plans include the Comprehensive Plan (2005), the Federal and State Land Use Policies (2006), the Sublette County Conservation District Long Range Plan (2019) and Conservation District Public Land Use Policies (2008), and the Community Wildfire Protection Plan (2022). The Comprehensive Plan outlines a vision for the county centered around preserving the local culture, economic freedom, and environment. Six goals are outlined for federal and State public lands: (1) maintain open communication and cooperative relationships with agencies, (2) encourage/support the management of lands and resources under a multi-use policy, (3) encourage/ support the development of renewable and non-renewable resources in an orderly manner, (4) ensure County economic, social and cultural interests and values are adequately and appropriately considered, (5) balance/consider the conservation and enhancement of natural resources with the economic benefit of resource development, and (6) encourage agencies to recognize the important benefits of recreational uses to local economies and encourage recreational enterprise. Other County and Conservation District plans provide more specific goals and policies covering all topics covered in this assessment.

Economically, cattle ranching has been the main industry with a boom in oil and natural gas drilling emerging in the 1990s. Today, construction, oil and gas, and ranching dominate the non-service sector of the labor market while retail, real estate, and lodging/food service dominate the service sector (US BEA 2023). Socially, many residents take pride in their pioneer heritage and have strong connections to the land tied to ranching, hunting, fishing, gathering firewood, and recreation. In the 2023 social survey, Sublette County residents also identified recreation as the top value attributed to the Forest, expressing more intense support for this value than residents in any other county. Like Lincoln County, residents of Sublette County expressed higher levels of support for off-road vehicle use and snowmobiling than other counties with levels of support for other recreation activities, grazing, commercial wood products, and conservation protections similar to Fremont and Park counties (Western 2024).

Teton County

Teton County forms the northern portion of the Forest surrounding Jackson Hole encompassing part of the Teton Range, the Snake River Range, the Gros Ventre and Teton Wildernesses, and the Snake River headwaters. Approximately 43% of the county lies within the Bridger-Teton National Forest. Overall, 97% of the county is federal land, 53.4% of which is managed by the Forest Service including some of the Caribou-Targhee and Shoshone National Forests. Unlike the other counties, National Park Service lands make up 42.42% of the federal lands with very little acreage managed by the BLM. Jackson is the county seat. Smaller communities include Wilson, Alta, Kelly, Moran, and Hoback. Teton County differs considerably from the other four counties socially and economically. Due to its rugged terrain and remoteness, it was largely unsettled until 1900 and did not experience the degree of fur trapping, logging or mining that occurred elsewhere. Cattle ranching occurred on the east side of the Snake River but tourism has been part of the county's economy from the beginning, mostly associated with guided elk hunts. Conservation has a long history in the County with landmark protections such as

Yellowstone National Park in 1872, the start of the National Forest System in 1891, and the National Elk Refuge in 1912. Rapid population growth began in 1970 spurred by the area's scenery, recreation opportunities, wildlife, ski resort development, and lack of a state income tax.

Five county-wide plans provide particularly relevant information as updated forest plan direction is developed with two of the plans relevant to the larger region. These plans include the Comprehensive Plan (2020), the Teton County Conservation District Long Range Plan (2021), the Community Wildfire Protection Plan (2024), the Teton Region Housing Needs Assessment (WSW Consulting 2022) and the Sustainable Destination Management Plan (JHTTB 2023). The County's vision is to "preserve and protect the area's ecosystem in order to ensure a healthy environment, community and economy for current and future generations" with goals around three core values: ecosystem stewardship, growth management, and quality of life. Unique to Teton County are two plans that cover the broader region and address the challenges associated with growth – housing and visitation that are particularly relevant to sustaining the workforce and recreation management on the Bridger-Teton National Forest.

Today, Teton County is considered the wealthiest county in the nation, largely due to investment income (Thuermer 2024). In 2022, travel-related spending in Teton county contributed $1.65 billion dollars to the economy and generated nearly $50 million in local taxes (Dean Runyan Associates 2023). Not surprisingly, construction jobs dominate the non-service sector of the labor market while lodging/food services, finance and real estate dominate the service sector. Retail trade and professional services are also important components (US BEA 2023). Population growth and wealth has created social challenges that many resort communities face – inequality, unaffordable housing, and traffic congestion. Of particular note, job growth has exceeded population growth with workers commuting from Teton Valley Idaho and Star Valley Wyoming (Headwaters EPS 2024). In the 2023 social survey, residents identified biological diversity as the top value attributed to the Forest with recreation second. Residents also expressed lower levels of support for motorized recreation activities, lower levels of support for commercial uses, and higher levels of support for special land protections compared to the other counties (Western 2024).

Fremont County

Fremont County includes two small portions of the Forest – one at the southern end of the Wind River Range and one in the Mount Leidy Highlands. The Wind River valley forms the heart of the county with the Wind River Range to the west and Owl Mountains to the north. Approximately 2.3% of the county lies within the Bridger-Teton National Forest. Overall, 55.4% of the county is federal land with most of the acreage managed by the BLM or the Shoshone National Forest. Unique to the county is the presence of the Wind River Indian Reservation, home to the Eastern Shoshone and Northern Arapaho Tribes. Although the county seat is in Lander, Riverton is the largest city and the county's economic hub. The county also includes the towns of Dubois and Shoshoni and many other small communities. The county's economy was historically rooted in buffalo hunting, mining, grazing, and logging. The boom-and-bust cycles associated with mining and logging created economic hardship for the county, particularly in the 1980s when sawmills closed. Fremont County is guided by its Land Use Plan to sustain its custom, culture, economic viability, and social stability (2004), a Natural Resource Management Plan similar to that developed for Sublette County (2021), and a Community Wildfire Protection Plan (2019), all of which are relevant to coordination and cooperation with federal and state agencies.

Today, ranching and construction dominate the non-services sector of the labor market, while health care/social assistance and retail dominate the service sector (US BEA 2023). In the 2023 social survey, residents identified biological diversity as the top value attributed to the Forest with recreation second. Moderate support was expressed for motorized recreation activities, commercial uses, and special land protections with support falling in between the views expressed by Teton, Lincoln and Sublette Counties (Western 2024).

Park County

Park County includes one small portion of the Forest in the northeast corner that is entirely located within the Teton Wilderness. Approximately 4% of the county lies within the Bridger-Teton National Forest. Overall, 81.5% of the county is federal land with most of the acreage managed by the Shoshone National Forest and Yellowstone National Park with some acreage managed by the BLM. The count seat is in Cody with Powell and Meeteetse the other incorporated towns. Park County serves as the eastern gateway to Yellowstone National Park and contains a portion of the first National Forest within the Shoshone National Forest. As such, it has a long history of tourism and conservation. Like Teton County, guided elk hunts figured prominently in its early economy. Park County is guided by its Land Use Plan that defines what makes the county unique at the individual and community level and establishes a vision that "Park County will facilitate well-managed growth that balances the rights of landowners with the stewardship of what matter most: our rural landscapes, our resources, our heritage, and our culture and sense of community" (2024). Like other counties, Park County is also guided in its interaction with federal and state agencies by a Natural Resource Management Plan (2021) and a Community Wildfire Protection Plan (2016).

Today, construction and ranching dominate the non-service sector of the labor market while lodging/food service and retail trade dominate the service sector (US BEA 2023). In the 2023 social survey, residents identified nearly equal value for recreation, future generations, and biological diversity. Interestingly, residents expressed higher value for economic activity compared with other counties but the difference among counties was not significant. Like Fremont County, residents support for various activities and land protections tended to fall in between the views expressed by Teton, Lincoln, and Sublette Counties (Western 2024).

Local National Forest Benefits

Under the Multiple-Use, Sustained Yield Act of 1960 and the National Forest Management Act of 1976, national forests are managed for six general purposes: 1) outdoor recreation, 2) range, 3) timber, 4) watershed, 5) wildlife and fish, and 6) wilderness. In addition to achieving these purposes, national forests provide a broad range of ecosystem services. Ecosystem services include both economic market and non-market contributions, and they are commonly defined as the benefits people obtain from ecosystems, including aspects of nature that contribute directly or indirectly to human health, wealth, and well-being (36 CFR 219.19). The social and economic benefits people obtain from the Bridger-Teton include the following described below.

- Diverse recreation opportunities that provide place-based jobs, local and regional economic activity, and they are integral to the lifestyle and culture of community residents. These opportunities include: high-quality dispersed recreation opportunities in easily accessed settings; motorized and non-motorized recreation opportunities; back country recreation opportunities; areas used by outfitters with guided clients, including river floaters; and areas for alpine skiing and outfitted backcountry skiing and snowmobiling.

- Important wildlife and fish habitat that sustains numerous species including threatened, endangered, and at-risk species. Wildlife and fish provide important recreational opportunities, subsistence, jobs, and income for local and non-local visitors looking to engage in wildlife viewing, hunting, and fishing.
- Forest and plant products that provide timber and wood products as well as carbon sequestration and reduction of greenhouse gases. Products support local economies as well as subsistence and cultural practices, which includes the: harvest of sawtimber, house logs, posts and poles, firewood, Christmas trees, ornamentals, mushrooms and berries.
- Forage for livestock grazing, which supports individual livelihoods and valued lifestyles as well as jobs and income to the agricultural sector.
- Support for human health through clean air, scenic beauty, and dark skies. Residents and recreationists benefit from clean air for health and enjoyment, including benefits derived from viewing scenic vistas and the ability to see stars and other celestial objects. These Bridger-Teton attributes support mental health and psychological well-being as well as physical health.
- Healthy watersheds protect the ecological integrity of the landscape and provide water for human consumptive and non-consumptive use, including for the following: municipal drinking water, agricultural needs, hydropower, and recreation. Clean water benefits local communities by greatly reducing the cost for treating municipal water.
- Natural lands that help people connect to nature and culture contributing to health and well-being as well as offering educational opportunities that enrich learning. Such spaces also contribute to the arts through: photography, painting, sculpture, and writing.
- Federal land payments, including payments in lieu of taxes (Federal payments to local governments to help offset losses in property taxes due to non-taxable Federal lands within their boundaries).

To obtain a more complete picture of residents' connections to the Bridger-Teton and their views on key topics, an independent social survey was conducted in 2023. The survey, which was based in social science theory around understanding people's underlying values, resulted in responses from a sample of people equally selected across the five counties encompassing the Bridger-Teton. The full report is available on the Bridger-Teton Forest Plan website. Per this survey, residents rank four key reasons why they value the Bridger-Teton (out of 14 total values): 1) recreation (place for favorite outdoor recreation activities); 2) biological diversity (provides a variety of wildlife, fish, and plant life); 3) future (allow future generations to experience the Bridger-Teton as they are now); and 4) aesthetic (enjoy scenery, sights, sounds, smells, etc.). There are some differences among counties with Lincoln, Sublette, and Park Counties ranking recreation most highly, while Teton and Fremont Counties ranked biological diversity most highly (Western 2024).

Population Structure and Dynamics

Growing population and development places greater demand on forest resources and it is identified as one of the stressors in Chapter 2 of this Assessment. The total population residing in the five-counties within the Bridger-Teton is 122,700 people. This number swells to 326,797 people if the adjacent counties of Sweetwater and Unita, Wyoming and Teton, and Bonneville, Idaho are included and millions of people if the larger region extending to the Wasatch Front in

Utah and the front range in Colorado are included. Table 27 summarizes some of the key metrics associated with population within the Bridger-Teton's five county region. The median age within the region is higher than the 38.5 years for the U.S. median age and it may indicate a larger number of retirees living in the region. Education levels are lower than the 34.4 percent U.S. average with the notable exception of Teton County, which is significantly higher. Education levels are important since they are often correlated with a community's resiliency and its ability to respond to potential changes in the local economy.

Table 27. Population characteristics for five counties within the Bridger-Teton National Forest

	Lincoln County	Sublette County	Teton County	Fremont County	Park County
Population 2022	20,660	8,763	23,287	39,472	30,518
Change in population since 1990	62.5%	79.5%	105.6%	17.6%	31.6%
Median age	40.7	41.7	39.9	38.9	45.0
Percent white alone	94.6%	93.8%	83.2%	71.4%	90.1%
Percent Hispanic	5.0%	7.0%	15.2%	7.8%	6.0%
Percent minority within population	8.6%	9.4%	20.3%	31.1%	11.7%
Percent with Bachelor's degree or higher	23.1%	25.6%	60.3%	24.3%	32.8%
Percent 5 years or older who speak English less than "very well"	1.6%	1.7%	7.1%	0.3%	1.1%
Percent 25 years or older with no high school degree	5.9%	4.1%	4.0%	6.9%	4.6%
Percent with disabilities, 2023	14.2%	15.7%	6.4%	15.2%	13.0%

Source: U.S. Department of Commerce. 2023, 2024. Census Bureau, American Community Survey (ACS) Office, Washington, D.C.
*ACS 5-year estimates used, e.g., the 2022 estimate is based on data collected between 2018 and 2022.

Population projections within the region suggest that migration, not natural population growth, will likely play an increasing role in population changes. The Wyoming Department of Administration and Information projects that all counties will continue to see an increase in population through 2040; however, when compared with population growth rates throughout the 1990s and early 2000s, the population forecasts show population growth occurring at a slower rate moving forward. The long-term influence of more flexible and remote work arrangements may accelerate pre-pandemic projections.

The information in Table 27 further analyzes the population structure and dynamics within the five counties. The identification of populations with large minority populations can help clarify the potential for geographical or proportional impacts on minority populations and help guide outreach efforts. Teton and Fremont Counties stand out as having minority populations above the Wyoming State average. Teton County's minority population is a mix of different races, whereas Fremont County's minority population is primarily American Indian. Communities or households with low-incomes typically will be more sensitive to management actions that

impose fees for use or access to Bridger-Teton resources. Fremont County stands out in this aspect.

Education level, English language proficiency, and disability measures, along with minority and poverty data, can provide valuable insight for identifying and considering groups with special needs for consideration in developing management direction. In many cases education is an indicator of higher incomes, higher growth rates, and better ability to withstand economic downturns in a community. Fremont and Lincoln Counties had higher percentages of those lacking high school degrees compared with the overall Wyoming population. Those with low English proficiency may have difficulty being engaged and participating in the forest plan revision; this suggests a need to offer materials in other languages, particularly within Teton County.

People with disabilities are another potentially vulnerable community. This is because they may be subject to health complications that make environmental risks more consequential. In addition, people with mobility disabilities may have increased difficulty accessing recreation opportunities. These five Wyoming counties, excluding Teton County, had higher percentages of the population with disabilities than the State average of 13.1 percent.

Economic Structure and Dynamics

The five-county region encompassing the Bridger-Teton was comprised of approximately 105,716 jobs and $16 billion in labor and non-labor personal income in 2022 (See Table 28). Personal income within most counties is proportional between labor income, which is place-based, and non-labor income, which is not place-based (e.g. dividends). The outlier is Teton County where 76 percent of personal income is generated from non-labor sources (US BEA 2023).

Table 28. Economic characteristics within the five counties encompassing the Bridger-Teton

	Lincoln County	Sublette County	Teton County	Fremont County	Park County
Employment (# of jobs), 2022	12,788	6,425	39,800	23,995	22,708
Unemployment rate, 2023	2.9%	3.3%	2.1%	3.4%	2.9%
Total personal income, 2022	$1.36B	$561.8M	$9.84B	$2.16B	$2.07B
Individuals below poverty	7.1%	8.1%	6.9%	13.9%	9.6%
People working in county of residence	80.7%	84%	96.3%	94.8%	91.4%
Bridger-Teton PILT payments to counties, 2023	$752,724	$520,166	$965,983	$129,262	$118,404
Other Bridger-Teton payments to counties, 2023[1]	$439,601	$639,815	$292,348	$100,252	$85,520

Source: US BEA, 2023; US Dept of Labor, 2024; US Census Bureau, ACS, 2023; US DOI, 2023; USFS 2023 Land Area Report (LAR).
1 - Includes total SRSCS and 1908 Act 25% Fund payments (sequestration incorporated) from the Bridger-Teton National Forest to associated counties. There are no proclaimed national grasslands associated with the Bridger-Teton National Forest, so the Forest does not make BHJ payments to counties.

Federal payments are also made to local economies. These payments compensate State and local governments for nontaxable Federal lands within their borders and share revenues received by Federal agencies from activities on Federal public lands (for example, timber, grazing, and mineral development). On USFS lands, payments are made to states and local governments through various programs, including Federal Payments-In-Lieu-of-Taxes (PILT), the Secure Rural Schools and Community Self-Determination Act (SRSCS), Bankhead Jones Act of 1937 (BHJ) and the 1908 Federal 25 Percent Fund. Most payments to counties come from payments PILT.

Bridger-Teton projects contributed 2.3% of the total jobs and $116M in labor income to the regional economy in 2019. The economic contributions made to the local communities by the Bridger-Teton include direct, indirect, and induced jobs and income associated with Bridger-Teton projects.[6] For these jobs, the job categories and percentages are as follows: recreation activity generates the most jobs at 56 percent, agency operations contribute 18 percent, livestock grazing and mineral extraction contribute 11 percent each, USFS payments to the State and counties contribute 3 percent, and forest products contribute 1 percent (USFS 2019, IMPLAN 2019). These are modeled results, representing the estimated economic contributions in the local economy stemming from Bridger-Teton visitors' spending, natural resources produced, authorized forage use, and agency operations. Despite the minor influence on local economy, the forest products industry is crucial to continue active management, achieve forest management objectives, and provide forest products.

While the Bridger-Teton is clearly vital to those individuals whose livelihood depends on the Bridger-Teton (e.g. livestock permittees, outfitter-guides, ski instructors, and agency employees), the economic contributions from Bridger-Teton activities fall within many industries in the area and contribute only a small portion of the total employment in the area. However, the social and non-monetary benefits of forest resources (e.g., intrinsic, existence, and bequest values, forest ecosystem services such as clean water and air, biodiversity, cultural resources, and wilderness) are not captured quantitatively above and are crucial to consider alongside the economic contributions discussed.

Within the service sector, which is the largest sector of the market in most counties, the influence of Bridger-Teton lands is particularly reflected in the real estate market, lodging and food services, and retail trade. Within the non-service sector, the influence of Bridger-Teton lands is particularly reflected in forestry, mining, and construction jobs. Employment in the government sector is also significant across counties. Interestingly, within the three counties with large acres of Bridger-Teton land, construction activity dominates the labor sector and real estate is a notable contributor within the service sector. The importance of both real estate and construction sectors underscores the value of public lands in supporting amenity-rich lifestyles that typically draw new residents to the area, generating economic activity (Headwaters Economics 2024).

[6] Modeling for economic contribution analysis estimates all pieces of sales through the regional economy that can be claimed as 1) being directly tied to USFS projects; 2) tied to businesses that support the directly affected firms of such projects; and 3) the pieces of people's income that are supported by (1) and (2), and what part of that income is spent locally. These are also known as direct (1), indirect (2), and induced (3) effects. In the context of jobs, these pieces are added up to get an estimate of the average annual number of jobs supported in the area by Bridger-Teton's direct, indirect, and induced effects.

All counties within the Bridger-Teton socioeconomic area of influence are also among the top ten counties ranked with the highest comparative cost of living indices in all of Wyoming. For the second quarter of 2024, Teton was ranked as the county with the highest cost of living, where the cost of living in Teton County was estimated to be 76 percent higher than the statewide average that quarter (WY EAD 2024). Table 29 below depicts additional housing characteristics associated with the local area.

Table 29. Economic housing characteristics within the five counties encompassing the Bridger-Teton

	Lincoln County	Sublette County	Teton County	Fremont County	Park County	State of WY
Residential Building Permits, 2023	162	109	102	21	200	1,681
Percent Change in Rental Rates, 2023 – 2024						
Apartments	4.1%	10.4%	5.9%	9.6%	10.0%	5.8%
Houses	10.0%	-1.5%	3.8%	4.6%	1.3%	2.6%
Mobile Homes	Empty Cell	Empty Cell	8.1%	5.1%	6.5%	4.1%
Mobile Home Lots	Empty Cell	Empty Cell	3.2%	17.4%	8.4%	5.9%
Average Rental Rates, 2024						
Apartments	$1,159	$983	$3,354	$909	$851	$1,009
Houses	$1,621	$1,437	$4,037	$1,145	$1,260	$1,428
Mobile Homes	Empty Cell	Empty Cell	$1,687	$1,036	$923	$992
Mobile Home Lots	Empty Cell	Empty Cell	$897	$324	$408	$490

Source: WY EAD 2024 (http://eadiv.state.wy.us/housing/housing.html).
Rental rate percent changes with no value indicate too few observable data points to estimate average rental rates.

Commuting data adds to this story with many people commuting into Teton County Wyoming where the number of jobs exceed the resident population. Diversification is important to create a resilient economy, however, most counties surrounding the Bridger-Teton have natural resource- and recreation-dependent economies to some extent. For this reason, Bridger-Teton recreation opportunities will be a valuable component in future land management decisions.

Production of Natural Resources

Forest Management

Key Takeaways

- The current role of forest management on the Bridger-Teton, in addition to providing forest products to the local market, primarily is to restore and maintain forest structure to be more resilient to natural disturbances and to reduce fuels to support fire management.
- Net annual growth of total tree bole volume on the Bridger-Teton was negative between 2011 and 2018 due to tree mortality caused by insects and fire.

Introduction

For many years, the timber products industry played a key role in the economics of the Bridger-Teton plan area. The timber base supported mills in Dubois and Afton, Wyoming through the early 1990s in addition to many smaller operations scattered throughout the region. Many of the mills supplied timber to mines in the area. Fuelwood was and has continued to be a major product and driver of timber industry in the area, both for personal and commercial use. House logs also have played a role in forest products harvested on the Bridger-Teton.

The current role of forest management on the Bridger-Teton is to restore and maintain forest structure and composition in fire adapted landscapes to increase resilience to natural disturbances, reduce fuels at strategic locations to support fire suppression, and to maintain a forest products industry in order to achieve management objectives and contribute forest products to the local economy. Additionally, forest management activities focus on the restoration and protection of whitebark pine, listed as threatened under the ESA by the USFWS. Forest products include commercial and personal use products, including sawtimber, house logs, fuelwood, posts, and poles, as well as Christmas trees, boughs, and aspen transplants.

Economic contributions to the local economy from forest products harvested on the Bridger-Teton are small compared to overall regional economic activity. The sum of the direct, indirect, and induced effects to the local economy from timber activities related to the Bridger-Teton in 2021 was estimated to be slightly over $1.5 million in total output and about 14 average annual jobs (USDA 2022b). [7] Despite the minor influence on local economy, the forest products industry is crucial to continue active management, achieve forest management objectives, and provide forest products.

Timber volume may be measured by board feet (BF), cubic feet (CF), or tons. A board foot is the volume of wood equivalent to a board 12 inches long by 12 inches wide that is 1 inch thick (12” x 12” x 1”), and it represents the amount of dimensional lumber that can be cut from a tree or log. Board foot volume is usually expressed as MBF (thousand board feet), or MMBF (million board feet). A cubic foot (12” x 12” x 12”) measures the total amount of wood in a tree or log. Board foot volume can vary depending on size of the log, thickness of the saw kerf, and amount of waste. Therefore, there is not an exact conversion factor between BF and CF measures, but on average over the last 10 years on the Bridger-Teton, 1 MBF is equivalent to 0.5587 CCF. Inversely, 1 CCF is equivalent to 1.79 MBF for sawlogs. There are different conversion factors for firewood, posts, and poles. Timber volume also is measured by weight in U.S. tons. The USFS established CCF to ton conversion factors for each tree species by national forest for green and dead timber.

[7] Recall that underlying modeling for economic contribution analysis estimates all pieces of sales through the regional economy that can be claimed as 1) being directly tied to USFS projects; 2) tied to businesses that support the directly affected firms of such projects; and 3) the pieces of people's income that are supported by (1) and (2), and what part of that income is spent locally. In the context of jobs, these pieces are added up to get an estimate of the average annual number of jobs supported in the area by Bridger-Teton’s direct, indirect, and induced effects related to timber harvesting. More specifically, a logger may have a full-time job with a logging company that works all over the area with only a small amount of time spent working on actual USFS projects. Thus, the USFS supports only a piece of this logger’s job, a bit of her income and only a smidgeon of her boss's expenditures on gas, oil, trucks, equipment, etc. It makes it difficult to visualize estimated jobs contributed, since there is no single logger to shake hands with, but it is a powerful measure of economic ties between USFS timber projects and the local area.

Current Forest Plan Direction

The Bridger-Teton Land and Resource Management Plan (1990 forest plan) established goals to annually provide an average of 12 MMBF (about 21,500 CCF) of green sawlogs and 5 MMBF (about 2,200 CCF) of products other than sawlogs for an average total annual timber products sold of 17 MMBF (USDA 1990). This is often referred to as the Allowable Sale Quantity (ASQ). Products other than sawlogs include fuelwood, posts, poles, and biomass.

The forest plan further establishes standards and guidelines to: protect old growth; define appropriate silvicultural methods by forest cover type; restrict timber harvest on specific lands to protect other resources and avoid irreversible soil damage; prioritize natural regeneration; establish maximum created open sizes; minimize impact to soils and riparian areas; and promote perpetuation of aspen within aspen cover types (USDA 1990).

Standing Inventory

The current existing vegetation inventory map layer for the Bridger-Teton was created in 2007 and updated in 2018. This layer was developed through a partnership between the Intermountain Regional Office (RO), Intermountain Region Remote Sensing Application Center, and Bridger-Teton staff for the purpose of providing continuous vegetation information across the entire Bridger-Teton to support forest planning and monitoring efforts (USDA 2007). Existing vegetation is classified based on the dominant vegetation type (“map unit class”) using aerial and Landsat satellite imagery and other geospatial data. In this section, data from map unit classes classified as “forest” were extracted and will be referred to as forest cover types. Forest cover types are defined as having at least 10 percent canopy cover comprised of tree species. Biophysical setting data was not used because it represents vegetation that was present, or potentially present, prior to European settlement, whereas this section is focused on existing vegetation. Table 30 summarizes the area classified by forest cover type for the entire Bridger-Teton, including Wilderness and Wilderness Study Areas. Nine forest cover types were classified on the Bridger-Teton occupying 2,089,670 acres (845,660 hectares), or about 61 percent of the Bridger-Teton (See Figure 26). Lodgepole pine mix is the most abundant cover type classified on about 37 percent of the total forested land, followed by spruce/subalpine fir mix (24 percent). Aspen is classified on about 7 percent of the forest land.

Table 30. Area of forested land classified by forest cover types on the Bridger-Teton

Forest Cover Type	Sum of Acres	Sum of Hectares	Percent of Total
Aspen	140,682	56,932	7%
Aspen/Conifer Mix	35,308	14,289	2%
Douglas-fir Mix	247,667	100,227	12%
Limber Pine	5,382	2,178	<1%
Lodgepole Pine Mix	762,923	308,744	37%
Rocky Mountain Juniper	1,060	429	<1%
Spruce/Subalpine Fir Mix	491,251	198,802	24%
Whitebark Pine	202,763	82,055	10%
Whitebark Pine Mix	202,634	82,003	10%
Total	**2,089,670**	**845,660**	**100%**

Approximately 39 percent of the forested area on the Bridger-Teton is classified in canopy cover class 4 (40-49 percent), followed by class 3 (30-39 percent) at 23 percent and class 5 (50-59 percent) at 19 percent (See Table 31). Canopy cover class 1 (10-19 percent) is classified on 4 percent of the forest land. No forest land is classified with canopy cover < 10 percent because it does not meet the definition of forested land; however, areas that were previously forested and recently burned typically fall within this category.

Table 31. Area of forested land classified by canopy cover class on the Bridger-Teton

Tree Canopy Cover Class	Sum of Acres	Sum of Hectares	Percent of Total
Tree Canopy 1 (10-19%)	74,185	30,022	4%
Tree Canopy 2 (20-29%)	202,177	81,818	10%
Tree Canopy 3 (30-39%)	488,973	197,881	23%
Tree Canopy 4 (40-49%)	812,475	328,797	39%
Tree Canopy 5 (50-59%)	403,825	163,422	19%
Tree Canopy 6 (60-69%)	93,541	37,855	4%
Tree Canopy 7 (70-100%)	14,495	5,866	1%
Total	**2,089,670**	**845,660**	**100%**

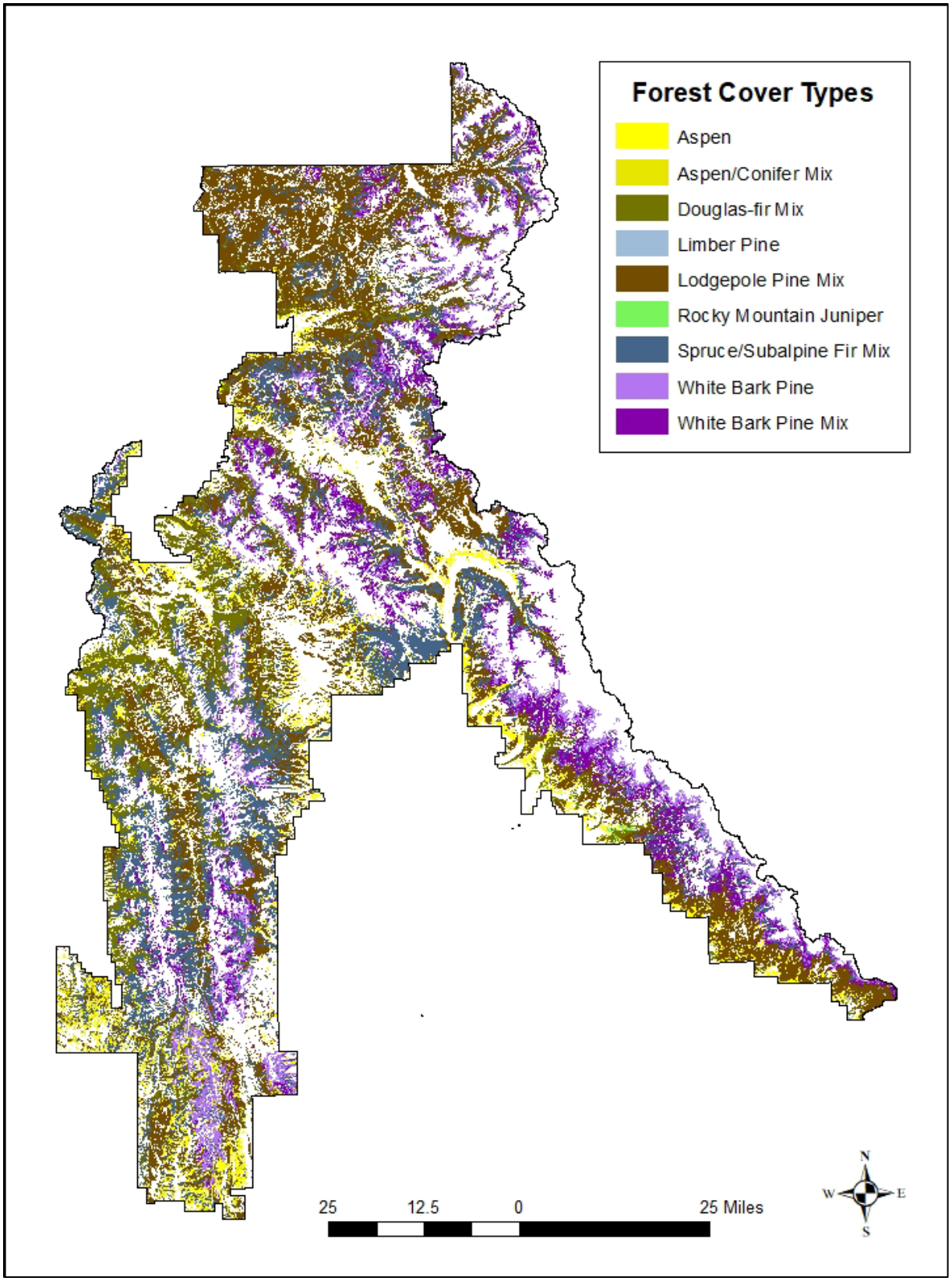


Figure 26. Map of forest cover types on the Bridger-Teton

Table 32 shows the area of forested land classified by tree size class. The majority, 51 percent, is classified in tree size class 4 (10 – 19.9” dbh), with 44 percent in tree size class 3 (5-9.9” dbh). The amount of forest land classified under 5” dbh likely under-counts areas that have recently burned, or had other disturbance, resulting in the less than 10 percent tree canopy cover.

Table 32. Area of forested land classified by tree size class on the Bridger-Teton

Tree Size Class	Sum of Acres	Sum of Hectares	Percent of Total
Tree Size 2 (< 5" dbh)	75,949	30,735	4%
Tree Size 3 (5 - 9.9" dbh)	911,990	369,069	44%
Tree Size 4 (10 - 19.9" dbh)	1,073,746	434,530	51%
Tree Size 5 (20 - 29.9" dbh)	27,570	11,157	1%
Tree Size 6 (30.0"+ dbh)	416	168	0%
Total	**2,089,670**	**845,660**	**100%**

The most common stand condition on the Bridger-Teton is mixed lodgepole pine within tree size class 5-19” dbh and 30-49 percent tree canopy cover accounting for over 560,000 acres, or about 27 percent of total forest land. Subalpine fir, Engelmann spruce, Douglas-fir, whitebark pine, and aspen are present in mixed lodgepole pine stands.

Estimates for stocking, growth and mortality were obtained from the USFS Forest Inventory and Analysis (FIA) (USDA 2022). There are 449 FIA plots on the Bridger-Teton, or about 1 plot for every 7,600 acres. Because of the small sample size compared to the size of Bridger-Teton and variation of the forested vegetation, the data is best used for analyzing trends and for broad conclusions about the condition of Bridger-Teton. Data is available for the Bridger-Teton for years 2011-2018.

The estimated total number of live growing stock trees (5-inch dbh and larger) on the Bridger-Teton is 269.9 million. Approximately 33 percent are subalpine fir, 21 percent Engelmann and blue spruce and 21 percent lodgepole pine.

Net growth of growing stock trees is summarized in Table 33. Growth is measured in 100 CCF of merchantable bole wood per year. Net growth is calculated by subtracting mortality from total growth. The average annual net growth for the Bridger-Teton from 2011-2018 was -791,206 CCF. Lodgepole pine forests had the greatest reduction in net growth in part because they occupy the largest area on Bridger-Teton and they have been most affected by recent disturbances. Whitebark and limber pine also had a large reduction in net growth. The sampling error for Table 33 is 18 percent.

Table 33. Estimated average annual net growth of sound bole volume of growing stock trees, 2011-2018

Tree Species	Net CCF Growth per Year
Douglas-fir	-19,904
Subalpine fir	40,152
Engelmann and blue spruce	-70,093

Tree Species	Net CCF Growth per Year
Lodgepole pine	-477,665
Rocky Mountain juniper	130
Whitebark and limber pine	-266,690
Cottonwood and aspen	2,864
Total	**-791,206**

Negative net growth is a result of tree mortality exceeding growth. The three primary causes of tree mortality from 2011 to 2018 are bark beetles, white-pine blister rust, and fires. (Forest health is discussed in detail in the next section.) Estimated average annual mortality is displayed in Table 34. Over 9 million growing stock trees died each year from 2011 to 2018. An estimated 3.3 million are lodgepole pine. The sampling error for Table 34 is 8.09 percent at a 68 percent confidence interval.

Table 34. Estimated average annual mortality of trees at least 5 inches DBH from 2011-2018

FIA Species Group	Number of Trees
Douglas-fir	469,823
Subalpine fir	2,044,923
Engelmann and blue spruce	897,186
Lodgepole pine	3,374,706
Rocky Mountain juniper	0
Whitebark and limber pine	1,665,737
Cottonwood and aspen	704,217
Total	**9,156,591**

FIA data estimates that over 97 million growing stock trees died from insects, disease, and fire between 2011 and 2018, or approximately 36 percent of all growing stock trees on Bridger-Teton. Nearly 36 million lodgepole pine died, primarily by insects. More than 14.2 million whitebark pine died by insects and 3.9 million died from disease.

Forest Health and Condition

The major insect and disease agents affecting forest health on the Bridger-Teton are MPB *(Dendroctonus ponderosae*), spruce beetle (*Dendroctonus rufipennis)*, western spruce budworm (*Choristoneura occidentalis*), Marssonina leaf spot (*Marssonina populi*), balsam wooly adelgid (*Adelges piceae*), and white pine blister rust (*Cronartium ribicola*).

MPB attacks lodgepole pine, whitebark pine, and limber pine. A large MPB outbreak occurred on Bridger-Teton between 2003 and 2012 and peaked in 2009 (USDA 2021a). Aerial detection surveys (ADS) to identify and map forest insect and disease are annually conducted by the Forest Health Protection branch of the USFS. From 2003 through 2012 the USFS used ADS and mapped 1.4 million acres (about 567,000 hectares) damaged by bark beetles. The majority of bark beetle mortality was caused by MPB attacks on lodgepole pine (approximately 1 million acres) and whitebark pine (approximately 390,000 acres). In areas where MPB populations

were high nearly all susceptible trees over 6 inches in diameter were killed and many have since fallen to the ground contributing to a high fuel loads and fire intensity. Current levels of MPB activity on the Bridger-Teton are at endemic levels with small, localized outbreaks. Since 2019, MPB activity has been on an upward trend, affecting mostly whitebark and limber pine, as well as some scattered lodgepole pine stands across the Bridger-Teton.

More recent aerial detection surveys conducted in 2018, 2019, 2021, and 2022 indicate that western spruce budworm (WSB), a defoliating lepidoptera that feeds on the buds and needles of conifers, caused the most acres of damage to forests on the Bridger-Teton, affecting approximately 124,000 acres (50,181 hectares). WSB does not usually kill trees outright unless there are multiple years of severe defoliation, however, it can weaken trees and make them more susceptible to other damaging agents such as bark beetles.

Spruce beetle damage affected over 12,000 acres (4,856 hectares) since 2018. Current spruce beetle activity is located from the southeast part of the Blackrock District, across the Gros Ventre Wilderness, to the headwaters of the Green River in the northwest part of the Pinedale District.

Recently, an insect of concern identified on the Bridger-Teton is the woolly balsam adelgid *(Adelgis piceae)* (BWA), a tiny sucking insect that was introduced to North America from Europe and is a serious threat to true firs. Subalpine fir is particularly vulnerable (Alston et al. 2018). BWA injects a toxic saliva into its host causing: swelling of wood tissues near branch notes and deformation; interfering with the transport of water and nutrients leading to needle chlorosis; premature needle loss; crown dieback and eventually death (Lowrey 2015). Prior to 2000, BWA was thought to be limited to Washington, Oregon and northern Idaho, but by 2010 it was detected in south-central Idaho (Lowrey, 2015) and in Utah by 2017 (Alston et al. 2018). It was first identified on the Bridger-Teton by aerial detection surveys in 2019, where approximately 300 acres (121 hectares) were observed in widely scattered patches along the west side of the Bridger-Teton. BWA appears to be limited by cold winter temperatures (January mean temperature of 12 °F) and expansion of its range into the central Rockies appears to be correlated with warmer winters (Lowrey 2015).

Marssonina leaf spot (*Marssonina* spp.) is a fungal disease that infects aspen and cottonwood. The primary concern is aesthetic as spots develop on the leaves which eventually turn yellow or brown and are shed early.

White pine blister rust (*Cronartium ribicola)* is an invasive fungus that attacks and kills five-needle pines, including whitebark and limber pine on the Bridger-Teton. Infections are widespread on the Bridger-Teton, though some trees have shown resistance to the disease. Infected trees produce fewer cones, branches begin to die back and eventually die and reduce the tree’s cone-bearing potential. Infected trees are more susceptible to attack by MPB.

Utilization Standards and Timber Volume Sold

Utilization Standards for sawtimber (also called merchantability specifications) are established by the USFS Region 4 Regional Forester and they represent the smallest piece size (log) that can be sold as sawtimber. Attributes include: minimum dbh, minimum small end diameter inside bark (dib), minimum length, and soundness. Current Region 4 utilizations standards are published in the Forest Service Handbook (FSH 2409.12, Ch. 10 R4 Supplement 03/17/2011). Merchantability standards are not likely to change soon. Rates and standards for forest

products, other than sawtimber (aka special forest products), are established by the forest supervisor and they were last updated in April of 2020 (USDA 2020, USDA 2020b).

Figure 27 shows the sawtimber volume sold by year from 2013 through 2022. Average annual sawlog volume sold was 1.03 MMBF, about 9 percent of the forest plan goal. Figure 28 shows the non-sawtimber volume sold for the same period. The average annual volume of non-sawtimber products was 7.38 MMBF, about 147 percent of the forest plan goal. The average annual volume of all timber products sold during the last 11 years was 8.42 MMBF, which is approximately 50 percent of the goal of 17 MMBF. While sawtimber volume sold was below the forest plan goals, non-sawtimber volume exceeded the forest plan goals, and somewhat compensated for the shortfall in sawtimber volume. Reasons for not achieving the timber production goals include lack of capacity of timber and support staff, other Bridger-Teton planning priorities, and reduction of available land for timber harvest. Some of the land identified as suitable in the 1990 Forest Plan is operable only with cable harvesting systems, but those areas typically do not have adequate roads and the cost of cable systems, including road construction, is much more than the value of the timber that would be harvested; therefore, no cable harvesting has occurred in the last 30 years. Changes since 1990 include the issuance of the 2001 Roadless Rule (USDA Forest Service 2001) which withdrew Inventoried Roadless Areas (IRA) from suitable timber land and designated “Wild River” segments under the Wild & Scenic Rivers Act (USDA Forest Service 2015).

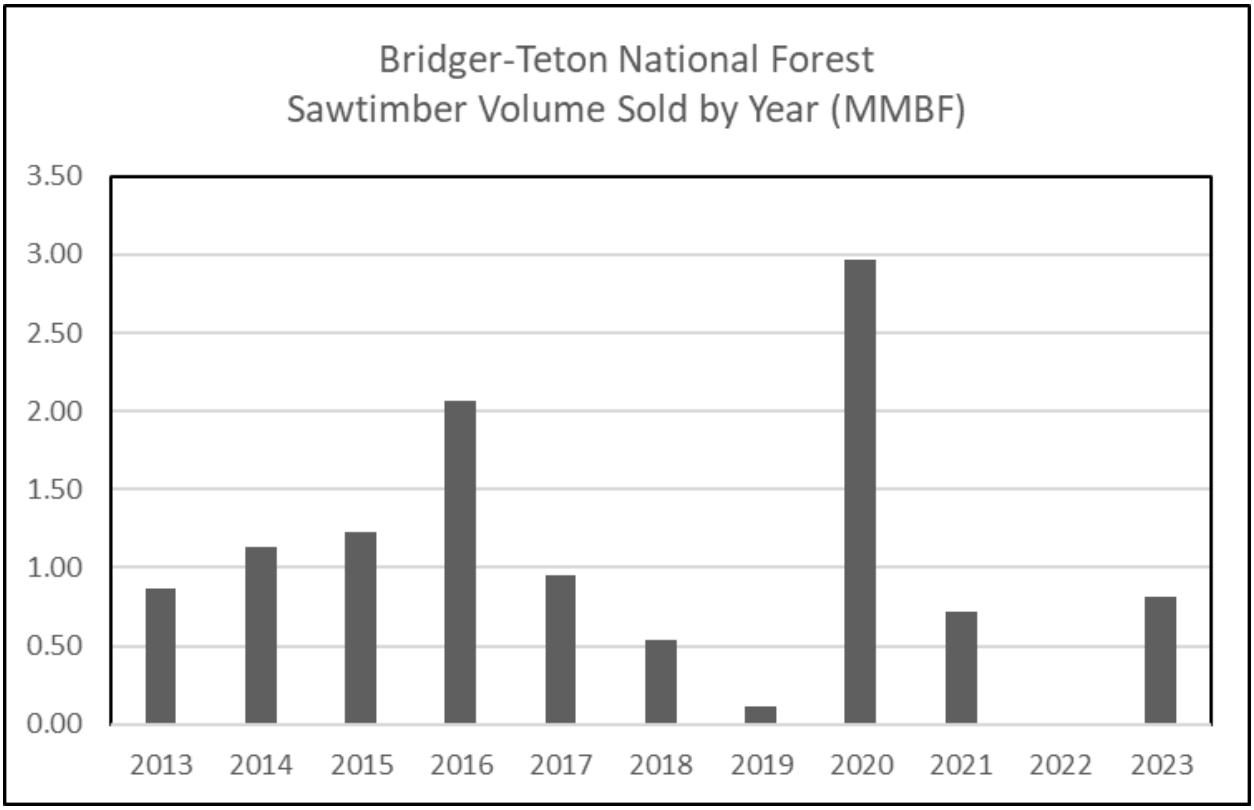


Figure 27. Sawtimber volume sold from 2013 through 2023

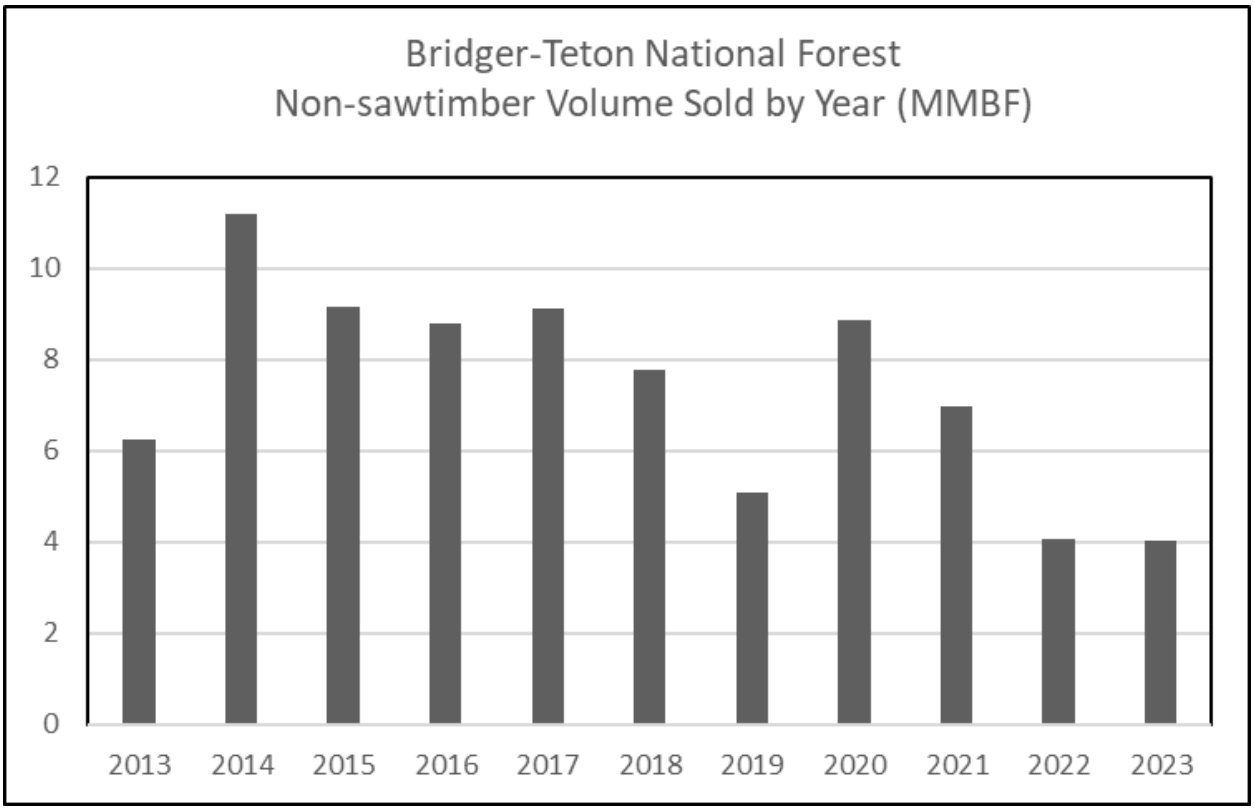


Figure 28. Non-sawtimber volume sold by year (MMBF) 2013-2023

Firewood comprises 7.37 MMBF (approx. 95 percent) of the non-sawtimber volume sold. This reflects the increased demand for firewood in the last 30 years and its importance for local communities.

Forest Products Industry

Since the approval of the existing forest plan there has been a general decline in the timber industry throughout Wyoming. Lumber production in Wyoming peaked in the 1980s and it has been declining since (Marcille et al. 2021). Markets hit bottom in 2009 following the crash of the housing market and recovered to pre-recession levels by 2014. In 2018, the most recent year in which data is available, a total of 81,621 MBF was harvested in Wyoming. This was a 21 percent increase over the harvest of 67,547 MBF in 2014, and a 51 percent increase over the 2010 harvest (Marcille et al. 2021). Timber volume harvested on national forest lands in Wyoming in 2018 was 54,525 MBF representing 67 percent of the total.

Timber volume sold on the Bridger-Teton did not follow the same trends, primarily because the Wyoming industry report is for green timber harvested for dimensional lumber, whereas most of the timber sold in recent years on the Bridger-Teton is dead timber used for firewood and houselogs.

The wood products market area for the Bridger-Teton includes four counties in Wyoming (Lincoln, Sublette, Teton, and Uinta) and five counties in Southeast Idaho (Bear Lake, Bonneville, Caribou, Jefferson, and Teton) (Marcille et al. 2021, Simmons 2022). The total number of forest product manufacturing facilities in the Bridger-Teton market area declined from 27 in 2000-2001 to 14 in 2018-2019 as shown in Table 35 (Morgan et al. 2004, 2005). Two

sawmills and four log home manufacturing facilities closed during this time period. Manufacturing facilities are classified based on the primary product they produce (lumber, posts and poles, logs for homes, furniture and other including firewood and residual products). However, most facilities produce multiple products. For example, South & Jones Timber in Evanston, Wyoming produces dimensional lumber, fuel pellets, and firewood. Two sawmills and four log home manufacturing facilities closed during this time period.

Table 35. Summary of forest primary products manufacturing facilities in the Bridger-Teton marketing area

Base Years	Sawmills (lumber)	Post & Pole	Log Homes	Furniture	Other	All Products
2000-2001	8	5	6	5	3	**27**
2018-2019	6	4	2	0	2	**14**
Change	-2	-1	-4	-5	-1	**-13**

The contraction in the industry in the last 20 years was caused by reductions in National Forest harvest levels in the 1990's, increased imports from Canada, and collapse in the housing market during the recession of 2008-2009 (McIver et al., 2014). Most timber purchasers of timber of the Bridger-Teton are small family operated businesses without much capacity or capital for growth, creating challenges to purchasing larger timber sales. Increased costs for labor, equipment maintenance and supplies since 2020 have only increased challenges for timber purchasers. Timber stumpage values have declined significantly making it difficult to offset the costs of road improvements and reforestation. In addition, long haul distances to mills further diminish the viability and value of timber sales.

Sawlogs harvested from the Bridger-Teton are primarily processed in the following facilities:

- Jensen Lumber Inc. in Ovid, Idaho
- South and Jones Timber in Evanston, Wyoming
- Yellowstone Log Homes, Rigby Idaho

There are a few small, family-operated mills and timber products businesses in the area, which generally manufacture and sell specialty products. Recently, a sawmill in southeastern Idaho was purchased by a company from Montana. They have not purchased any timber sales on the Bridger-Teton, but they are within haul distance of parts of the Bridger-Teton.

Current Forest Vegetation Management Methods and Harvesting Systems on the Bridger-Teton

The primary methods used to manage forest vegetation on the Bridger-Teton include: timber sale contracts, forest product permits, timber stand improvement (TSI), mechanical and prescribed fire fuels reduction treatments, and management of lightning ignited wildfires. Mechanical fuels treatments within forest stands may include: thinning, pruning, piling of fuels, chipping or mastication.

All current timber sale purchasers that operate on the Bridger-Teton use ground-based harvesting equipment. All have mechanical tree feller/bunchers with rubber-tired, grapple skidders. Some operators also have forwarders. Most have the capability to mechanically

process trees (remove limbs and top) in the woods, or to process at the landing where the non-merchantable material is piled.

Since the approval of the forest plan in 1990, a total of 9,985 acres have been harvested (See Table 36). About 69 percent of the acres were treated with commercial thinning, sanitation, and salvage cuts. While the sanitation cuts annually occurred since the mid-1990s, salvage harvests primarily occurred in the last 7 years, a response to the MPB outbreak and large wildfires since 2007. About 28 percent of the harvest area was treated with even-aged harvests with clearcuts used to regenerate lodgepole pine stands being the most common treatment. Seed tree and shelterwood systems account for about 5 percent of the acres harvested and they are used in mixed Douglas-fir stands. Uneven-aged systems, single-tree selection and group selection account for about 3 percent of acres harvested and they are used in Engelmann spruce/subalpine fir stands.

Table 36. Summary of timber harvest treatments (1990-2022)

Silvicultural System	Acres	Hectares	% Total
Intermediate Harvest[1] Commercial Thin/Improvement Cut	1,369	554	13.7%
Intermediate Harvest - Salvage Cut	3,092	1,251	31.0%
Intermediate Harvest - Sanitation Cut	2,460	996	24.6%
Intermediate Harvest - Subtotal	6,921	2,801	69.3%
Even-aged - Clearcut	933	933	23.1%
Even-aged - Overstory Removal Cut	18	18	0.5%
Even-aged - Seed Tree	16	16	0.4%
Even-aged - Shelterwood	148	148	3.7%
Even-aged - Subtotal	1,115	1,115	27.6%
Two-aged - Coppice	15	15	0.4%
Two-aged - Shelterwood	18	18	0.4%
Two-aged - Subtotal	32	32	0.8%
Uneven-aged - Single-tree Selection Cut	67	67	1.7%
Uneven-aged - Group Selection Cut	25	25	0.6%
Uneven-aged - Subtotal	93	93	2.3%
Grand Total	**9,985**	**4,041**	**N/A**

1 Not final regeneration harvest

Management Implications

Four major policy changes occurred that affect timber management since the current forest plan was signed in 1990: the 2001 Roadless Rule (36 CFR 294), listing of the Canada lynx as a threatened species in 2000, listing of the whitebark pine as a threatened species in 2022, and EO 14225 “Immediate Expansion of American Timber Production.” Additionally, the Good Neighbor Authority was permanently authorized by Congress in 2014 and allows the USFS to authorize states, counties, and federally recognized Indian tribes to conduct certain projects on federal lands. The Good Neighbor Authority has generally enhanced state-federal relationships and addressed cross-boundary land restoration needs.

In 1990, the forest plan identified 279,400 acres of suitable timber production lands compatible with other resource management objectives (USDA 2015). Approximately 40 percent of the area initially identified as suitable for timber production are within mapped Inventoried Roadless Areas (IRAs), which place prohibitions on road construction and restrictions on timber harvest; (36 CFR 294). This had a major impact on the ability of the Bridger-Teton to meet harvest volume objectives as these lands are now restricted for timber harvest, even though many roadless areas contain roads and were logged prior to the 2001 Roadless Rule. Note that there are exceptions to the prohibition on timber harvest in IRAs, but only to meet other management objectives such as fuels reduction in the WUI or wildlife habitat restoration (36 CFR 294.13) No new roads can be built and the volume harvested does not count towards the Allowable Sale Quantity.

Additional standards and guidelines were amended to the forest plan for management of Canada lynx habitat in 2007, which restrict some commercial harvest practices where departure from historic conditions, i.e., lack of disturbance such as wildfire, has allowed development of an understory conducive to snowshoe hare habitat. As a result, fewer acres can be annually treated commercial and non-commercially for timber production.

The listing of whitebark pine is expected to have little impact to the timber program because whitebark pine is not considered a commercial species and the Bridger-Teton already adopted many of the protection guidelines in the whitebark pine Standing Analysis for Effects to Whitebark Pine (USDOI 2023).

Timber management goals and objectives in the current Forest Plan cannot be met due to reduction in land suitable for timber production; lack of internal capacity to plan and implement timber sales; and reduction in merchantable growing stock. During plan revision, plan components should be developed that are reasonable, implementable, and support the continuation of a forest product industry. This infrastructure will be needed to continue active management, achieve forest management objectives and desired conditions, and provide forest products for the local economy.

Key Issues Regarding Timber Management of the Bridger-Teton

Reforestation Backlog.

The 1976 National Forest Management Act (NFMA) requires National Forest lands must be restocked within 5 years of a regeneration harvest. If lands cannot be adequately restocked within that time, they should be removed from suitable timber land. Restocking may be accomplished by natural regeneration or by planting. The NFMA also states that all forest lands in the National Forst System shall be maintained in appropriate forest cover (36 CFR part 219). The Bridger-Teton currently has a reforestation backlog of 41,073 acres, nearly all (40,599 acres) are due to wildfires. Timber harvests in lodgepole pine typically have adequate regeneration within 5 years following harvest, planting may be needed if the area subsequently burns and there is insufficient seed for regeneration. The highest priority for planting within burned areas is in previously harvested units.

Economic and Social Perceptions.

Many of the public users and visitors to the Bridger-Teton view the value of the Bridger-Teton in terms of: outdoor recreation, scenic beauty, wildlife viewing and habitat, and for hunting and

fishing. Commercial timber harvest is a limited component of the economic contribution from the Bridger-Teton to local economies (USDA 2022b). However, with recent landscape scale disturbances, such as bark beetle outbreaks and large wildfires, many users and residents would like to see more timber management and harvest activities to reduce hazardous fuels; to promote forest health and resilience; and to spur economic growth by providing opportunities for a stronger timber industry (USDA 2022b).

Impact of Timber Management on Ecological Integrity.

Commercial harvesting on the Bridger-Teton has very little impact on ecological integrity because it annually occurs on less 0.3 percent of the Bridger-Teton. Salvage treatments account for most area treated in recent years. Slightly over 3,000 acres have been salvaged since 1990, and sanitation harvests (removing trees infected by disease or insects) have occurred on about 2,400 acres, which represent a small fraction of the acres affected by bark beetles and fire.

Clearcutting in lodgepole pine stands occurred on just over 2,000 acres since 1990. All clearcut patches are less than 40 acres, with an average size of 17 acres. Clearcutting and clearcutting with reserves replicate the natural regeneration of lodgepole pine following stand-replacing fires. Generally, natural regeneration of lodgepole pine is vigorous following harvest. Regeneration surveys are conducted following harvest, and if the stocking is below the desired level after 3 years, they are planted.

Local effects of timber harvesting include, but are not limited to, the following: soil compaction, erosion, noise, dust, and spread of noxious weeds, all of which are minimized or mitigated through current forest plan standards and guidelines and design features in decision documents.

Some positive contributions of timber management to ecological sustainability include: improving horizontal heterogeneity, restoration of historical conditions, reduction of fuels, and improving growing conditions of tree species at risk.

Impacts of System Stressors.

Climate change, insect outbreaks, disease and landscape scale wildfires are the primary stressors that affect timber management. Warmer and drier summers stress trees and make them more susceptible to bark beetles. Periods of severe drought are usually followed by landscape scale bark beetle outbreaks as happened in the early 2000s. White pine blister rust is a major stressor on whitebark pine, which reduces cone production, reduces resistance to bark beetle attack, and usually kills the tree. Large wildfires reduce the amount of live timber available for harvest, which is partially offset by salvage; however, salvage does not count toward the Bridger-Teton Forest Plan harvest goals. Nevertheless, salvage counts toward the Bridger-Teton annual timber targets. Long rotation ages for tree species on the Bridger-Teton mean trees that regenerate following fire will not reach merchantable size for at least 60 years.

Multiple, interacting stressors, such as drought, bark beetle outbreaks and wildfires, may result in regeneration failures and conversion from conifer forests non-forest cover types such as grass/forbs and shrubs, or may favor regeneration of aspen. On the Bridger-Teton, foresters observed lower rates of natural regeneration of lodgepole pine following repeated, interacting disturbances of MPB outbreaks and large fires. A few research papers document altered tree regeneration patterns following multiple disturbances including fires following bark beetle outbreaks and repeated fires (Stevens-Rumann et al. 2022).

Need for Ecological Restoration.

The current forest plan does not address ecological restoration. There is a need for restoration in Douglas-fir, aspen and whitebark pine forests, as many are outside of the NRV or are threatened by stressors. Future disturbances such as wildfires and insect or disease outbreaks may create a need for recovery and restoration (USDA 2021).

Outdated Standards and Guidelines in the Current Forest Plan

A few of the existing standards and guidelines are outdated and need to be revised. For example, the Old Growth Standard does not have a definition of old growth forests, and it is not consistent with the current understanding of disturbance ecology (USDA 2023f). The Silviculture System Standard defines which silvicultural practices are allowed by forest cover type, but it does not allow for changing conditions, adaptation, or new silvicultural treatment options.

The areas mapped in the current plan based on DFC have not been updated following the 2001 Roadless Rule (36 CFR 294). Specifically, IRAs cover large areas within the DFCs where timber harvesting is scheduled (1B, 7A, and 10).

Non-Timber Forest Products (NTFP)

Key Takeaways

- The majority of the non-timber forest product (NTFP) permits sold on the Bridger-Teton are for firewood and Christmas trees.
- Illegal harvesting of NTFP occurs, especially near major population centers.
- Resource damage caused by accessing and harvesting NTFP is a concern.
- Some NTFP could be harvested at unsustainable rates, but the amount of NTFP that are legally or illegally harvested without a permit is not known.

Introduction

Non-timber forest products (aka, special forest products) include, but are not limited to, the following: bark, berries, boughs, bryophytes, bulbs, burs, Christmas trees, cones, ferns, firewood, forbs, grasses, mushrooms and other fungi, nuts, pine straw, roots, sedges, seeds, shingle and shake bolts, transplants, tree sap, wildflowers, fence material, mine props, posts, poles, and rails (USDA 2020b). Gathering occurs for both commercial and non-commercial personal use reasons. For tracking purposes, special forest products fall into two categories 1) convertible and 2) nonconvertible timber products.

Convertible timber products are those that can be “converted” into cubic feet measurements of solid wood volume and they include: firewood, poles, posts, rails, fence stays, mine props and bow staves. Convertible timber produces contribute to the total volume harvest reporting.

Non-convertible timber products do not directly convert into cubic feet measurements and include: Christmas trees, tree sap, boughs, bark, cones, burls, bark, shingle/shakes, and transplants. This category also includes botanical products including: berries, bryophytes, bulbs, ferns, forbs, grasses, nuts, pine straw, roots, sedges, seeds, wildflowers, mushrooms, and shrubs.

Status and Trends

A personal-use or commercial forest products permit must be purchased for special forest products. A collection of limited quantities of some products for personal use without a permit is allowed. Standard and minimum rates and free-use limits are established by the Bridger-Teton Forest Supervisor, and they are published as a supplement to the Forest Service Manual. The most recent supplement for special forest products on the Bridger-Teton was approved in 2020 (USDA 2020b). In the last 10 years (2013-2022), permits were issued for: firewood, posts, poles, Christmas trees, boughs, cones, foliage, mushrooms, roots, transplants, wildflowers and seed. An average of 10,239 cords of fuelwood are sold per year (See Table 37). The amount of fuelwood permits sold has been increasing in the last 10 years. An average of 2,348 Christmas trees permits are sold each year. The number of Christmas tree permits sold has been declining from a high of 3,110 in 2013 to 885 in 2022. The Bridger-Teton sells an average of 186 tree transplant permits per year, primarily aspen and lodgepole pine. There has been a declining trend in the number of transplant permits sold from 323 in 2013 to 173 in 2022. Pounds of boughs sold fluctuated between 0 and 750 per year with an average of 296. Other permits issued include foliage (average 8 lbs./year) and wildflowers (average 19 lbs./year). Very few permits were issued for: mushrooms, roots, cones, and seed.

Table 37. The 10-year average amounts of special forest products sold on the Bridger-Teton (2013-2022)

Product	Unit Of Measure	10-year Average
Boughs	Pounds	296
Christmas Trees	Piece	2,348
Cones-Dry	Bushels	1
Foliage	Pounds	8
Fuelwood	Cord	10,239
Mushrooms	Pounds	0
Post & Poles	Piece	4,012
Roots	Pounds	13
Transplants	Piece	186
Wildflowers	Pounds	19
Seed	Pounds	410

Firewood gathering is highly valued in the small farm and ranch communities as it serves as the primary, and in many homes, the only source of heat. It is likely this will continue in the future as demand for firewood is increasing and it is considered an annual chore or ritual, that is ingrained in the farming and ranching culture of Wyoming (USDA 2022).

Other commercial permits include: mushrooms, wildflowers, seeds, roots, and cones. The amounts vary from year-to-year with many years when no permits were sold. The Bridger-Teton allows “free use” of these products for incidental personal use for values up to $20. Since no permit is required, the Bridger-Teton has no way of tracking the quantities of botanical products harvested from the Bridger-Teton. The Bridger-Teton is aware that many users of the Bridger-Teton collect all sorts of forest products without a permit. This has been occurring on national

forest lands ever since they were established and the Bridger-Teton considered it is a traditional use that management is reluctant to restrict.

Currently, only Christmas tree permits may be purchased online, however, the USFS is in the pilot testing phase of online permitting for all personal-use permits.

Illegal harvesting of special forest products varies by: location, time of year, value of the product and the overall economy. Illegal harvesting is most common on National Forest lands closest to large population centers. Firewood theft increases late in the year as winter approaches and when snow is on the ground. Illegal harvesting also increases when the economy is poor or during a recession.

Another common illegal activity is selling special forest products harvested with a personal use permit or without any permit. The USFS regulations require anyone harvesting a forest product for resale to acquire a commercial product permit. It is well known that many users sell products obtained with a personal-use permit, firewood being the most common example. Many other products are collected and resold without any permit. For example, morel mushrooms have a very high value and they are frequently collected without a permit and resold.

Being able to harvest: firewood, posts, poles, Christmas trees, and some fruits (e g., huckleberries) is important for cultural identity and a sense of place to the families and communities surrounding the Bridger-Teton.

Resource damage caused by harvesting special forest products is a concern. Rutting and ground disturbance caused by driving off system roads lead to soil erosion and development of “user created” roads and trails, which can lead to further erosion from continued motorized use. Stream and wetland crossing with motorized vehicles causes damage that may remain for extended periods. In addition, there are limited funds available to repair or remediate these damages. A few special forest products, especially fuelwood, are being harvested at unsustainable rates near larger population centers forcing people to drive further into the Bridger-Teton and further away from system roads. There may be a need in the future to close areas to fuelwood harvesting to protect other resource values such as wildlife habitat and soils.

Other NTFP that could be harvested at unsustainable rates include mushrooms, seeds (e.g., sagebrush seed in the 1990s), or any other special forest product that may be determined to be of high value in the future. An example of a highly valued forest product is pacific yew, which was harvested way beyond sustainable levels in the Pacific Northwest in the 1990s when it was discovered to be a treatment for cancer (yew does not occur on the Bridger-Teton). Fortunately, a synthetic replicate of Taxol, the chemical in yew, was developed and harvesting of yew bark declined (National Cancer Institute, 2015).

The economic value of NTFP to the local economy is small and difficult to quantify, since most are for personal use. The two exceptions are fuelwood and morel mushrooms that are often harvested by individuals or businesses for resell in the local economies; however, the USFS does not track economic contributions of these products.

The current forest plan does not contain any specific direction regarding NTFP. Current management of NTFP is at the district level and, therefore, may vary across the Bridger-Teton. The timber staff is responsible for determining rules and regulations for NTFP permits by identifying areas where harvesting is allowed and for taking the lead on NEPA analysis. Currently, there is only one area identified on the Bridger-Teton for cutting posts and poles on the Blackrock District. Lack of capacity to conduct NEPA is a reason for lack of additional areas

specifically for harvesting NTFP. Digging of trees for transplant is allowed by manual methods only adjacent to open system roads as displayed on the Motor Vehicle Use Map (MVUM). No areas were specifically designated for commercial or mechanical digging of trees for transplant. A personal use or commercial permit is required for harvesting the following: firewood, posts, poles, rails, and transplants. Occasionally, free-use areas are identified for harvesting firewood. Salvage of dead trees for firewood is a major component of commercial timber sale contracts on the Bridger-Teton.

Range Management

Key Takeaways

Range management plays a vital role in the sustainability of our native rangelands both on and off National Forest System Lands. Domestic livestock grazing on rangelands contributes to the economic diversity and sustainability of: Sublette, Lincoln, and Teton Counties (Taylor et al. 2007).

The most important issues, concerns and opportunities related to range management are the collaborative management of grazing in a sustainable fashion. On the Bridger-Teton, the Bridger-Teton staff manage grazing with a holistic approach that balances the needs of: livestock producers, wildlife, fisheries, water quality and local communities that depend on these lands for prosperity. This is accomplished by engaging grazing community partners including the: NRCS, BLM, WGFD and local Soil and Water Conservation Districts. Currently, the Bridger-Teton staff use an interdisciplinary approach to manage grazing using the best available science.

Summary

Livestock grazing can act both as a driver and stressor of ecosystems and both support or compromise ecological integrity. Timing, frequency, duration, and intensity of grazing are critical factors that determine its effects on the landscape. These factors influence how grazing affects plant communities, ecosystem function, and overall landscape health. Other disturbances, such as fire and drought, can further interact with grazing to influence ecosystem dynamics. Grazing management can serve as an effective tool for vegetation manipulation, removing fine fuels and contributing to more manageable fire behavior (Ratliff et al., 2022). Domestic grazing that does not consider timing, frequency, and duration, and does not provide adequate plant recovery can result in an increase of annual grasses and forbs, nonpalatable perennial grass species, bare ground, erosion, and the spread of nonnative species, which can compromise ecosystem integrity. Unmanaged grazing can adversely affect pollinators, which require habitats rich with floral resources and continuous blooming from spring to fall. Ecosystems on Bridger-Teton, which experience the greatest impacts from grazing include Riparian, Subalpine Forb, and Sagebrush Steppe. The cumulative effects of grazing, fire, and climate are important to recognize their combined impacts on the ecosystem. However, current management efforts on NFS lands aim to prevent negative ecological effects on ecosystems through rotational grazing and other sustainable practices to protect plant communities and overall ecosystem health. Grazing effects are measured through effectiveness monitoring. Effectiveness monitoring is used to identify whether the actual effects of implementing a grazing practice are consistent with the effects originally projected and/or whether adjustments are needed to attain intended outcomes. The methods used to conduct effectiveness monitoring include establishing and monitoring long-term or permanent monitoring sites such as: MIM sites, riparian photo points,

greenline, species composition and groundcover transects, as well as habitat monitoring for Greater Sage-grouse and other species of concern.

Domestic livestock grazing occurs on National Forest System Lands as part of the USFS's multiple use mandate. The 36 CFR 222.2 requires forage producing National Forest System Lands be managed for livestock grazing. Term Grazing Permits are used to manage grazing on Nation Forest Service System Lands. The Term Grazing Permit is the implementation tool for project specific National Environmental Policy Act (NEPA) decisions. The Term Grazing Permit authorizes kind and class of livestock, numbers of livestock and season of use. The Term Grazing Permit also includes limitations on allowable vegetation use and it implements any other measures necessary to ensure grazing occurs at a sustainable level and coexists with other multiple uses.

Western Wyoming's high-altitude, long winters, and short growing seasons require more acreage for economically sustainable grazing operations. This, combined with the small percentage of private land holdings in the three counties, places a high demand on public land for grazing.

There are currently 155 grazing allotments on the Bridger-Teton. There are 93 active allotments, 15 forage reserve allotments, 0 vacant allotments, 18 vacant unavailable allotments, and 29 closed allotments (Figure 29). Vacant allotments are allotments that do not have an active permit but are considered available for use. Vacant unavailable allotments are allotments that do not have an active grazing permit and are not available for use due to resources concerns, pending closures, or other reasons. Closed allotments are allotments that were formally active but for which a decision has been made though the environmental analysis process to no longer make it available for use and occupancy by permitted livestock. The land retains the designation of closed in Forest Service databases for historical tracking purposes. The 93 active allotments, provides 223,845 head months of occupancy, to 105 permittees, encompassing over 1.5 million acres on the Bridger-Teton. Of the 223,845 head months, 31,807 cattle and 39,945 sheep are permitted for an average 3 month grazing season.

Agriculture has been one of the only consistent, year-round economic industries in the three-county area from Wyoming's territorial days to the present. (The other two area industries are tourism, which is traditionally seasonal but in recent years has become more stable, and energy extraction, which is fraught with economic boom and bust.) Critical to agricultural sustainability is the access to public lands grazing. Ranches that remain in agriculture and, therefore, maintain open space, are essential for wildlife by providing an open route for migration in the fall and the spring as well as for providing winter habitat. Wildlife significantly contribute to the local economy, notably with tourism and hunting.

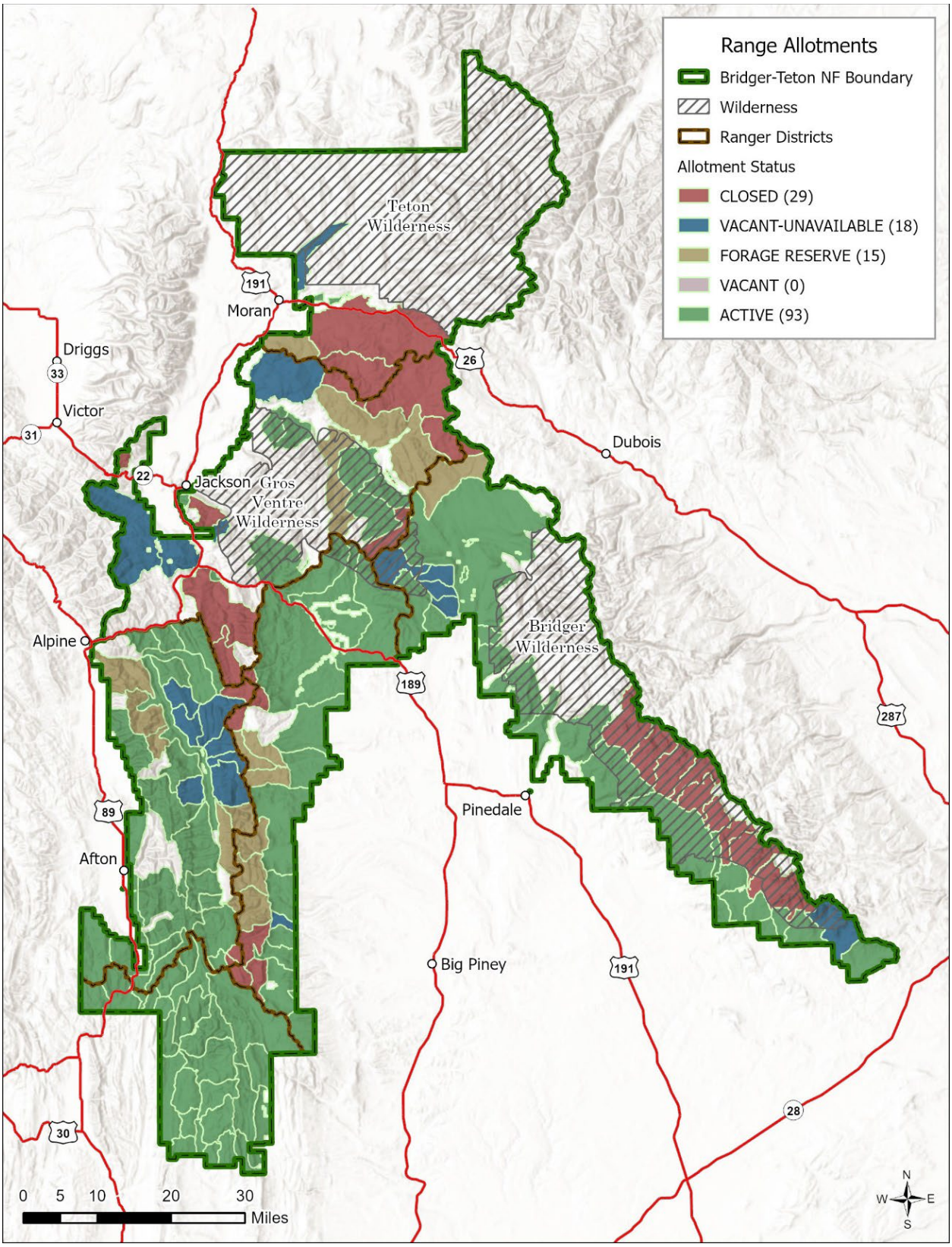


Figure 29. Grazing allotment status map

It has been well documented that when ranches no longer remain in agriculture, and especially if they are sold and subdivided, the open space that is lost is detrimental to wildlife. Maintaining large tracts of lands in working landscapes has been recognized by many groups as a key to sustaining these ecosystems (Taylor 2003). Research by the WGFD indicates that rural development contributes more to the vulnerability of Wyoming Species of Greatest Conservation Need (SGCN) than oil, gas, or wind development (Copeland et al. 2014). The Bridger-Teton staff work closely with grazing and wildlife interests to strike a balance between needs of the core native bighorn sheep herds and domestic sheep grazing. Many of the allotments in the “closed” category were voluntarily vacated by permittees and closed to prevent comingling between bighorn and domestic sheep. The Bridger-Teton staff actively participates in the statewide Bighorn/Domestic Sheep Interaction Working Group.

Allotment Status Changes

Grazing authorizations and the availability of allotments on the Bridger-Teton have undergone significant changes since the signing of the current Land and Resource Management Plan. Large carnivore conflicts, grazing permit waivers back to the Forest Service without preference, and bighorn/domestic sheep interaction/separation have been the three primary drivers of these changes. This has resulted in more than 40 allotments becoming unavailable for permitted livestock grazing. Below is a brief discussion of the disposition of these allotments, separated chronologically and by type of permitted livestock.

Sheep Allotments

The Squaw Creek-Weiner Creek, White Creek-Man Peak, Birch Creek-Star Peaks Allotments were changed to vacant allotment status with no permitted grazing prior to the current Land and Resource Management Plan Decision. This was in response to a lack of industry demand and are not included in the above listed 40 allotments. In 2005, the allotments went through the NEPA process, and the resulting decision designated them as forage reserves.

The forage reserve designation is for allotments that have no current term grazing permits issued for some or all of the available head months and there has been an analysis and subsequent decision to make the allotments available to provide management flexibility when there is a loss of forage availability, or to resolve short-term resource concerns arising from a variety of factors including but not limited to:

- Drought,
- Fire - either prescribed or wild,
- Rangeland restoration activities,
- Litigation or consultation needs,
- Short-term resolution of resource concerns on other NFS allotments. (R4 FSH 2209.13)

In 1999 the North Fork Allotment was waived back to the Forest Service without preference. In 2005 Baldy Lake, North Fork, Middle Fork and Pipestone Allotments were closed after being voluntarily vacated by sheep grazing permittees citing a need for physical separation between Domestic Sheep and Bighorn sheep and inconsistency with Forest Plan DFC 6A language which prohibits livestock grazing.

In 2005 the Upper Grayback/Phosphate and Pickle Pass Allotments along with portions of Grizzly and Corral Creeks Allotments were closed. Separation of Bighorn and domestic sheep was listed as the primary reason for the closure. Also in 2005, North Horse Creek, Mule Creek and Prospect Peak Allotments term grazing permits were waived back to the Forest without preference. These allotments were not restocked citing issues with resource conditions. These three allotments were designated as the Wyoming Range Allotment Complex (WRAC) forage reserve and are available for domestic sheep grazing.

In 2006 the Triple Peak, North Piney, Marten Creek, Bare Mountain and South Fork Sheep Creek Allotments term grazing permits were waived back to the Forest Service without preference citing issues with vegetation conditions at upper elevations leading to sedimentation in cutthroat trout spawning habitat in North Piney Creek and Darby Mountain bighorn sheep/domestic sheep separation. These allotments were vacated to permitted livestock grazing but turned into the Triple Peak Forage Reserve and are available for current domestic sheep grazing permittees of the Bridger-Teton National Forest who are displaced by wildfire or other issues.

In 2012, the Stewart, Deadman, Grizzly Basin, Blind Bull, Blind Trail, Black Canyon and Cabin Creek Allotment term grazing permits were waived back to the Forest without preference and the allotments are currently in vacant unavailable status.

In 2015, Cross Lake, Raid Lake, East Fork, Bunion Creek, and Temple Creek allotment term grazing permits were waived back to the Forest without preference. The allotments were then vacant. Current LRMP direction for the Bridger Wilderness is to close an allotment to scheduled grazing when it becomes vacant. All 5 allotments are now closed.

In 2017, the Elk Ridge, Tosi Creek Rock Creek and Lime Creek Allotment term grazing permits were waived back to the Forest Service without preference. Issues with predation of domestic sheep by large carnivores and the permittees inability to comply with the terms and conditions of the biologic opinion caused the permittee to waive the permits. The allotments are currently in vacant unavailable status, undergoing NEPA to convert to cattle grazing.

Cattle Allotments

The Middle Piney Allotment is very small, has low capacity and has been vacant since before the current Land and Resource Management Plan was signed. The allotment has a history of conflict with recreation.

The permittees on Ditch Creek and Mosquito- Fall Creek experienced livestock mortality from larkspur annually. Livestock losses became financially unsustainable, and the term grazing permits were waived back to the Forest without preference.

Between 2000 and 2009 grazing permits on the Blackrock- Spread Creek, Upper Gros Ventre, Bacon Creek, Fish Creek, Union Pass and Pacific Creek Allotments were waived back to the Forest without preference due to heavy levels of predation by large carnivores. Portions of Bacon Creek, Fish Creek, Union Pass and the Upper Gros Ventre have been placed into forage reserve status with the remaining portions being either closed to permitted grazing or have portions still under active grazing in the case of the Upper Gros Ventre.

In 2011, the term grazing permit associated with the Willow Creek allotment was waived back to the Forest without preference and was closed to grazing in favor of incidental recreation and outfitter/guide use.

In 2024, the permittee on the Munger Mountain Allotment waived the term grazing permit back to the Forest without preference and the allotment was placed in vacant unavailable status. NEPA analysis needs to occur prior to restocking. Also in 2024, the Porcupine Allotment term grazing permit was cancelled for extended personal convenience non-use and the allotment was placed in vacant unavailable status pending future NEPA analysis.

Status and Trends

Two Zones, the East and West Zones, account for 96 percent of the domestic livestock grazing on the Bridger-Teton. The East Zone, Pinedale and Big Piney Ranger Districts have a combined 188 upland trend monitoring sites, 91 Winward Greenline riparian sites, and 24 Multiple Indicator Monitoring riparian sites. New MIM sites are being added in 2024 through joint cooperative monitoring projects. The overall trend of upland and riparian conditions appears to be in a static or upward trend across all allotments with only a few individual sites, less than 5 percent, not meeting desired condition. Sites where recent trend analysis has shown locations that are not meeting desired conditions are being individually addressed at the allotment management level or through site specific NEPA. Overall, historic photos and data across the East Zone indicate dramatic improvements in riparian vegetation, overall stream health and upland conditions (District 2210 Files). Monitoring results for 18 East Zone allotments that have recent upland utilization measurements show the average utilization rate at only 12% with the defined utilization threshold being 40-60% (depending on allotment) and riparian stubble heights averaged 9 inches with the minimum threshold being 4-6 inches depending on allotment. These rates indicate that where allotment data is present, utilization rates are far below established thresholds and well above the minimum threshold for riparian stubble heights. Utilization is measured on key species and is defined as the percentage of use by all herbivores, on current year’s growth, by weight, at the end of the growing season. Use prescriptions expressed as stubble height apply to herbaceous riparian and meadow vegetation. Stubble height is measured on vegetative parts of key species, at the end of the growing season, and expressed as the median or average height of the plants.

The West Zone, Kemmerer and Greys River District have approximately 3,300 rangeland and other monitoring studies. These studies include repeat photography, Ocular Macro Plots, Line Point Intercepts, and Winward Greenlines. These studies indicate that vegetation is at or trending to desired conditions and are mostly associated with sheep allotments with a subalpine forb component (refer to the subalpine forb terrestrial ecosystem section for details on monitoring results and conditions).

Ecosystem stressors on rangeland management that have been identified include climate change, invasive species, and dispersed recreation. Current adaptive management accounts for annual and long-term trends in production. The dramatic increase in dispersed recreation over the past three decades has had a significant impact on grazing management and rangeland vegetation. Large camper cities and associated activities have changed permittees’ abilities to distribute livestock. These large, unmanaged campsites alter vegetation composition and cause disturbance allowing for the introduction of invasive species (See recreation section for additional information). Recreation users often fail to close gates, which also affects cattle distribution, timing and intensity of grazing, and it adds to the difficulty of permit compliance.

(USDA Forest Service District 2210 files 1993 to present.) Invasive species are another stressor on rangelands. The presence of invasive species can: degrade watersheds; decrease biodiversity; decrease forage and habitat for livestock and wildlife; alter fire return intervals; and decrease soil moisture (Rangelandsgateway.org 2023). Invasive annual grasses have been the biggest threat to rangelands on the Bridger-Teton and until just recently they comprised the largest percentage of area infested by invasive species. With the recent decision allowing the Bridger-Teton staff to apply herbicides from the air (USDA 2020a), combined with development of a safer, more effective herbicide, the Bridger-Teton is beginning to make progress in reducing the cover and distribution of invasive annual grasses.

Energy and Minerals

This chapter describes and evaluates energy and mineral resources on the Bridger-Teton. Information used to conduct the Assessment includes public documents and data produced by: Federal and State agencies, internal USFS documents and studies, peer-reviewed scientific literature, company profile websites, USGS maps, Federal regulations, Forest Service manual direction, and personal communication with professionals considered to be knowledgeable in their respective fields.

Renewable Energy

Energy resources including hydroelectric, solar, wind, geothermal and biomass are discussed in this section. Only utility-scale renewable energy development is considered. Power site classification withdrawals and utility corridors also are mentioned due to their relevance to electricity generation and transmission.

Renewable energy resources are managed through a mix of regulatory authorities, but often as special uses under the Federal Land Policy and Management Act 1976.

Key Takeaways

Renewable energy development on the Bridger-Teton does not substantially affect ecological, social, or economic sustainability in the region.

That said, electricity generated from small hydropower plants is locally important to Jackson Hole, Star Valley and adjoining areas of southeast Idaho. There is also substantial technical opportunity for more hydropower along the Bridger-Teton's river corridors. Full development of these resources would have the potential to cause significant ecological impacts and be highly controversial.

There is no utility-scale development of other renewable energy sources and there is limited potential.

The current forest plan does not provide renewable energy guidance and the above-listed hydropower development is directed by overarching Federal law, regulation, and USFS-wide policy. A revised land management plan could address the suitability of different areas of the Bridger-Teton for renewable energy development in a fashion similar to that done for oil and gas leasing.

Summary

Electricity generated from two small hydropower plants on the Bridger-Teton contributes power to Jackson Hole, Star Valley and adjoining areas of southeast Idaho (See Figure 30 for a schematic overview of hydropower). Lower Valley Energy operates the Strawberry Creek run-of-river hydropower installation (1.5 MW) that was originally built in 1951 and the Afton culinary water system conduit hydropower facility on Swift Creek (2.25 MW) that was initially constructed in 1938, abandoned in the 1960's, and reconstructed in 2010 (UW 2025). For comparison, Lower Valley Energy sources the bulk of its 57.6 MW of 'green power' from the Horse Butte Wind Farm (LVE 2025).

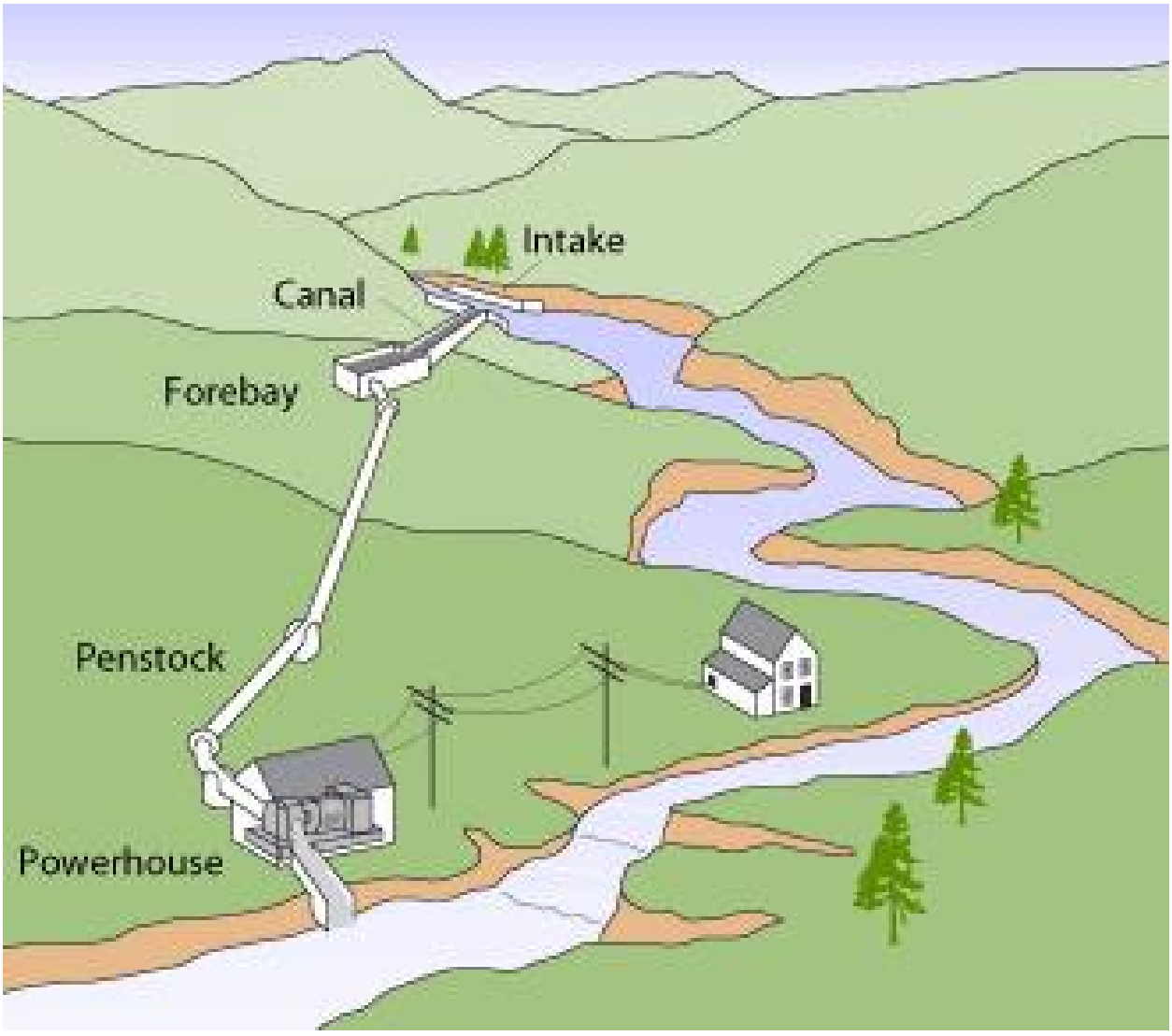


Figure 30. Schematic of Run-of-River Hydropower (DOE 2025)

There are no other types of utility-scale renewable energy development on the Bridger-Teton. Renewable energy did not rise to a level of importance for consideration in the 2022 Socioeconomic Baseline Report for the Bridger-Teton National Forest. No project proposals were received or are seen on the horizon. The technical opportunities for renewable resources,

such as wind, exist to some extent, but they are limited by other land management factors (e.g., Roadless Areas, Wilderness, steep slopes, etc.).

Renewable energy development would have similar impacts on the ecosystem as fossil fuel development (surface disturbance for facilities, road building, vehicle traffic, etc.), although it would incrementally ameliorate rather than exacerbate climate change. Hydropower development would have notably additional impacts to rivers. Based on these direct impacts, new proposals could elicit public concern similar to that of natural gas development. Tens of thousands of public comments received during consideration of oil and gas leasing and drilling proposals over the current forest plan period indicate the Bridger-Teton's mountainous landscape tends to be valued for its recreational opportunities, sense of wild place, and intact ecosystem rather than its potential to produce minerals and energy.

Status and Trends

Hydroelectric power generation by Lower Valley Energy is the only renewable energy development on the Bridger-Teton. The Strawberry Creek run-of-river hydropower installation and the Afton Culinary Water System Hydroelectric Facility are classified as small hydropower by the U.S. Department of Energy and they are permitted as special uses under the authority of the Federal Land Policy and Management Act of 1976. There are also power site classification withdrawals[8] along river corridors throughout the Bridger-Teton, indicating substantial additional hydropower potential. Full development of these resources via dam construction would have the potential to cause significant ecological impacts and be highly controversial. Rivers and lakes with power site withdrawals include the following: Buffalo Fork, Gros Ventre River, Fish Creek, Snake River, Game Creek, Greys River, LaBarge Creek, Fontenelle Creek, Hoback River, Dell Creek, Cliff Creek, Granite Creek, Green River, Tosi Creek, Crow Creek, Roaring Fork, New Fork Lake, Willow Lake, Fremont Lake, Half Moon Lake, Pole Creek, Fall Creek and Boulder Lake. These withdrawals can be viewed on the Forest Service ALP Land Status and Encumbrance interactive map. Several are in administrative conflict with later Wild and Scenic River designations.

There is some limited potential for geothermal power generation on the Bridger-Teton. The National Forest is adjacent to the main geothermal resource in the State (Yellowstone Park) and there is moderately elevated geothermal potential around Jackson Hole and Star Valley. The rest of the Bridger-Teton has lower favorability (NREL 2025). Notably, the 2013 U.S. Department of Energy analysis of renewable energy potential of the National Forest System excludes much of the Bridger-Teton from potential development through screening criteria, which include the presence of Wilderness, Inventoried Roadless Area, and USFWS designated critical habitat, steep slopes etc (Zvolanek et al. 2013).

The Bridger-Teton has substantial wind resources along the crests and eastern flanks of mountain ranges. After the same screening as above, however, the Department of Energy highlights only 247 acres on Deadline Ridge as potentially suitable (Zvolanek et al. 2013). Natural gas is produced by ExxonMobil from this same location. This could provide both opportunities and challenges for wind development logistics at the same location.

[8]The Secretary of the Interior has authority to withdraw lands in Federal ownership, effectively removing an area from settlement, sale, location or entry for the purpose of limiting activities to maintain other public values in the area or to reserve it for a particular public purpose or program.

The Bridger-Teton does not receive enough solar radiation to be a prospective for utility-scale solar power generation, as modeled by the U.S. Department of Energy in 2013 (Zvolanek et al. 2013).

Sublette and Lincoln County Commissioners have shown interest in researching the feasibility of biofuel production using biomass generated by Bridger-Teton management projects. However, the density of biomass resources may not be sufficient to support energy development. Findings in a planned report on the subject can still be considered once it is completed.

There are bulk power transmission lines serving the various communities in and around the Bridger-Teton (Pacificorp, Bonneville Power Administration and Lower Valley Energy). Several of these traverse the National Forest. The most substantial lines go over Teton Pass and through the Snake River Canyon. However, there are no high voltage corridors passing through the Bridger-Teton that would be needed to support more intensive renewable energy development. The closest Section 368 designated energy corridor (2005 Energy Policy Act) passes 40 miles south along Interstate 80. Also, an unbuilt section of the Gateway West Transmission Line Project would pass within 10 miles of the Bridger-Teton's southern boundary between Kemmerer and Cokeville, Wyoming (new 500 kV minimum voltage power line).

Energy production is a societal necessity. The proportion sourced from renewable energy projects will likely grow in the United States in the coming decades. Nevertheless, the local, regional and national public may express a desire to displace them away from the GYE and onto lands perceived as less intact/desirable/important.

The 1990 forest plan does not provide management guidance on renewable energy development. There have not been any large renewable energy project proposals over the current plan period, and none are known to be planned. However, there is opportunity to write renewable energy guidance similar to that done for fossil fuel and mineral management on the Bridger-Teton that could set the framework for management of potential future renewable projects.

Fossil Fuels and Mineral Resources

This section discusses fossil fuel and mineral development on the Bridger-Teton.

Key Takeaways

Development of fossil fuels and minerals on the Bridger-Teton does not substantially affect regional ecological sustainability due to the small amount of activity. This is influenced by the fact that a large majority of the Bridger-Teton is legally unavailable for development. It does, however, have a small to moderate impact on social and economic sustainability as the Bridger-Teton program area with the second largest economic impact (after recreation).

Natural gas production from the Bridger-Teton is locally important to the communities of Big Piney, LaBarge and Kemmerer. It is also relevant to the tax revenue of Sublette and Lincoln Counties. In addition, it is important to understand the statewide economic context in which mineral taxes are critical to Wyoming's revenue structure. The amount generated from the Bridger-Teton is annually important to some county services, but it is small in comparison to overall oil and gas royalty revenue in the State of Wyoming.

The current oil and gas management approach, as written in the 1990 forest plan, is a technically adequate framework to administer development activities and address natural resource issues. However, it is out of step with the 2009 Wyoming Range Legacy Act mineral withdrawal, agency no-lease decisions over the last 20 years and public sentiment supporting both of these. A new oil and gas leasing availability analysis with supporting documentation, such as a reasonably foreseeable development scenario, would be needed to guide future leasing. A leasing availability decision often occurs within a forest plan, though it is not required by the 2012 Planning Rule.

Summary

The USFS manages fossil fuel and mineral development in coordination with the U.S. Department of the Interior, Bureau of Land Management. The BLM has final authority over the Federal mineral estate underlying USFS administered lands. The USFS authority varies from no discretion regarding initial entry and claim staking on open lands under the 1872 Mining Law to full control of whether, where, and with what conditions to consent to the BLM leasing of oil and natural gas in accordance with the 1920 Mineral Leasing Act. The USFS manages mineral materials (e.g., common variety construction aggregate and landscape stone) at its own discretion according to the 1947 Materials Act.

Energy development on the Bridger-Teton is dominated by natural gas production. Although the level of development is far exceeded by that on adjacent BLM lands, it is still the second largest economic driver on the Bridger-Teton (next to recreation) and it contributes to social and economic sustainability in the area. It does so by providing direct jobs, driving related economic activity, and by collecting mineral-specific taxes, royalties and rents that fund county, state, and federal government services. Development negatively impacts the ecosystem to varying degrees of significance while active, although on-the-ground impacts are mitigated over the long-term via reclamation. Operations on the Bridger-Teton also incrementally contribute to global climate change impacts that cannot be fully mitigated.

Despite high geologic potential for oil and gas resources and a 1990 forest plan that allows for substantial development (USFS 1990b), the Bridger-Teton has a very small amount of leasing and production. Over the past two decades, this was due to local, regional, and national public opposition rooted in the social value of undeveloped lands in the GYE. Local public sentiment is also informed by Wyoming's early 2000's oil and gas boom that resulted in extensive new development of open spaces adjacent to the Bridger-Teton (e.g., Pinedale Anticline) and its associated effects, such non-attainment of the National Ambient Air Quality Standard for Ozone (Clean Air Act). Since adoption of the 1990 forest plan, legislation passed by Congress and final agency management decisions generally have mirrored public sentiment against new leasing.

Status and Trends

The Bridger-Teton National Forst has substantial technical geologic potential for oil and gas exploration and development. For example, the southwestern portion of the forest is within the Wyoming Thrust Belt, a province in which the U.S. Geological Survey most recently estimated mean undiscovered, technically recoverable conventional resources of 26 million barrels of oil and 700 billion cubic feet of gas (USGS 2017). However, a large majority of the Bridger-Teton is unavailable for mineral development (over 80 percent). This is mostly due to actions by Congress, with some additional lands found unsuitable to oil and gas leasing by the Secretary of the Interior and the USFS (See Table 38 and Figure 31).

Table 38. Lands legally unavailable for mining and oil and gas development

Withdrawn Area[1]	Approx. Acres[1] (GIS polygons)	Proportion of the Bridger-Teton[1] (~3,461,256 acres total)
Bridger Wilderness 1964	425,743	12%
Teton Wilderness 1964	583,434	17%
Gros Ventre Wilderness 1984	285,758	8%
Shoal Creek WSA 1984	32,339	1%
Palisades WSA 1984[2]	133,258	4%
Wyoming Range Legacy Act 2009	1,214,630	35%
Krug Memorandum 1947[3]	35,497	1%
Subtotal	2,675,162 acres withdrawn	78% of the Bridger-Teton
Unsuitable for O&G in Forest Plan (USFS discretion)	76,400	2%
Total	**2,751,562 acres**	**80% of Bridger-Teton**

1 These numbers do not include other mineral withdrawals for administrative, recreation and power sites. These are normally withdrawn from appropriation under the 1872 Mining Law, but not necessarily the 1920 Mineral Leasing Act because leasing is discretionary for the land management agency.
2 Wilderness Study Areas are generally made unavailable to leasing by the 1987 Federal Onshore Oil and Gas Leasing Reform Act, but the legislation also allows for exceptions. In this case, the 1984 Wyoming Wilderness Act withdrew the Palisades WSA from entry under the 1872 Mining Law, but specifically left it open to O and G leasing.
3 In 1947 the Secretary of the Interior Krug Memorandum withheld lands north of the 11th Standard Parallel and outside of the Teton Wilderness from oil and gas leasing, with limited exception in T.45.N, R.113.W, 6th PM. This order also puts stipulations on leasing other lands within the Bridger-Teton (northern half of the Bridger-Teton).

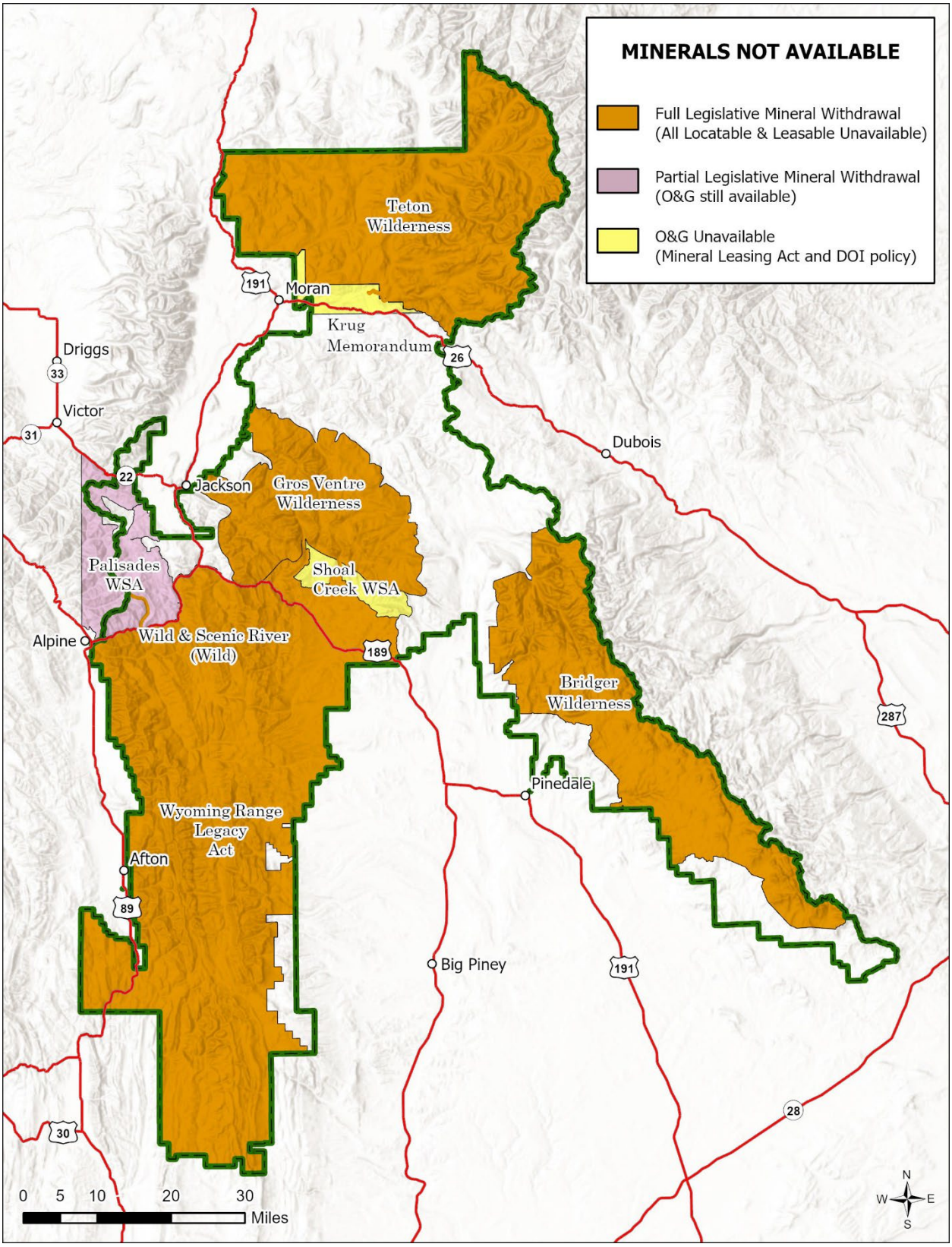


Figure 31. Minerals not available for development on the Bridger-Teton

The forest plan does not account for the large 2009 legislative mineral withdrawal covering the greater Wyoming and Salt River Ranges. That is, many lands on which the forest plan encourages development can no longer be mined or drilled due to congressional action. The Bridger-Teton already implements the legislation, but this is a major change to the management guidance as written in the 1990 forest plan.

Since passage of the 1920 Mineral Leasing Act, almost all of the Bridger-Teton has been under an oil and gas lease at one point. The only lands that have never been leased are those along the core of the Wind River Range. Most of this leasing did not result in actual drilling or production. Today there are about 31,171 acres leased (~1 percent of the Bridger-Teton), mostly from leases obtained in the 1960s and 1970s. One of the existing leases was issued in 1991 and BLM applied the appropriate stipulations listed in the 1990 forest plan. There is no actual development on this lease. It is held active by production elsewhere in the unit. A unit is a BLM grouping of leases formed to efficiently produce oil and gas resources from a common reservoir which, in this case, is structurally trapped natural gas in the Madison Limestone.

Although there has been little new leasing on the Bridger-Teton since 1990, the USFS and BLM have proposed new leases, completed the analysis process, and even made preliminary decisions to lease. This was encouraged by the forest plan and the newly written USFS oil and gas regulations (also completed in 1990). Some lands were successfully leased during the 1990s, though all but one of these leases expired without development (See buyouts below). The most substantial oil and gas leasing decisions by the USFS were to *not* authorize BLM leasing where the forest plan envisioned it (Hoback Basin/Upper Green River Basin/Union Pass/Moccasin Basin in 2003 and the Wyoming Range in 2018). These final decisions came after the public initiated BLM and USFS administrative reviews of initial leasing decisions. Thousands of public comments gathered through the NEPA process also were influential (individuals, Congress people, and varied outdoor organizations of outfitters, recreationists and environmentalists). The strongest theme among these comments was that oil and gas production would compromise the undeveloped character of the area and the associated recreational opportunities; especially when considering the adjacent highly developed Green River Basin. In the same vein, over the last 15 years conservation-oriented interests bought a substantial number of oil and gas leases that pre-dated and were within the boundary of the Wyoming Range Legacy Act. The new owners then allowed leases to expire and the mineral withdrawal to take effect.

Overall, leasing resulted in 158 total oil and gas wells being drilled on the Bridger-Teton between the years 1927 and 2009 (See Figure 32). This includes nine wells drilled since implementation of the 1990 forest plan (WOGCC 2025). Most recently, the USFS and the BLM approved two drilling permits in 2018, although these wells were not drilled. One hundred forty-four of the drilled wells were plugged and abandoned and 14 natural gas wells remain active; this is a relatively small amount of development activity. In comparison, there are thousands of producing oil and gas wells on adjacent BLM, State, and private lands in the Green River Basin, including approximately 3,800 wells in the Pinedale Anticline alone.

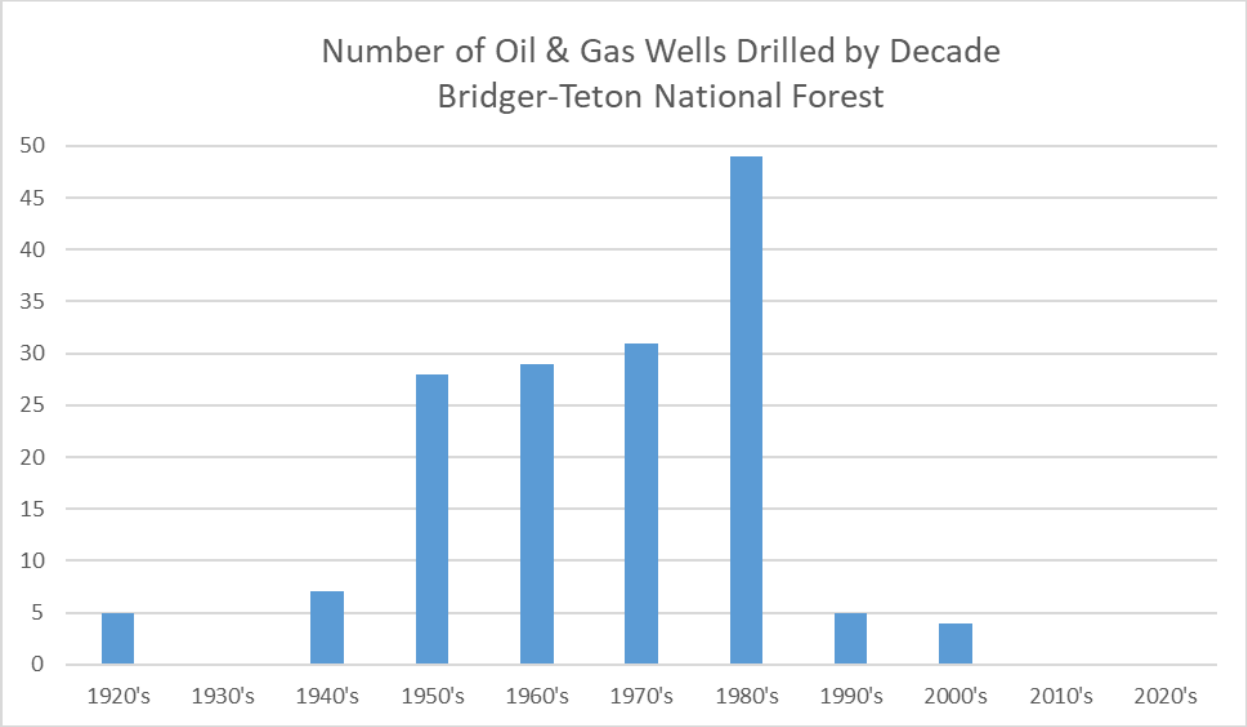


Figure 32. Number of oil and gas wells drilled by decade on the Bridger-Teton (WOGCC 2025)

In spite of minimal development, the value of natural gas currently produced from the Forest is notable. In 2019, total production sales were $99 million with Federal royalties, fees and rentals of $4.7 million (USFS 2022b). About half of this Federal revenue went back to the State of Wyoming. The State also applied a severance tax to the production value (6 percent). Sublette and Lincoln Counties collected property tax on the production value (1.2 percent in Sublette County). The above revenue stream from the national forest is mostly the result of ExxonMobil operations that began in the 1980s and have an estimated life of over 100 more years (USEPA 2018). Again, this amount is small in the context of overall oil and gas activity in Wyoming. For example, the 16.7 billion cubic feet of gas produced from BTNF 2019 (USFS 2022) is a tiny fraction of the 1,562 trillion cubic feet produced in Wyoming overall (in 2017) (WOGCC 2019).

The active well operators on the Bridger-Teton are ExxonMobil (multinational corporation) and GPO Operations (very small company based in LaBarge, Wyoming). ExxonMobil has the most substantial field of 10 wells producing abnormally large quantities of a distinctive natural gas mixture (CO_2, hydrogen sulfide, methane, and helium) (USEPA 2018). These wells are part of a field that produces 20 percent of the world's helium supply. GPO has four wells that produce a small amount of methane and natural gas liquids for about 8 months of the year (WOGCC 2025). In 2021, GPO bought the operation from True Oil, the company that originally leased the oil and gas and drilled the wells. True Oil never fully developed the leases as planned due to marginal economics.

In addition to local gathering lines servicing the above wells, there is a natural gas distribution pipeline run by Lower Valley Energy that passes through the Bridger-Teton along the Hoback River between the Green River Basin and Jackson, Wyoming.

Construction aggregate is also produced from the Bridger-Teton in locally meaningful amounts. This is primarily from two larger pits. It is used by other government entities on public road

projects (Grand Teton National Park, Wyoming Department of Transportation, and Sublette County Road and Bridge Department). Disposals of: sand, gravel, landscape stone and other mineral materials from the Bridger-Teton are done at the USFS discretion when in the public interest. The above-described Wyoming Range Legacy Act does not prohibit use of mineral materials.

The final mineral of economic note is sodium. There is one sodium lease with minor production of sodium brine from a small, intermittently operated pond. In the past it has been used as treatment on haul roads at the Smoky Canyon phosphate mine (Caribou-Targhee National Forest and BLM managed lands adjacent to the Bridger-Teton).

Other minerals on the Bridger-Teton are not currently socioeconomically important (USFS 2022), but there are relevant occurrences and past work.

Although there are no coal leases or operations on the Bridger-Teton today, coal was historically produced from small to medium sized underground mines. For example, the Blind Bull Mine operated from 1933-1956 and it produced 317,723 tons of coal. Additionally, there are large areas of coal classification withdrawal on the Bridger-Teton. These pre-date the Mineral Leasing Act and were meant to remove coal from open entry under the Mining Law due to its strategic value to the United States.

The Phosphoria Formation underlies much of the Bridger-Teton, and is mined for phosphate in large, modern operations on adjacent lands (e.g., Smoky Canyon Mine). Phosphate was reserved by the United States in various land patents and phosphate classification withdrawals that cover much of the Bridger-Teton. However, there has been no production from the forest. A substantial amount of the prospective area is now unavailable for disposition under the Mineral Leasing Act due to the 2009 Wyoming Range Legacy Act.

The Phosphoria Formation also contains vanadium and rare earth elements. These are critical elements, which are those determined by the U.S. government to be at high risk of supply chain disruption or to serve an essential function in energy technologies. There are no proposals to develop critical elements on the Bridger-Teton and the same mineral withdrawal impacting phosphate availability applies to them as well. Notwithstanding the lack of current proposals, in 2018 a company staked claims for vanadium (a critical element) hosted in the Phosphoria Formation east of Afton. The company (Forum Energy Metals) published a press release (available here) when they realized their claims were invalid (Forum 2018). BLM did not initially catch the problem when the claims were recorded because the withdrawal was not yet showing on Master Title Plats.

There is currently no production of metals or other locatable minerals from the Bridger-Teton. Most public inquiries about mining pertain to prospecting for recreational purposes (e.g., gold panning). The USFS does not, however, officially recognize any level of mineral exploration or mining as recreation. All activities are managed as entry under the Mining Law. People often intend to prospect along the Greys River or some other location withdrawn from mineral entry. In these cases, the public is re-directed to open areas of the forest. Where open to entry, USFS authorization is not usually needed for low-impact prospecting with hand tools. If there is doubt about the significance of impacts, a mining claimant will submit a Notice of Intent. With this information the USFS determines if a Plan of Operations and further analysis and compliance with the NEPA and other laws is needed.

The most notable historic metal production on the Bridger-Teton occurred at the Lake Alice District in Lincoln County from a deposit characterized by stratabound copper-silver-zinc hosted in the Triassic to Jurassic age Nugget Sandstone and the Gypsum Spring member of the Jurassic Twin Creek Limestone. Some ore was shipped from the Lake Alice District from 1914-1920 and in 1942. According to recent correspondence with the Wyoming State Geological Survey (2025), exploration occurred as late as the 1980s with multiple drill holes by Kennecott Copper Corporation. There are no active mining claims in the Lake Alice District today and the area is withdrawn from mineral entry.

There also have been relatively small-scale attempts at mining placer gold along the Snake, Gros Ventre and Hoback Rivers. These placer deposits contain very low overall gold grades, but may have narrow lenses with higher concentrations. This gold is sourced from Tertiary age conglomerates such as the Pass Peak Formation. The gold is colloquially known to be very fine grained and difficult to extract through the normal placer gravity methods. High gold prices in the early 2000s generated interest and claim staking targeting these formations and streams draining them in and around the Hoback Basin. No meaningful operations resulted and the claims lapsed. Many of these areas are now withdrawn from mineral entry, though the Gros Ventre River remains open.

Notwithstanding the lack of gold mining success on the Bridger-Teton, there are a handful of unpatented mining claims that are kept active via annual payments to the BLM instead of doing on-the-ground exploration and development work. Several of these are on open lands along Pacific Creek just outside of the Teton Wilderness. Another is on Fish Creek Mountain in the Wyoming Range (it pre-dates the 2009 Legacy Act mineral withdrawal). Before approval of any future plan of operations on this particular claim, a validity exam should be completed. This is for several reasons including: 1) the claim has lacked exploration and development activity through periods of high gold price, 2) the probability of an economic lode mining operation is lowered due to the small area claimed and limited obvious mineralization, and 3) the mineral withdrawal would apply if the claim lapses or it is found invalid.

Other metal occurrences on the forest include:

- Molybdenum mineralization in the Southern Wind River Range around Temple and Schiestler Peaks. This is a vein-type occurrence associated with the Bears Ears and Louis Lake batholiths. WSGS Mineral Report 55-3 (Wilson 1955) described the location and did not consider it economically significant at the time, though it did recommend exploration. Exploration and minor mining and/or bulk sampling of the deposit took place intermittently from 1950’s through the 1980’s, with the last mining claim case being closed by the BLM in 1989. Cleanup of abandoned equipment and hazmat was completed in the 1990’s through coordination of the Forest Service and Wyoming DEQ. This area was withdrawn from new mineral entry by the 1964 Wilderness Act.
- Copper sulfide veins hosted in granite, schist and diorite at the early 1900’s workings of the Buffalo Fork prospect (Antweiler 1989). This area was withdrawn from mineral entry by the 1964 Wilderness Act
- Chromium, nickel, cobalt, lead, copper, tin, vanadium, molybdenum, and silver in the Gros Ventre range (Marsh 1984). This area was withdrawn from mineral entry by the 1984 Wyoming Wilderness Act.
- Critical minerals in heavy mineral sandstones/paleoplacers.

The Wyoming State Geological survey has indicated through recent correspondence (2025) that these poorly studied areas have potential for critical trace elements that are of socioeconomic significance and may warrant further scrutiny in the future. However, much of this is currently outside of U.S. Forest Service management authority and scope of land and resource management planning due to legislation.

There is currently one abandoned mine with safety closure proposed by the WDEQ–Abandoned Mine Lands Division. Three others were completed in the last 10 years. This work is done in coordination with the USFS as described in a participating agreement between the State of Wyoming and USFS Intermountain Region. WDEQ inventoried additional abandoned mine locations on the Bridger-Teton, though none are currently understood to require closure action for human safety or serious environmental reasons such as acid mine drainage.

Fire Management

Key Takeaways

- Wildland fire on the Bridger-Teton is a key driver that shapes forest, sagebrush, and grassland plant communities and it supports their ecological integrity. Periodic fire helps to: maintain vegetation composition, patch size, age class distribution, and watershed conditions. At the same time, human-caused changes, including climate change, in the frequency and severity of wildland fire may be considered a stressor that impairs the ecological integrity of the Bridger-Teton fauna and flora.
- Since 1930, approximately 700,000 acres of the Bridger-Teton have burned in wildfire, with most of the acres burned since 1985.
- The Bridger-Teton staff were one of the early pioneers in prescribed burning, beginning in 1974 approximately 85,000 acres have been prescribe burned.
- The Bridger-Teton also implemented one of the first wilderness fire programs in the USFS, which allowed natural fires to burn when there was low potential to impact values at risk. The forest plan was amended in 2004 to allow natural ignited fires to be managed with a resource benefits objective.
- The predominate fire regimes on the Bridger-Teton are considered moderate to long interval (50 to 250 years). The effects of active fire exclusion on the landscape are more difficult to quantify versus short interval dry forest fire regimes.
- Fire suppression in the WUI has become increasingly complex and costly. Fires often cross multiple jurisdictions. Mitigation efforts are ongoing with coordination between state, local and Federal agencies.
- The 2014 National Cohesive Strategy provides unified direction for Federal, state and local management of wildland fire.
- Extensive new datasets including fuels, fire effects monitoring, and fire history are now available to assess risk and benefits at both a local and Bridger-Teton-wide scale.
- Unwanted fires may cause negative social and economic effects both on Federal and adjacent private lands. Negative effects may include damage to natural resource values such as merchantable timber or livestock forage, or damage to both private and public infrastructure as well as smoke impacts.

Fire Management Background and History

Although fur trappers passed through the area in the early 1800s, it was not until the mid-1880s that non-native settlement began in western Wyoming. Following settlement, new arrivals were responsible for both unintentional and intentional fires. Concurrent with settlement, a warming period following the “little ice age “of the previous century increased favorable conditions for wildland fires to start and grow. Significant areas of northwest Wyoming burned from 1875 to 1890.

There is little documentation on the role of indigenous people and their use of fire in western Wyoming. Indigenous peoples may have burned small areas at low elevations but within what it now the Bridger-Teton Forest, lightning-ignitions played the dominant role (Vale 2013).

The creation of the Teton Forest Reserve in 1897, followed by establishment of the Wyoming and Bonneville National Forests in 1908 (later becoming the Teton and Bridger National Forests), led to the first efforts at organized fire suppression and a policy of fire exclusion (Loope 1973). From 1910 to 1970, most fires were suppressed at small acreages with only an occasional fire growing beyond 1,000 acres. Past fires, and generally moderate climate conditions, aided the fire suppression effort. Only two fires grew beyond 10,000 acres, the 1931 Gravel Creek Fire (10,980 acres) and the 1934 Fall Creek Munger Mountain Fire (12,000 acres).

A trend towards larger wildland fires began in the 1980s. Since 1987, several fire seasons with favorable weather and fuel conditions resulted in large, long duration fire events. The benchmark year was 1988 when over 270,000 acres on the Bridger-Teton burned. The three largest fires that season were the Mink (111,600 acres), Huck (107,816 acres) and Fayette (38,500 acres). Sustained hot and dry conditions, along with large areas of mature spruce-/fir and lodgepole stands all contributed to large and aggressive fire behavior. Since the 1990s, the Bridger-Teton experienced a trend towards fewer per year, but an increase in acres burned, with most acres burned by a handful of fires (See Figure 33 and Figure 34).

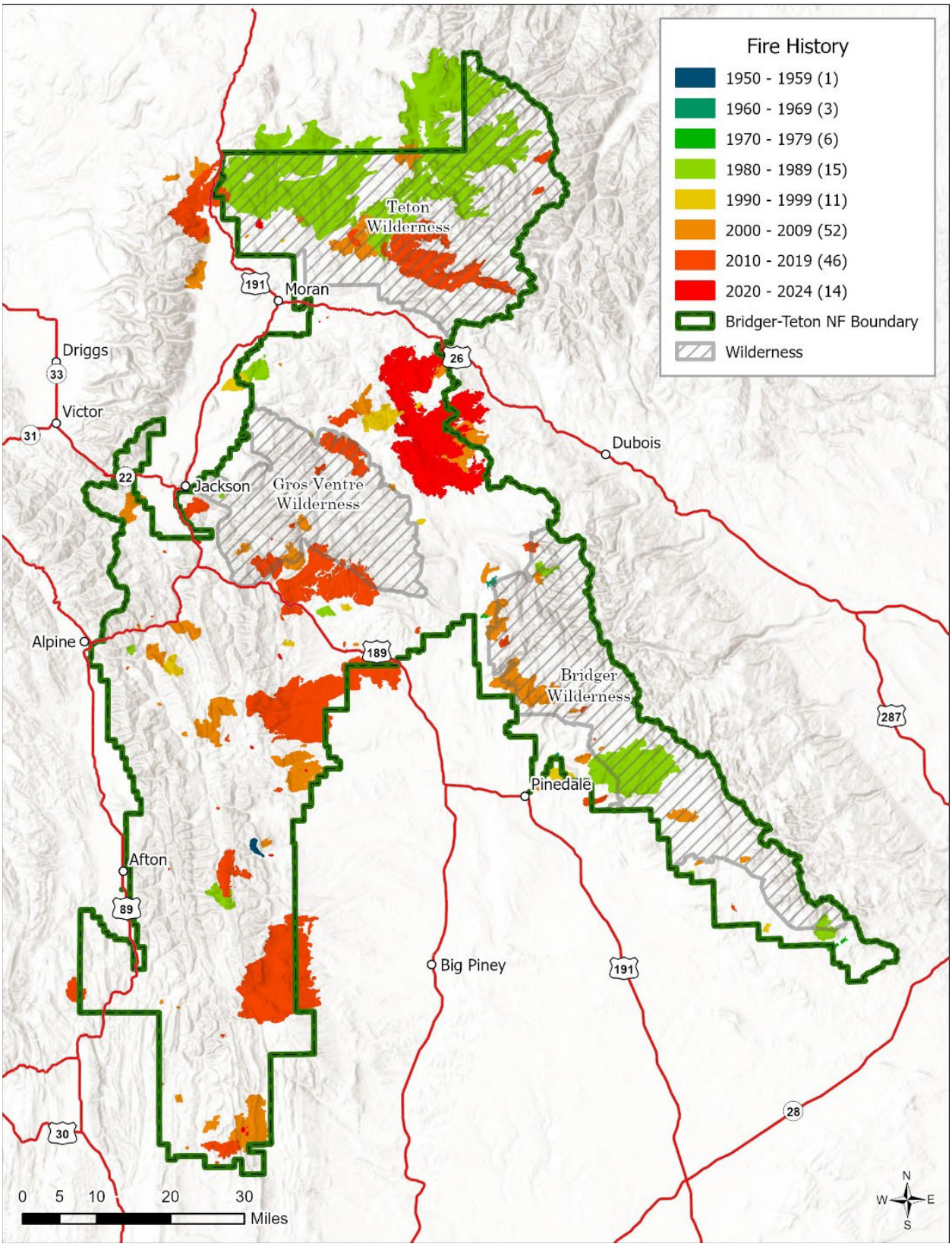


Figure 33. Fire History 1950-2024, Bridger-Teton National Forest

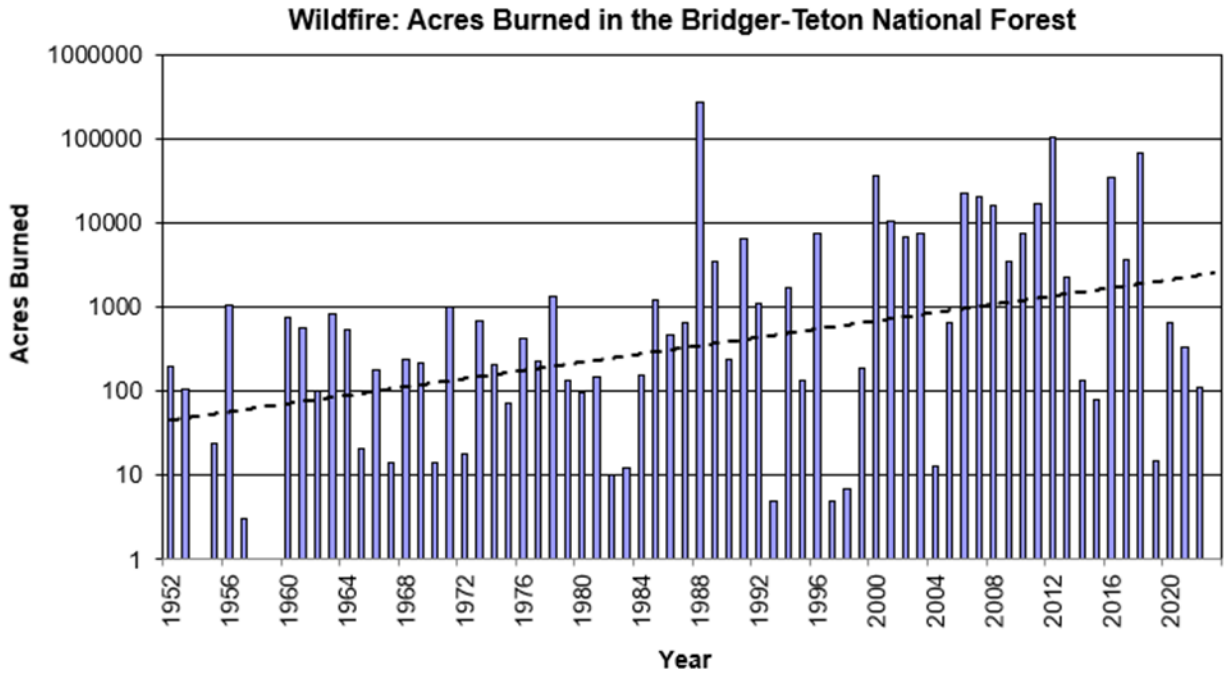


Figure 34. Number of acres burned in wildfires and trendline of acres burned in the Bridger-Teton by calendar year from 1952-2023

There are several possible reasons for the decrease in detected fires.

- The Bridger-Teton increased the prevention program, both on the ground with Bridger-Teton staff patrols and increased use of public information through increased use of social media.
- Implementation of fire restrictions during periods of high fire danger became a more routine practice.
- Large areas of the Bridger-Teton that have burned in the past 40 years, the resultant reduction in available fuels, reduced the chance of fires growing to a detectable size in these recently burned areas.
- The observed trend towards fewer detectable fires, but an increase in average acres burned is complex to understand given that a good portion of the forested landscape has a stand replacing interval of greater than 100 to 250 years. These fires are characterized by a couple of factors:
    - long periods, (often more than a week) of extreme fire weather including hot, dry, and windy conditions and
    - receptive stands are predisposed to large fires because of stand structure and composition including more homogenous landscape fuel continuity.

An example of these long-term fires is the 2018 Roosevelt Fire that burned approximately 61,000 acres over a 2-week period. During these favorable fire conditions, large fires are sustained at all elevations and in all vegetation types. More discussion of the changes in fire regimes is included in a following section.

Fire atlas records from 1920 to 1951 recorded approximately 33,829 acres burned in wildfires. More accurate wildfire records from 1951 to 2022 is 666,064 acres or about 22 percent of burnable acres on the Bridger-Teton.

The number of detected ignitions for that time was 3,570 fires (See Figure 35); 56 percent of fires were attributed to lightning and the remaining 44 percent were human caused, most often the result of abandoned campfires.[9]

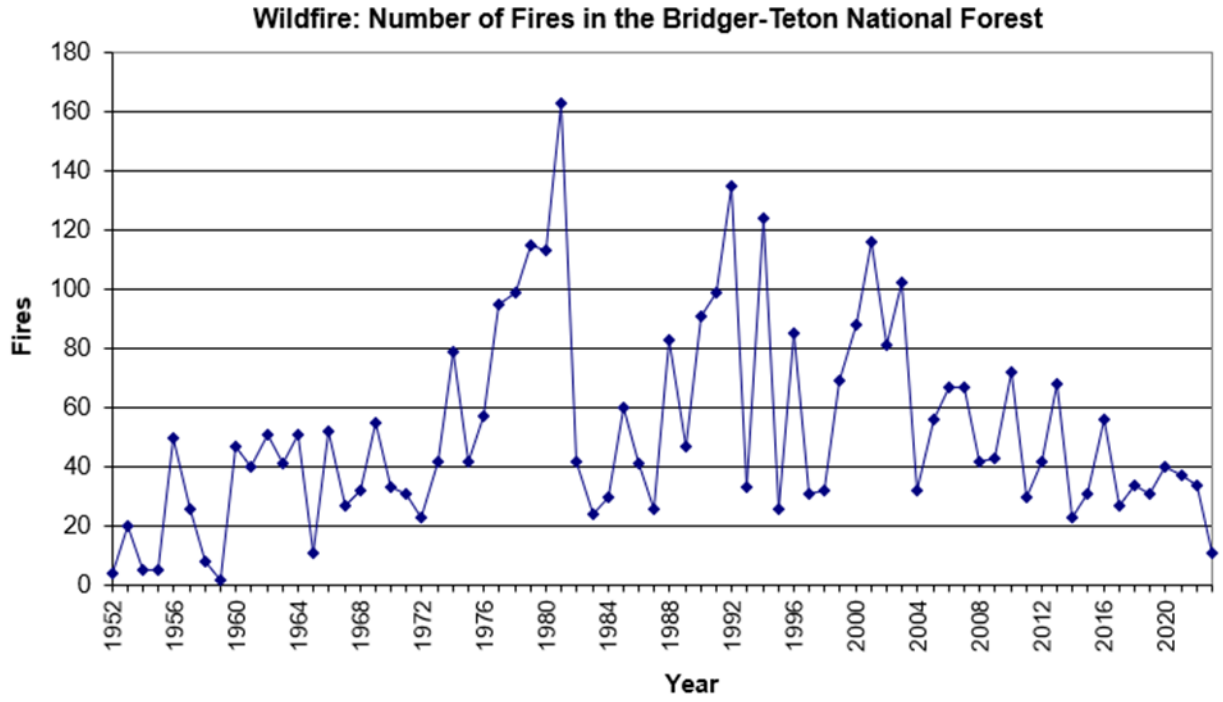


Figure 35. Number of wildfires in the Bridger-Teton from 1952-2022

Returning Fire to the Landscape

The USFS adopted the 10:00 a.m. policy in 1935: “When first attack fails… organize and activate sufficient strength to control every fire within the first work period. If the fire is not controlled in the first work period, the attack will be planned and executed before 10 o’clock the next morning” (USDA 1978).

The USFS revised their policy in 1978 to “provide well planned and executed fire protection and fire use programs that are cost effective and responsive to land and resource management goals and objectives” (USDA 1978).

This policy change occurred as local land managers and researchers were looking at how the landscape may have been affected by the period of active fire suppression. They concluded that fire exclusion was responsible for vegetation becoming older and more homogenous and a return to a more natural fire regime would benefit forest and rangelands. Wildlife and livestock also would benefit from the application of fire by increasing abundance and diversity of forage.

[9]Sources for historical fire records include “fire atlases” located in the Supervisor’s Office Map Room, printed fire records located in Jackson District Office, and FAMWEB/INFORM national databases. Source: Excel spreadsheets, located in Pinyon Assessment Folder “Fire Management.”

George Gruell, a wildlife biologist on the Bridger-Teton, undertook a project that involved retaking historic photos to display landscape changes showing a trend toward late seral or 'mature' forests with little diversity (See Figure 36 and Figure 33). While fire exclusion was demonstrated by these pictures, recent research emphasized caution interpreting these pictures with the understanding that fire return intervals in many of the Bridger-Teton forests may be greater than the timeframe of these photos. On the other hand, there is no doubt that fire exclusion has affected the landscape in terms of patch size and diversity.

The 1905 slide represents an early seral unlogged landscape following a fire in 1890, while the 1970 and 2001 pictures show a late seral situation where the fuels are receptive to burning and will return the stand to a young aspen stand (Gruell 1980). His photo collection was retaken within the past 10 years and over 300 retakes are available.



Figure 36. Series of photos depicting the results of fire exclusion. Source: George Gruell 1980, USFS Staff 2001.

This appreciation of wildland fire's ecological role led to the beginning of landscape prescribed burning in 1974 followed by the beginning of the Bridger-Teton's wilderness fire program 2 years later in 1976.

Prescribed Fire

The Bridger-Teton was one of the early implementers of landscape burning in the Intermountain Region. Early landscape level prescribed burns began in 1974 and they focused on range and wildlife improvement (Figure 37 and Figure 38). Most of the acres treated were in lower elevation sagebrush/grass and aspen. While much of the prescribed burning still occurs in these types of landscape level prescribed burns, there has been a gradual trend towards prescribed burning in all vegetation types including conifer. Typically, burns are scheduled during two burn "windows," the first in late spring following snowmelt, but before green-up, and the second during the fall after the peak of the fire season. Burning includes both "activity fuels" that result from mechanical treatment, such as timber harvest or thinning for fuels reduction, and "natural fuels" that are burned with no significant pretreatment. Recent landscape burns combined pretreatment, such as cutting some trees to increase the surface fuels that support a larger prescription window and higher severity burn, have shown increased vegetation response.



Figure 37. Breakneck Flats prescribed burn

Prescribed burning during the 1970s and 1980s focused in several areas including the Gros Ventre watershed, Buffalo Valley and Labarge Creek. The burn program went through several ebbs and flows on account of several factors.

In October 1991, a late unexpected dry, cold front brought high winds and dry weather that lead to the Dry Cottonwood prescribed fire escape. The escape and management changes that followed led to several years of little or no prescribed burning. By 1996, the burn program was well established again with several large, prescribed burns throughout the Bridger-Teton.

Following the 2000 fire season, the Bridger-Teton increased treatment of urban interface areas, much of this with mechanical treatments, leading to a short-term decrease in burning. Landscape burning decreased again between 2011 to 2020. Several factors including the 2012 burn moratorium; 2014 and 2017 Pole Creek prescribed fire escapes; COVID pandemic impacts; and along with several difficult national fire seasons, all limited prescribed burning opportunities.

Approximately 85,000 acres were treated in prescribed burns since 1974 (See Figure 38).

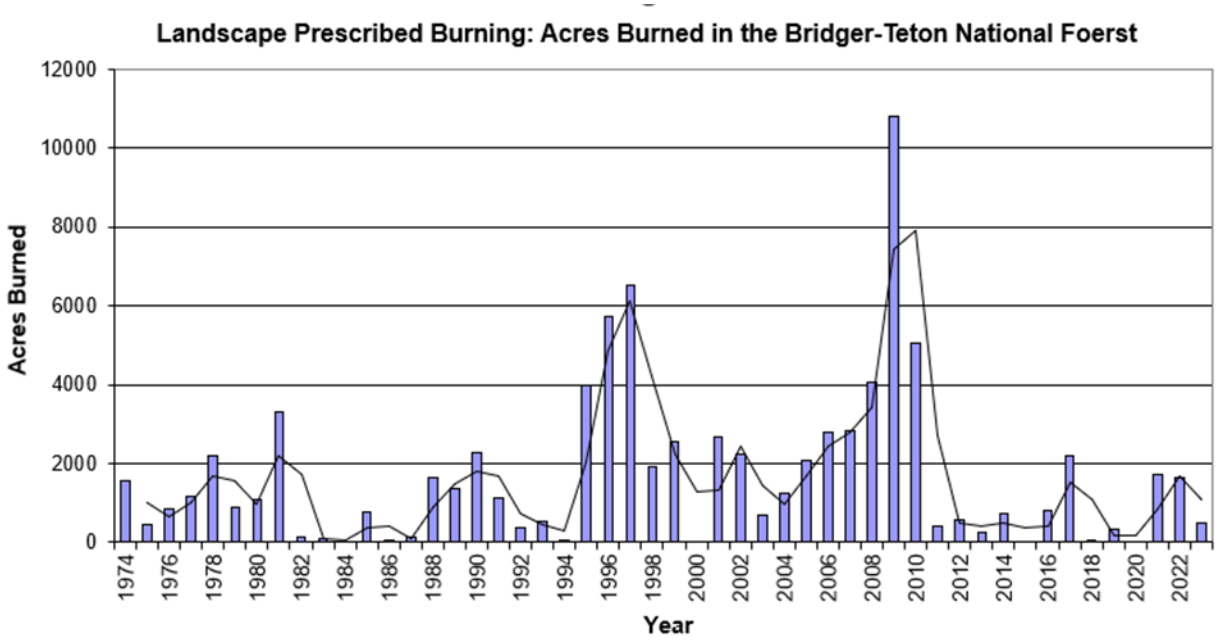


Figure 38. Number of acres burned from prescribed fire by calendar year from 1976-2023

Current and Emerging Important Topics

Changes in Federal and Forest Service Specific Wildland Policy

The Land Management Plan (LMP) was amended in 2004 to address policy changes as well as clarifying the fire management goals for the USFS. Federal policy again has changed and technical changes to the LMP will be needed. The 2004 amendment included “wildland fire use” as a separate type of wildland fire. The classification was removed; all unplanned fires are wildfires, but given policy and LMP direction, suppression of natural-caused fires may include objectives to meet Forest Plan desired future conditions.

The National Wildfire Coordinating Group (NWCG) Fire Management Board (Fire Management Board 2019) mutually has agreed to the following definitions for policy and documentation described below.

- Wildland Fire: Any non-structure fire that occurs in vegetation or natural fuels that includes wildfires and prescribed fires.
- Wildfire: A wildland fire originating from an unplanned ignition, such as lightning, volcanos, unauthorized and accidental human caused fires, and prescribed fires declared wildfires.
- Prescribed Fire: A wildland fire originating from a planned ignition in accordance with applicable laws.
- Use of Wildland Fire: Management of wildfire or prescribed fire to meet resource objectives specified in land/resource management plans, policies, and regulations to meet specific objectives.

The 2004 Amendment also referenced the USFS requirement for maintaining a Fire Management Plan (USDA 2017c). In 2017, the USFS required transition to the Fire Management Reference System (FMRS) and Spatial Fire Planning (SFP) concept as a replacement for Fire Management Plans (FMP). “The LRMPs for the National Forests and

Grasslands provide direction and make decisions while SFP products visually depict that direction and FMRS documents guide implementation of the LRMP direction and decisions. Strategic objectives, represented in the SFP format, must link back to the resource management objectives found in the LRMP".

Forest plan direction should be flexible enough to adjust to continuing changes in Federal fire and vegetation management direction without requiring additional amendments. FMRS and SFP are the links between overall USFS LMP guidance and implementation on the ground, including the recommended fire organization.

National Cohesive Strategy

The National Cohesive Strategy (USDA 2014c) provides a framework for fire management on both public and private lands to do the following: to safely and effectively extinguish fire when needed; use fire where allowable; manage our natural resources; and as a nation, to live with wildland fire. The National Cohesive Strategy requires an "all lands approach" that includes state, private and Federal land managers.

The National Cohesive Strategy establishes a national vision for wildland fire management and it defines three national goals. Using the best available science, the National Cohesive Strategy provides implementation planning guidance aimed at making meaningful progress towards these goals:

- Restore and maintain resilient landscapes. Landscapes across all jurisdictions are resilient to fire-related disturbances in accordance with management objectives.
- Create fire-adapted communities. Human populations and infrastructure can withstand wildfire without loss of life and property.
- Ensure safe and effective wildfire response. Participate in making and implementing safe, effective, and risk-based wildfire management decisions.

The National Cohesive Strategy describes the wildland fire challenges; identifies opportunities to reduce wildfire risks; and establishes national priorities focused on achieving the national goals.

Stressors Related to Fire Management

Wildland Urban Interface and Fire-Adapted Communities

During the past 30 years, rapid development on private lands adjacent to the Bridger-Teton led to a dramatic increase in the size and complexity of the WUI. The WUI describes the line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels (Fire Management Board 2019).

Community wildfire protection plans are in place for counties within the Bridger-Teton (Wyoming State Forestry Division 2021). Sublette County revised their plan in 2022 (Teton Wildfire Mitigation and Y2 Consultants 2022). Teton County completed their most recent revised plan with an updated WUI boundary in 2024 (Hughes 2024). Lincoln County is planning to begin revision in 2023-2024 (Lincoln County, Wyoming 2015).

"A Community Wildfire Protection Plan (CWPP) identifies and prioritizes areas for hazardous fuel reduction treatments and recommends the types and methods of treatment on Federal and

non-Federal land that will protect one or more at-risk communities and essential infrastructure and recommends measures to reduce structural ignitability throughout the at-risk community. A CWPP may address issues such as wildfire response, hazard mitigation, community preparedness, or structure protection - or all the above" (National Wildfire Coordinating Group 2023).

The most significant increase in WUI complexity has been in Teton County on the north end of the Bridger-Teton. Teton County includes several large urban interface areas that are adjacent and often downwind of USFS lands. Most notable, are the Teton County interface areas in Wilson and Buffalo Valley. These areas often have high density of development; large expensive structures; and older, poorly developed road access; and they are topographically aligned to be at risk from fires moving off the Bridger-Teton.

Sublette and Lincoln Counties are experiencing continued development, which significantly increases the potential for exposure in the wildland-urban interface (WUI). In Lincoln County, much of the WUI is concentrated in the corridor between Alpine and Afton. This area faces substantial risks, as the combination of private land development, topography, and prevailing wind patterns could exacerbate wildfire spread into communities. Sublette County is a mix of challenges, including adjacent private lands and structures, and USFS permitted operations. Sublette County also includes large areas of oil and gas development, mostly on the BLM lands, but some of these developments are close to or next to USFS lands and they do present wildfire concerns.

Since 1990, several wildfires threatened private lands and structures. Protecting private lands and structures from wildland fires is complex, costly, and often involves a higher degree of risk to both wildland and structural firefighters. Local and county fire departments are challenged to provide protection to these private lands, but through mutual agreements Federal agencies often provide heavy resource commitment. To date, the largest and most significant urban interface fire on the Bridger-Teton was the 2018 Roosevelt Fire that burned over 61,000 acres of Federal and private lands. The fire reached the Hoback Ranches Subdivision resulting in the loss of 55 houses. The other significant urban interface fire was the 2001 Green Knoll fire southwest of Wilson that cost over 17 million dollars to control.

Vegetation in many of the older developments continues to mature within the private WUI that are adjacent to USFS lands. Forestlands that abut these developments also continue to mature, but access as well as public support to treat, either with prescribed fire or mechanical treatment, in these areas can be challenging. There also has been a cultural shift as new residents move into the urban interface areas. They do not understand the wildfire threat to their homes. Some new residents may have unrealistic expectations of the local, State, and Federal agency's ability to protect their homes in the event of a major fire.

Lastly, the overall trend of acres burned in wildfires shows an increasing trend over the past 25 years (See Figure 34). During this timeframe, wildfires increased in size and duration with higher intensity that are more difficult to control as they move off the Bridger-Teton. Fires that start several miles away from interface areas now may threaten these private lands within only a few burning periods; the part of each 24-hour period when fires spread most rapidly is typically from 10:00 a.m. to sundown.

Most of the USFS special use permitted sites, such as ski areas, recreation facilities and summer home sites, are included in the WUI zones. Many of these sites, especially the summer

home sites, are located within or adjacent to heavily wooded areas that present an elevated risk from fire.

While some USFS administrative sites, such as guard stations or campgrounds, are located within the designated WUI zones, others lie outside of these zones and they may not be technically considered WUI, but they are at risk, and they require mitigation and protection.

Urban Interface Mitigation

Before 2000, there were only occasional wildland urban projects in the urban interface. Following the 2000 fire season, several national initiatives were developed to address the growing problems in the urban interface. All three counties worked with State and Federal agencies to implement community wildfire plans (US Fire Administration 2020).

Following the 2000 fire season, the Bridger-Teton staff began a focused treatment program on lands adjacent to at-risk communities. Local counties, in conjunction with the Wyoming State Forestry Division, worked with private landowners to treat areas adjacent to Bridger-Teton lands. Following the 2000 fire season, the Bridger-Teton staff initiated a focused treatment program on lands adjacent to at-risk communities, which continues to this day. Most WUI projects involve thinning the tree canopy, removing dead and down vegetation on the ground, and removing “ladder fuels,” which are small trees that would allow a ground fire to move into the crowns.

Since 2000, approximately 14,000 acres of Bridger-Teton lands have been mechanically treated using a combination of: thinning, pruning, pile burning and timber harvest (See Figure 39 for an example). Fuel treatments are designed to effectively reduce risk to homes. The objective of fuel treatments is to change fire behavior from crown fire to a surface fire, reducing spotting distances and convective and radiant heat. Suppression resources are effective only if fire intensity is reduced to moderate or low intensity surface fire. This level of intensity allows firefighters to extinguish spot fires and allow safe “close in” engagement (Murphy 2007). Treated areas normally range from 200 feet to a quarter mile wide. The possibility of torching trees and embers lofting over the treatment area also must be considered when projects are designed. Structure loss is often not the result of a main fire, but the result of embers landing on receptive structure fuels.



Figure 39. Pre- and 1 year post treatment in the Phillips Bench Unit of the Bridger-Teton to Snake Wildland Urban Interface project

The most critical area requiring treatment to prevent structure loss is the “home ignitibility zone”, which is the area within approximately 100 feet of the home. The condition and distribution of fuels in the home ignition zone principally determine ignition potential during wildfires (Sutherland 2004, Cohen 1999). Building materials, design and location of homes are also critical to increase the survivability of structures (National Fire Protection Association 2023). Treatments that only occur on National Forest System lands adjacent to these private lands will be markedly less effective.

While treatments in the immediate WUI area are most critical, larger landscape burns and mechanical treatments further from the WUI zone break up homogeneous fuels increasing the strategic options for fire managers.

LMP direction should address expectations on how the Bridger-Teton staff collaboratively works with the public and private individuals to increase their ability to withstand unwanted wildfires, regardless of their origin. Robust hazardous fuels’ treatments and strategies will be required on both private and public lands.

Air Quality

Air quality concerns have increased from both planned and unplanned wildland fires locally and throughout the western United States. While smoke from local fires have caused impacts, many of the most significant air quality issues have been the result of long duration wildland fire burning west of the Bridger-Teton. The severity and intensity of the fires also affect the amount and duration of smoke impacts.

The WDEQ Smoke Management Plan (WDEQ, no date) details requirements and monitoring direction for prescribed burning and wildland fires.

State, local, and Federal agencies monitor air quality throughout the Bridger-Teton and adjacent lands. State and Federal thresholds guide decisions choosing suppression strategies and tactics that reduce impacts to smoke sensitive areas. Fire managers schedule prescribed fires when atmospheric lift is favorable and they will disperse smoke into higher altitudes, reducing the air quality concerns in neighboring communities.

Additional information on air quality is included in the “Air Quality Assessment” section.

Increased Forest Use

Recreation use on the Bridger-Teton dramatically increased both in terms of numbers, but also activities since 1990. Rapid population growth in the communities surrounding the Bridger-Teton led to increased recreation and general visitation within the Bridger-Teton boundaries. ATVs, mountain biking, and dispersed camping have been examples of increased diversity of recreation use. The housing shortage in several of the neighboring communities also led to more dispersed camping. Increased visitation and camping increased the potential for human-caused fires, especially when the fire danger is high or extreme. The Bridger-Teton prevention and education program has been effective in communicating with visitors through: newspaper articles, radio broadcasts, posting signs, and patrolling. However, it is difficult to reach all user groups and cover such a large geographic area. Increased education, prevention, and coordination with western Wyoming land management agencies, as well as State and counties, will be required to mitigate this risk.

Current and proposed recreation facilities, including campfire sites, should be constructed in accordance with Firewise standards. Firewise techniques include minimizing the risk of home ignition by carefully doing the following: landscaping around residential structures, such as thinning trees and brush; choosing fire-resistant plants; selecting ignition-resistant building materials; and positioning structures away from slopes. Permitted special uses such as communication sites, ski areas, and other resorts should also meet Firewise standards. Egress from heavily used recreation areas should be designed to allow safe exit in the event of wildfires.

Invasive Species

Prescribed and wildland fires may increase the spread of invasive species. Preventing the spread of invasive species in burned areas (both planned and unplanned ignitions) is difficult, but it is essential to maintain ecological integrity.

Currently, the most concern with invasive species is in the sagebrush steppe vegetation. Managers are now reluctant to prescribe burn in sagebrush steppes because of the high probability of cheatgrass (*Bromus tectorum*) establishment following this disturbance, which can increase future wildfire risk through the cheatgrass-fire cycle. Type conversion to cheatgrass from wildland fire also is a significant stressor to greater sage-grouse populations.

Per Bridger-Teton staff direction, prior to implementation of prescribed fires, pretreatment monitoring is required to identify the presence and quantity of weeds within the area being treated. The Bridger-Teton invasive species program is tasked with monitoring weeds pre- and post-treatment, but capacity is limited. Through effective partnerships with Wyoming Game and Fish Department, Sublette County Invasives Task Force, Jackson Hole Weed Management Area, and Lincoln County Cheatgrass Program, capacity has been increased, particularly for inventory and monitoring of invasive annual grasses (IAG). Volunteers have contributed to weed inventory and mechanical treatments as well. However, increased capacity, and additional guidelines or standards, may be needed in the future to effectively manage weeds through strengthening existing partnerships and additional new partnerships, specifically in areas that receive prescribed burns or wildland fires.

Additional discussion of invasives is addressed in Ecosystem Drivers and Stressors at the beginning of chapter 2.

Changes in Fire Regimes

This section provides a general discussion of past and current fire regimes and the probable causes of those changes. (A detailed discussion of fire regimes by Biophysical Condition is discussed in the Terrestrial Ecosystem section.) “Biophysical Settings (BPS) represents the vegetation system that may have been dominant on the landscape prior to Euro-American settlement and is based on both the current biophysical environment and an approximation of the historical disturbance regime” (USDA 2023d, DOI 2023).

A clear understanding of the fire regimes of western Wyoming is critical, especially regarding mid- to long interval fire regimes and associated high intensity fire and effects that are within the natural range of variability (Romme et.al. 2011)

Fire Suppression

Prior to European settlement, wildland fires were ubiquitous on the landscape and fire size and duration only were limited by existing fuels, weather and topography, ultimately defining the natural fire regimes. Current thinking is that most ignitions were lighting caused, although indigenous people may have been responsible for some smaller fires (Loope 1973, Vale 2013).

The most notable changes to fire regime in the past 40 years occurred in the lower to mid-elevation vegetation such as sagebrush/grass and aspen, along with some shrub communities, best represented by “Rocky Mountain Aspen and Woodland and Intermountain Basin Sagebrush Steppe Biophysical conditions. Suggested fire return intervals for these BPS types range from 10 to 100 years. In addition to fire suppression, in areas of heavy livestock grazing in grasslands there has been a reduction in the number of herbaceous fuels and consequently reduced fire frequency and spread. Grazing combined with fire suppression in shrub communities caused a shift to dominance by woody vegetation. Depending on shrub spacing and density, this can lead to either very rapid fire spread under moderate to extreme fire conditions or little or no spread under low to moderate conditions. Fire exclusion during the past 100 years led to some areas having large, homogenous sagebrush communities that burn more severely with larger patch size than historically occurred. Lack of fire in aspen stands also has been noted with many aspen stands in older age classes lacking younger sprouts. The threat of cheatgrass establishment also may lead to shorter, uncharacteristic fire return intervals. It germinates in the fall and early spring, and it rapidly grows in high numbers, making it highly competitive with native species. Cheatgrass disrupts the fire cycles in ecosystems, leading to more frequent and more intense fires by creating a homogenous, continuous flammable fuel bed. Homogenous cheat grass fuel beds can have a fire return interval of 1 year.

Older age aspen classes may have increased conifer encroachment. Ideally, the landscape consists of aspen stands with varying age classes and conifer densities providing habitat to a variety of fauna.

The effect of fire suppression in the mid- and upper elevations with longer fire return intervals is more difficult to quantify. The fire return intervals for these regimes are often 100 to 400 years, so the effect of 100 years of fire suppression is more difficult to document (Schoennagel 2004). These fire regimes include both mixed severity and high severity stand replacing fires. During many years, weather and fire conditions are not conducive to fire spread in these fuels, and ignitions do not grow to significant size. “The recent period of consistent, effective fire suppression in remote high elevation sites, which has lasted 50 years at most, represents only a small portion of typical fire-free intervals in subalpine forests. Studies of fire history show that long fire-free periods (as long as, or longer than, the fire exclusion period during the 20th century) characterized the fire regimes of these forests before Euro-American settlement” (Schoennagel 2004). Fires during these years range in size from less than an acre up to patches of 500 or 1,000 acres. Fire suppression activities were effective on the fires that occurred during these low to moderate conditions, and they limited the creation of these small to mid-sized patches. An example of this would be the 2003 fire season in which only 17 acres of wildland fires burned Bridger-Teton-wide.

Reviewing the Biophysical Conditions and S classes and comparing them to reference conditions shows a surplus of young stands from recent fire, deficit in mid-seral stage, and some overrepresentation in older stands (USDA 2023d). Reducing the deficit in the mid-seral stages will require time or possibly some other silvicultural treatment to help fill in this gap.

Climate Change

While there always have been large and active fire years, current research points towards a warmer climate leading to increased periods of favorable burning conditions and larger and longer duration fires (Hostetler et al. 2021). Present and imminent changes in climate pose a multitude of threats that will test the resiliency of GYA's fire-adapted forests.

Hotter, drier summers result in more frequent large fires, likely reducing the fire return intervals to less than 100 years. Lodgepole pine stands produce cones once they are at least 15 years of age, but cones on young trees are generally not serotinous (remaining closed on the tree with seed dissemination delayed or gradually occurring). Cone serotiny can develop as a tree ages, but not every lodgepole pine displays serotiny. Serotinous cones have a resinous bond between cones scales, not opening and dispersing seed until the cones are exposed to higher temperatures from wildfire or summer soil surface temperatures (Lotan 1976). Thus, fires that burn in young lodgepole pine stands experience very low tree regeneration (Hansen 2019). In addition to reduced fire return intervals, warming temperatures and drier summers likely will increase the size and severity of fires that occur (Turner et al. 2022). In larger burned patches that are surrounded by immature forests, tree seeds may have difficulty making their way from unburned forests to re-establish in burned areas. Hot, dry conditions will pose additional challenges for tree seedlings to survive. Anticipated increases in the frequency of large fires may exceed the historical range of variability in the GYA and challenge the ability of forests to recover. Once dense forests could fail to regenerate following fire and instead transition to open landscapes dominated by herbaceous plants and shrubs.

Current Management

Wilderness Fire Program

In 1976, the Teton Wilderness fire plan was approved by the Chief of the USFS. The Teton Wilderness fire plan allowed naturally occurring fires to burn under certain weather and fire behavior conditions, meeting the intent of the Wilderness Act, which emphasizes allowing natural processes to occur with minimal human intervention. Similar plans were approved for the Bridger (1980) and Gros Ventre Wilderness (1996). From 1976 to 1988, managers employed a relatively conservative fire use strategy, with only 14 fires classified as fire use. None of these fires grew beyond 1 acre.

Forest Plan Goals for Wilderness Fire Management from 2004 Forest Plan Amendment

- Forest Plan goals for Wilderness Fire Management from the 2004 Forest Plan Amendment include:
- Fire management emphasizes preservation of wilderness values and allows for natural processes of ecological change.
- The number, size and intensity of fires approximate the natural fire regime.

These goals may need to be adjusted in the new Forest Plan due to interagency policy changes that require each fire to have a specific strategy and management action points in place to safely and effectively manage the fire. Both the Bridger and Teton Wildernesses are large areas suited for wildland fire with the objective of resource benefit. USFS policy does allow for prescribed fire in wilderness areas with site specific NEPA. Normal fire behavior is for fires to burn from the west into the wilderness, away from any values at risk (such as homes,

infrastructure, etc.). The Gros Ventre Wilderness is a bit smaller and it includes lands adjacent to private lands that are considered during management of fires.



Figure 40. Jim Creek Fire, Bridger Wilderness

Following the national controversy over the 1988 fire season, wildland fire use was suspended, pending several regional and national reviews. Over the course of the next few years, the two original plans (Teton and Bridger) were revised and approved. With the completion of the Gros Ventre plan in 1996, fire use was authorized in all three wilderness areas (1,300,000 acres). These three plans were “stand alone” plans with site specific NEPA.

Beginning in 2001, the Bridger-Teton moved toward accomplishing resource objectives on larger and more complex wilderness fires. While the wilderness fire program remains stable, several recent concerns developed with goals of wilderness management and natural caused fires. Invasive plants and diseases, such as cheatgrass and white pine blister rust, that arrived from outside the wilderness now present the management challenge of how to maintain wilderness character and processes where fire may exacerbate these concerns. Additionally, there has been some discussion about indigenous peoples and their role before settlement by non-native settlers. Research suggests that they may have burned small areas at low elevations but within what it now the Bridger-Teton Forest, lightning-ignitions played the dominant role (Vale 2013).

The forest plan was amended in 2004 to clarify the role of managing wildfires with a resource management objective throughout the entire Bridger-Teton. The amendment provided direction

that fire use outside of wilderness is allowed, but it must meet the resource objectives and desired future conditions for each management area. Wildland fire managed with resource objectives (formally referred to as “fire use”) often entails increased risk management due to the multiple LMP objectives, as well as proximity to private lands and other highly valued assets. The three wilderness standalone plans became obsolete, and the LMP and Bridger-Teton-wide Fire Management plan provided direction for wilderness fire management.

Monitoring, Analysis and Planning

Beginning in the early 2000s, a comprehensive fire effects monitoring program was established on the Bridger-Teton. Monitoring is completed post-wildfire and throughout the duration of prescribed fire and mechanical treatments. Plot and photo points are established pre-treatment to assess existing conditions. Each location is revisited post-treatment and then at 2, 5, 10 and up to 20 years to collect follow-up data. Data analysis and field notes are compiled into reports after each visit, and they are presented to Fuels staff each spring. Findings from the long-term monitoring program provide empirical results that resource managers use to refine objectives and implementation methods for future projects.

Forest Service policy also requires a Burned Area Emergency Response (BAER) be completed 1-7 days after a fire is contained. Additionally, data from Monitoring Trends in Burn Severity (MTBS) has provided spatial burn severity for large fires since 1984.

Quantitative Wildland Fire Risk Assessment (QWRA)

Wildland fire (or the lack of it) may benefit one resource while negatively affecting another resource on the same landscape. An example would be a high intensity fire would have benefits for big game winter range, while the same fire would have negative effects for Canada lynx habitat and whitebark pine.

The QWRA is one process for rating and comparing the effects of wildland fire on different ecological and social values. The Assessment identifies “highly valued resources and assets” (HVRAs) both ecological and social and then it estimates the probability of a wildland fire occurring and the loss or benefit to each HVRA at different fire intensities. An initial QWRA (Scott et al. 2013) was completed in 2013 and a revised QWRA (Helmbrecht 2021) was completed in 2021 for the Bridger-Teton and Grand Teton National Park. QWRA accounts for both losses and benefits resulting from fire and it considers:

- how often fire occurs (Likelihood),
- the intensity when a fire occurs (Intensity), and
- the effects of fire on HVRAs (Susceptibility).

Bridger-Teton resource professionals identified the following HVRAs in the 2021 assessment:

- ecological integrity
- heritage resources
- human habitation
- municipal watersheds
- recreation and administrative structure
- special uses

- production timber
- utilities infrastructure
- wildlife habitat

The QWRA displays spatial information on the positive and negative fire effects for each individual HVRAs. The Assessment also combines all the HVRAs to provide overall net value change (NVC) on the landscape. Spatial information may be queried using the ArcGIS Online QWRA application.

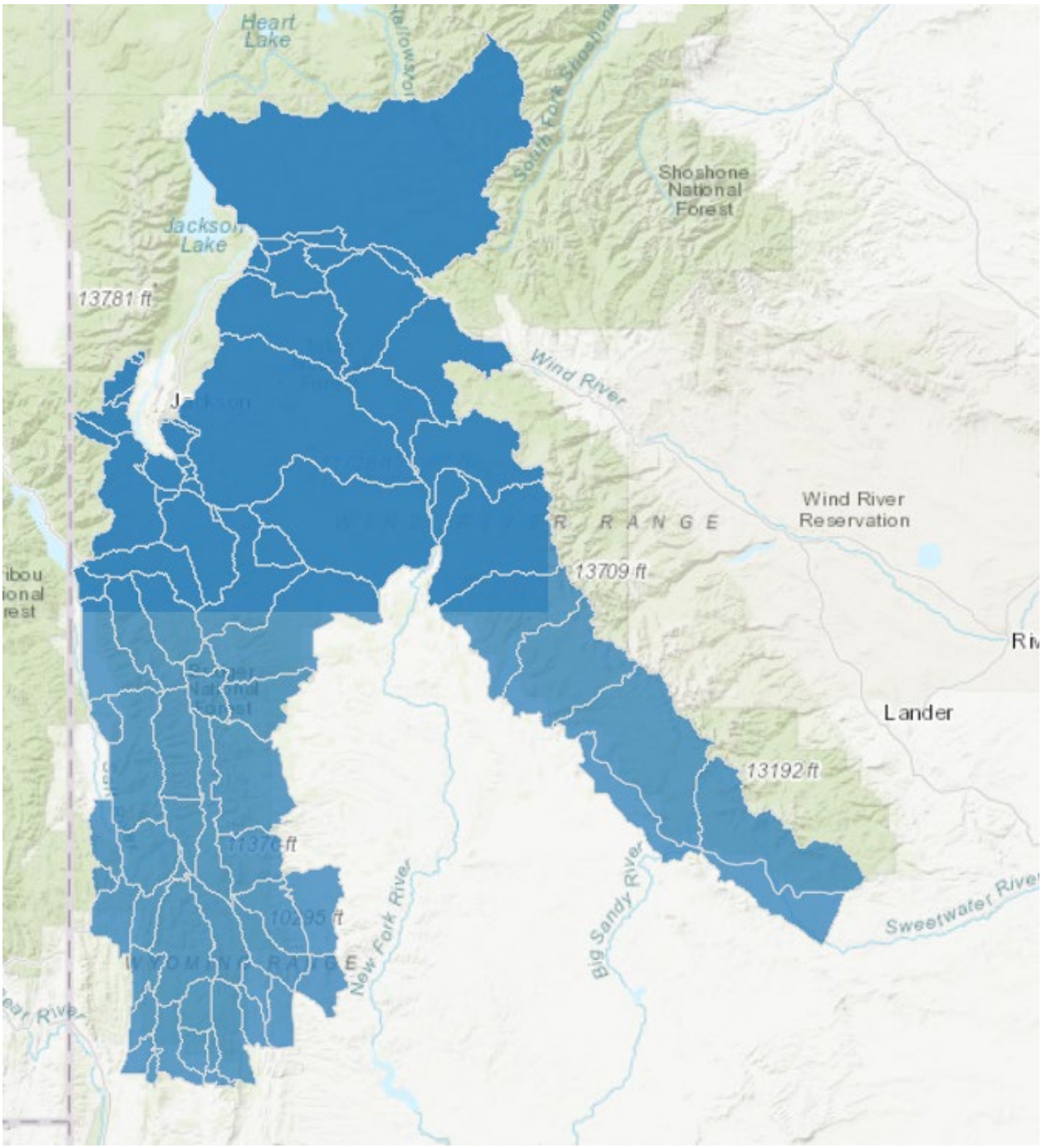


Figure 41. Potential operational delineations (PODS)

Potential Operational Delineations (PODS) are spatial units or containers defined by potential control features, such as roads and ridge tops, within which relevant information on forest conditions, ecology, and fire potential can be summarized (See Figure 41). PODs combine local fire knowledge with advanced spatial analytics to help managers develop a common understanding of risks, management opportunities, and desired outcomes to determine fire management objectives (Rocky Mountain Research Center, 2022).

PODs for the Bridger-Teton were developed in 2022, and they will be refined in the upcoming years. Forest PODS are available to view on the National Risk Management Dashboard.

The QWRA results were spatially summarized for each POD.

Additional spatial planning tools are currently available or are in development that allow spatial analysis for proposed treatments as well as on real time fire management decision-making.

Integration of Vegetation Management Programs

Successful implementation of the Bridger-Teton's fire and fuels management program requires integration of all vegetation management resources. Fire management is vegetation management whether it is wildfires, prescribed fire, or mechanical fuels treatments.

Management Implications

Social and ecological conditions have become increasingly complex since implementation of the 1990 forest plan. "Climate change and continued development on fire-prone landscapes will only compound current problems. Emerging strategies for managing ecosystems and mitigating risks to human communities provide some hope, although greater recognition of their inherent variation and links is crucial" (Moritz 2014).

Future fire and vegetation management will require an integrated approach that acknowledges past vegetation management practices, such as fire suppression or timber management practices, range management and recreation use as well as climate induced change.

Cultural and Historical Resources

> A people without the knowledge of their past history, origin, and culture is like a tree without roots.
>
> — Marcus Garvey

Within the Bridger-Teton there are numerous cultural resources which provide a link to past human activity. They provide a rich, detailed context for understanding contemporary landscapes and natural resource issues that make up northwestern Wyoming and its surrounding areas. They provide a connection to the past history of indigenous peoples of the GYE through Euro-American settlement of the GYE region, which the public has an opportunity to: visit, explore, enjoy, and learn about the diverse cultural heritage that is part of the Bridger-Teton.



Figure 42. Cultural resources can include (from left) historic administration sites, such as Sherman Guard Station, precontact artifacts, and precontact structures

Some of the challenges faced on the Bridger-Teton include increased exposure to cultural resources, whether through natural threats, such as: natural erosion, wildfire, flooding, or wind-blown events, or human caused, such as increased recreation, visitation, and construction. Also, for USFS administrative buildings, recreation sites and residences that have approached or passed the 50-year threshold defining a building or site as 'historic', Federal laws and regulations require the Heritage Program to record, protect, and maintain these sites as well.

These challenges on the Bridger-Teton only have increased since the 1990 forest plan. Since then, many changes in laws and regulations regarding cultural resources occurred. Out of 3.4 million acres of the Bridger-Teton, only a fraction of the land has been systematically inventoried for cultural resources because comprehensive inventories take considerable time in terms of funding, personnel, and scheduling. While a cultural resource overview (Schoen n.d.) was developed, much more is needed in: recording and inventorying significant sites eligible for inclusion to the National Register of Historic Places (NRHP): updating eligibilities for unevaluated sites; updating Heritage GIS spatial and record databases; inventorying non-project areas deemed high probability for cultural resources; and coordinating with tribes to identify locations regarded as traditional cultural or special use areas. Education and outreach programs designed to increase public awareness are needed to reduce impacts and site damage from theft, looting, and vandalism.

Cultural Background

The Bridger-Teton is located in northwestern Wyoming spreading out over 3.4 million acres across multiple mountain ranges that make up the Central Rocky Mountain system. These mountain ranges, which include portions of the: Teton Range, Absaroka Range, Wind River Range, Snake River Range, Wyoming Range and Salt River Range, form the 'spines' of each section of the Bridger-Teton, and they also serve as the southern portion of the GYE. These mountain ranges feed into three major river systems including the Yellowstone, Snake and Green, and to a lesser extent, the Smith Fork and Big Sandy rivers.

The area is tied to three major cultural areas: Columbia Plateau in the northwest, Great Basin to the west and southwest, and Great Plains to the east. Within these millions of acres reside a culturally rich environment—consisting of both historic and prehistoric resources as well as continuing uses for cultural purposes by tribes. These resources include: sites, trails, buildings, roadside interpretive sites, or objects. They also include features that have scientific, historic, or

social values; artifact collections; historic documents; maps; photographs; and traditional cultural properties (TCPs) (Schoen n.d.).

The Bridger-Teton has had significant occupation dating back at least 11,000 years. Routes into and out of the GYE region were traversed by many indigenous groups from the Columbia Plateau, Great Plains, and the Great Basin areas. Many of these lands and resources found within the Bridger-Teton are considered traditionally significant or sacred to several Native American tribes, which include the: Shoshone-Bannock, Eastern Shoshone, Northern Arapaho, Crow, Nez Perce Tribe, Blackfeet, Ft. Belknap Indian Community, and Confederated Salish & Kootenai Tribes. Some of these properties are considered eligible for inclusion to the NRHP (note, knowledge regarding locations of culturally significant sites maybe restricted to tribal nations only).

National Register Status for Historic Properties

As of early 2023, approximately 114,425.4 acres on the Bridger-Teton have been systematically inventoried for cultural resources. This represents an increase of 89,025.4 acres of inventory since the current forest plan was issued in 1990. To date, a total of 1,145 historic and prehistoric sites were recorded on the Bridger-Teton, or one site for every 99 acres of inventory. Some of the site types found on the Bridger-Teton include: precontact habitation sites (stone circles), procurement areas, vision quest sites, drive lines, hunting blinds or defensive positions, petroglyphs (rock art), cabins, Civilian Conservation Corps (CCC) camps, CCC constructed campgrounds, facilities, buildings, tie hacking camps, logging camps, mines, homesteads, ranches, USFS fire lookouts, and lodges. Table 39 displays the types of sites recorded and their eligibility status for listing on the National Register.

Table 39. Eligibility status of cultural resource sites recorded on the Bridger-Teton (as of 2023)

Site Type	On the National Register	Eligible for the National Register	Not Eligible for the National Register	Unevaluated for the National Register	Total	%
Prehistoric	0	205	334	182	721	63%
Historic	6	95	207	70	378	33%
Multi-component[1]	1	10	21	5	37	3.2%
Unknown	0	2	0	7	9	0.8%
Total	**7**	**312**	**562**	**264**	**1,145**	**Not applicable**
Percent	0.6%	27.2%	49.1%	23.1%	Not applicable	Not applicable

1 Contains both historic and prehistoric components.

Four criteria are measured and evaluated for each resource to be considered a “historic property” as defined in 36 CFR § 60.4:

- Criterion A: that are associated with events that have made a significant contribution to the broad patterns of our history.
- Criterion B: that are associated with the lives of persons significant in our past.

- Criterion C: that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction.
- Criterion D: that have yielded, or may be likely to yield, information important in prehistory or history.

In addition, for a property to be listed on the National Register based on the different National Register criteria, it must exhibit integrity. Integrity requires evaluation of:

- location,
- design,
- setting,
- materials,
- workmanship,
- feeling, and
- association.

To understand its relative significance, the key to determining integrity lies in which of these aspects relate the most to a property and its importance, so all levels of integrity are not necessarily required. Knowing the why, where, and when can help in determining the overall significance of a historic property (DOI 1995).

At present, seven properties on the Bridger-Teton are listed on the NRH Ps including the following:

- Rosencrans Cabin Historic District,
- The Green River Drift Trail,
- Craig Cabin,
- The Church of St. Hubert the Hunter and Library (also known as Bondurant Protestant Episcopal Church),
- Huckleberry Mountain Fire Lookout,
- Chamber's Lodge, and
- Big Sandy Lodge.

The Bridger-Teton also contains cultural landscapes or districts (the Green River Drift Trail, which is in continued use today), prehistoric trails, and historic routes and trails (e.g., Lander Cut Off Historical Trail).

Cultural Resources and Recreation

Some ways in which cultural resources contribute to social and economic sustainability is through the recreation-use rentals of historic USFS guard stations, retired fire lookouts, and through the Forest Service's Recreation Residence Program. What makes the USFS's Recreation Residence Program unique from other forest recreation opportunities is that members of the public previously had the opportunity to build cabins or structures under specific

restrictions on national forests by obtaining special use permits (Vora 2009). The ability to have a 'piece of the wilderness' often has been passed down through generations; it is through this special use that enables many people to enjoy national forests today.

Because the Recreation Residence Program ran from the early 1930s through the 1960s, many of these recreation residences are now considered historic properties, and through evaluation of certain criteria and levels of integrity, they can be eligible for inclusion on the NHRP (Randolff 2011). The ability to own summer cabins on the Bridger-Teton was one of many uses promoted by the USFS in the early 20th century. It provided not only an outlet for those wanting to experience the outdoors, but it also justified use of public land to go along with its other uses to provide "the greatest good to the greatest number of people". The Bridger-Teton has a total of 136 recreation residences on nine different summer home groups (SHGs) over five districts on the Bridger-Teton including:

- Big Piney Ranger District: Middle Piney SHG – 11 lots,
- Blackrock Ranger District: Turpin Meadow SHG – 19 lots,
- Greys River Ranger District: Cottonwood Lake SHG – 5 lots,
- Jackson Ranger District: Jack Pine SHG – 23 lots and Black Canyon SHG – 3 lots, and
- Pinedale Ranger District: Willow Lake SHG – 1 lot, Temple Creek SHG – 17 lots, Sylvan Bay SHG – 45 lots, and Fremont Lake SHG – 12 lots.

Even before certain Federal reserves were renamed as national forests in 1907, recreation was one of the first uses that occurred on them, though it was not mentioned in the Forest Reserve Act of 1891. The Mineral Springs Act of 1899 first permitted the building of hotels and sanitariums near mineral springs for comfort and convenience for those visiting the geothermal hot spots for extended lengths of time (Randolff 2011).

One such historic property on the Bridger-Teton is the Granite Hot Springs Pool and Bathhouse that was constructed in 1935 by the CCC (See Figure 43). The site remains a popular destination for use year-round on the Bridger-Teton, and it is managed under a special use permit. Another type of cultural site with economic value are the many historic lodges and dude ranches that still operate on the Bridger-Teton that include: Heart 6 Ranch, Togwotee Mountain Lodge, Turpin Meadow Ranch, Box Y Ranch, Big Sandy Lodge, Lakeside Lodge, Half Moon Lake Lodge, Boulder Lake Lodge, and Green River Lake Lodge. Big Sandy Lodge, on the Pinedale Ranger District, recently was added to the NHRPs in November 2023. It was built in 1950 by the USFS and it was the original location of mountaineer and outfitter guide Finis Mitchell's fishing camp in the 1930s. As the most remote lodge on the Bridger-Teton, it has continually served as a retreat and hunting basecamp for guests for over 90 years, and it is the only lodge on the Bridger-Teton that retains its original setting and design with many of the buildings unchanged since their construction in 1950 (Humstone 2023).



Figure 43. CCC construction of the Granite Hot Springs pool in 1935. Source: USFS stock photo.

The Green River Drift Trail (See Figure 44) is an important and highly valued 58-mile-long cattle trail still used by ranchers in the same manner since the 1890s. Listed on the National Register in 2014 as a traditional cultural property, it is the first ever ranching-related TCP in the Nation (greenriverdrift.org, 2023).

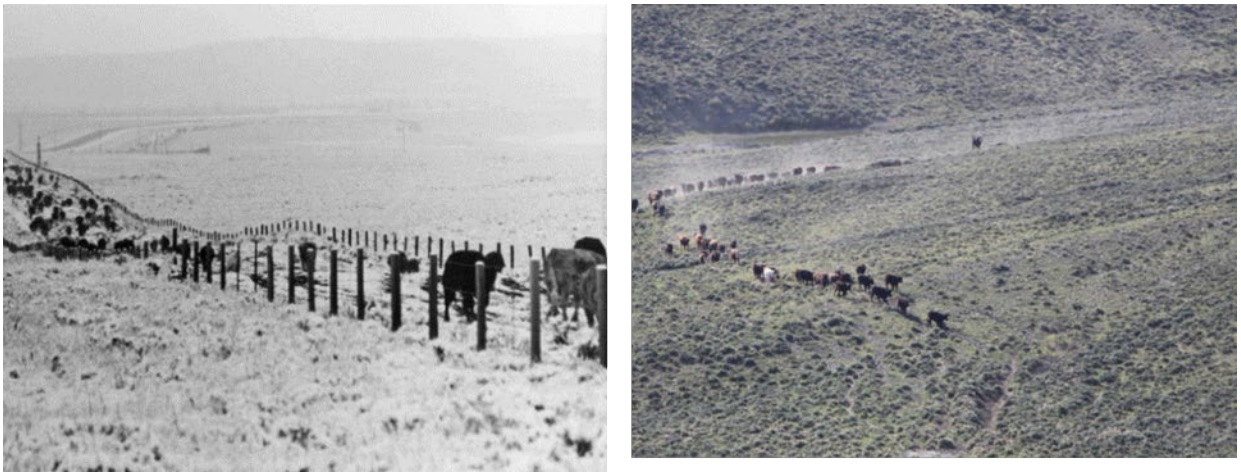


Figure 44. Photos of the Green River Drift Trail past and present. Source: USFS stock photo.

The historic Lander Cut-Off Trail retains importance to members of local communities, particularly in Kemmerer and Star Valley where many claims have ancestral ties to the emigrants who passed through the region utilizing this shortcut on the California Trail.

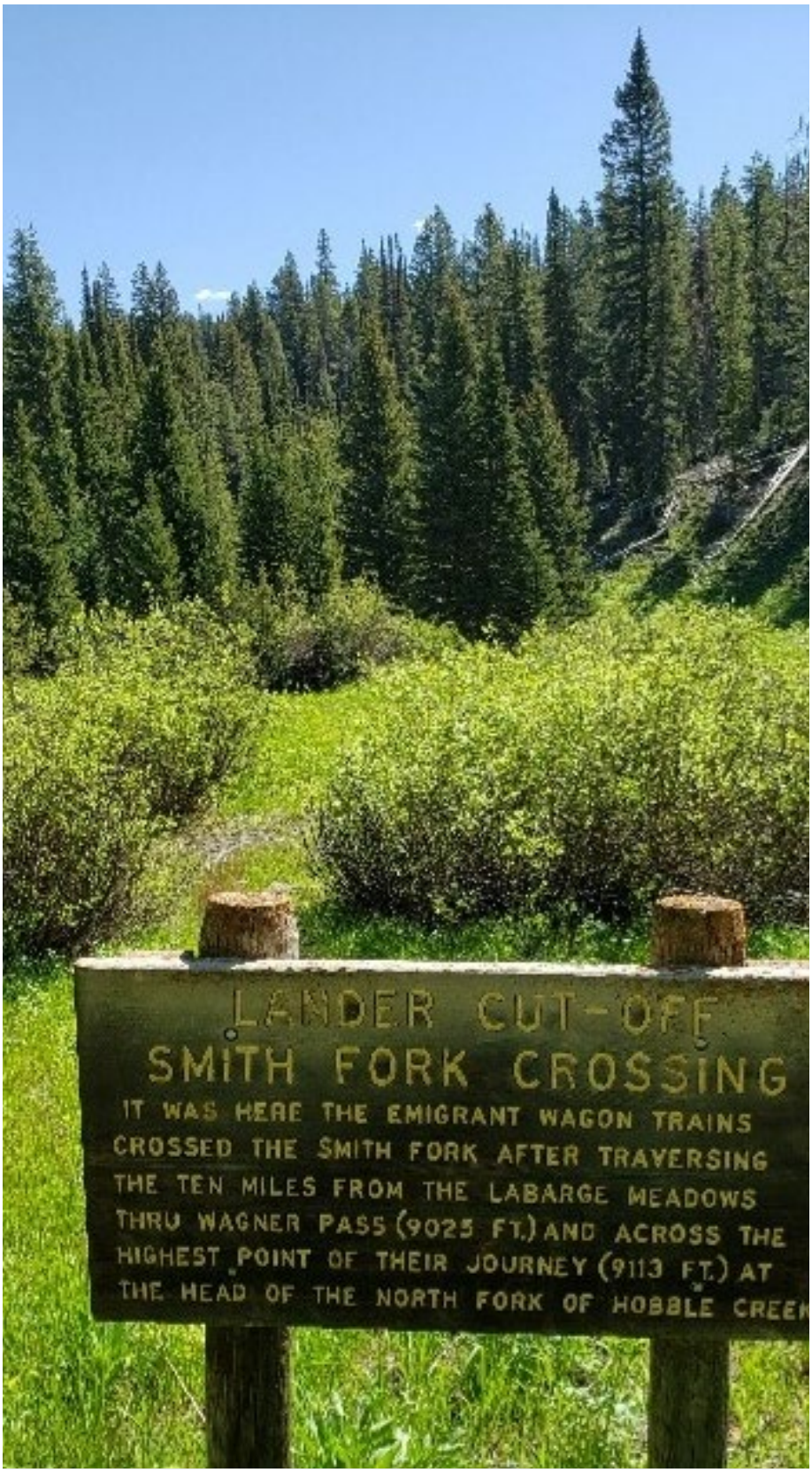


Figure 45. Lander Cut Off Trail. Source: T. Randolff photo.

Status and Trends Involving Cultural Resources

Every cultural group has unique and distinct attributes that enhance our understanding of the broad cultural history of the Nation. The recent DOI Secretarial Order 3404 (2021) identifies the word “squaw” as a derogatory term and requires eradicating it from geographical locations and place names within public lands. Tribes were offered an opportunity to rename those areas with an appropriate name that is significantly meaningful to indigenous groups. On the Bridger-Teton, consultations are ongoing. Currently, there have been five names submitted for replacing names. The new names may provide interpretive opportunities as communities learn about their meanings.

Key Risk Factors

The continued increase in motorized recreation and new user-created trails and routes increases the potential for adverse impacts such as: exposure, dispersion, destruction, or removal of cultural resources that may forever alter the presence or integrity. Prevention methods, such as placing rip rap, carsonite signs, and simply dragging brush, dead trees, and branches to cover resource areas, can help for some areas that should be closed. In addition, providing Bridger-Teton motor vehicle use maps to the public can help prevent unwanted vehicle use in sensitive areas not authorized for wheeled vehicle use.

With an increasingly warming climate, gradual receding of high-altitude ice patches or glaciers are revealing paleobiological and archaeological resources that have otherwise been buried under ice for centuries. Recent studies conducted within the higher elevations of the Rocky Mountain region revealed archaeological materials such as wooden artifacts (dart shafts), butchered animal remains, and lithic materials as well as paleobiological remains of bison, bighorn sheep, and other large ungulates within these exposed ice patches (Lee 2014). The Bridger-Teton contains numerous glaciers in the Absaroka Range to the north and the greatest number of glaciers (and largest) within the Wind River Range to the east. The rates of receding ice patches and glaciers are monitored by geologists in the field by taking measurements and photographs. These data can help determine the rates of receding ice over the course of years and its effect on cultural resources, but also on lower elevation water sources and ecosystems (Snyder 2023). With the increasing exposure, this creates an opportunity for: increased damage, decay, vandalism, and/or collection of archaeological materials that may become exposed as warming trends continue. However, it can also increase our knowledge pertaining to high-altitude studies of: human subsistence patterns, hunting activities, occupation areas, travel or trade routes, or possible evidence of past transhumance (the seasonal movement of livestock) (Ramming 2020).

Wildfire also has the potential to affect historic properties, particularly wooden structures, which can be totally destroyed. Archaeological studies on impacts to cultural resources from wildfire are ongoing and vary depending on the amount of: fuel consumption, intensity, duration, and temperature of the fire. Included in these studies are pre- and post-burn archaeological inventories and materials’ studies that provide baseline information on specific impacts to cultural resources, most notably to lithic resources (Sturdevant 2014). Spalling, cracking, crazing, pot lidding, bubbling, smudging, and discoloration are just some of the impacts that fire has on flaked or groundstone materials. These impacts can create adverse effects to these artifacts and features, especially to those found on the surface (Deal 2012). With increasing severity and frequency of wildfires each year, it continues to pose a threat to vulnerable cultural resources.

Management Implications

The main objective of the Heritage Program on the Bridger-Teton is the: inventory, protection, evaluation, study, interpretation, and preservation of cultural resources. This provides a synthesis of cultural resource: numbers, site types, locations based on predictive modeling, and site identification strategies. The Heritage Program also establishes annual monitoring targets in the form of Priority Heritage Assets (PHAs). PHAs are significant sites that are monitored every 5 years to assess their condition and measure success of treatment, or if needed, mitigation measures. PHAs can be added or removed. The Bridger-Teton also manages artifact collections, which are maintained at the University of Wyoming's Archaeological Repository (UWAR). Through its 2020 inventory, UWAR has curated a total of 9,742 artifacts for the Bridger-Teton in its facility. The Bridger-Teton also has seven small boxes of artifacts that have been collected and curated over years of conducting pedestrian inventories. They are housed at the Supervisor's Office in Jackson. However, this does not meet Federal curation standards as required through 36 CFR § 79 (Curation of Federally Owned or Administered Archeological Collections).

Laws and regulations that govern the protection of cultural resources on the Bridger-Teton include: Section 106 of the National Historic Preservation Act of 1966 (as amended, and its implementing regulations [36 CFR § 800]), the Antiquities Act of 1906, the American Indian Religious Protection Act of 1980, the Native American Graves Protection and Repatriation Act of 1990 (NAGPRA), and EO 11593 (Protection and Enhancement of the Cultural Environment) issued in 1971.

Along with these national policies, laws, and regulations, the Bridger-Teton also adheres to and follows the programmatic agreement pertaining to cultural resources executed by the: Wyoming State Historic Preservation Office (SHPO), Advisory Council on Historic Preservation (ACHP), and Wyoming State Forests. In addition, the Bridger-Teton also adheres to National Register Bulletins in complying with all: laws, rules, directives, EOs, and regulations. The USFS guidelines in FSM 2360 – Heritage Program Management, and FSH 2309.12 – Heritage Program Management Handbook provide protocols for any inadvertent discoveries of cultural resources or human remains and for theft or damage to cultural resources.

The bottom line in managing cultural resources is the protection and management of these historic properties. When management conflicts occur, the overall situation is evaluated and considerations given to the cultural resource are weighed against the values of the proposed project or land use. Consideration for the cultural resource includes its: NRHP eligibility status, research potential of the site; whether there is current, significant prehistoric or historic cultural value that relates to a significant event; group(s); or persons in the past; exhibiting unique characteristics or architectural design; or likelihood of disturbing historic or prehistoric burials. When these factors are examined, projects then may be: minimized, re-designed, relocated, or terminated. In the event adverse effects cannot be avoided to a cultural resource, it is then mitigated as per directed in 36 CFR § 800 along with full SHPO, tribal, and, if needed, ACHP consultation.



Figure 46. Bridger-Teton Heritage crew conducting a pedestrian survey during the 2022 summer field season. Source: USFS photo.

Main Points to Consider

Because cultural resources are considered ‘static’ (non-renewable), they can be susceptible to both natural and manmade factors that can cause negative impacts to the resource. Some examples of these impacts include: natural and manmade erosion, climate change, fire, vandalism, defacement, collection (pilfering), construction, mining, logging, and livestock grazing. Once a cultural site is damaged or removed, it is likely gone forever. Though some historic cultural resources can be restored, they cannot be fully returned to their original integrity.

Many Federal laws, rules, and regulations have been enacted to provide protection and preservation of our cultural resources, some of which were not in place or addressed in the 1990 forest plan. Much more support is needed to: protect, record, study, and manage the cultural resources found on the Bridger-Teton. Coordinating with tribes to assess areas of importance and significant cultural areas is key. In addition, the following can be helpful to protect cultural resources including: USFS programs such as PIT; outreaches through schools, universities, community events, such as the Blackrock Field Camp and Youth Outdoor Discovery Day; shared stewardship activities with NGOs; and historical societies can help spread information on the protection of cultural resources by allowing a ‘take a picture, but leave

behind' policy when it comes to encountering and/or observing cultural resources on the Bridger-Teton.






Figure 47. (Clockwise) Tie hacking cabin, Youth Outdoor Discovery Day, shovel test unit, and Blackrock Field Camp

Areas of Tribal Importance

Key Takeaways

Tribal nations have a unique relationship with our forest lands. The Bridger-Teton includes the homelands of indigenous peoples and as such, tribes not only have a historical relationship with these lands, but an ongoing and special relationship to forest lands, such as the Bridger-Teton.

Forest lands are not only tribally important, but they are a key contributing part of tribal life. Historically, tribes lived in the region for: hunting, gathering, ceremonial purposes and other needs. Ongoing tribal uses on the Bridger-Teton include gathering plants or resources such as tepee poles from trees that are critical for ceremonial and other purposes.

Bridger-Teton land was part of the tribal homelands that provided sustenance, and it also was the place of residence for many tribes. Some tribes continue to reside relatively close to Bridger-Teton lands, but other tribes who had resided on what today comprises the Bridger-Teton, now live states away. However, that distance does not indicate those tribes are no longer connected with these lands. Tribes living outside the vicinity of Wyoming still claim an ongoing relationship with Bridger-Teton lands.

Sacred sites, sacred places, tribal cultural landscapes, traditional cultural properties, and traditional uses on the Bridger-Teton landscape have continuing religious, cultural, and traditional importance to indigenous individuals and Native American tribes.

The connection of tribal nations was not necessarily an extractive one with forest lands, but it was more of a relationship. It is this perspective that will be welcomed in forest plan revision efforts.

Historical Background

The Bridger-Teton and surrounding area in northwest Wyoming and eastern Idaho is a region used by many Native American tribes as they travelled and stayed in the region for: hunting, gathering, ceremonial, social purposes, and other needs. Some tribes note that they have been present in the region for 12,000 years. Indigenous people followed their primary source for sustenance, the buffalo. Tribes relied on the buffalo, hunting them as they roamed the area in the warmer months.

Because of tribal connections to this area, one report said the landscape is, “Viewed as a friend with whom tribes have shared thousands of years of history through their families, and it is hoped that such a relationship will continue indefinitely into the future for their descendants” (Walker 2007).

As time went on and non-Native American settlers gradually encroached on lands that the tribes were living on and using to survive, Native Americans were forcibly removed from the majority of their traditional homelands. But while this forced separation from their traditional hunting and seasonal living grounds resulted in the tribes no longer being present in the region in the same way they had been for thousands of years, tribes are still connected to the Bridger-Teton area. Most treaties with the tribes limited them to residing on reservation lands, but off-reservation hunting rights, for example, were protected.

Tribes today are still connected to these lands as in their ancestral past for hunting, visiting sacred sites, and gathering plants. “The historical record describes Native Americans hunting migratory animals: elk, moose, deer, bison (buffalo) and pronghorn antelope-in all corners of Wyoming” (wyohistory.org). As “An Assessment of American Indian Occupation and Uses of Cultural and Natural Resources of the Grand Teton National Park and National Elk Refuge” (Walker Research Group 2007) report notes, “The region continues to be important to tribes for its many cultural and natural resources, which include flora, fauna, mineral resources, hot springs, ceremonial sites, and the viewshed itself, as well as for many historical reasons…Despite historic opposition and their official removal from the area, tribal members continue to visit the (area) for diverse purposes, thus maintaining links with their ancestors and their traditions as well as preserving their connections with the area for future generations” (Walker 2007).

Places of Importance

The vast 3.4 million acres of the Bridger-Teton borders both Grand Teton National Park and the National Elk Refuge. Bridger-Teton lands also were connected to historic tribal uses through the important Snake River corridor and through seasonal trade. Indigenous people relied on, traveled through, and stayed on Bridger-Teton lands and waters while they were in the region (See Figure 48 and Figure 49):

> Tribes moved across an extensive network of trails to hunt migratory game and harvest plant resources. These same trails also served other purposes, such as trade, war, harvesting tepee poles or visiting extended family members. In many cases, the travel routes established by Native Americans followed natural corridors of rivers or passes that traversed mountains and crossed between sagebrush basins. (wyohistory.org)



Figure 48. Union Pass on the Bridger-Teton

Native American travel trails left a permanent mark, in some cases eventually becoming the highways and roads of today.

A number of Native American tribes communicated their ongoing connections, some dating back roughly 12,000 years, to Bridger-Teton lands. From as far south as Oklahoma, as far north as the Canadian border, east to the Dakotas and west to Idaho, tribal connections to the Bridger-Teton go back thousands of years and continue to today.

The closest tribes geographically remain the Eastern Shoshone and the Northern Arapaho and the Shoshone-Bannock tribes:

> Tribes generally subsisted as hunters and gatherers, traveling during the spring and summer seasons, collecting foods for use during the winter months. They hunted wild game, fished the region's abundant and bountiful streams and rivers

(primarily for salmon) and collected native plants and roots such as the camas bulb. Buffalo served as the most significant source of food and raw material for the tribes. (sbtribes.com)

Additional tribal connections to the Bridger-Teton are still being learned.



Figure 49. South Pass, Wyoming, a critical travel route for tribes and others

As Bridger-Teton staff and leadership continue to meet with the tribes, access to Bridger-Teton lands is an important issue to tribal people. Tribes communicated that ensuring tribal access to Bridger-Teton lands for tribal uses including: hunting, fishing, camping and traditional gathering is an important issue to tribal members. To provide proper access, continuing education is needed for staff and concessionaire/contractors about reserved tribal rights and the importance of providing access, especially for elders, or especially in often-crowded areas.

Tribal life involved nearly every resource on the Bridger-Teton. Specific tribal uses on the Bridger-Teton are still being learned, but tribes lived, hunted and visited throughout the Bridger-Teton. Whether it was hunting, fishing or gathering for survival, for ceremonies, or for social purposes, having respect for the land because of their beliefs, informed every aspect of tribal life on Bridger-Teton land.

Management Implications

The current land management plan does not directly address specific tribal uses and connections to Bridger-Teton lands. Because tribal uses on Bridger-Teton lands are not really noted in the current forest plan, traditional ecological knowledge is not being fully utilized in current forest land management.

During the increased number of in-person consultations with tribal leaders, traditional ecological knowledge is one of the benefits Bridger-Teton staff is hoping to learn from their increased nation-to-nation consultations.

While employing traditional ecological knowledge may not be happening as much as possible currently under today's forest management plan, the hope and expectation is with stronger working relationships with indigenous tribes that vital information will be shared and eventually make its way into an updated forest management plan.

That is not to say that Bridger-Teton staff have not engaged Native American tribes in the work of the Bridger-Teton. Historically, Bridger-Teton staff, primarily the archaeological staff, informed interested tribes of project work and of any cultural/archaeological finds that the tribes need to be informed of and involved with. This information sharing also included regular, quarterly meetings with tribal representatives to have tribal input in the management of the Bridger-Teton.

Geographical areas, resource values, and other uses that are important to various tribes are generally noted in this section. As direct consultations with the tribes are conducted, it is possible that more specific information, helpful to forest planning and forest management, will be shared from the tribes.

Scenic Character

> "Everybody needs beauty as well as bread, places to play in and pray in, where nature may heal and give strength to body and soul alike." – John Muir

Key Takeaways

- Scenery is a resource Bridger-Teton visitors and adjacent communities appreciate with aesthetics one of the top four values county residents believe differentiates the Bridger-Teton from other lands. The scenic character of the Bridger-Teton provides an integral and important community sense-of-place, backdrop, setting and series of character-defining elements.
- Much of the Bridger-Teton is an in undisturbed condition, with 96 percent of the Bridger-Teton exhibiting very high or high existing scenic integrity. Perennial snow fields, wildflower meadows, numerous lakes, river corridors, and spectacular views of the: Teton, Wind River, Wyoming, and Gros Ventre Mountain Ranges contribute to the existing scenic integrity.
- There is a need to update direction for scenery management since the 1990 forest plan used an outdated Visual Management System, which has since been replaced by a Scenery Management System that offers more ability to inventory and manage scenic resources for their contribution to social and economic sustainability of the Bridger-Teton.

Introduction

The 2012 Planning Rule requires the USFS to inventory and manage scenic resource values and evaluate scenic character as part of the contribution to social and economic sustainability of the Bridger-Teton. Scenic vistas and viewing natural features are clearly important for those who are recreating or driving for pleasure, but the Planning Rule requirements recognize that scenery is not just a component of the recreation experience, but a resource enjoyed and appreciated by people who are not even visiting the Bridger-Teton.

The 1990 forest plan used the 1974 Forest Service Visual Management System (VMS) to assess and manage scenery. This VMS was replaced in 1995 by the Scenery Management System (SMS) (USDA 1995). Both systems recognize the value of natural-appearing forest system landscapes. However, the SMS recognizes that landscapes are dynamic and change as a result of disturbance processes. The SMS also recognizes the positive scenic values some human modified (cultural) features and settings may provide. For example, rustic cabins, historic bridges, buck-and-rail fences, or ghost towns all may be considered a valued part of the scenery, influencing the scenery in a positive way. The SMS also provides for improved resource integration of: aesthetic, biological, physical, social, and cultural resources (USDA1995, USDA 2019c).

For this Assessment report and per the National Scenery Management System Inventory Mapping Protocol (2019), there are four major components of scenery management that form the foundation for plan revision. Three components are discussed in this section: inherent scenic attractiveness, existing scenic integrity, and scenic character. A fourth component - concern levels on travel-ways (roads, trails, and streams) – has been mapped and will influence the development of scenic integrity objectives later in the forest planning process (Hill 2019). (Trends associated with drivers and stressors also influence scenery and they are discussed at the beginning of chapter 2 under Ecosystem Drivers and Stressors.)

Scenic Character

The 2012 Planning Rule defines scenic character as “a combination of the physical, biological, and cultural images that gives an area its scenic identity and contributes to its sense of place. Scenic character descriptions describe a geographic area’s visual and cultural image, by discussing the combination of physical, biological, and cultural attributes that make each landscape identifiable or unique. The descriptions include the valued attributes of the landscape, important elements of the social environment, environmental regimes, and disturbance regimes” (Hill 2015).

The Bridger-Teton spans three major zones, which are ecologically, socially, and economically different. Fifteen Landscape Character sub-units have been identified within the three zones. Table 40 below identifies the sub-units along with notable viewpoints within each zone.

Table 40. Sub-units along with notable viewpoints within each zone

Zone	Landscape Character Sub-units	Notable scenic viewpoints
Teton/Gros Ventre (Jackson Hole region – North Zone)	Teton Wilderness Buffalo Valley Mount Leidy Highlands/Gros Ventre Corridor Jackson Hole Highlands Snake River Range/Palisades Gros Ventre Mountains Snake/Hoback Corridors	Togwotee overlook The Wedding Tree Curtis and Sheep Mtn. overlooks Shadow Mountain Slide Lake overlook Teton Pass Granite Falls Lunch Counter Top of JHMR Aerial Tram
Wyoming/Salt Range (Thrust belt region – West Zone)	Greys River Corridor Wyoming Range/Big Piney Front Bondurant Basin Afton Front/Salt River Range Kemmerer thrust belts	Periodic Springs Henderson overlook McDougal Gap Tri-Basin Divide Big Springs Lake Alice
Wind River Range (East Zone)	Wind River Range Upper Green basin and river corridor Pinedale Front	Skyline Drive overlook Green River Lake (Squaretop Mtn.) Union Pass Interpretive site Upper Fremont Lake overlook Fortification Mtn. (White Pine ski resort)

Inherent Scenic Attractiveness

Inherent scenic attractiveness measures the scenic importance of how visually unique and distinctive a landscape is based upon human perceptions of the intrinsic beauty of its: landform, rock form, vegetative patterns, and composition (including seasonal changes), water features and characteristics, and cultural land use. These enduring visual qualities of landscape generally do not change, however, natural events such as: wildfires, floods, landslides, and major human modifications may alter scenic attractiveness temporarily or permanently.

Inherent scenic attractiveness has three ratings:

1. Class A (Distinctive): areas where landform, vegetation patterns, water characteristics, and cultural features combine to provide unusual, unique, or outstanding scenic quality.
2. Class B (Typical): areas where landform, vegetation patterns, water characteristics and cultural features combine to provide ordinary or common scenic quality.
3. Class C (Indistinctive): areas where landforms, vegetation patterns, water characteristics, and cultural features have low scenic quality. Often water and rock form of any consequence are missing in Class C landscapes.

For the Bridger-Teton, only Class A landscapes were identified with all other lands considered Class B (See Table 41 and Figure 50). Overall, 40 percent of the Bridger-Teton is mapped as having outstanding scenic quality.

Table 41. Scenic attractiveness

Landscape	Class A (Distinctive)	Class B (Typical)
Teton/Gros Ventre (Jackson Hole region) * (North Zone)	18%	24%
Wyoming/Salt Range (Thrust Belt) * (West Zone)	13%	10%
Wind River Range * (East Zone)	9%	26%

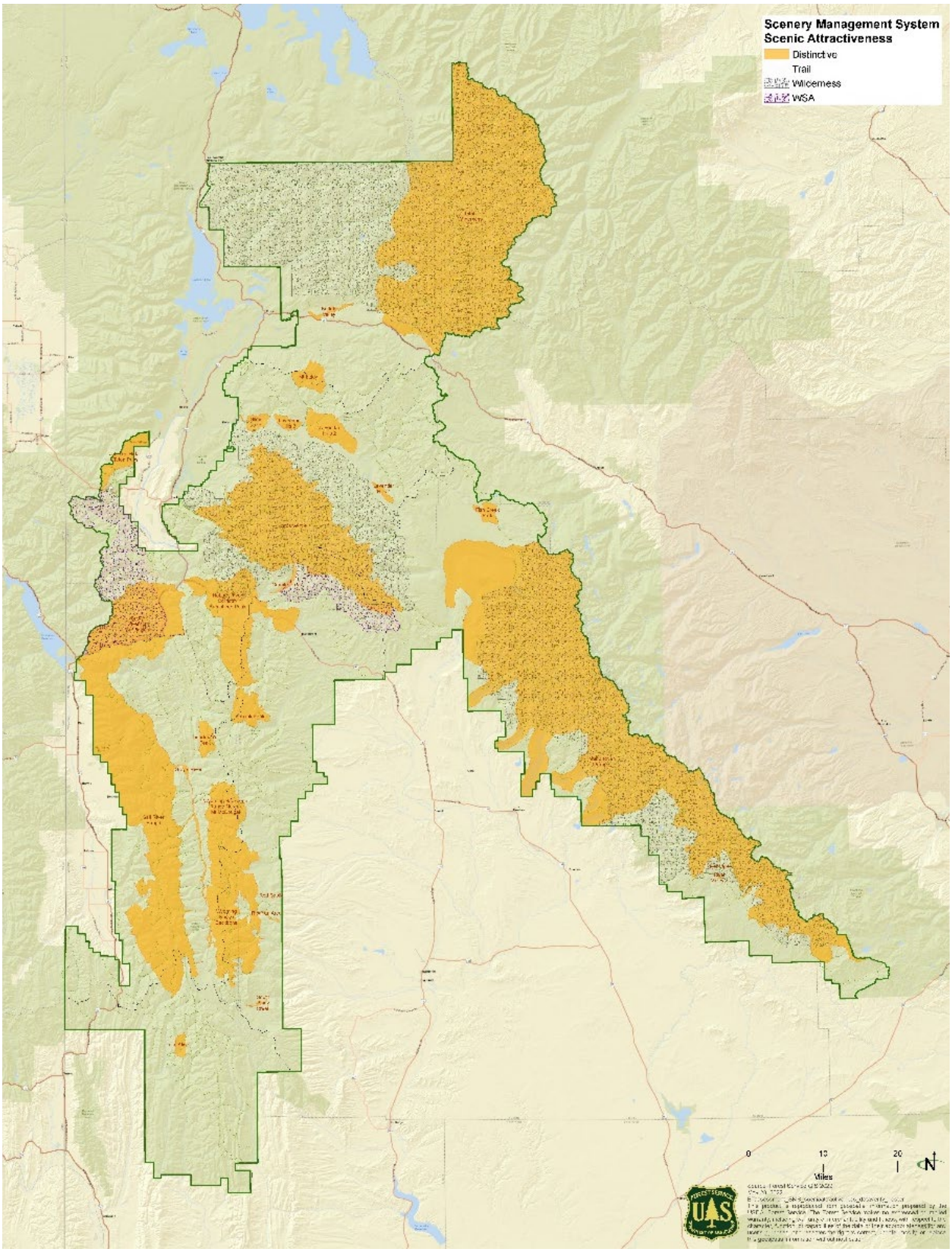


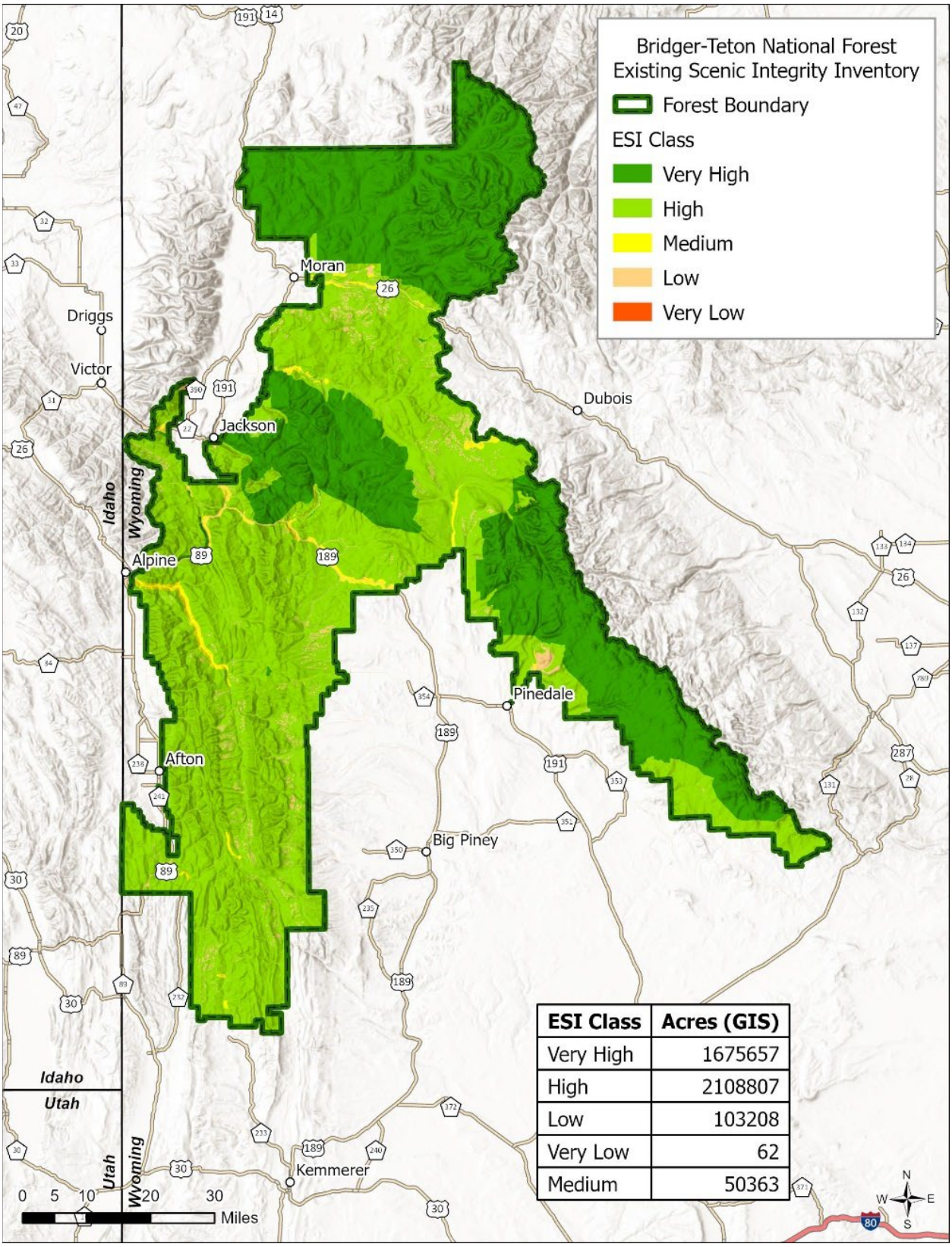
Figure 50. Distinctive landscapes on the Bridger-Teton National Forest

Existing Scenic Integrity

Scenic integrity is defined as “a measure of the degree to which a landscape is visually perceived to be complete, when compared to the landscape character described for that area”. Existing scenic integrity refers to the current condition of the landscape and its alterations by human modifications or constructed features that are generally not considered valued components. Scenic integrity indicates the degree of intactness and wholeness of the scenic character. Existing scenic integrity is expressed and mapped in terms of: very high, high, moderate, low, very low, and unacceptably low. A landscape with very minimal disruption is considered to have high existing scenic integrity. Landscapes with more noticeable disruption in the scenic attributes have lower existing scenic integrity. The highest scenic integrity ratings are given to those landscapes which have little or no deviation from the character valued by constituents for its aesthetic appeal.

Existing scenic integrity was mapped for the Bridger-Teton. It is a GIS-generated product using available data at the time. The resulting product rated the existing scenic integrity of the landscapes into one of four levels: very high, high, moderate, and low. Over the course of a week, several areas were ground-truthed to confirm the mapping. Overall, 96 percent of the Bridger-Teton was mapped as having very high or high existing scenic integrity with designated Wilderness rated as very high (See Figure 51).

Landscape-level drivers that affect scenic integrity include human-caused visual disturbances such as: timber harvesting, road construction, mining, utility corridors, recreation facilities, ski areas, and other special uses. Naturally caused visual disturbances include wildfires, insect and disease outbreaks, and wind and ice storms. Population is expected to increase demand for energy and communication infrastructure, which could impact recreation experiences and sense of place.



ESI Class	Acres (GIS)
Very High	1675657
High	2108807
Low	103208
Very Low	62
Medium	50363

Figure 51. Existing scenic integrity



Figure 52. Six photos illustrating the scenic character of sub-units in the Absaroka/Gros Ventre province

Teton/Gros Ventre Zone (Jackson Hole Region)

Teton Wilderness Sub-unit

The Teton Wilderness sub-unit encompasses the northernmost portion of the Bridger-Teton and it is bounded by Grand Teton National Park, Yellowstone National Park, and Shoshone National Forest. The landform transitions from the vast plateaus of the Yellowstone area and volcanic breccia of the southwestern Absaroka Range go into sedimentary mountains that form the eastern edge of the Jackson Hole valley. Long cliffs of loose volcanic material create bands along alpine plateaus. Elevation ranges from over 12,000 feet in eastern areas to 7,500 feet in

the western areas. Fire and natural disturbances affect the mosaic of vegetation. Vegetation alternates between dark groves of forest, open grassy slopes, and rolling meadows. Water is abundant and the integrity of the rivers and associated willow complexes are a unique feature. Spectacular views of the Teton Range are visible from numerous vantage points. The Continental Divide National Scenic Trail follows the hydrologic divide between the Atlantic and Pacific watersheds. Much of the unit is designated wilderness, one of the first protected areas in the United States. The presence of historic ranger cabins along with the CCC era Huckleberry Mountain Lookout add to the scenic character of the area.

Buffalo Valley Sub-unit

The Buffalo Valley sub-unit encompasses regions of three significant river valleys including the Buffalo Fork, Pacific Creek, and Blackrock Creek. All three are designated wild and scenic rivers. Lower reaches flow through landscapes interspersed with pastoral ranchland, which highlight western outfitting heritage. The Buffalo Fork and Pacific Creek are wide, meandering rivers with numerous side channels, gravel bars, and willow complexes. Tracy Lake is a unique feature set in a small basin above the Buffalo Fork. The main channel of Blackrock Creek is fed by numerous springs and rimmed by expansive meadows with unique riparian plant communities. The Buffalo Valley unit encapsulates a major east-west highway corridor over the Continental Divide at Togwotee Pass. The modern highway traces the same route that indigenous people traveled since time immemorial. Togwotee Pass is the nexus of the Absaroka and Wind River Ranges and characteristics of both of them are visible. As elevation drops moving west from the pass towards Jackson Hole, the views become increasingly more open with the Teton Range framed by the Bridger-Teton. Views of Two Ocean Mountain, Breccia Peak, and Sublette Peak are focal points travelling eastbound.

Mount Leidy Highlands/Gros Ventre Corridor Sub-Unit

The Mount Leidy Highlands/Gros Ventre Corridor sub-unit is characterized by the: rolling terrain, expansive willow meadows, Gros Ventre River, and a few isolated peaks, notably Mount Leidy and Grouse Mountain. The landform is composed of sedimentary mountains that contain diverse features such as: meadows, aspen groves, cottonwood forest, coniferous forest, sagebrush flats, exposed badlands, moderate to high gradient streams, small lakes, and wetlands. The Gros Ventre River Corridor is a designated wild and scenic river that has exceptional scenic quality associated with geology and historic ranches that convey a pastoral setting. Geological features include numerous: landslides, red hills, lavender hills, and grey hills, all of which add a diversity of color and variety. The Gros Ventre Corridor is also a major wildlife corridor including the path of pronghorn, the longest remaining terrestrial migration in the lower-48 states and popular for wildlife viewing as well as for scenic drives.

Jackson Hole Highlands Sub-Unit

The Jackson Hole Highlands sub-unit is characterized as the foothills ringing Jackson Hole and consists of two discrete areas. The area east of the Jackson Hole basin is geologically connected with the sedimentary formations of the Gros Ventre Range. It contains highly visited areas such as the: Cache-Game trail system, Snow King Mountain Resort, Curtis Canyon, Shadow Mountain, and Toppings Lake/Spread Creek area. A defining feature of these areas is the combination of access (either by good trails or roads) and dramatic views of the Teton Mountain Range. The area west of the Jackson Hole basin is geologically connected with the more granitic Teton Range. It contains the developed infrastructure provided by Jackson Hole

Mountain Resort as well as prominent peaks such as Rendezvous Mountain and Apres Vous Peak. This area also contains the popular Teton Pass area. A diversity of habitat types from: sagebrush, aspen groves, cottonwood galleries, mature Douglas fir, and whitebark pine are present with evidence of fire, floods, and avalanches shaping vegetative patterns. Both the east and west areas contain many of the scenic viewpoints frequented by commercial filmmakers, photographers, and tourists capturing photos of their Jackson Hole visit. With its accessibility and scenery, this sub-unit is at the fore of tension between development and conservation within the larger Jackson Hole region.

Snake River Range/Palisades Sub-Unit

The Snake River Range/Palisades sub-unit is a large, rugged area bounded by four highways and split between two National Forests, Caribou-Targhee and Bridger-Teton, and four counties, two in Wyoming and two in Idaho. Much of the area within Wyoming is congressionally designated as a Wilderness Study Area except for Munger Mountain, which separated from the rest of the sub-unit by the Fall Creek Road. The Snake River Range is characterized by a dissected landscape with narrow V-shaped drainages and numerous prominent peaks. The geology is typical of the Overthrust Belt with a sedimentary sequence like that found in the Salt River and Wyoming Ranges. As its namesake implies, a defining scenic feature is prominent limestone cliffs. Large landslides are found throughout the area. Vegetation is typical for ecosystems of Rocky Mountain spruce/fir-Douglas-fir and Rocky Mountain sagebrush steppe. However, a few plant communities are somewhat uncommon, including curl-leaf mahogany and bigtooth maple. The presence of maples adds considerable scenic attraction with their vibrant red fall colors. Montane parklands in the mid-to-upper elevations have a wide diversity of forbs that create spectacular wildflower displays. Munger Mountain is less rugged and it carries the distinction of having one of the most contiguous aspen stands in the Jackson Hole region due to a fire that swept through the area in the 1930s. It attracts many recreationists in early summer to view the balsamroot and mules ear wildflower display and in the fall to walk, bike, or ride through the golden aspens.

Gros Ventre Mountains Sub-unit

Much of the Gros Ventre Mountains sub-unit is congressionally designated as either the Gros Ventre Wilderness or the Shoal Creek Wilderness Study Area. It is a geologically old mountain range with: high elevation mesas, prominent peaks, glaciated cirques, and three large river drainages. Spectacular views of the Teton Range are seen from most high points. The Teton Range is comprised of steep to moderately steep mountains of sedimentary rock such as Jackson and Darwin Peaks. The highest peak is Doubletop Mountain at 11,740 feet. The sub-unit contains distinctive geological features such as colorful red rocks, extensive karst topography, and fossils. It is an area prone to landslides, including the highly visible Gros Ventre Geological Slide. Two mountains within this sub-unit are particularly significant from a scenic perspective – Sheep Mountain and the Sawtooth. When the sun sets in Jackson Hole, the last mountaintop to hold the fading alpenglow is Sheep Mountain (often called Sleeping Indian), an iconic symbol for Jackson Hole. Likewise, the Sawtooth to the Elbow is a dramatic ridge of peaks rising steeply above Bondurant Basin and visible to all those travelling on Highway 191 near the rim. High gradient elevation, precipitation, soil types, and aspect combine to create a diverse variety of plant communities including alpine meadows above treeline. Wildfires, active landslides, insects, and other disturbances continue to shape these communities.

Snake/Hoback River Corridors

This sub-unit includes the main stem of the Snake River as well as the Hoback River and Granite Creek. All three river corridors are congressionally designated wild and scenic rivers that possess a scenic outstandingly remarkable value. The Snake and Hoback corridors include major state highways for commuters, visitors, and commerce in and out of Jackson Hole. As such, annually millions of people soak in the beauty of the canyons through the changing seasons. Granite Creek has carved a gentle sloping valley, but both the Snake and Hoback corridors are more varied with segments of steep-walled canyons, where flat, open areas allow for rural residential development and the canyon floor has a rustic setting. Elsewhere, tight canyon bottoms nestle recreation sites, such as boat launches, trailheads, and campgrounds. Broader canyon bottoms harbor sagebrush flats, aspen groves, and meadows. Deciduous plants, such as maple, cottonwood, and aspen, display brilliant fall color. Water flows add a scenic element ranging from translucent pools to small cascades associated with beaver dams, to rapids with large standing waves. Hot springs add geothermal laden water in the Granite Creek and Astoria areas.

Wyoming/Salt Range Zone (Thrust Belt)

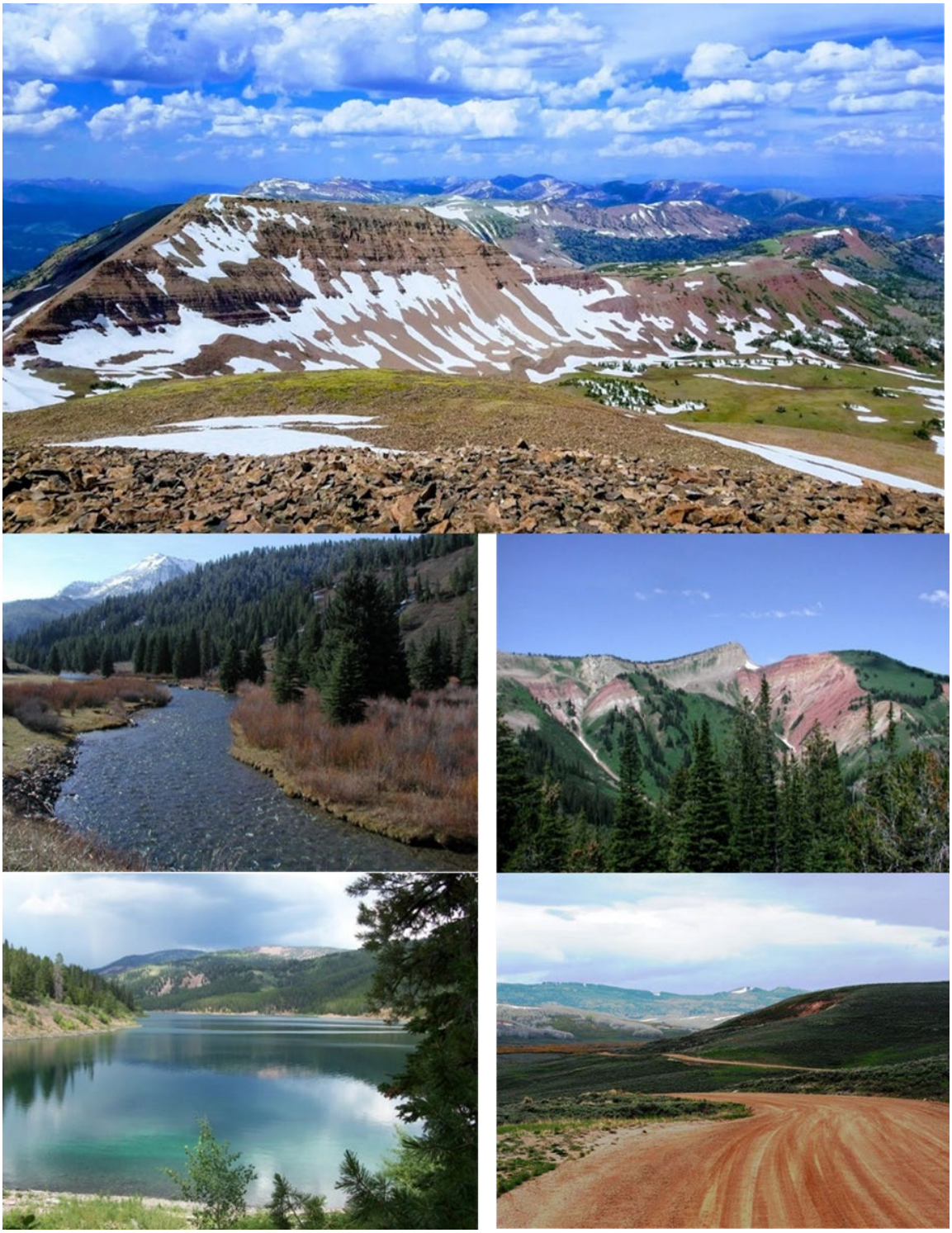


Figure 53. Five photos illustrating the scenic character of sub-units in the Wyoming/Salt River province

Greys River Corridor Sub-unit

The Greys River Corridor sub-unit encompasses the Greys River from its headwaters along Tri Basin Divide to its confluence with the Snake River. The Greys River carved a gentle sloping valley, which separates the Wyoming and Salt River Ranges. As it flows south to north, it picks up over 85 tributaries. In the north, the primary tributary is the Little Greys River, which carved a separate valley through the Wyoming Range. Numerous springs, fed by the mountain's snowpack, contribute to stream flow. During the summer, the base flow is clear with blue-green hues. The low gradient is prime habitat for beavers, which create wetlands replete with willows and side channels. Cottonwood groves mix with Engelmann Spruce in bottomland forest. South facing slopes are dry and open with: meadows, grasses, sagebrush, and shrubs. Dense coniferous forest of lodgepole pine and Douglas fir cloak north facing slopes. Openings in vegetation provide views of the surrounding high peaks. The sub-unit provides a good network of roads fishing, hunting, and large family campouts. Guard Stations and "buck'n'rail" fence reflect the long history of USFS management. A favorite viewpoint along the Greys River overlooks a bend in the river through an aspen grove and up toward the steep bare slopes of Virginia Peak.

Wyoming Range/Big Piney Front Sub-Unit

The Wyoming Range extends nearly 80 miles and offers stunning beauty that is often overlooked since the range is somewhat hidden behind frontal mountains and low sagebrush hills for those travelling on the major highways. However, for adventurers the range offers stunning beauty. Its creeks plunge over cliffs in spectacular falls feeding the Green, Hoback, and Greys Rivers. High lakes are a hidden treasure. The view from the 11,363-foot Wyoming Peak reveals a series of plateaus and mountain faces carved from the multi-colored sedimentary rocks of the overthrust belt. Vegetation communities include: willow-lined streambanks, Engleman spruce, open sagebrush flats, large stands of aspen and lodgepole pine/Douglas fir/subalpine fir, and a small alpine zone along the crest rimmed with whitebark pine and stunted fir (Marsh 1995).

Once the sheep capital of the world, visitors are still likely to encounter sheep grazing in the mountains and cattle drives blocking roadways in a landscape that exudes an "old West" ambience and cultural heritage.

Bondurant Basin Sub-Unit

The Bondurant Basin sub-unit is characterized by rolling terrain dominated by sagebrush and aspen. It lies north and south of Highway 191/189 between Granite Creek and the Rim Station. It includes interspersed private land with many historic ranches that give travelers a sense of early western settlement. The area includes Noble Basin and Raspberry Ridge as well as key tributaries to the Hoback River such as Dell Creek and Fisherman Creek. Wildfires are very evident as a large portion of the sub-unit burned in the 2016 Cliff Creek Fire and the 2018 Roosevelt Fire. Ancient pebble/cobble stream deposits of white and yellow rock are exposed and add scenic interest along the highway as travelers ascend towards the Rim Station.

Afton Front/Salt River Range Sub-Unit

The Salt River Range extends nearly 56 miles and forms the eastern boundary of Star Valley. The highest point is the striking Mount Fitzpatrick at 10,907 feet. Like the Wyoming Range, the Salt River Range is part of the Overthrust belt, but it features more lakes than the drier

Wyoming Range. Narrow canyons above Star Valley feature big-tooth maple with vibrant fall colors and the sculpted beauty of curl-leaf mahogany. The Swift Creek drainage houses a rare cold-water geyser that pulses on and off during low-water season attracting visitors from afar. At the south end of Star Valley, a long, rounded ridge on the west known as the Gannett Hills features unusual mudstones. To the east lies Wagner Peak under which the Salt River begins its journey. The pass between the two marks the divide between the Great Basin and the Columbia River watershed and it is the starting point for a scenic byway along State Highway 89.

Kemmerer Sub-Unit

The Kemmerer sub-unit forms the southernmost portion of the Bridger-Teton and it is characterized by long, open ridges with names like: Commissary, Indian, Mahogany, Absaroka, all of which make up the little-known Tunp Range. Golden eagles and other raptors follow these ridges during spring migrations before spreading out across their breeding range. The northern edge of this zone straddles a divide that separates the uppermost reaches of the Columbia River watershed from both the Great Basin of the intermountain interior deserts and the upper Colorado River watershed on the west. Big Fall Creek highlights mixed clastic/carbonate terraces splitting into numerous threads in a sparkling woven pattern of waterfalls, intermixed with wildflower displays. Big Springs, another water feature with its long, mossy spill, provides the main attraction for a scenic backcountry byway that makes a long loop through alternating forests and meadows. Lake Alice, created by a small debris slide, is an anomaly of still water within this often-dry landscape.

Wind River Range Zone











Figure 54. Five photos illustrating the scenic character of sub-units in the Wind River province

Wind River Range Sub-unit

The Wind River Range sub-unit is a visually striking, isolated mountain range trending 80 miles north-south. The Wind River Range is composed of colossal, granitic mountains with broad glacial basins and spectacular jagged peaks. Elevations range from 8,000 feet at Green River Lakes to 13,804 feet at Gannett Peak, the highest mountain in Wyoming. Squaretop Mountain at the head of Green River Lake is a Wyoming icon, gracing vehicle license plates and promotional materials. The monolithic mountains are one of the oldest ranges in North America. They have 13 glaciers dotted along its western slope, including two of the largest in the lower-48. Glaciation created 2,000 lakes, ponds and potholes scattered across the range ranging in size from tiny tarns to large lakes. The web of alpine lakes and streams are the headwaters of the Green River. Forests are predominantly lodgepole pine at lower elevations and spruce-fir at higher elevations with limber and extensive whitebark forests. The Wind River Range also includes a significant alpine zone with tundra plants intermixed with talus, bedrock, and tarns. The Wind River Range is the scenic backdrop for Pinedale and the Highway 191 corridor. Most of the sub-unit is designated as the Bridger Wilderness, one of the first protected areas in the United States, and it encompasses 142 miles of the Continental Divide National Scenic Trail.

Pinedale Front Sub-Unit

The Pinedale Front sub-unit forms the foothills between the valley floor and the Wind River Mountain Range. Six large glacial lakes are its notable scenic feature with much of the visitor attention focused on Fremont Lake, the second largest natural lake in Wyoming and one of the nation’s deepest. Skyline Drive offers ample opportunity for visitors and photographers to enjoy a leisurely drive and soak in the scenery of the lakes with the stunning Wind River Mountains in the background. Cultural features associated with cattle operations and historic ranches add to the scenic value.

Upper Green Basin Sub-Unit

The Upper Green Basin sub-unit is an area of transition between the Gros Ventre Range and the Wind River Range. Pinon Ridge is a prominent hydrologic divide internally within the unit. The terrain is lower in elevation than adjacent mountain ranges and it lacks prominent summits. The Green River Basin, a primary tributary of the Colorado River system, is the heart of the sub-unit and its’ focal point. Also notable is the Union Pass area, a landscape dotted with small lakes, springs, and seeps that affords sweeping vistas with its expanse of sagebrush and wetland meadows intermixed with aspens. An extensive road network offers ample opportunity to explore the views throughout this sub-unit. Cattle operations are prevalent, which adds historic interest in this area. The road along the Green River passes the remains of the earliest dude ranch in Sublette County, the first in a long history of ranching businesses. For several weeks each June, the Green River Drift, one of the longest-running cattle drives in the Nation, takes place as wranglers push livestock from adjacent valleys about 70 miles to reach higher grounds with rich mountain pastures.

Land Ownership, Status, Use and Access

Key Takeaways

To meet the USFS’s mission of sustainability and productivity of the Nation’s grasslands and forests, all the resource areas noted within this Assessment are managed for numerous benefits

and uses. However, managing the lands within the boundary of the Bridger-Teton becomes more complex when we examine all the lands within the boundary are not national forest lands, but rather a complex mosaic of ownership with varying access and utilization. This section describes how: land status, ownership, use, and access patterns influence the management of the Bridger-Teton.

Summary

Land Ownership and Status

In the simplest terms and in the context of this Assessment, land ownership and status is the condition of title, consisting of the rights and obligations conferred through land transactions. Within the category of land status are included the legal uses, permissions, and restrictions of the land. When referring to ownership and status, the categories below may be used:

- reserved public domain lands,
- existing rights-of-way (also referred to as linear easements of record),
- private land inholdings,
- leased lands,
- acquired lands,
- land withdrawals,
- lands with reserved or outstanding rights, and
- lands in designated areas.

Land status also encompasses: planning, zoning, easements, or other legal designations when considering private inholdings or adjacent lands. Land status also may include management status of public land managed by other agencies whether local, State, or Federal.

“National Forest System lands” officially refer to the lands that are managed by the USFS. Within the boundaries of National Forest System lands, there are inholdings privately held by other agencies. These areas are taken into consideration within the framework of this Assessment and future planning efforts because they influence the management of the plan area and vice versa. This becomes notable when considering natural resources within the greater ecosystem and the interconnected nature of wildlife and associated habitats, watersheds, and timber, as well as the influence of larger forces such as climate change and wildfire, for example.

Land Use and Access

Land use refers to the way the land is utilized. The uses can include: commercial, agricultural, residential, governmental, or industrial. Land use also includes management practices and authorized uses, as noted in existing land management plans either for the USFS or adjacent public lands. These can include: rights-of-way, easements, grazing allotments, timber sales or management areas, to name a few. Management plans typically describe both existing land uses and desired future land uses. In addition, plans in areas adjacent to USFS land can influence uses and future management of USFS land.

Access is defined as the legal right to ingress and egress upon National Forest System land, private inholdings or other real property. Means of access may include, but are not limited to, the following: motorized roadways, motorized trails, non-motorized trails, foot paths, and pedestrian modes across undeveloped areas. Within this Assessment, access typically can be thought of as initial access into USFS lands across the USFS boundary.

Status and Trends

Land Ownership within the National Forest Boundary

The Bridger-Teton Forest Plan Area consists of approximately 3,466,348 acres, which is considered to be the administrative USFS. Included within this acreage and Bridger-Teton boundary is approximately 34,147 acres of in-holdings (See Table 42).

Although the Bridger-Teton's landownership pattern is relatively well consolidated, there remains opportunities to further consolidate land ownership within the administrative USFS. The purpose of consolidating land ownership is to: reduce maintenance costs (management efficiencies), protect wildlife habitat and patterns, ensure water flow and quality (watershed protection/climate resilience), and open the lands for recreational uses.

All potential purchases begin with a willing seller. The USFS does not and will not take land. The USFS will, however, outreach when land becomes available on the real estate market and they will actively engage landowners in information sharing. Future options to consider include: private lands, State of Wyoming – Investment Lands, State of Wyoming, and WDGF lands. All non-Federal lands may find benefits for inclusion into the USFS consolidation while benefitting the non-USFS landowner.

Table 42. Acres of land classified by ownership within the Bridger-Teton National Forest Plan area

Bridger-Teton	Acre
Plan Area Acres (administrative USFS)	3,466,348.00
Plan Area USFS Administered Acres	3,432,201.00
Plan Area Inholding (Non-USFS lands within the administrative boundary)	34,147.00

Federal lands outside the Bridger-Teton include lands managed by the BLM, NPS (Yellowstone and Grand Teton National Parks) and USFS. The Bridger-Teton also shares boundaries with two other national forests, Caribou-Targhee and Shoshone National Forests. Other lands include the Wind River Reservation, Wyoming State lands, and the county lands surrounding the Bridger-Teton (See Figure 1).

Land Additions, Subtractions, and Exchanges

Land Purchases

In the time period since the approval of the 1990 forest plan and the writing of this Assessment, there were 15 land purchase transactions resulting in an additional 1,523 acres added to Federal ownership on the Bridger-Teton. The USFS typically works with private land trusts to purchase lands until the USFS is able to secure funding. Partners include: The Conservation

Fund, The Trust for Public Lands, The Nature Conservancy, and the Jackson Hole Land Trust. These partnerships are critical to the success of the land adjustment program because they have the ability to move more quickly than the Federal processes. In addition, the USFS will continue to pursue land acquisition opportunities in the future through the Land and Water Conservation Fund (LWCF) program.

Land Conveyances

The Bridger-Teton conveyed an administrative site through the Forest Service Facilities Realignment and Enhancement Act of 2005 (FSFREA). The proceeds were retained for the construction of a new administrative facility. The USFS has few land disposal authorities, however, when in the public interest, they will continue to manage qualifying trespass and encroachment issues using authorities such as the Small Tracts Act of January 12, 1983 or the National Forest Townsite Act of July 31, 1958.

Land Exchanges

Land exchanges on the Bridger-Teton occurred in nine separate transactions since the current forest plan was written, resulting in a net gain of nearly 3,000 acres. These same transactions resulted in just over 87 acres of USFS land transferred out of Federal ownership through five transactions. The largest gain of land in one of these exchange transactions occurred in 2005 resulting in almost 2,500 acres. The other land exchanges, including acquisition and disposal, varied in size from just over 300 acres to a quarter of an acre.

Minor land exchanges are expected to continue, and new proposals are evaluated on a case-by-case basis. However, due to the lengthy and costly process of conducting land exchanges, the number of proposals that can be processed is limited.

Land Donations

The Bridger-Teton has the authority to accept land as a donation and the process is similar to the purchase process. Land donations overall account for a smaller percentage of acquisitions than other land actions. Prior to the current forest plan, only four land donations occurred from 1915 through 1951, accounting for a gain of less than 30 acres. There have been two land donations to the Bridger-Teton since 1990 totaling 23 acres. The land donations were received from two separate private individuals.

Rights-of-Way and Easements

Rights-of way are legal rights provided by the USFS to another party or from another party to the USFS to pass along a specific route, such as a transmission line passing through a national forest or a national forest trail or road passing through a private inholding. Easements are permissions the USFS grants to another party to use national forest land for a specified purpose, such as a private landowner needing to build a road across national forest land to access their property. Within these classifications, the Bridger-Teton grants easements to departments of transportation; easements to public road agencies who cooperate with the USFS in construction and maintenance; and easements and permits through the Federal Land Policy and Management Act.

There are just over 80 rights-of-way and easements on the Bridger-Teton that provide public access to the Bridger-Teton through adjoining non-USFS land. The Bridger-Teton has several

conservation easements that are annually monitored by a partnership with a land trust. Work is ongoing to identify new rights-of way and easements because the USFS anticipates a need for additional public access routes in the future. Establishing new rights-of-way and easements will greatly depend on the cooperation of adjacent landowners where these routes and corridors may occur. Many of the rights-of-way and easements that have yet to be obtained are complex and complicated and they may take many years to complete if owners are willing.

Communication Sites

There are 10 communication sites on the Bridger-Teton. At these 10 sites, the Bridger-Teton administers 18 special use authorizations that provide services to the public, including the following: private mobile radio service, broadcast translator/low power TV and FM, power TV and FM, and cellular service. These leases are held by various entities, including: local emergency service providers, universities, Wyoming Department of Transportation, private mountain resorts, Federal Aviation Administration (FAA), and communication corporations. Currently, the Bridger-Teton has limited ability to accommodate additional uses at existing sites due to limited capacity. As cellular technology continues to develop, the need for additional or expanded facilities is likely. The Bridger-Teton has communication site plans in place for all 10 sites.

Boundary Surveys

USFS Intermountain Region survey crews annually perform boundary line surveys at different locations around the region, usually by specific request by a program on the Bridger-Teton. Much of the boundary line needs maintenance, and in some cases, needs to be resurveyed. Additional boundary line maintenance and surveys are needed in the next decade; this should include any inholding land that has not yet been surveyed and marked, as well as a boundary line that has not been maintained within the last 20 years. Continued development adjacent to the Bridger-Teton boundary will require periodic maintenance of posted boundary markers and surveys to identify encroachments and trespasses. Per FSH 5609.11 CH. 60.3, prior to any land, resource, or restoration management activities occurring within 1-quarter mile of any National Forest System boundary line, all of the following: property corners, property controlling corners, Public Land Survey System corners, property lines, and special designated area boundary lines must be surveyed, located, monumented, marked, and maintained to USFS standards.

Mineral Withdrawals

A mineral withdrawal removes specific areas of the national forest from prospecting and mining activities. It can only occur through an act of Congress or an extensive public process led by the Secretary of the Interior. The BLM has final authority over the Federal mineral estate underlying the Bridger-Teton. Approximately 80 percent of the Bridger-Teton, or 2,751,562 acres, is withdrawn from prospecting and mining activities. (Please reference the Energy and Minerals section of this Assessment for additional information.)

Special Uses

Bridger-Teton staff processes and administers lands and recreation special use authorizations for a variety of purposes. (Recreation special uses are covered in the Recreation section of this Assessment.) Lands uses range from: roads, powerlines, canals, and water pipelines to small

dams and reservoirs, and many more. Requests for and interest in these types of authorizations are primarily increasing for utilities such as: power, oil, gas, fiber optic lines, and cellular infrastructure. Many of these permits generate revenue to the Treasury, regional USFS Office, Bridger-Teton, State government, and county governments through the collection of rent as land use fees, cost recovery fees for processing and/or monitoring, or transfer fees.

There are currently over 400 lands special use authorizations on the Bridger-Teton (exclusive of rights-of-way and easements). Land special uses are diverse and include uses such as:

- agricultural and agricultural improvements,
- arts (filming and photography),
- communications infrastructure,
- cultural resource,
- dams and reservoirs,
- electric transmission and distribution,
- energy generation and transmission,
- oil and gas development,
- precipitation and seismic measuring stations,
- research,
- storage,
- telephone and fiber optic lines,
- water gauging stations, and
- water transport (canals, ditches, and pipelines).

National Forest Access/Visitor Access

The Bridger-Teton is accessed by several primary and secondary roads. (Please refer to the Roads and Trails section of this Assessment for more detailed information.)

Conclusions and Future Considerations

Many of the trends and needs for action from the 1990 forest plan persist to this day. Lack of formalized easements or rights-of-way pose a threat to Bridger-Teton access, whether that be for the general public or administrative access. The Bridger-Teton has implied access through other agencies, such as the State, NPS or BLM land, and this access is not likely to be removed at any point in time. Access to NFS USFS land has, at times in the past, been granted through informal “handshake” agreements, which because they are not documented, could be revoked at any time. Many of the less complex rights-of-way and easements have already been obtained, leaving the more complicated, contentious, and lengthy land actions to be pursued. The restriction of access to Bridger-Teton lands poses the dual problem for the public losing access to Federal lands and greater administrative costs for staff to access and manage those lands.

Counties adjacent to the Bridger-Teton have seen drastic increases in property value and a fast-paced seller's market as populations move away from dense, urban areas to more rural areas of the country. With these changes come the desires for landowners to consolidate lands and access and clarify boundary lines, resulting in the potential for increased land action inquiries. The trend of more residential development on private lands adjacent to the Bridger-Teton will continue to result in greater potential for trespass and encroachment, which requires closer monitoring from Bridger-Teton staff, and has the potential to negatively impact Bridger-Teton resources. Clearly marked boundary lines are a key preventative measure for deterring trespasses and encroachments.

Along with the above considerations, the need for special use authorizations will continue to grow as there is a larger and more diverse population and an increased popularity and visibility of the region. The 1990 forest plan noted the potential for growing demand for electronic transmission sites, and this persists to this day, especially with the greater presence of internet and cellular connections in our daily lives. Residential areas place greater demand on the electric grid, resulting in potential increase in the need for greater capacity at communication and electronic transmission sites. There is a need to identify and analyze utility corridors to reduce impacts to visual resources, encourage colocation, reduce wildfire risks, and to streamline the authorization process for broadband and communication use applications.

The USFS staff will pursue land exchange, purchase, and donation proposals and continue to manage existing and future proposals for special use authorizations, rights-of-way, and easements when in the public interest and as capacity allows.

Recreation Settings and Opportunities

Key Takeaways

- Recreation is the primary way people connect with the Bridger-Teton. With nearly 2.2 million visitors and diverse, year-round recreation opportunities, it is the second most heavily visited forest within the GYE and the most heavily visited forest in Wyoming. As such, the Bridger-Teton plays a vital role in serving local communities, directly contributing to memorable visitor experiences and annually supporting the regional economy with an estimated $173 million in direct and indirect economic impact (USDA 2022b). Recreation is the largest economic driver generating 46 percent of Gross Domestic Product and 81 percent of all special use receipts generated by the Forest (Forest Level Economic Contributions Dashboard – 2019 | U.S. Forest Service (usda.gov) (USDA 2022b).
- Recreation activity on the Bridger-Teton substantially increased since 1990 based on trail counter data, outfitter-guide activity, and field observations. It is anticipated to continue increasing in response to population growth in the region and a societal shift towards valuing experiences and leisure as much or more than work. More important than the sheer numbers of visitors, how and where visitors recreate has evolved, largely driven by technological and demographic changes. Winter recreation opportunities (e.g. skiing and snowmobiling), trail-based recreation (hiking and bicycling), and wildlife-fish-scenery based recreation are particularly distinctive recreation opportunities on the Bridger-Teton with most recreation occurring in undeveloped, dispersed settings.
- Recreation must be well-managed to protect the natural and social qualities that underpin quality visitor experiences. With the rapidly changing nature of recreation, sustainability is a

major concern. Key issues include: effects on water quality from improper sanitation and vegetation loss near streams; wildfire risk due to escaped campfires; wildlife disturbance in key habitats; improper food storage; spread of noxious weeds; trail proliferation; social conflict; increasing search and rescue incidents; and staffing to maintain infrastructure or provide adequate coverage for visitor education and enforcement. Progress on these issues is being made, largely due to partnership efforts, but managing recreation with a sharper focus and updated forest plan direction is necessary to help navigate the increasing complexity of issues managers face.

- With the tremendous change that occurred over the past 30 years and the challenges anticipated over the next decade, updated recreation direction is needed to sustain a desired mix of recreation settings and acceptable resource conditions. Five key findings are expected to shape the future of recreation and underpin the need for an updated forest plan direction: (1) easily accessed areas and key destinations will face increased pressure; (2) social conflict will be more challenging to address than ecological effects; (3) electric technology will blur the line between motorized and non-motorized use; (4) winter recreation planning to address non-motorized, motorized, and wildlife values will be particularly challenging; and (5) climate change will increasingly affect recreation settings and opportunities.

Overview

> “Nature challenges us, revitalizes us, humbles us, exhilarates us, and restores our souls. It reminds us that we are part of a larger universe, stewards rather than masters of our world” - Nicholas Kristof, NYT 2011

Recreation plays a very prominent role on the Bridger-Teton with diverse year-round opportunities and outstanding natural assets, some of which are nationally recognized through special designations. The Bridger-Teton is an integral part of the GYE and it is especially valued for its: large backcountry and wilderness areas, rivers, lakes, wildlife and fish-related opportunities, and unparalleled winter recreation. With nearly 2.2 million visits annually, it is the second most heavily visited forest within the GYE and the most heavily visited forest in Wyoming (NVUM 2018). As such, the Bridger-Teton plays a vital role in serving local communities; contributing directly to residents’ quality of life; and supporting the regional economy.

Recreation is the primary way most people connect with the Bridger-Teton and it is a vital thread in the fabric of society; this is especially true in Wyoming where 94.6 percent of residents say that public parks and public recreation areas are important or very important to their quality of life (Wyoming SCORP 2019). Access to outdoor experiences is incredibly important. Clean air, clean water, healthy forests, robust wildlife populations, and scenery are equally important because the natural environment is the foundation that underpins the quality of the visitor experience. Recreation connects people with their natural and cultural heritage; promotes physical and mental health; enhances bonds with family and friends; inspires art and writing; and offers personal rejuvenation. Recreation also contributes to the economic vitality of communities supporting outfitter-guide services, local retailers, real estate, and the hospitality sector. In Wyoming, outdoor recreation annually generated an estimated $2 billion to the GDP in 2022. Recreation and tourism currently contribute 4.1 percent of the State GDP, and it is a rapidly growing sector that contributes to the desired diversification of the State’s economy (University of Wyoming 2024). Notably, hunters, anglers and wildlife watchers bring around $1

billion to the State each year with snowmobiling, trail activities, RVing, and skiing/nordic activities also substantially contributing to the State's economy (University of Wyoming 2024, Outdoor Industry Association 2017, Newcomb 2013).



Figure 55. Child playing on the Bridger-Teton. Photo credit: Ted Porwoll, Bridger-Teton.

The diversity of recreation settings and opportunities on the Bridger-Teton can be further described by understanding three distinct zones on the Bridger-Teton (See Figure 56), each of which contributes to the values for which the Bridger-Teton is known.

Teton/Gros Ventre (North Zone)

The north end of the Bridger-Teton (the Teton/Gros Ventre zone) includes the Blackrock and Jackson Ranger Districts and is strongly influenced by Grand Teton and Yellowstone National Parks, each of which annually attracts two to four million visitors. The National Elk Refuge additionally annually attracts 472,000 visitors with most use occurring in the winter for wildlife viewing. The north end of the Bridger-Teton plays an important complimentary role by providing opportunities for activities such as: dispersed camping, mountain biking, dog walking, and snowmobiling, which are prohibited or more restricted in the parks and refuges in addition to providing more opportunity for recreation in undeveloped, less crowded settings.

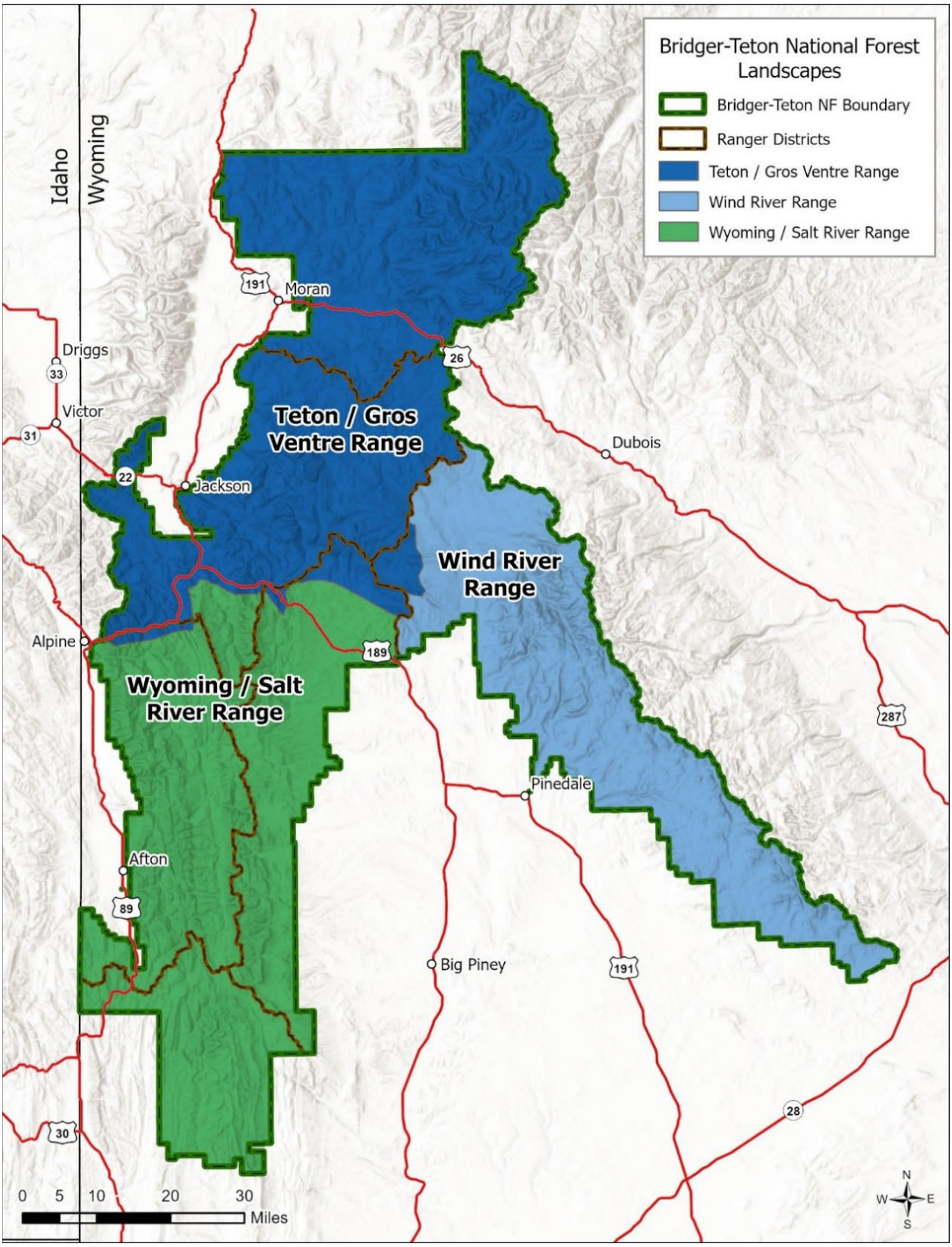


Figure 56. Zones on the Bridger-Teton

The Blackrock District is defined by: wilderness, wildlife, elk hunting, stock use, and snowmobiling. The Teton Wilderness makes up more than 80 percent of the District, and it is considered one of the premier places in the Nation for multi-day horse packing trips including travel on the Continental Divide National Scenic trail. As part of the first national forest, Blackrock has a rich conservation history and miles of wild rivers supporting a premier wild fishery. Grizzly bears are common. There are spectacular Teton Range views from many vantage points. Outfitters provide substantial amounts and varieties of service for visitors from across the Nation, enhanced by full-service all-season guest ranches. The demand for dispersed camping substantially increased in portions of the Blackrock District due to being adjacent to Grand Teton National Park.

The Jackson District is defined by an extensive wildland-urban interface offering a variety of accessible summer and winter dispersed and resort-based recreation, surrounded by exceptional backcountry, wild rivers, and wilderness. The Jackson District contains notable designations including the: Gros Ventre Wilderness, wild and scenic Snake River and its tributaries, path of the pronghorn, and Gros Ventre Slide Geological site. With Jackson Hole Mountain Resort as an international tourist destination, recreation use is very high, notably for day use activities that compliment what is available in the adjacent national parks and National Elk Refuge. Recreation opportunities cater to those who live and work in the Jackson area as well as to visitors, many of whom desire outfitted services. Wild lands provide the connective tissue that is integral to crucial wildlife habitat and migration corridors in the GYE and they offer destination shed hunting, wildlife viewing, and fall hunting opportunities.

Wyoming/Salt River (West Zone)

The west side of the Bridger-Teton (the Wyoming/Salt River West Zone) includes the Greys River, Big Piney, and Kemmerer Ranger Districts and is influenced by adjacent BLM public lands and the Caribou-Targhee National Forest, both of which provide more abundant opportunities for OHV use, while the Bridger-Teton provides more unroaded, backcountry opportunities. Coordination on travel management and public access is especially critical between the Bridger-Teton and the BLM in this area. Fossil Butte National Monument is located close to Kemmerer, and it provides a different visitor experience annually attracting around 20,000 visitors.

The Greys River District is best known for the Greys River corridor where the highly traveled road provides important access for: dispersed camping, motorized and non-motorized travel, hunting, fishing, snowmobiling, and gathering forest products. Relatively intact backcountry areas are cherished havens for hiking and horseback riding, and they are especially known for mule deer hunting opportunities. Local residents enjoy multi-generational connection to the land based on longstanding Bridger-Teton use. The Greys River and its tributaries provide intact aquatic habitat important to the conservation of Snake River cutthroat. The Greys River District contains one of the world’s only cold-water periodic springs and portions of the historic Lander Cutoff National Historic Trail and Wyoming National Recreation Trail.

The Big Piney and Kemmerer Districts are defined by good road access and camping along the Bridger-Teton boundary and major drainages complemented by a very solitary and primitive setting. The Big Springs scenic backway provides ample opportunity for the following: dispersed camping, CCC-era cabin rentals, hiking, horseback riding, mountain biking, snowmobiling, and off-highway riding. The heart of the Kemmerer District provides unroaded, backcountry recreation opportunities in wild landscapes of lakes, ridges, and valleys that follow the spine of

the Wyoming Range along Commissary Ridge. The Big Piney and Kemmerer Districts contain both the Wyoming National Recreation Trail and the Lander Cutoff National Historic Trail. Plentiful opportunities exist for firewood collection, hunting, and fishing, with one of the only places to catch Bonneville Cutthroat as part of the cutt-slam challenge.

Wind River (East Zone)

The east side of the Bridger-Teton (the Wind River East Zone) includes the Pinedale Ranger District and is also influenced by the BLM public lands and the Shoshone National Forest. The Shoshone National Forest, along with the Wind River Indian Reservation, manages the Wind River Mountains east of the Continental Divide with most of the area wilderness or roadless. This makes cross-boundary coordination on wilderness stewardship topics essential.

With the headwaters of the: Green River, historic cattle drives, the highest peak in Wyoming, two of the largest glaciers in the U.S., home of the mountain man, and the path of the pronghorn antelope, the Pinedale District bridges the gap between rich natural and cultural history. Over half of the district falls within the Bridger Wilderness, which is known as an international destination for backpacking, fishing, and rock climbing. Wilderness opportunities feature thousands of high-altitude lakes and hundreds of miles of non-motorized trail, including many miles of the Continental Divide National Scenic Trail. Developed and dispersed summer and winter recreation are coveted opportunities around the shores of glacially carved lakes accessible by road. Breathtaking scenic drives along Skyline Drive, up to Green River Lake, or over Union Pass, transect the Pinedale District, allowing visitors to experience remote areas without leaving their car.

The Assessment findings presented here summarize information about recreation settings, recreation activities, trends, and sustainability of opportunities on the Bridger-Teton. Since 1990, when the current forest plan was approved, tremendous recreational change occurred. As a result, the direction in the forest plan needs to be updated to achieve the promise of sustainable recreation into the future.

Recreation Trends

Human population growth in the western U.S. with its associated demographic and technology change, are the factors expected to most influence the sustainability of recreation settings and opportunities over the next 10-15 years.

Recreation has always been an important use in the Bridger-Teton with areas of heavy use acknowledged in the 1990 Forest Plan. The same holds true today and has been amplified by the substantial increase and evolution in recreation activity since 1990. Nationwide, visitor use increased 25 percent in just 1 year (2019-2020) mostly within dispersed settings (camping, boating, trail, and wilderness use) (USDA 2021a). Camping and trail use numbers on the Bridger-Teton increased 20-40 percent between 2019 and 2021 in some locations based on trail counter and campground occupancy data. Although this dramatic increase was a result of the “Great American road trip” during the pandemic, it highlights the trend of increased recreation use that had been occurring for many years, and it underscores the public value of recreation on national forest lands. Increasing visitor use coincides with a societal shift towards spending more on experiences rather than material goods. Two studies in 2004 (Cordell and Roper) both noted that most Americans consider leisure to be as valuable as work and many report that leisure is more important than work. Factors driving this trend include people seeking authentic

experiences that create a sense of belonging or bonding with family or friends, seeking rejuvenation and stress-relief, as well as perceiving experiences as enhancing one's status (Han et al. 2023).

The shifting nature of recreation has been more dramatic than the sheer numbers of visitors. Technological advances in equipment, clothing, and sources of information are the leading factors driving change. Completely new recreational activities have emerged and grown such as: e-bikes, downhill mountain bikes, drones, geocaching, fat tire bikes, paragliding, packrafting, stand-up paddle boards, motorized snow bikes, and side-by-side vehicles. Other technological advances have made recreation activities easier, more comfortable, or capable of accessing more terrain. Examples of this include: lighter mountain bikes with high-quality suspensions, alpine touring backcountry skis, split boards, lighter more powerful snowmobiles, super light-weight backpack gear, and clothing that is breathable and keeps you warm and dry. Information about recreation opportunities was once largely distributed through guidebooks, agency publications, and word of mouth, however, a growing number of recreationists now seek information through online apps like All Trails, The Dyrt, and Summit Post (Valenzuela 2019). Crowd-sourced forums can provide detailed information about specific places, which can help people discover new opportunities and plan their visit. However, such information is often not vetted so it may contain inaccuracies, and it can lead to increased use in an area that is not prepared to handle the increase (Johnson 2021).

Demographics, knowledge and skill also play a role in the shifting nature of recreation. Wyoming, along with rest of the country, is aging, but remaining active, and becoming more diverse and urbanized (Wyoming Economic Analysis Division 2022, Wyoming SCORP 2019, U.S. Census Bureau 2022). Racial minorities are not participating in recreation opportunities at the same rate as their white counterparts, although outreach efforts by retailers and many organizations have helped make outdoor experiences more welcoming to all (Miller et al. 2022, Flores et al. 2018). This finding holds true for the Bridger-Teton (NVUM 2018). The western U.S. is the most urbanized part of the country (i.e. most people live in cities) and it has been trending towards more urbanization for decades (U.S. Census Bureau 2022). As a result, many new participants have not been exposed to the knowledge and skills needed to recreate safely and responsibly in the outdoors (Outdoor Industry Association 2021). People new to outdoor adventures combined with more desire to "go big" is resulting in a large uptick in the number and severity of search and rescues occurring each year, both during the summer and winter seasons (TCSAR 2023).

Table 43. Top issues and concerns for outdoor recreation in Wyoming

2013	2018
Public Land Access	Public Land Access
Concern about ORV / Snowmobile Use	Maintenance of both facilities and natural settings
Cost	Cost
Development of more parks / facilities	ORV / snowmobile use
Maintenance	Crowding

A national survey of people who recreated in the past year revealed people are noticing changes in their outdoor experience. The rank order of top concerns were: environmental impacts, crowding, noise pollution, "bad apples," maintenance, availability, and access (OnX

Report 2023). The Wyoming Statewide Outdoor Recreation Survey noted similar concerns, although the rank order differs (Wyoming SCORP 2019) (See Table 43).

The Wyoming statewide survey (2019) results indicate that loss of access and degradation of recreation spaces are broad concerns. Crowding, lack of visitor ethics and changes in environmental quality may deter users. Several comments were tied to concerns around motorized recreation. Off-road vehicle and snowmobile enthusiasts express concern about losing access and non-motorized users express concerns about resource and experience impacts.

Given the national and Wyoming trends, the nature-based assets found on the Bridger-Teton and described in the following section, are expected to draw more people to live in the region or visit. Based on current and past use, regional visitation is likely to make up the majority of future visitation as the population of counties within a day's drive of the forest grow. But visitors from afar may increasingly be drawn to the forest in the future due to crowding or interest in activities not permitted within the National Park. Recreation experiences that are highly valued come with higher expectations for forest managers (e.g., OHV riders expect wider trails, mountain bikers and dirt bikers expect purpose-built single-track trails, and skate skiers expect well-groomed trails). The trends described in this section are expected to profoundly affect future recreation settings and opportunities and they will affect all aspects of sustainability – ecological, social, and economic.

Sustainable Recreation

Sustainability is the core concept within the 2012 Planning Rule and it applies to all aspects of Bridger-Teton management. Nationally, sustainable recreation is defined as the set of recreation settings and opportunities on the National Forest that are ecologically, economically, and socially sustainable for present and future generations. Ultimately, sustainable recreation requires appropriate management of recreation use on the National Forest, integrating recreation with other agency programs, and investing in valued visitor experiences and community well-being. From an ecological perspective, sustainability means recreation activity does not unacceptably impair the land, water, and wildlife. Socially, sustainability means the diversity of settings and associated opportunities defined in forest plans and associated project plans (from urban to primitive settings) are maintained with minimal social conflict and positively contribute to the quality of life in communities. Economically, sustainability means managers and partners have the skills and capacity to maintain recreation infrastructure (e.g., toilets, trails, camping areas, and signage) and they are able to provide the educational and enforcement contacts to gain compliance with forest regulations and responsible recreation guidelines.

Although the concept of sustainability has been central to the USFS mission for a very long time, the thinking has evolved. Early efforts focused on physical infrastructure conditions – for example, whether campgrounds and buildings were being maintained or if trails were functional (i.e., not severely eroded or washed out). In 2010, the USFS released the Framework for Sustainable Recreation to align the entire recreation program around the three pillars of sustainability – ecological, social, and economic. The release of the Framework for Sustainable Recreation brought into focus that, in the face of growing and evolving recreation demand, the USFS must think and act differently to sustain recreation benefits. A hard truth is the national forest cannot be all things to all people in all places. The USFS must work collaboratively to invest wisely and balance USFS offerings with those on other public or private lands (Implementation Guide to the Framework for Sustainable Recreation). The explosion of

recreation during the pandemic brought a new urgency to the importance of national forests for recreation and the need to manage use. Reimagine-Recreation launched in 2022 to address the challenges and urgency emerging from the pandemic.

Investing wisely to sustain what makes recreation opportunities truly memorable requires focus. The Bridger-Teton staff began this work in 2019 by initiating discussions around what is distinctive about different parts of the Bridger-Teton. Distinctive qualities and assets associated with the north, west, and east zones of the Bridger-Teton are noted in the introduction to this section. Staff at each district then completed a rapid assessment of gaps and opportunities relative to the ecological, social, and economic sustainability of nine programs within the: Recreation, Wilderness, Trails, and Public Service umbrella. Key gaps identified included:

- summer dispersed recreation, notably the need for more patrol coverage, corridor planning and enforcement of forest regulations;
- trail and road maintenance;
- effective visitor education about safety and responsible recreation prior to visits;
- maintenance and improvements to priority recreation facilities, including trailheads;
- travel planning and management – both summer and winter; and
- monitoring the effects of recreation activity.

Since then progress has been made to address some of these challenges, but capacity issues continue to constrain the enormous work remaining to achieve true sustainability. Gaining increased attention is recognition that achieving sustainability requires a broader lens – one that encompasses an *"all lands – all hands"* approach to collaboratively work with agencies at all levels, private sector businesses, non-profit organizations, and universities across multiple jurisdictional boundaries. The Bridger-Teton Forest has been and will need to remain actively engaged with two important efforts: implementation of the Teton County Sustainable Destination Management Plan (SDMP) and the Wyoming State Outdoor Recreation Framework (JHTTB 2023; Univ.of Wyoming 2023). The Teton County SDMP identifies eight goals necessary for sustainability:

1. education and communication;
2. visitor flow management;
3. workforce recruitment and retention;
4. community housing;
5. transportation and mobility;
6. climate action;
7. monitoring and reporting; and
8. governance.

Priority actions for each goal have been identified along with key performance indicators which are being monitored and reported. The Wyoming Office of Outdoor Recreation, in concert with the Office of Tourism, uses a framework built around three pillars:

1. Educate visitors and empower them to reduce their impact;
2. Disperse recreators across the state and into areas that desire increased tourism; and
3. Concentrate use visitors into areas that can sustain increased use.

Common to both of these efforts is a shift towards managing visitor use, not just promotion, recognizing that the quality of visitor experience is just as important as the quantity of visitation.

Offering Choice: A Spectrum of Recreation Settings

Since the early 1980s, the USFS has used the Recreation Opportunity Spectrum (ROS) to classify, plan, and manage a range of recreation settings. Recreation settings are defined as "the social, managerial, and physical attributes of a place that, when combined, provide a distinct set of recreation opportunities." Contrary to a common myth, encouraging dispersal of recreation use across the landscape is not USFS policy. Rather, the goal is to plan for a spectrum of settings and then manage so that unique or vulnerable setting attributes are not lost (FSM 2310). The concept of planning and managing for a spectrum of settings is based on the premise that people do not all seek the same opportunities, thus providing a diversity of settings provides more choice and helps meet the needs of a broader diversity of public interests (Haas, et.al 1987, Clark and Stankey 1979). The spectrum of settings included in the ROS range from highly developed to very undeveloped, or as Nash (2014) phrased it, "from the paved to the primeval". Six distinct settings including: urban (U), rural (R), roaded natural (RN), semi-primitive motorized (SPM), semi-primitive nonmotorized (SPNM), and primitive (P)—are defined using specific physical, social, and managerial setting criteria (36 CFR 219.19) (See Figure 57 and Table 44).

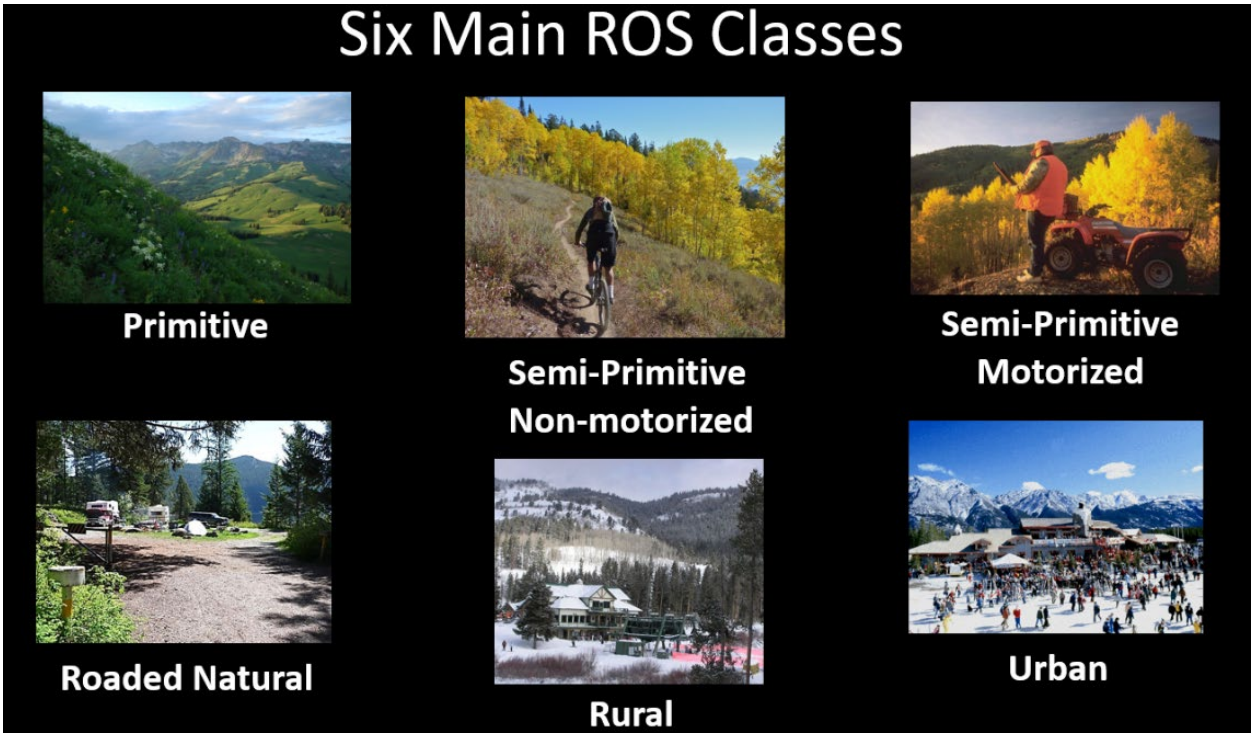


Figure 57. Examples of the six main ROS classes

Five mapping criteria were used to define the physical, social, and managerial setting of the Bridger-Teton using the USFS national protocol (USDA 2021b). The summer ROS mapping effort was an update from work done in 2006. Comparing the two mapping efforts, the biggest change is a shift from a roaded natural setting to semi-primitive motorized setting (i.e. an increase in the area offering a less developed setting) which reflects the more rustic, backcountry feel visitors experience travelling on the many miles of low maintenance road the forest provides. The winter ROS mapping effort was new, thus no change from previous mapping can be determined. The ROS mapping effort is sufficient to provide a forest-wide view of the spectrum of settings (See Table 45, Figure 58 and Figure 59), but mapping errors may exist if the map is used at a site-specific scale.

Table 44. Mapping criteria for the recreation opportunity spectrum

Settings	Mapping Criteria
Physical Setting	Remoteness * Size * Evidence of Humans
Social Setting	Visitor Density
Managerial Setting	Visitor Management

Table 45. Recreation opportunity spectrum classes on the Bridger-Teton as mapped in 2022

ROS Class	Brief description	Summer Acres	Winter Acres	Example
Primitive	Opportunity for isolation from human sights, sounds and visitor controls in an unmodified natural environment. Facilities only for resource protection. No motorized use.	1,501,811 43%	1,291,950 37%	Wilderness, spine of Wyoming Range
Semi-Primitive Non-Motorized	Some opportunity for isolation from human sights, sounds, and visitor controls in a predominately unmodified environment. Facilities for resource protection and safety. No motorized use.	1,082,345 31%	87,381 2%	Cache-Game area in summer, Star Valley Ranch front
Semi-Primitive Motorized	Some opportunity for isolation from human sights, sounds, and visitor controls in a predominately unmodified environment. Facilities for resource protection and safety. Motorized use permitted.	676,923 20%	1,790,576 52%	Upper Greys River corridor, Union Pass area, many areas in winter
Roaded Natural	Equal opportunity to affiliate with other groups or be isolated from human sights and sounds. The landscape is generally natural with modifications moderately evident. Facilities for group activities may be present. Both motorized and non-motorized activities are present.	141,192 4%	137,797 4%	Lower Greys River corridor, Big Springs byway, Buffalo Valley, Skyline Drive
Rural	Opportunity to affiliate with others is prevalent in a natural environment that may be substantially modified. Human sights and sounds are readily evident. Developed sites, roads, and trails are designed for moderate to high uses.	62,505 2%	64,486 2%	Hoback and Togwotee highway corridors

ROS Class	Brief description	Summer Acres	Winter Acres	Example
Urban	High levels of human activity and concentrated development are prevalent. Environment is substantially urbanized, although the background may have natural-appealing elements. Developed sites, roads and other recreation opportunities are designed for high use.	3,127 0.1%	3,417 0.1%	Jackson Hole Mountain Resort, Snow King Resort
Closed	Areas annually closed from Dec. 1 – May 1 to protect winter wildlife habitat.	0	101,954 3%	Area adjacent to National Elk Refuge

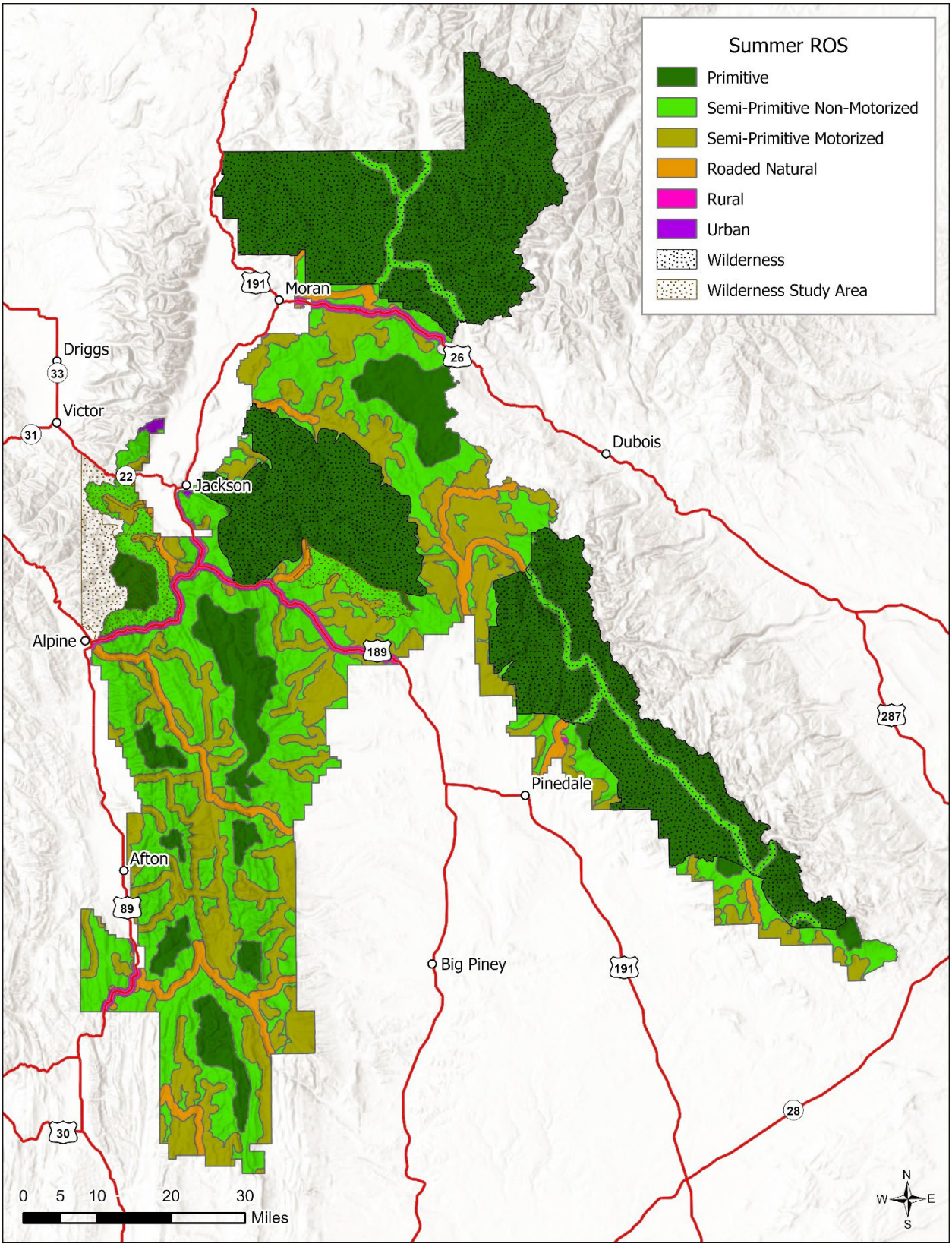


Figure 58. Summer recreation opportunity spectrum

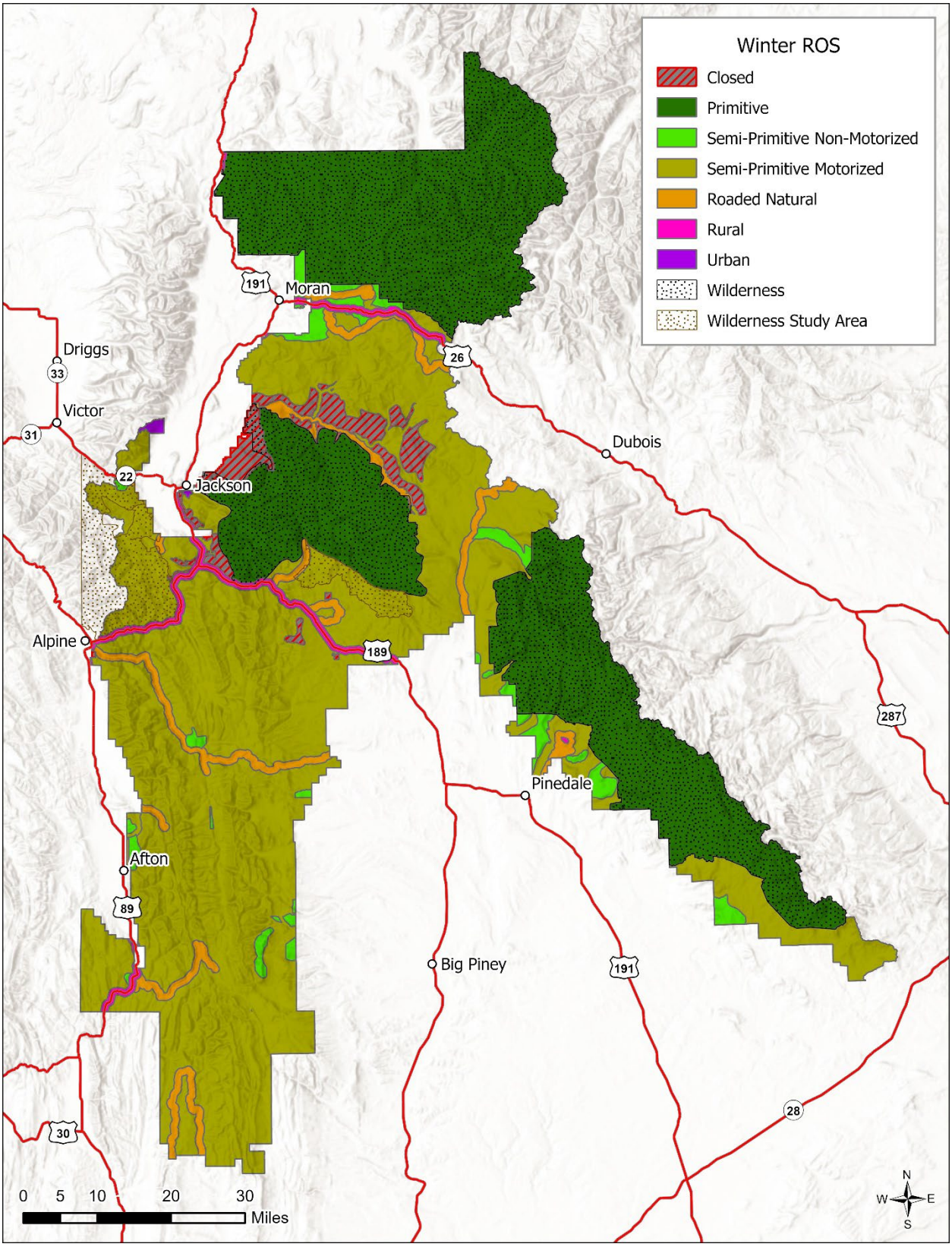


Figure 59. Winter recreation opportunity spectrum

A Closer Look at Recreation Activity and Opportunities

The Bridger-Teton offers opportunities for very diverse recreation interests (See Table 46), but the activities' visitors identify as their primary activity are: hiking/walking, downhill skiing, snowmobiling, cross-country skiing, viewing natural features/wildlife, and bicycling (NVUM 2018) (See Figure 60). Given the Bridger-Teton's abundant snowfall, it is not surprising that many of the primary activities are snow based. Many of these activities remain the same as what was occurring in 1986 when the current forest plan was developed with notable changes being a decline in non-outfitted horseback riding and increased participation in bicycling and cross-country skiing.

Of the Bridger-Teton's 2.2 million annual visitors, about 75 percent live less than 50 miles away and 48 percent annually visit the Bridger-Teton more than 50 times, underscoring the importance of the Bridger-Teton to local residents (NVUM 2018). Visitor use tends to be concentrated in places where the Bridger-Teton is close to communities, adjacent to the national parks, at resorts, or in nationally designated areas.

Table 46. A sample of key recreation places in the three major zones

Teton/Gros Ventre Range	Wyoming/Salt Range	Wind River Range
JH Mountain Resort	Greys River Corridor	Bridger Wilderness
Snake River Canyon	Periodic Springs	Fremont Lake
Togwotee Pass	Big Springs Byway	White Pine Resort
Teton Pass, Cache-Game	Lake Alice	Green River Corridor
Teton Wilderness	Historic cabins and trails	Skyline Drive
Granite Hot Springs	Wyoming National Recreation Trail	CCC Ponds
Gros Ventre Corridor	Commissary Ridge Trail	Union Pass
Shadow/Toppings/Curtis		









Figure 60. Photos of different recreation activities on the Bridger-Teton. (Clockwise from upper left: dispersed camping, resort skilling, fly fishing, and stock use on trails for shed hunts.)

Figure 61 and Figure 62 display the relative spatial distribution of recreation use across the Bridger-Teton during the summer and winter months. Data to produce these maps was obtained from a sampling of cell phone “pings” that are stripped of all personal information and processed by researchers at the Rocky Mountain Research Station. Due to the challenges associated with accurately understanding patterns of recreation use, these maps should be interpreted as representing how the intensity of use varies across the Bridger-Teton rather than the amount of use in any one location, especially within areas displayed as having low use. As these maps illustrate, summer use is more widely distributed compared to winter use and use tends to be concentrated near major road corridors and at recreation destinations.

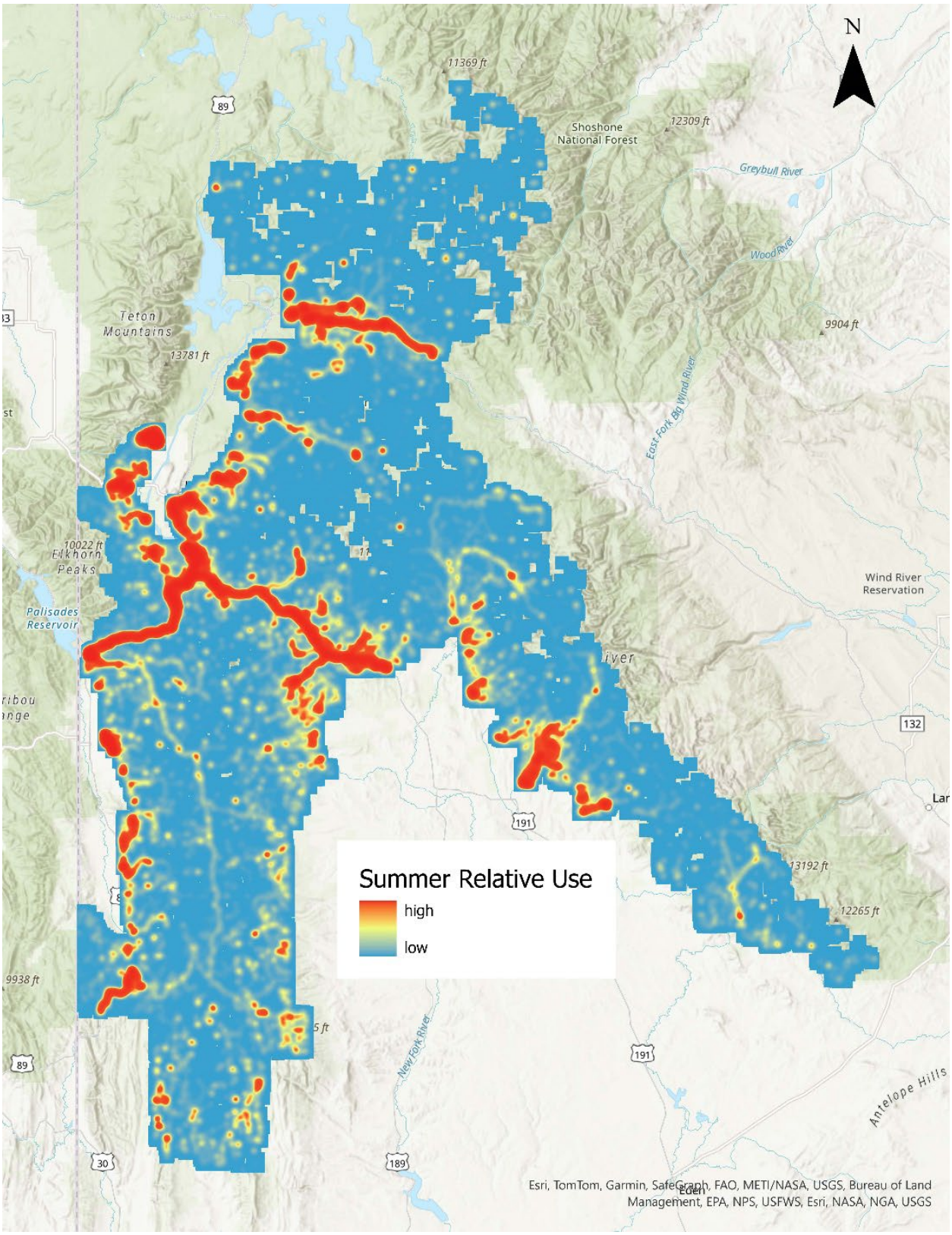


Figure 61. The relative spatial distribution of summer use across the Bridger-Teton, RMRS 2023

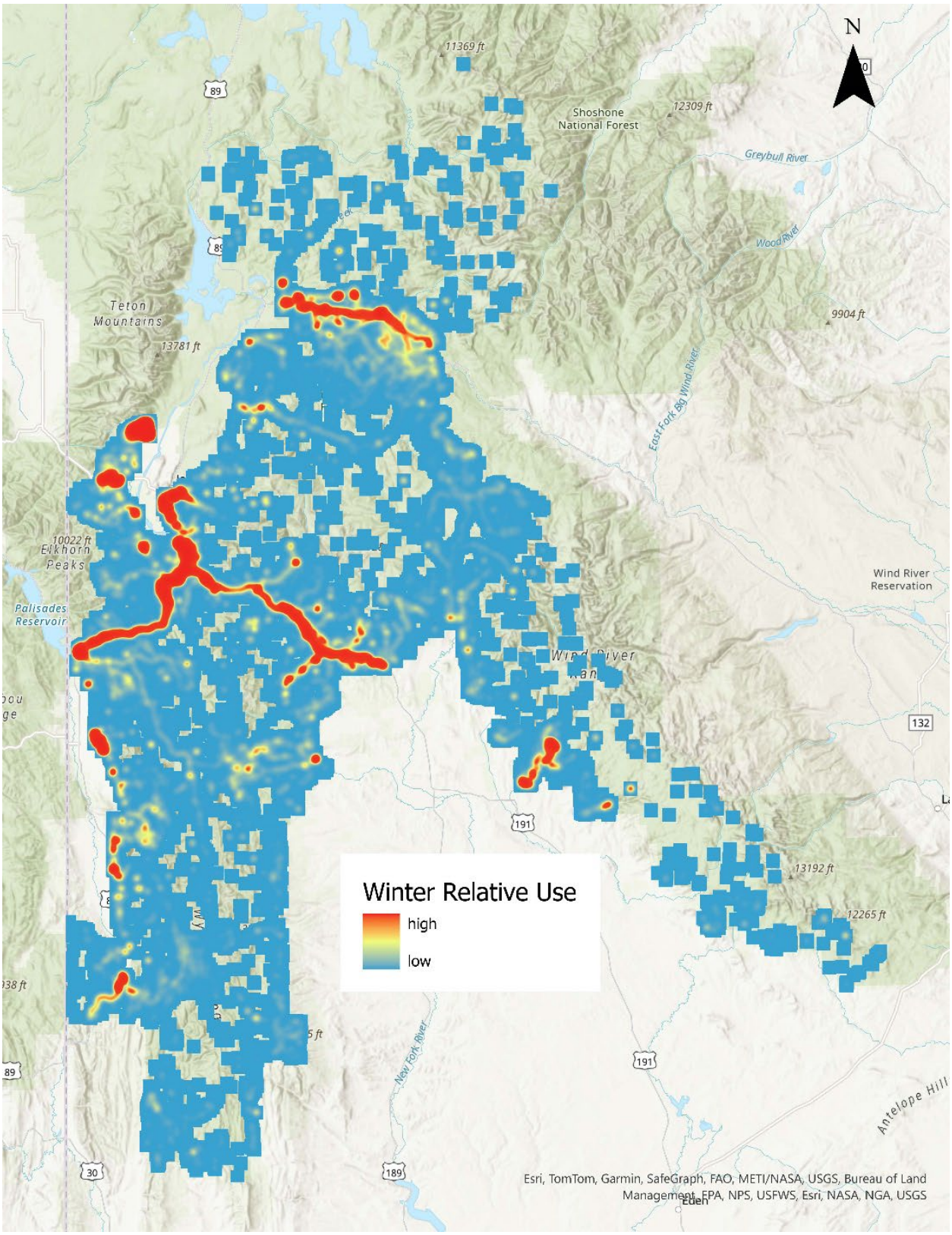


Figure 62. The relative spatial distribution of winter use across the Bridger-Teton, RMRS 2023

Developed Recreation

Recreation that occurs with the support of facilities is referred to as “developed recreation”. These facilities are designed (not user-created) and provide a degree of visitor comfort and/or resource protection that allows for more concentrated visitor use while also serving as staging areas for people engaged in dispersed recreation activities (e.g., boating, hiking, and off-road vehicle travel). As much as 52 percent of national forest visits in the forest occur at developed day use sites (e.g. mountain resorts) with a smaller proportion at developed overnight sites (e.g. campgrounds) (NVUM 2018). This use occurs primarily within two desired future categories (9A and 9B) which make up less than 1% of the forest acreage; a vivid indicator of this concentrated use. Most recreation sites on the Bridger-Teton fall within development scale 2 or 3 (low to moderate investment on a 5-point scale). Table 47 displays the primary types of developed recreation facilities on the Bridger-Teton by zone. Facilities on Bridger-Teton that are privately owned, such as ski/mountain resorts, guest ranches, and recreation residences, operate under a special use authorization. These type of facilities are described in the recreation special uses section.

Table 47. Developed recreation facilities on the Bridger-Teton by Zone

Recreation Facilities	Gros Ventre/*Teton Zone	Wyoming/Salt River Zone	Wind River Zone	Totals
Boat Ramps/Docks (paved)	7	3	6	**16**
Campgrounds	13 * 240 sites, * + 2 group sites	10 * 150 sites, * + 1 group site	11 * 186 sites, * + 5 group sites	**34**
Picnic Areas	1	5	2	**8**
Interpretive sites	6	1	8	**15**
Rental Cabins	0	9	1	**10**
Trailheads (approx.)	30	40	20	**90**
Other sites (hot springs, observation area, beach)	2	0	1	**3**

The Bridger-Teton completed a Recreation Facility Analysis in 2006 followed by a Recreation Site Analysis in 2015. It considers how recreation sites contribute to social stability, environmental integrity and economic vitality for the Bridger-Teton and its communities. To aid in prioritization for future investment, sites are grouped into four categories: (1) key sites that attract tourists, (2) key sites important to locals, (3) resource protection sites, and (4) other. Reinforcing the Bridger-Teton’s backcountry nature, key sites for the Bridger-Teton important for tourism or locals are not campgrounds. Instead, the top 16 sites include: 9 major wilderness, winter, or river trailhead/access sites, 3 unique interpretive or geological sites, 3 historic cabins or hot springs, and 1 campground. As recreation use grows and evolves, many existing developed recreation sites will need to be upgraded and re-designed. For example, campgrounds built in the 1950s and 1960s no longer accommodate the larger RVs or live-in horse trailers, thus they need to be modified with pull-throughs. Water system standards are also becoming far more stringent, which will require transitioning to expensive well systems or discontinuing water availability. Additionally, as demand for camping increases, the ability to reserve sites in advance is a desired public service to assure certainty. Additionally, the growth

in winter recreation and shoulder season use has increased demand for camping availability year-round.

Developed recreation sites are inventoried on a 5-year cycle to assess annual maintenance needs (to prevent deterioration), deferred maintenance (infrastructure needing repair/replacement), and desired capital improvements (enhancement needed to meet increased demand and/or resource protection). While condition surveys need to be updated, the available data suggests that most developed recreation facilities meet minimum standards for health and safety (based on Facility Condition Index reports 2021). Maintenance and improvement of recreation facilities is funded through two primary sources - funding from Congress and fees retained from campgrounds and cabin rentals as displayed in Table 48.

Table 48. Recreation Funding Sources from 2018-2023

Funding Type	2018	2019	2020	2021	2022	2023
Funding from Congress	$80,058	$127,600	$127,600	$56,815	$59,681	$61,461
Campground and cabin receipts	$132,922	$165,718	$213,274	$231,878	$237,846	$236,030
Total	**$212,980**	**$293,318**	**$340,874**	**$288,693**	**$297,527**	**$297,491**

In recent years, Congressional Acts, such as the Great American Outdoors Act and the Bipartisan Infrastructure Investments and Jobs Act, provided a much-needed funding boost to address the deferred maintenance backlog. However, there is still over $3 million dollars of recreation facility deferred maintenance on the Bridger-Teton. Site maintenance and improvement is not keeping pace with growing recreation demand (e.g., some campgrounds are now regularly exceeding 80 percent occupancy). In addition, as recreation use increased, infrastructure is needed to protect resource conditions. For example, the Bridger-Teton already maintains 180 vault toilets, but there is more demand for restrooms at popular trailheads and dispersed camping areas, and costs for pumping and cleaning have dramatically increased. Additionally, lower priority sites often hold meaning for some members of the public and they cannot be easily decommissioned to focus more attention on other sites. For the sustainability of developed recreation sites, universal accessible design will be more important, sites will need to accommodate larger RVs, and lower maintenance and firewise materials and design will be required. Tough choices about where to prioritize limited investments will be necessary.

Summer/Fall Dispersed Recreation

Dispersed recreation includes the many activities that occur outside of developed recreation areas (not at mountain resorts or campgrounds). Visitor use monitoring data suggests nearly half of all recreation use on the Bridger-Teton occurs in dispersed recreation settings (NVUM 2018).

Management of dispersed recreation tends to focus on camping as this activity has increased throughout the Bridger-Teton and it has the most effect on resource conditions. Dispersed camping is defined as camping that occurs at sites that are user-created with no or limited USFS-provided facilities and typically no fees. Dispersed camping became a prominent issue during the pandemic, with widespread media attention (Langlois 2021, McIntosh 2021). Camping at dispersed sites has become just as popular as camping in a developed site with the

increase in vans and RVs that offer campers more comfort and self-reliance; a trend that is evident on the Bridger-Teton as well as on other national forests in the West. Some campers are also staying longer with a camp set-up that allows remote work while enjoying the great outdoors. As such, wi-fi and cell phone reception is a desired attribute. Age is a factor too in the transition from tent camping to RV camping. Many hunters and horse riders now prefer to camp in an RV and go out for the day rather than pack into the backcountry and thus seek roadside campsites that accommodate stock. Dispersed camping issues have been aggravated by the simultaneous increase in people attempting to reside on the Bridger-Teton (Cerveny 2021).

In 2020, a partnership project was initiated to map and inventory conditions at all established dispersed campsites. To date, 940 campsites were mapped with 47 percent of the 55 camping zones covered (See Table 49).

Table 49. Number of mapped dispersed campsites by district

Dispersed Campsites	Kemmerer	Big Piney	Greys River	Jackson	Blackrock	Pinedale
Number	71	2	262	341	167	96
# camp zones/ # mapped	7/2	10/0	9/4	13/13	7/6	9/1

Of these mapped sites, the following was noted:

- 34 percent of sites had evidence of human waste;
- 75 percent of sites had some level of trash, 5 percent had extensive trash; and
- 51 percent of the sites are within 300 feet of water.

In response to the rapid growth in dispersed camping, the Bridger-Teton implemented a designated site program in 2019 within selected areas to limit the expansion of sites. To date, 192 campsites are managed under the designated site program within the Jackson and Blackrock Ranger Districts. An ambassador program has also been implemented in partnership with Friends of the Bridger-Teton to place volunteers in busy areas to: welcome visitors, share responsible recreation information, resolve conflicts, promote safety for people and bears, and patrol campsites and trails. These programs have been effective at reducing the threat of escaped campfires and improving resource conditions and the visitor experience and are expanding with support from the Jackson Hole Travel and Tourism Board, Sublette County Commissioners, and Star Valley Ranch. Five key responsible recreation practices are stressed in camping areas: (1) ensuring campfires are cold to the touch when not attended; (2) burying human waste and packing out toilet paper or using a portable toilet; (3) properly storing food and other attractants so they are not available to bears; (4) packing out all trash; and (5) complying with the camp stay limit (typically 14 days, but shorter in some areas).

The Bridger-Teton is known for wildlife and water; thus, hunting, fishing and wildlife-viewing are very important dispersed recreation activities. Elk hunting has a long history on the Bridger-Teton, notably within the Jackson Hole region, while the Wyoming Range is coveted for mule deer hunting (Responsive management 2009). Wildlife tours are a growing sector of the tourism economy with at least 10 companies operating in the Jackson Hole area. As Figure 63 below indicates, participation is expected to remain especially strong for fishing and wildlife viewing (Dietsch et al. 2018). Current participation was measured in terms of whether the person had

engaged in the activity within the past year, which is likely the reason behind the lower percentages.

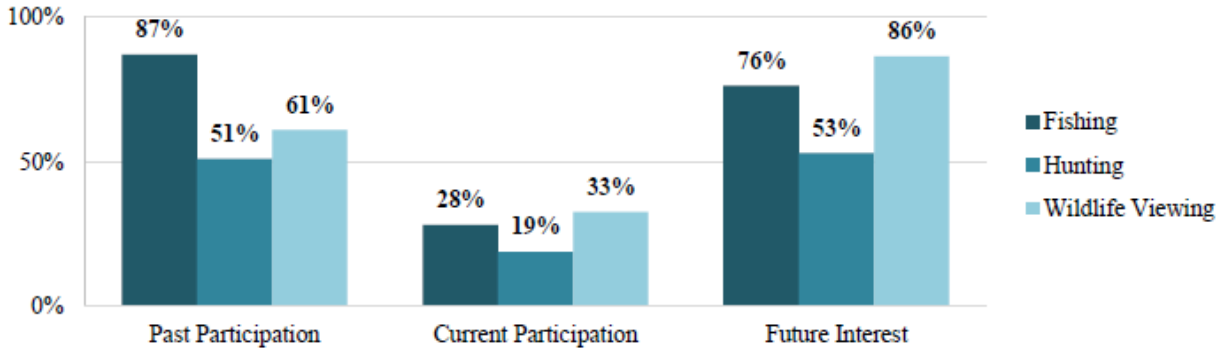


Figure 63. Wyoming resident participation and interest in fish and wildlife-related recreation. Source: Dietsch et al. 2018.

License sales are another indicator of hunting and fishing interest, tempered by regulations to achieve wildlife population objectives (See Table 50). The data below reflect state-wide information and is intended to reflect trends as well as relative magnitude among species. More detailed information is available by species and herd unit and can be obtained on the Wyoming Game and Fish Department website (https://wgfd.wyo.gov/hunting-trapping/job-completion-reports). Harvest rates considerably vary by species due to annual weather patterns, population status relative to WGFD objectives, season structure, and the rugged and remote areas some species inhabit. With an aging hunter population, the public desire for easier access is growing, albeit easier access does not equate to increased harvest because hunted species tend to avoid human activity. With this trend, outfitting will likely play a larger role in achieving harvest goals. The Wyoming Range hunter study found the presence of large antlered bucks and the ability to be outdoors with family/companions were the primary attributes of a quality experience while seeing more hunters and lack of game sighted were major detractors (Responsive Management 2009). This suggests forest managers will be increasingly challenged to balance access with the need to maintain the habitat security necessary to sustain wildlife populations.

Table 50. Trends in Wyoming hunting and fishing license sales for selected species

Species	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Elk	69,188	71,014	71,890	72,038	71,430	70,764	70,781	70,199	74,122	74,754
Mule deer	69,017	66,816	66,102	69,151	72,631	69,805	71,485	70,646	73,827	69,032
Black bear	4,121	4,133	4,392	4,508	4,605	4,646	4,730	4,539	5,375	5,688
Sport fishery	321,795	329,640	332,245	351,989	355,599	346,720	317,080	310,252	340,374	317,044

Source: WGFD Annual Report 2017, 2022.

Recreation funding has traditionally been allocated based on infrastructure associated with facilities or trails. As a result, dispersed recreation does not receive any specific funding, despite the enormous need for (1) education and enforcement visitor patrols to encourage responsible recreation and gain compliance with forest regulations; (2) signing; and (3) resource work to address issues with unattended or abandoned campfires, sanitation, weeds, trash, vegetation loss, and soil erosion. The widespread increase in dispersed recreation use over the past 5-10 years has brought a new urgency to the resource and social needs as well as the need to establish direction in the forest plan to sustainably manage this important use.

Motorized and Non-motorized Trails

Trails facilitate much of the dispersed recreation use on the Bridger-Teton. The status and trend of the trail system is covered in the road and trails section of this report, whereas this section focuses on the use of the trail system. A recent on-line survey of recreationists (primarily associated with non-motorized and motorized trail interests) revealed that: experiencing nature, exercise, adventure/thrill, and a sense of solitude were primary reasons for visiting the Bridger-Teton. Overall, those who responded expressed being somewhat or very concerned about ecological changes and social changes with social concerns related to crowding, conflicts, and parking. Top desires for the future included more and improved trails, more and improved facilities (restrooms and parking), along with sustaining wildlife (Outdoor Alliance 2024).

Non-motorized trail uses on the Bridger-Teton include: hiking, running, biking, horseback riding, and dog walking. Mountain bike use surged during the 1990s with improved cross-country bikes and began diversifying in the 2000s with the emergence of downhill/free-ride bikes and now gravel bikes8. Trail running also emerged as a growing activity, although hiking/walking still accounts for the largest numbers of visitors. Pet ownership also dramatically increased with a subsequent increase in people valuing trails that permit off-leash dogs. Obtaining accurate estimates of overall trail use is extremely difficult due to the sheer number of trailheads and access points across the Bridger-Teton. A sampling of use numbers from locations with trail counters is displayed below in Table 51.

Table 51. Estimates of primarily non-motorized trail use for selected areas

Zone	Location	Trail numbers	Trail types	Remarks
Teton/Gros Ventre	Cache Creek	361 people/day	Hike, bike, dogs, horse	Counts based on 61 days of data 2022. Cache-Game trail system use estimate is 355,135 people per year.
Teton/Gros Ventre	Josie’s Ridge	277 people/day	Hike, dogs	Counts based on 61 days of data 2022. Cache-Game trail system use estimate is 355,135 people per year.
Teton/Gros Ventre	Nelson Drive	433 people/day	Hike, bike, dogs	Counts based on 61 days of data 2022. Cache-Game trail system use estimate is 355,135 people per year.

Zone	Location	Trail numbers	Trail types	Remarks
Teton/Gros Ventre	Arrow	36 people/day	Bike	Counts based on 62 days of data 2022. Teton Pass trail system use estimate is 211,778 people per year.
Teton/Gros Ventre	Ski Lake	212 people/day	Hike, dogs	Counts based on 62 days of data 2022. Teton Pass trail system use estimate is 211,778 people per year.
Teton/Gros Ventre	Old Pass Road	167 people/day	Hike, bike, dogs	Counts based on 62 days of data 2022. Teton Pass trail system use estimate is 211,778 people per year
Teton/Gros Ventre	Munger	148 people/day	Mostly bike, hike	Count based on 62 days of data 2022. Munger trail system use estimate is 37,595 people per year.
Wyoming/Salt River	Dry Beaver Creek	0.38 people/day	Not specified	Total of 91 people counted at 9 trail counters (63 days of data, July 6-Sept. 6, 2022).
Wyoming/Salt River	McDougal Gap	2 people/day	Not specified	Total of 91 people counted at 9 trail counters (63 days of data, July 6-Sept. 6, 2022).
Wyoming/Salt River	Cliff Creek	4.3 people/day	A few mtn. bikes	Total of 91 people counted at 9 trail counters (63 days of data, July 6-Sept. 6, 2022).
Wyoming/Salt River	S. Fork Horse Creek	2.3 people/day	Some mtn bikes, 1 ATV	Total of 91 people counted at 9 trail counters (63 days of data, July 6-Sept. 6, 2022).
Wind River Range	Big Sandy TH	182 people/day	Mostly hikers	Bridger Wilderness. A total of 183,871 people were recorded at 10 trail counters (2022).
Wind River Range	Elkhart Park near Sacred Rim	175 people/day	Mostly hikers	Bridger Wilderness. A total of 183,871 people were recorded at 10 trail counters (2022).
Wind River Range	Scab Creek	30 people/day	Mostly hikers	Bridger Wilderness. A total of 183,871 people were recorded at 10 trail counters (2022).
Wind River Range	Green River Lakes	83 people/day	Mostly hikers	Bridger Wilderness. A total of 183,871 people were recorded at 10 trail counters (2022).

The source for trail counter data in the Teton/Gros Ventre zone is Friends of Pathways. Trail counters in the Wyoming and Wind River Range are maintained by the Forest Service.

Motorized trail use (i.e., ORV or OHV use) includes travel by ATV, dirt bike, or side-by-side vehicle. Wyoming State has required annual registration permits since 2002 for all ORVs using trails and any unlicensed ORV using an enrolled road. The number of registered ORVs in Wyoming more than doubled from 28,150 in 2005 to 58,229 in 2020 (Bastian et al. 2022a). In recent years, the rate of increase in registrations seems to be slowing, but the proportion of non-

residents relative to residents has increased. Most non-residents purchasing Wyoming registration permits are from Colorado or Utah. Within the Bridger-Teton, the Star Valley/Wyoming Range area is most popular for ORV use, but no area in the Bridger-Teton is as popular as the Bighorns or Snowy Range. Surveys of both resident and non-resident ORV riders found that: riding, camping, hunting, and fishing were key activities. The survey also reveals congruence with key desires for the future: more designated ORV trails, better trail maintenance, more loop trails, longer trails, accurate and easy to read maps, and better signage (Bastian et al. 2022a). Unlike non-motorized trail use, all wheeled motor vehicle must occur on designated routes in accordance with an annual Motor Vehicle Use Map. This includes e-bike use, which is classified as motorized by the USFS. (Travel management is covered in more detail in the roads and trails section of this Assessment.)

Technology has profoundly influenced trail activity, notably due to advancements in mountain bikes and OHV vehicles along with social media apps that help people discover new outdoor adventures. Management challenges relate to the: proliferation of user-created trails, non-compliance with travel regulations, social conflict, spread of noxious weeds, wildlife disturbance, and soil erosion. These challenges will necessitate forest planning to go beyond infrastructure direction to provide direction for the sustainable use of trails.

Recreation Special Uses

A special use authorization is required for any activity where there is a fee for services that occur on the national forest, a guide is being paid to lead guests, structures will occupy national forest land, or a product will be removed (e.g., Christmas trees, firewood). Authorizations are also required for any group activity over 75 people and for filming that is intended to promote a product or be used for commercial purposes. Recreation special use authorizations include: recreation residences, resorts and guest ranches (including winter ski resorts), shelters, marinas, outfitter and guide services, recreation events, organization camps, and campground concessionaires. In 2023, the Bridger-Teton managed approximately 400 active recreation special use authorizations (See Table 52 and Table 53).

Table 52. Recreation special uses (number of permits) on the Bridger-Teton, 2023

Type	Teton/Gros Ventre zone (D4, 6)	Wyoming/Salt River zone (D1, 2, 3)	Wind River zone (D7)	Total
Outfitter-guide	133	47	40	**220**
Recreation events	12	8	8	**28**

Table 53. Privately-owned facilities that are authorized under recreation special use permits

Type	Teton/Gros Ventre zone (D4, 6)	Wyoming/Salt River zone (D1, 2, 3)	Wind River zone (D7)	Total
Mountain Resorts (ski areas)	2	0	1	**3**
Guest ranches /cabins	3	0	4	**7**
Recreation residences	44	16	75	**136**

Type	Teton/Gros Ventre zone (D4, 6)	Wyoming/Salt River zone (D1, 2, 3)	Wind River zone (D7)	Total
Organizational camp	1	0	1	**2**
Boat docks	0	0	2	**2**
Target range	1	0	0	**1**
Shelter	1	1	1	**3**

Outfitting and guiding is the most prominent type of recreation special use with outfitters operating within authorizations that: specify service day limits, where they can operate, the season of use, insurance requirements, and other terms and conditions. These permits are issued to give a broader sector of society a chance to experience the outdoors, including those who may not have the knowledge, equipment, or skill to do an activity on their own. Such services also enable many youth camps, enhance training or skill development, or simply allow people to be with a guide who can provide local knowledge about the natural environment. With extensive wildlands, a rich guiding history, and abundant recreation offerings, the Bridger-Teton has the largest outfitter-guide program in the Intermountain Region. Although outfitting and guiding represents only about 10 percent of total visitor use on the Bridger-Teton, approximately 1 million in receipts are annually generated on the Bridger-Teton through the Federal Land Recreation Enhancement Act which is the authority under which the Forest Service issues permits. These receipts, which also include money generated from recreation events and Christmas tree permit sales, fund much of the work that occurs on the ground and leverages capacity through numerous partners. Passage of the 2016 National Forest System Trails Stewardship Act provided the authority for outfitters to reduce the fee owed to the government in exchange for performing approved trail maintenance and resource work. Some Bridger-Teton outfitters have opted to do this, and it will likely become an increasingly valuable mechanism in the future to accomplish stewardship tasks.

Table 54. Number of client days (actual use) provided by outfitter-guides, 2013-2023

Activity	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Backpack Hiking, climbing	22,147	21,694	20,521	23,084	20,360	21,563	22,235	11,739	18,292	16,458	16,207
Day use summer[1]	2,371	1,956	2,848	3,345	3,023	3,385	4,058	2,663	3,421	3,958	2,330
Fishing	4,569	3,512	5,311	5,740	4,403	5,359	5,214	6,269	6,421	5,690	6,215
Horse rides, pack trips	25,547	40,433	23,707	30,946	31,851	33,418	30,345	29,336	42,915	38,231	38,230
Hunting	11,954	11,120	12,705	11,597	11,484	10,884	11,176	10,664	14,119	12,447	12,059
Wagon rides, cookouts	23,126	21,918	23,565	26,145	23,058	25,456	22,831	11,994	29,185	29,990	25,790
Rafting, kayaking, canoe	88,689	75,968	82,957	88,182	80,896	78.642	88,339	60.294	106,230	81,817	71,819
Total Summer	**178,403**	**176,601**	**171,614**	**189,039**	**175,075**	**178,707**	**184,198**	**132.959**	**220,583**	**188,591**	**172,650**
Day use winter[2]	3,931	4,902	4,085	4,007	4,277	6,920	8,948	7,807	4,941	7,383	8,473
Snow-mobiling	6,406	7,639	7,754	7,643	18,271	17,55	15,448	14,113	16,013	18,049	15,316
Total Winter	**10,337**	**12,541**	**11,839**	**11,650**	**22,548**	**24,477**	**24,396**	**21,920**	**20,954**	**25,432**	**23,789**

1 Day use summer activities include ATV tours, environmental education, wildlife viewing, biking. Some missing data in 2023
2 Day use winter activities include backcountry and Nordic skiing, dogsledding, heli-skiing, avalanche training, snowshoeing
Source: Forest Service Special Use Database (best available data)

As Table 54 illustrates, summer use dominates outfitting activity in the Forest and has increased 5.7% between 2013 and 2022. The majority of outfitted activity is associated with day use activities (80-83% of summer use and 100% of winter use). Overnight activities include backpacking, horse packing, and hunting. The predominance of day use activity aligns with the preference of many visitors who want to participate in many different activities during their short vacation, as well as the logistical difficulty of accommodating large numbers of people overnight. Activities with the most outfitted activity skew towards those they require specialized equipment (e.g. rafting, wagon rides, horse rides). The pandemic increased recreation use throughout the forest and this increase was also reflected in summer outfitting activity which increased 19.8% between 2019 and 2021. Guided float and bank fishing are trending upwards with a 36% increase in activity between 2013 and 2023, whereas hunting activity has remained stable, increasing less than 1% in the same time period. Winter use has grown much more than summer use, increasing 146% between 2013 and 2022 with all activities increasing significantly.

Guest ranches are often historic lodges that have welcomed guests for generations. Use has been highly variable due to changing ownership and downturns in the economy or during the pandemic. However, most guest ranches are experiencing an upward trend consistent with the desire of more people seeking greater comfort and convenience with their outdoor adventures (See Table 55).

Table 55. Room nights at guest resorts Bridger-Teton, 2012-2021

Resort Area	2012	2018	2019	2020	2021
Teton/Gros Ventre zone (3 lodges)	21,604	17,223	16,868	14,373	20,516
Wind River zone (4 lodges)	3,012	3,144	4,437	4,674	5,210

Like recreation as a whole, the outfitting industry is also changing (Table 52). When the forest plan was approved in 1990, outfitting activity was dominated by traditional activities including: hunting, horse-based pack trips, rafting, and snowmobiling. While these activities remain popular, there is also a notable increase in requests for new or expanded outfitted activities. An indicator of this demand is that incidents of unauthorized outfitting are rising (e.g. fishing, hiking, skiing). These requests are coming from existing outfitters seeking to diversify their services, ranches and resorts and wanting to offer personalized guided trips for their guests and non-profit organizations. Proposals to offer guided services are also coming from youth and organizational camps, training and wellness programs, high-end housing associations, and individuals wanting to offer non-traditional activities (USDA 2012b). Special use proposals must go through a screening process, prospectus (if there is competitive interest in providing the service), and environmental analysis.

Public interest in outfitted services is expected to remain strong as people seek high quality experiences, have limited time to plan their own adventure, or are unsure about their own knowledge and skill. Guests are also seeking more luxurious services with professional guides, good food, and comfortable overnight accommodations. Historically, outfitting was a small business often owned by a family. However, now when a business transfers, the sale price can be steep. This, combined with rising insurance and labor costs, is resulting in business consolidations and corporations acquiring businesses. Updated direction in the forest plan that goes beyond big game hunting, snowmobiling, and rafting would help managers navigate this

increasingly complex topic while meeting the challenge to serve a broader diversity of public service needs.

Winter Recreation

Developed and dispersed winter recreation opportunities are a distinctive aspect of the Bridger-Teton and a major reason why recreationists value the Bridger-Teton. Winter recreation on the Bridger-Teton is characterized by four major activities including: downhill skiing/snowboarding at the three mountain resorts (See Table 56), snowmobiling, backcountry skiing/snowboarding, and nordic activities (cross-country and skate skiing, fat biking, and snowshoeing). With the huge growth in winter recreation activity and their growing importance, the Bridger-Teton plays a part in providing opportunities. (This topic will require much more attention when developing forest plan components.)

Table 56. Total skier visits at ski resorts Bridger-Teton, 2013-2022

2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021	2021-2022	2022-2023
615,765	596,559	613,686	611,199	690,819	774,751	631,771	716,632	686,701	789,939

Jackson Hole Mountain Resort opened in 1966 and has grown to be a premier destination resort attracting international visitors and enticing many people to move to Wyoming. Snow King Resort opened in 1936 and is Wyoming's oldest ski area. White Pine Resort opened soon after in 1940, but it struggled in the 1980s and closed for 10 years before being revived in 1999. Visitor use at all mountain resorts is increasing due to on-mountain and marketing investments; emergence of passes that allow skiers to visit multiple resorts; and more frequent visits by existing skiers/snowboarders (3.4 percent average increase over the past 10 years). A notable change since the 1990 forest plan is the 2011 Ski Area Recreational Opportunity Enhancement Act (Public Law 112-46) which gave resorts the ability to offer a wide array of summer activities. As a result, resorts today operate nearly year-round and cater to a diversity of visitor interests. The resort environment is especially attractive for families and those seeking a more urban setting with nearby facilities. All three resorts in the Bridger-Teton have expanded their summer operations to varying degrees, offering activities like mountain biking, hiking trails, ropes courses, gondola rides, via ferratas, weddings, paragliding, and music concerts. Summer activities have helped resorts recruit and retain employees and bolster their economic viability; particularly during years with smaller snowpack and less skiers. Summer activities have proven to be very popular, attracting large numbers of visitors, although visitation numbers are not reported. The increase in summer activity has also increased the need for ancillary services, such as county sheriff and fire/EMS services as well as forest patrol presence in nearby camping locations, especially during music concerts and large events.

Like the off-road vehicle program, Wyoming State Trails requires a registration permit for snowmobile use. Funds from this program pay for: trail grooming, trail maps, trailhead plowing, and education/enforcement patrols. There were a total of 37,657 snowmobile registrations in 2020, which is 35 percent less than the number of registered OHVs. Residents account for 36.4 percent of the registered snowmobiles while non-residents account for 63.6 percent. While total snowmobile use appears to be holding steady at 543,000 use-days in Wyoming, the number of non-resident riders is increasing (mostly from Minnesota) and resident riders is decreasing. The Bridger-Teton encompasses the Continental Divide and Wyoming Range snowmobile areas,

which are the 2nd and 3rd most popular destinations in the State behind the Snowy Range. Within the Bridger-Teton, Alpine (Greys River), Togwotee Pass, and Horse Creek are the top destinations. Priorities for use of registration fees include parking area snow removal, trail grooming, and trail signs. Avalanche education was a higher priority for non-resident riders. Not surprisingly, key attributes for a quality experience include good snow conditions and access to off-trail powder with solitude also ranking high for resident riders (Bastian et al. 2022b).

Backcountry skiing/snowboarding, nordic activities, and wildlife tours are a growing segment of the winter recreation picture. As crowding and the desire to find untracked powder has grown, backcountry skiers and snowboarders are seeking new terrain throughout the Bridger-Teton, often using snowmobiles for access. These activities generally are less expensive than resort-based skiing or snowmobiling; thus, offer alternate activities for people to enjoy the long winters. Both backcountry and nordic ski sales skyrocketed during the pandemic (Peruzzi 2021). Fat biking also experienced steady growth over the years (Monz and Kulmatiski 2016). Teton Pass remains the premier backcountry ski destination with an estimated 100,000 ski runs each winter. Trail counters recorded an average of 537people/day with the majority boot-packing up Mt. Glory (FoP 2023). Ambassadors have played a critical role in educating visitors and enhancing safety on Teton Pass through an expanding partnership (Pope 2024) In response to significant challenges with managing recreation parking and public safety within a critical transportation corridor, Teton County, Wyoming lead a partner effort to complete a Teton Pass Corridor Plan to guide multi-agency infrastructure development (Fed. Highway Admin, 2024) Rapidly growing winter use in backcountry settings, combined with recreationists accessing more avalanche-prone terrain, resulted in a sharp rise in fatalities starting in the late 1990s (Page et al. 1999). The Bridger-Teton put out its first avalanche bulletin in 1976, and with partner support, it has grown to cover the third largest forecast area in the U.S. Drawing on information compiled from five weather stations, a handful of forecasters, and observations submitted by recreationists, daily forecasts are prepared for four primary zones – the Tetons, Togwotee Pass, Snake River Range, and Wyoming/Salt River Range. The Avalanche Forecast Center annually makes over 1.5 million contacts through the website. Educational classes with demand for additional coverage and products are on the rise.

Influence of Recreation on Ecological and Social Conditions

All recreation activity inevitably results in some degree of impact; the trick is to determine how much change is acceptable. Since the mid-1960s, an entire field of study called “recreation ecology”, developed to understand the effects of recreation on physical, biological, and social conditions (Monz et al. 2013, Sumanapala and Wolf 2019, Hennings 2017). A central finding is that five factors influence the degree of impact: (1) the amount of use, (2) the location or distribution of use, (3) the timing of use, (4) the type of use, and (5) the behavior of users (Cole et al. 1987). Undesirable behaviors can be further characterized as: careless, unskilled, uninformed/unprepared, unavoidable, or malicious (Center for Outdoor Ethics, Lawhon).

State-of-knowledge papers (https://visitorusemanagement.nps.gov/VUM/Framework) offer brief summaries of the nature of recreation impacts on environmental, wildlife, and social conditions. A summary of recreation effects on ecological and social conditions follows. While these effects are broad, examples of each can be found on the Bridger-Teton.

Water Quality and Soils

The main effect of recreation activity on water quality is sedimentation associated with erosion from trails, roads, and campsites. Poor trail and camp location and lack of water control structures (e.g., waterbars) are the primary culprits. Timing also plays a role as trails and roads are much more easily damaged in the spring when they are wet. Poor sanitation from improper disposal of human and dog waste can introduce disease pathogens.

Invasive Species

Invasive plant species are a major threat to the integrity of native plant communities and to the quality of wildlife habitat. Aquatic invasive species can cause irreplaceable harm to fisheries and aquatic ecosystems. Recreation is considered one of the key mechanisms that introduces and spreads both invasive plants and invasive aquatic species.

Wildlife

Recreation clearly effects wildlife with many studies documenting negative effects (Larson 2016). In general, wildlife are affected by: mortality, food conditioning, disturbance, or habitat loss (Knight and Cole 1995). Putting hunting aside, recreation can result in mortality if there is a negative human-bear or lion encounter. This typically happens when the animal is killed in self-defense or is later killed due to a human injury or death. Vehicle collisions is another common source of mortality, associated with highways that traverse the forest (JH Wildlife Foundation 2022). Sublethal effects of disturbance and loss of habitat from recreation also can result in negative population level impacts via negative effects to demographic parameters (e.g., declines in reproductive success). Typically, food conditioning occurs when an animal receives a food reward and subsequently associates people with food, posing safety issues. Habitat loss occurs through the spread of invasive species; development of recreation infrastructure; or through animals avoiding habitats due to human disturbance. Human disturbance effects are subtle and complex depending on a suite of factors related to recreation characteristics, specific species, and habitat characteristics. Recreationists disturbing individual animals is the most common effect, but it is often difficult to determine population level effects. Forest staff initiated a wildlife-recreation co-existence project in 2020 to better inform decisions related to recreation-wildlife interactions. In addition to advancing knowledge around this topic, the effort spawned work to map the spatial distribution of recreation use discussed earlier and two specific studies around the effects of recreation noise and the response of various species to the intensity of use (Zeller, et.al. 2024, Larson, et.al. In preparation). Key findings to date suggest the following described below (Miller et al. 2020).

- The number and type of recreationists matters, especially with respect to cumulative impact, but results are mixed.
- Faster speed and direct approach towards wildlife tends to cause a larger flight response (e.g., trail running, biking, and photographing wildlife).
- Activity that is less predictable creates a stronger flight response (e.g., dispersed activity vs. on-trail).
- Activity occurring in the morning or at dusk tends to create more disturbance
- Noise plays a role with bird species most sensitive to noise.
- Light pollution is a factor particularly affecting nocturnal species.

- Dogs are more alarming to wildlife than people recreating without dogs.
- Hunted species tend to show a larger flight response than non-hunted species.
- Pregnant females and females with young show a larger flight response.
- Habitat availability and habitat structure/quality play a role in flight response.
- Seasonality is a big factor with the winter (snow) season being very important to help reduce disturbance. Minimizing disturbance during the spring nesting/calving season is also important.

Cultural Resources

Recreation activity can affect pre-historic and historic resources through development that inadvertently disturbs an important resource, looting of artifacts, or vandalism.

Social Conditions

As noted earlier in this section, the: amount, location, timing, type, and behavior of recreationists determine the degree of impact, both on resource conditions and on the quality of other visitor's experience. Perceptions of crowding and competition for space relate to the amount of use or location of use. Competition for space may manifest at trailheads/boat ramps where vehicle space is at a premium, or where campsites are limited, in places where fish or game tend to be found, in those secret untracked powder stashes. Recreation conflicts can be explained by "theory of goal interference". This theory states that perceptions of conflict arise when the presence and/or behavior of one group of users is incompatible with the social, psychological, or physical goals of another group (Jacob and Schreyer 1980). Conflict was found to relate to: activity style, focus of trip, expectations, attitudes toward the environment, level of tolerance of others, and different norms held by different users (Moore 1994). Sometimes concerns expressed about recreation impacts on resource conditions are, at their heart, about social conflict.

Staffing

Labor shortages are apparent in every line of work today and land management is no exception. Recreation growth and high expectations drive a desire for more service whether it is for: maintaining bathrooms, repairing deteriorating facilities, conducting education and enforcement patrols, administering permits, providing visitor information, or deconflicting disputes. Repeated contacts with non-compliant behaviors, as well as the increasing probability of encountering a person experiencing a mental crisis or holding an anti-government sentiment, takes a toll on field staff and volunteers. Staffing shortages are aggravated by the high cost or lack of housing and staffing is simply not keeping up with the demand. This includes the many volunteers who provide essential capacity for search and rescue and first response.

Looking Forward: Conclusions

As the largest national forest in Wyoming and the largest within the GYE, the Bridger-Teton plays a distinctive and important role in contributing to ecological, economic, and social conditions for communities, the State, and the Intermountain Region. Wildlife and fish-related recreation, dispersed recreation/trails, and winter recreation opportunities are particularly distinctive assets. Managing recreation use has always played an important role for the Bridger-Teton and many projects and programs have been implemented over the years to respond to

emerging issues and changing conditions. This includes substantial effort to work with volunteers and partners to leverage staff capacity. National Forests do not have entrance gates thus management strategies lean more on engineering (i.e. infrastructure design), education/enforcement, and evaluation strategies, as well as working with the other factors that influence impact: the type of use (e.g. designating routes for motorized use), the location or distribution of use (e.g. re-locating trails out of riparian areas, implementing a designated campsite program), the timing of use (enacting seasonal closures to protect wildlife), and the behavior of visitors (e.g. establishing ambassadors for responsible recreation). New programs and projects will be needed to meet future challenges to achieve desired conditions specified in the forest plan using the best available science around visitor use management and the collective knowledge and capacity of staff and partners (IVUMC 2016).

We stand on the shoulders of many before us who worked to protect the wildlife, water, and wildlands of northwest Wyoming, including indigenous people. Because of this history, the Bridger-Teton is extremely fortunate to have a relatively intact natural environment. The current recreation direction in the forest plan established desired ROS settings for various management areas, and it set standards and guidelines primarily around facility development, campsite condition, and OHV trail development with a focus on summer activities that dominated in the 1980s. With the tremendous change that occurred over the past 30 years and the challenges anticipated over the next decade, updated recreation direction and robust monitoring is needed to achieve the three pillars of recreation sustainability – condition of the environment, visitor experience/public service, and economics including employee/ partner capacity. Change is inevitable, but updated direction must retain the recreation settings and opportunities that honor the natural assets and experiences found on the Bridger-Teton that are not readily available elsewhere.

Five findings that will shape the need for updated forest plan recreation direction include the following described below.

- Easily accessed day use areas, road-accessible camping areas, and key destinations will face increased pressure. These settings and destinations, including new places popularized through social media, are likely to face increasing recreation pressure and overwhelm existing infrastructure and staff capacity. The pressure on easily accessed areas comes from a broad array of activities - hiking, dog walking, running, biking, water-based activities, OHV motorized use, climbing, road-accessible camping, skiing, and target shooting. This pressure will aggravate crowding and congestion, ecological, and social concerns. Dispersed camping and re-design of campgrounds and trailheads will require special attention.
- Social conflict will be more challenging than resource effects. Social conflict and concerns about appropriate use include the loss of setting characteristics (e.g., a favorite place that was quiet years ago may now be more crowded or is now popular for very different activities). Other concerns center around: noise, odor, speed, or safety (notably between motorized and non-motorized uses, but they also involve dogs, mountain bikes, and other activities). Still other concerns center around activities that physically change conditions for other uses (e.g., use that makes a trail muddy or rutted, snowmobiles riding over a nordic track or leaving tracks in a popular ski bowl). Most people do not go into the outdoors intending to harm others or to create conflict. To avoid conflict, there will be increasing pressure for forest managers to modify visitor expectations around shared use or separate conflicting uses, either spatially or temporally.

- Electric technology will blur the line between motorized and non-motorized use. E-bikes are currently the fastest growing segment of the bicycle market, and the technology is rapidly advancing to the point where electric dirt bikes are out-performing gas-powered bikes (Grand View Research 2023). Electric snowmobiles, electric off-road vehicles, and e-pack wheels (game carriers) are also on the market with growing consumer interest. The move to electric recreation vehicles has obvious benefits for the climate as well as reducing noise and odor, but the technology comes with growing pressure on managers to provide areas where these uses are appropriate and can be accommodated.
- Winter recreation planning for non-motorized, motorized and wildlife interests will be challenging. With backcountry skiing and nordic activities surging in popularity, snowmobilers seeking more off-trail powder areas and challenging terrain, as well as growth in hybrid snowmobile-ski interest, the potential for significant conflict is high. Providing more separation between motorized and non-motorized interests will be needed. Plans also will need to factor in the demand for regularly plowed trailheads and re-design of many existing winter trailheads that are increasingly congested. An additional challenge will be the need to reduce disturbance from recreation use in areas of native wildlife winter range.
- Climate change will increasingly affect recreation settings and opportunities. The climate encompassing the Bridger-Teton is expected to be warmer, especially during the spring, with slightly more total precipitation and drier summers (Hostetler et al. 2021). Some changes may lead to increased recreation (e.g. more winter activity due to the consistent snowpack compared with other destinations and increased river and lake recreation due to triple digit summer temperatures in regional metropolitan areas). Other changes may lead to restrictions (e.g. fishing restrictions due to prolonged hot water temperatures), disruption to recreation access (e.g. due to wildfires, floods or extreme wind events), or a mismatch between on-the-ground conditions and seasonal dates pertaining to travel management, campground opening/closing and other activities (Miller et al. 2022). Increased congestion in the Snake River canyon during July when triple-digit temperatures occur in the Salt Lake City area and an increase in dispersed camping well into October are examples of the changes that are already apparent on the Bridger-Teton.

Forest Road, Trail System, and Infrastructure

Roads and trails are critical infrastructure that support public access and enable much of the Bridger-Teton's multiple uses. Infrastructure also includes essential buildings, structures, and offices for management of the Bridger-Teton. Facilities enable recreational opportunities for many, provide water and sanitation, and help make a visit to the Bridger-Teton a quality experience.

Infrastructure is defined as the human-built property created to support the management and use of the land. The infrastructure categories covered in this section include: national forest roads, trails, bridges, dams, administrative facilities, water and wastewater systems.

Key Takeaways

- Roads and trails are critical infrastructure that support public access, contribute to economic vitality and social well-being, as well as enable most of the Bridger-Teton's multiple uses. The Bridger-Teton staff manage 2,168 miles of road and manages the largest network of trails in Wyoming – 2,807 miles in the summer and 668 miles in the winter. Included in this

mileage, are nearly 200 road and trail bridges. Bridger-Teton infrastructure also includes facilities that play a big role in the USFS's ability to serve the public and manage the land, which includes: radio communication sites, 47 water systems, 21 dams, administrative offices, 180 vault toilets, warehouses, and living quarters for permanent and seasonal employees.

- Most of the Bridger-Teton infrastructure was built decades ago and it was not necessarily built nor designed to accommodate the amount and type of current use. Maintenance requirements and public interest in new or re-designed infrastructure exceed demand and existing Bridger-Teton capacity. In some cases, the deterioration is creating serious health and safety concerns. Unauthorized (user-created) roads and trails, as well as natural events like landslides, fire, and flooding, add to the challenges. New sources of funding are helping, but reliance on private-public partnerships remain essential for the future.
- The current forest plan does contain direction for roads, trails, and facilities. Maintenance, re-design of existing infrastructure, and travel planning are the primary needs into the future. However, updated direction in the forest plan is needed to (1) establish a framework for subsequent summer and winter travel planning based on the travel management rule; (2) identify appropriate areas for additional employee housing; and (3) incorporate newer direction for trails including trail classes and concepts around sustainable trail strategies.

Roads

Roads are vital for the social sustainability as they provide access to national forest lands. The strong desire for access leads to important decisions regarding the balance between social, economic, and ecological sustainability. Road maintenance is one of the most challenging aspects associated with the transportation system. Not only does the upkeep of the existing system allow for continued access, but it also decreases impacts on other natural resources. It is not feasible for current, existing USFS personnel to address maintenance of 1,000s of miles of roads every year. To aid in capacity, the Bridger-Teton collaborates with the adjacent counties, Federal Highway Administration, and others to address ongoing and deferred road maintenance.

Background

National Forest System Roads (NFSR) are those the USFS deems necessary for the: protection, administration, enjoyment and use of national forest land and resources. These roads are under the jurisdiction of the USFS and they are mostly located on National Forest land or on adjacent land under easement agreements. They range from rough, single-lane dirt tracks to paved, double-lane highways. These roads are a part of an overall transportation system managed with Federal, State, county, and municipal agencies with the goal of providing a seamless road network for a variety of people.

Bridger-Teton roads play a major role in the social and economic sustainability of western Wyoming. Many Bridger-Teton roads are used to: commute to jobs, access businesses operated within the Bridger-Teton, access private property, aid in fire operations, and provide access to an abundance of recreational opportunities. The arterial and collector transportation system was developed over several decades to access different portions of the Bridger-Teton, often to develop natural resources and to provide for a variety of public uses. While they were being developed, there was likely little to no long-term transportation planning.

Status and Trends

The Bridger-Teton has 3,221 road miles that fall under USFS jurisdiction and maintenance. Of these, 998 miles are unauthorized or user-created, illegal routes. Many of these routes are old timber roads, temporary roads of some kind, or routes created by Bridger-Teton visitors over the years. These unauthorized routes are not legally open, but some of them have regular use; this leaves 2,168 miles of official Bridger-Teton system roads (See Table 57). Of these, the Bridger-Teton has 606 miles of administratively closed roads under the maintenance level (ML) 1 category. These routes are closed to the public, but they are available for emergency response and administrative uses including timber removal in accordance with site-specific decision documents. The Bridger-Teton has 1,561 miles of open public roads under maintenance levels 2 through 4 (See Table 57 for the breakout of miles and percentages). The Bridger-Teton does not have management responsibility for any maintenance level 5 roads, but Wyoming Department of Transportation maintains and improves several level 5 State highways within the Bridger-Teton. Maintenance levels on Bridger-Teton roads widely vary based on traffic levels, conditions, and other factors. The USFS standards of road maintenance levels are summarized in

below. Generally, the total number of road miles has declined over the past 20 years as roads were no longer needed for management activities, roads were closed to improve wildlife habitat security, or roads were converted to motorized trails. Despite these changes, the total miles of road open for public use today (1,561 miles) is remarkably similar to the miles of system road that was present on the forest in 1990 (1,539 miles).

Table 57. Miles of national forest system roads by operational maintenance level

ML	Total Miles	Percent of Total
1	606	28%
2	967	45%
3	380	17%
4	214	10%
5	0	0%

Table 58. Summary of USFS Road Maintenance Levels

Operational Maintenance Level	Surface and Roadway User Comfort and Convenience	Typical Surface	Traffic Volume and Speed	Vehicle Strategy	Subject to Highway Safety Act	Manual of Uniform Traffic Control Devices	Lanes	Service	Route Marker
5	Very smooth and comfortable for prudent drivers in passenger cars	Paved Chip-Seal Aggregate Dust Abatement	High	Encourage Passenger car	Yes	Yes	Double	Arterial Collector	Distinctive or Horizontal
4	Moderate smoothness and comfort for prudent drivers in passenger cars	Paved Chip-Seal Aggregate Dust Abatement	Moderate	Encourage Passenger car	Yes	Yes	Single or double	Collector	Distinctive or Horizontal
3	Low-priority, but still passable by prudent drivers in passenger cars	Aggregate Dust Abatement Native	Low to Moderate	Encourage or Accept Passenger car	Yes	Yes	Single with Turnouts	Local	Horizontal
2	Surface smoothness is not a consideration. Surface may be rough, potholed, or washboarded.	Native	Low to moderate	Accept High Clearance Discourage passenger car	No	Yes	Single	Local	Vertical
1	Custodial maintenance. No annual maintenance other than a condition survey may be required so long as no potential exists for resource damage. Road may deteriorate at this level.	Paved Chip-Seal Aggregate Dust Abatement Native	No Motor vehicles	No Motor vehicles	No	No	Single or double	Arterial Collector Local	Vertical

The routes on the Bridger-Teton are a mixture of paved, improved, and native surface types that often access non-motorized areas such as designated wilderness and backcountry areas. ML 2 and ML 3 roads are generally native surfaced with some level ML 3 roads surfaced with aggregate. These roads are often near streams, as these areas provide the easiest terrain for passage. Some roads provide access to larger recreational areas (Greys River, Green River Lake, Union Pass, and Gros Ventre). Other roads are important for access to administrative or heavily used recreation sites. Many roads, even at ML 3, are local in nature and access limited parts of the Bridger-Teton. ML 3-ML 5 roads are collectively maintained, assuming travel/use by prudent drivers in standard passenger vehicles. These roads fall under the requirements of the National Highway Safety Act and the Manual of Uniform Traffic Control Devices, which require warning signs and traffic control devices are provided to alert prudent driver of situations that may violate expectations.

On a national level, road maintenance dollars are allocated to each national forest based on the “roaded” land area and recreation visitor use. During the past two decades, appropriated funding for road construction and maintenance decreased. Meanwhile, usage and wear increased, while expenses rose to improve safety, protect resources and complete USFS planning requirements. Funding for repairs and maintenance is expected to continue to decrease, while national requirements and efforts for planning and maintenance continue to increase. Additional maintenance is accomplished using other methods, such as watershed improvement funds, local and national partnerships, and agreements with local counties. The inability to adequately maintain existing roads could result in reduced access, recreation services and public use. Given these circumstances, the creation of a new forest plan offers the opportunity to define a realistic and sustainable desired infrastructure.

The Bridger-Teton has a road crew that can address only a small fraction of the ongoing maintenance needs across the Bridger-Teton. Road maintenance is mainly prioritized by high recreation usage and resource protection, but also what is needed to support timber or fire operations. Road-related deferred maintenance items include: slide and slump repair, grading, re-establishing ditch lines, culvert clean out, resurfacing with aggregate and drainage improvements.

In general, the Bridger-Teton staff strive to reduce unauthorized routes to reduce erosion, wildlife disturbance, and other resource damage. Generally, these routes were never part of the Bridger-Teton transportation system, and they can be challenging to manage due to limited Law Enforcement Officers covering millions of acres of land. There is also concern for how the transportation system is impacting sensitive soils and geologic stability, which may lead to more road-related failures. Water quality, riparian resources and stream channel stability are other concerns due to potential loss of aquatic habitat and sediment transport from roads to streams. Overall, existing road access may not be adequate for future management needs and, therefore, new road construction may be necessary to support these needs, including rerouting existing roads to lessen ecological impacts.

Recreation concerns are centered around condition and maintenance level of the road system and whether they are consistent with recreation settings and user desires. Since the Bridger-Teton welcomes a wide variety of recreational users, it may be increasingly important that the access provided to desired destinations are adequate for the type of intended vehicle. Another concern is the type of use on the transportation system as both OHVs and highway vehicles occasionally share routes, and this motorized mixed use can raise safety concerns. Limited

sight distance, as well as deferred maintenance, contribute to the safety within the transportation system. Unfortunately, some road improvements may inherently negatively impact the safety of road users as improvements can increase speed of travel and traffic volume. Higher speeds also lead to more dust and other consequences, such as collisions.

Summer and Winter Trails

Recreation is one of the most important multiple uses on the Bridger-Teton and trails facilitate most of this access providing multiple benefits. Trails enhance people's life by providing: connection with nature, social bonding, adventure, and release of stress. Trails are part of the Nation's wellness infrastructure, promoting physical and mental health. Trails also contribute to the economic vitality of communities, support outfitter-guide services, and are one of the key amenities that draw tourists as well as residents and businesses. To realize these benefits, trails need to be well-maintained and managed.

Background

The USFS manages more miles of trail than any other agency, thus has played a lead role in developing trail management frameworks. Trails are broadly classified as either system or non-system. System trails are defined as those trails necessary for the protection and use of the national forest. System trails are further categorized into five classes ranging from minimally to fully developed. The trail class system was initiated in 1999 and it is periodically refined with the current classification and management directives established in 2008 (FSH 2309.18) (See Table 59). The desired development level for any trail should be consistent with the broader recreation opportunity setting. For example, a class 1 trail would be appropriate in a primitive recreation setting, but a class 5 trail would not be appropriate. However, in a rural or urban setting, a paved class 5 trail would be appropriate.

Table 59. Trail class and description

Trail Class	Description
Class 1: Minimally developed	Tread intermittent and indistinct • Obstacles common, often substantial • Constructed features non-existent • Route markers may be present • Recreation environment natural and unmodified (route-finding may be required)
Class 2: Moderately developed	Tread continuous and discernable, but narrow and rough • Obstacles may be common, but blockages cleared to define route Constructed features non-existent • Constructed features are of limited size, scale and quantity • Signing limited to junctions; route markers may be present • Recreation environment natural and essentially unmodified
Class 3: Developed	Tread continuous and obvious • Obstacles may be common. Vegetation cleared outside of trailway • Trail structures may be common and substantial • Signs at junctions and as needed for user reassurance Recreation environment natural and primarily unmodified

Trail Class	Description
Class 4: Highly developed	Tread wide and relatively smooth with few irregularities • Obstacles infrequent and insubstantial. Vegetation cleared outside of trailway • Constructed features frequent and substantial. Trailside amenities may be present • Wide variety of signs likely present with interpretive signs possible
Class 5: Fully developed	Tread wide, firm, stable, and uniform • Obstacles not present. Grades typically less than 8 percent • Constructed features frequent – may include bridges, boardwalks, handrails, and trailside amenities • Wide variety of signs present with interpretive signs common • Recreation environment may be highly modified

In 2013, the Government Accountability Office (GAO) issued a report highlighting the issues facing trails on national forests and they noted that the agency had more miles of trail that it can maintain resulting in a persistent maintenance backlog with a range of negative effects (GAO-13-618). In response, the USFS developed the National Strategy for a Sustainable Trail System and they established a trail advisory group to guide implementation of the strategy (USDA FS-1206). At the same time, Congress passed the National Forest System Trails Stewardship Act of 2016, which directs national forest units to seek innovative ways to work with: partners, volunteers, outfitters and guides, and other land managers to finance and maintain trail systems. On the Bridger-Teton, two priorities were established under the stewardship act – the Continental Divide National Scenic Trail and the Wyoming Range National Recreation Trail-Lander National Historic Trail.

Status and Trends

The Bridger-Teton has 3,475 miles of trail, which is one of the largest networks in the Intermountain Region and the largest in Wyoming (See Table 60). This system includes 2,807 miles of native surface trails, 36 percent of which are located within wilderness and 9 percent of which are designated for off-highway vehicle use. Within this system, there are 323 miles of National System Trails (Scenic, Historic, and Recreation). In addition to native surface trails, there are 668 miles of winter trails, 94 percent of which are groomed for snowmobile use and 5.7 percent of which are groomed for nordic activities. Ninety-one percent of the trail system is managed in class 2 or 3 (moderately developed or developed). There are currently 97 trail bridges recorded, some of which are complex structures, although the data is incomplete. Like roads, the Bridger-Teton also contains hundreds of miles of non-system, user-created trails. Non-system trails are not eligible to receive maintenance funds and they have never received design or construction effort to ensure their sustainability. The proliferation of non-system trails is a major challenge as these trails: are often poorly located, create resource damage, make it difficult for visitors to follow the system trail, and are difficult to erase from the landscape.

Table 60. Summary of system trail miles within three zones, Bridger-Teton

Type	Gros Ventre/Teton Zone (D4, D6)	Wyoming/Salt River Zone (D1, D2, D3)	Wind River Zone * (D7)
Non-motorized trails (miles)	1,123	873	545
Motorized trails (miles)	80	171	15
Snowmobile trails (miles)	202	288	140
Nordic trails (miles)	18	5	15
Trail bridges (#)	75	6	16
Total Trail Miles	**1,423**	**1,337**	**715**

Given the extent of the trail system, it may not be surprising that only 10 percent of the system meets standard. The 40+ million dollar deferred maintenance backlog is the result of a trail system that largely evolved from game trails rather than being sustainably designed and constructed plus years of insufficient maintenance on lower priority trails. Roughly 28 percent of Bridger-Teton trails are maintained each year, with work primarily focused on clearing downfall. Significant wind events occurred in recent years, sometimes requiring months of crew time to re-open miles of impassable trail. Time spent clearing downfall leaves little capacity to perform other trail tasks necessary for the trail to remain functional and sustainable. These tasks include: drainage, tread repair, brushing, junction signing, bridge or turnpike work. Water is the most destructive force on trails, and if not addressed, results in the trail becoming eroded, washed out, or widened due to persistent mud. Funding for on-the-ground trail work entirely comes from the: retention of outfitter-guide receipts (FLREA funds); grants from the Wyoming State Recreational Trail Program; specific funding for the Continental Divide National Scenic Trail; and multiple partners and volunteers who provide invaluable maintenance and improvement assistance, particularly on front country trails. For winter trails, the Bridger-Teton partners with Wyoming State Trails to groom routes including the popular Continental Divide Snowmobile Trail. Snowmobile trail grooming is funded via State snowmobile permits. Trails groomed for winter nordic activities are mostly associated with resorts or guest ranches. They are groomed by individual resorts, county parks and recreation departments, or by local non-profit organizations. Grooming is an expensive endeavor and it is becoming more difficult to adequately fund.

The trail system on the Bridger-Teton has evolved and grown 17% since the 1990 forest plan – in overall miles, miles of designated motorized trails, and miles of groomed nordic trail. The miles of dirt trails increased for several reasons: (1) more accurate inventories, (2) planning efforts have added existing non-system trails to the system or converted old roads to motorized trails, and (3) resorts added mountain bike and nordic trails to the amenities they offer. Although the system has grown, the interest in additional trail-based recreation is high, particularly for summer mountain bike trails, winter nordic trails, and motorized trails. As discussed in the recreation section of this document, the interest in trails by multiple recreation interests is creating more demand for use-specific, separated trails to provide desired experiences as well as to reduce potential conflict with other trail uses.

Current Forest Plan Direction

The current forest plan has two goals for trails which are (Goal 1.2) A safe transportation system meets the needs of commercial users (e.g. trails to support outfitting and guiding) and (Goal 2.5)

A safe trail system provides access to a range of recreation opportunities and settings. A Bridger-Teton-wide trails prescription states that “non-motorized and motorized trails are provided for a variety of uses and difficulty levels. Trails are maintained to appropriate levels or signed as closed with reasons stated”. A Bridger-Teton-wide guideline states that “the trail system should be managed to minimize conflicts among users, including motorized and non-motorized recreation and livestock”. In addition to this Bridger-Teton-wide direction, trail densities and development guidelines are established for various desired future condition zones.

Conclusions

Trails are a critical part of the Bridger-Teton’s transportation system. They are a wise investment along with maintenance of the trail system being essential to “care for the land and serve people”. Forest planning offers the opportunity to provide guidance on how the trail system should evolve to help achieve the spectrum of desired visitor experience and to improve the overall sustainability of the system while also protecting sensitive wildlife habitat. Clear opportunities for improved management direction include imbedding concepts from the National Strategy for a Sustainable Trail System and Trails Challenge in plan goals and desired conditions, using the trail classification system and trail management objectives to help formulate plan standards and guidelines, and developing specific plan components for National System Trails based on national guidance.

Travel Management

Travel management focuses on motorized use within the Bridger-Teton, both wheeled vehicle use and over-snow vehicle use. It is a topic of high public interest since motorized travel is central to how many people choose to access and explore the Bridger-Teton whether they are: simply driving to a trailhead, accessing a favorite fishing stream, riding a dirt bike, or snowmobiling. Forest plans do not result in travel plans for specific areas of the Bridger-Teton. Travel plans require project-level analysis to determine which routes should be open to motor vehicle use along with the class of vehicle and season of use for each route. However, the forest plan does establish objectives, desired conditions, and standards and guidelines that subsequent site-specific travel management projects need to be consistent with.

Background

The 1970s brought broad attention nationally and locally to the issue of off-road vehicle management. In 1972, President Nixon issued the now rescinded EO 11644 – “Use of ORVs on the Public Lands” which directed Federal land management agencies to develop regulations governing off-road vehicle use to protect natural resources, promote public safety, and minimize conflicts among uses. During the 1990s, off-highway vehicle use rapidly grew with the improvement of ATVs. By 2005, unmanaged off-road vehicle use became one of four key issues affecting the national forests. In response, the USFS released a National Travel Management Rule (36 CFR 212) on November 9, 2005 with three subparts. Subpart A requires completion of a Travel Analysis Report to identify the minimum transportation system needed for safe and efficient travel and for protection, management, and use of the Bridger-Teton. Subpart B requires wheeled motor vehicle use only occur on designated routes or areas and it establishes a process for local Bridger-Teton leaders to decide which routes should be designated, what class of vehicle should be permitted on each route, and what season of use should apply. Thus, travel management involves more than simply opening or closing routes, offering the

opportunity to tailor decisions to address specific issues. A free Motor Vehicle Use Map (MVUM) displays the motor vehicle system and it must be annually produced. Subpart C authorizes, but initially did not require, forest staff to regulate over-snow vehicle use. In response to a lawsuit, subpart C of the Travel Management Rule was amended in 2015 to require forest staff to determine which routes and areas should be open to over-snow vehicle use where snowfall is adequate for over-snow vehicle use to occur. Local Bridger-Teton staff must make these decisions through conducting environmental analysis that addresses minimization criteria and involving the public with the results displayed on an Over-snow Vehicle Use Map (OSVUM).

More recently, the USFS issued guidance for managing e-bike use, establishing e-bike as a separate class of motor vehicle under the Travel Management Rule and identifying criteria for designating routes for e-bike use on non-motorized trails, where appropriate. In promulgating the National Travel Management Rule and subsequent amendments, definitions for different types of motor vehicles and e-bikes are established. The larger effect of these regulatory changes is that instead of the Bridger-Teton being generally open to motorized travel, except where specifically closed, the national forests are generally closed except where specifically open. USFS directives provide guidance for local Bridger-Teton staff to work through the complex, and often controversial public process, to make travel management decisions (FSM 7700). An important distinction is that while the Bridger-Teton is responsible for where and when motorized use and e-bike use is allowed, Wyoming State regulates safety, driver licensing and annual permit requirements for operating off-road vehicles and snowmobiles.

Status and Trends

The Bridger-Teton staff completed the Travel Analysis Report to fulfill subpart A of the National Travel Management Rule in 2015.

Fulfilling subpart B has a longer history since the travel rule allows previous motor vehicle route decisions that designated routes to be displayed on MVUMs without additional analysis. The Bridger-Teton began producing travel maps for wheeled motor vehicle use in the late 1970s and 1980s. For the Wyoming/Salt River portion of the Bridger-Teton, designated routes for wheeled motor vehicle were determined through planning completed in the early 1990s. For the Wind River area, motor vehicle routes were designated in 1997. By 2005, portions of the Gros Ventre/Teton area were the only place where designated routes were not established. Route designation in these areas was completed in 2009. Wheeled motor vehicle use is now restricted to designated routes on the entire Bridger-Teton and displayed on three MVUMs. Since 2009, motorized vehicles have continued to evolve. Most motorized trails on the Bridger-Teton were originally designated for motorcycles or machines 50 inches or less in width (e.g. single driver ATVs). However, use of 50-inch machines has significantly declined in favor of wider off-highway vehicles that offer more comfort and multi-passenger capacity (e.g. side-by-side utility terrain vehicles [UTV]). As a result, some existing 50-inch motorized trail systems have been converted to allow vehicles up to 64” wide. The emergence of wider side-by-side machines has made travel management more complicated in that they are often licensed to be street legal and can operate on public roadways other than interstate highways. Consequently, street-legal machines can legally operate on any forest road open to all classes of vehicle. In addition, two motorized trail opportunities were added to the system through project planning efforts – one for motorcycle use in the Jackson area and one for 64-inch vehicles in the Greys River area. Trail systems that offer quality experiences and discourage off-trail use include: designing loops, incorporating scenic views, providing varying levels of challenge, and accessing attractive destinations (Duford. Great Trails Guidebook, Crimmins 2006). Because much of the Bridger-

Teton transitioned to designated routes prior to the emergence of four-wheel ATV and UTV off-highway vehicles, older travel maps contain many dead-end routes and do not incorporate current information on motorized trail system design.

The Bridger-Teton staff has not published any OSVUMs per subpart C of the Travel Rule. Currently, winter vehicle travel is governed by a collection of Bridger-Teton special orders. The Teton Division of the Bridger-Teton (Blackrock, Jackson, and a portion of the Big Piney District) has a winter travel map that dates to 1993 with minor adjustments made through subsequent planning efforts to improve winter wildlife protection. This travel map originates from efforts in 1990 to balance recreation access with winter wildlife habitat protection (32 percent of non-wilderness acres restrict snowmobile use or allow no human presence between Dec. 1st – May 1st). The Wind River and Wyoming/Salt River areas have special orders that close small important wildlife areas to snowmobile travel; 14 percent of non-wilderness acres in the Wind River and 2.5 percent in the Wyoming/Salt River area. Overall, outside of designated wilderness, much of the Bridger-Teton is open for snowmobile travel and the acreage has remained relatively stable since 1990. Like wheeled motorized vehicles, over-snow vehicle technology evolved with tracked ATVs/UTVs becoming more common as well as snow bikes (i.e. track and ski-steered motorcycles). The Wyoming/Salt River and Wind River areas currently permit tracked ATVs on groomed snowmobile trails, whereas the area covered by the Teton Division Winter Travel Plan includes a requirement that over-snow vehicles must be ski-steered in addition to having tracks. This difference in the definition of an over-snow vehicle can be confusing to winter recreationists.

There has not been a Bridger-Teton-wide effort to address e-bike use under the new policy. However, one proposal for select trails on the Jackson Ranger District is currently under analysis.

Current Forest Plan Direction

In addition to the overall trail system goals, the forest plan contains a Bridger-Teton-wide OHV standard stating “motorized off-highway vehicles (OHVs) will be restricted to routes or open roads designated for that use. Vehicle use will be consistent with State law and federal regulations for both licensed and unlicensed vehicles and operators” and a winter restriction standard that “oversnow vehicles and helicopters for skiing will avoid crucial winter ranges”. The forest plan also provides some general guidance about whether off-road vehicles and snowmobiles are appropriate within the various desired future condition zones.

Conclusion

Travel management is a topic of very high public interest. While the forest plan does not make travel management decisions, it establishes the overall guidance and context for making subsequent route decisions. For wheeled motor vehicle use, designated routes already have been established, but there is a need for updated direction to potentially transform dead-end routes into more effective loop systems, use the class of vehicle and season of use to resolve specific issues, and address the growing safety issues with mixed UTV and regular vehicle use on roads. Forest plan guidance on winter travel and e-bike use, as well as other e-modes of travel, is largely absent in the current forest plan and there is a clear need for it in the future.

Infrastructure

Infrastructure is an essential aspect that enables much of the national forest's recreational and commercial use. Infrastructure provides transportation, housing, goods, and services. Infrastructure includes: residences, offices and other support facilities for management of the national forest, enables recreational opportunities, provides for water and sanitation, and makes visiting the national forest a unique and gratifying experience. Maintaining the national forest's infrastructure is also important to local economies and quality of life for people living in nearby communities.

Background

The infrastructure categories covered in this section include: bridges, dams, administrative facilities, communication towers, water, and wastewater systems.

The infrastructure within the Bridger-Teton plays a huge role in the USFS's ability to serve the public and manage the land. The existing infrastructure allows for radio communication and community water usage. It also provides office space, equipment storage and living quarters for permanent and seasonal employees. The Bridger-Teton is heavily integrated into local communities due to the outdoor recreation opportunities across all ranger districts. To keep this connection viable, key infrastructure, such as bridges, water systems, and wastewater systems, need to be prioritized.

Status and Trends

The Bridger-Teton Forest Plan describes forest-wide and management area-specific goals, objectives and standards related to facilities and transportation. Since the 1990 forest plan, a facility master plan was created to be consistent with the Forest Service Manual, the Forest Service Handbook and other Federal land management guidelines.

The number of visitors to Bridger-Teton rose in recent years, as has demand for various uses including recreational and commercial uses. But while demand and use rose, budgets and staffing have not kept pace. As a result, it has become increasingly difficult to sustain the Bridger-Teton's infrastructure in a condition that adequately provides for and protects visitors and natural resources. This also includes ensuring existing infrastructure meets Federal accessibility standards. It is unknown what percent of sites allow for accessible access; thus, we assume that most infrastructure related sites need improvement.

Employee housing is a major priority for the Bridger-Teton. Affordable housing availability in Teton County has historically been low, and it precludes new employee recruitment as well as current employee retention (WSW Consulting 2022). Housing options in the other counties within the Bridger-Teton's boundaries (Sublette and Lincoln Counties) recently experienced drastic increase in home prices with a decrease in rental and affordable housing options. Prospective employees are not incentivized to move or work on the Bridger-Teton unless provided with living quarter options. Permanent employees, in federally owned housing in Jackson, are currently limited to 6 years rental leases, but they are encouraged to find more permanent residences prior to the end of their leases. However, the cost prohibitive housing situation continues to be an issue. Therefore, construction of new housing for employees has been a top priority for the Bridger-Teton staff and collaboration with Teton County and other local entities is on-going to craft innovative solutions. As engineering staff prioritize housing construction, the deferred maintenance of existing infrastructure continues to grow. As a result,

two of the major challenges facing the Bridger-Teton are how to manage the current backlog of deferred maintenance and provide housing solutions to alleviate the staffing shortage and reduce employee turnover.

Conditions of the facilities on the Bridger-Teton widely vary, but all include some level of deferred maintenance. Common major maintenance needs include: roof replacements and repairs to siding, foundations, windows, appliances, water systems, wastewater systems and HVAC systems. Since a lot of the government owned and operated infrastructure includes housing, there are many maintenance tasks that address health and safety issues. If deferred maintenance items are not addressed, the longevity of the facilities will rapidly diminish. Facilities may become unusable and potentially a hazard to the government.

The Bridger-Teton has a fiscal capability to only maintain so much of the existing USFS-owned infrastructure. Living quarters are partly supported by rental payments, while administrative facilities and other facilities are supported through annual budget appropriations. Because of limited budgets and hiring backlogs, there is not enough support to maintain all the infrastructure. This results in a reactionary approach to address maintenance needs rather than proactive planning. Bridger-Teton leaders are aggressively working to reduce deferred maintenance, including working with partners to find funding and volunteer support.

Some of the recent legislation, such as Great American Outdoors Act (GAOA), helped in reducing deferred maintenance on a variety of projects. For example, two water systems on the Greys River Ranger District, Deer Creek and McCain Guard Station are under contract to receive long overdue maintenance. Water systems located on the Bridger-Teton have become a precious commodity, especially for visitors staying at campgrounds. Many water systems at campgrounds are decades old and increasingly do not meet EPA standards for public water systems. The expense associated with replacing a water system is typically much higher than available funds.

In addition to deferred maintenance, existing infrastructure interacts with ecological changes and it faces threats from climate change and fire. Existing infrastructure, such as bridges, enhance ecological integrity by allowing rivers to flow without barriers that may otherwise exclude some species from migrating. Water and wastewater systems that correctly operate ensure that nearby water sources do not get contaminated. More intense and frequent storms are a huge concern for bridges, which were mainly designed to withstand 100-year flood events. All USFS-owned infrastructure is threatened by fire due to the proximity to fuels.

Following are descriptions of several infrastructure types on the Bridger-Teton.

Airfields

One undeveloped airstrip is located on the Pinedale Ranger District and it is administered under a special use permit.

Bridges

There are 97 active road bridges on the Bridger-Teton. These bridges are inspected every 2 years, but some instances require 1 year frequency or allow for a 4-year frequency. Of these bridges, three are classified as being in “Serious” or “Critical” condition. In this case, those three bridges are annually inspected. Currently, there is one bridge on the Bridger-Teton that meets the Federal Highway Administration's definition of nonredundant steel tension member, meaning

the inspection is more technical and thus is performed via regional contract with an architectural and engineering firm. Bridge inspections include a list of maintenance items that need to be addressed. Unfortunately, most items, if none at all, do not get completed and appear on the list year after year deteriorating each year. The highest priority bridge for replacement is located at Bryan Flat within the Hoback Canyon. Exposed rebar at the footings and heavy debris flow after snowmelt cause the deterioration of the bridge to accelerate. Maintenance such as this is prioritized, but funding and staffing play a huge role in addressing critical repairs. The Bridger-Teton does not have a bridge replacement program that replaces undersized culverts and bridges with new structures that allow aquatic species to pass through more easily.

Dams

The USFS database identifies 16 existing, active dams on the Bridger-Teton, two of which are owned by the USFS (Middle Piney and Cottonwood Lake Dam). The 14 others are owned and operated by local government, public utility or private. The Wyoming State Engineers Office (SEO) has recently or is in the process of reclassifying some of the structures, and so the inventory may decrease. These dams vary in use from recreation to irrigation to hydroelectric energy generation. They are maintained, operated, and inspected by the USFS, State agencies or private contractors. There is no specific funding available for maintenance of dams instead maintenance is completed as part of regular operations and with project-specific funding. Current management plans specify dams are to be maintained in working condition and regularly inspected. Middle Piney Lake Dam is classified as a high hazard dam, one of two USFS owned high hazard dams in the Intermountain region.

Fire, Administrative and Other Buildings

As of April 2023, there are 201 USFS owned and four leased fire, administrative and other (FA&O) buildings on the Bridger-Teton. These buildings include: administrative offices, employee residences, bunkhouses, fire support buildings and warehouses. (Note FA&O does not include recreational or range related support facilities.) Employee dwelling facilities are partly supported through rental payments while other FA&O facilities are supported through annual budget appropriations. Most, if not all, facilities are continuing to accumulate deferred maintenance, that is becoming more challenging to address due to limited budgets. These facilities are located within all districts in the Bridger-Teton. The facilities are in a wide variety of conditions and ages ranging from 1 to 109 years old. The existing Facilities Master Plan, dated 2003 with Amendment I (2005), includes more detailed information on all Forest Service facilities on the Bridger-Teton.

Communication Towers

There are 21 active listed communication towers on the Bridger-Teton that serve as radio towers and repeater sites. These sites are vital to carry out day to day operations on the Bridger-Teton and allow for communication in areas with no cell phone service. These sites are located throughout the Bridger-Teton on all ranger districts.

Water and Wastewater Systems

There are approximately 69 drinking water systems and 46 sanitary sewer systems within the plan area. These systems are Forest-wide and they are in a variety of conditions. The drinking water systems provide water at campgrounds, guard stations and administrative sites, including

employee residential and work center areas. The source types vary between groundwater wells and spring collection development. In the State of Wyoming, the USEPA administers the public water supply program and they implement the Safe Drinking Water Act. Public water systems are divided into the following categories community, transient non-community and non-transient non-community. The designation determines the type and frequency of testing required. Sampling and testing are completed by USFS employees or campground concessionaires and then they are sent to labs for testing. All wastewater systems that are USFS owned typically consist of septic systems or holding tanks.

Designated and Protected Areas

Key Takeaways

- Designated and protected areas greatly contribute to the distinctive role and contributions the Bridger-Teton makes to the larger landscape. The Bridger-Teton contains both congressionally designated areas (Wilderness, WSRs, National Scenic Trails, etc.) and administratively protected areas (Scenic Byways, Geological Sites, Inventoried Roadless Areas, etc.). The congressionally designated areas account for approximately 41 percent of the Bridger-Teton, reinforcing the national significance of the Bridger-Teton's natural assets. Administratively protected areas account for an additional 41 percent of the Forest. While administrative protections are generally less restrictive than congressional designations, they contribute notable geologic, ecological, scenic, historic, and recreation values and underscore the relatively undeveloped character of the forest.
- The current forest plan was written prior to the 2001 Roadless Rule so there is opportunity to clarify opportunities for management activities while adhering to the Roadless Rule. Also, because much of the: Wyoming Range National Recreation Trail (WRNRT), Lander Cutoff National Historic Trail (NHT), RNAs, portions of the Continental Divide National Scenic Trail (CDT), and designated and eligible wild and scenic rivers are within inventoried roadless, there is an opportunity to ensure consistency across multiple types of protections.
- Current forest plan direction provides very little guidance for the interim management of the congressionally designated Wilderness Study Areas (WSAs) and guidance in USFS directives is largely absent. As a result, there is an opportunity to provide better management direction in the updated forest plan. Additionally, updated forest plan components are needed to meet current agency direction for National System Trails and to incorporate the requirement to preserve wilderness character for designated Wilderness. Little management direction currently exists regarding administratively protected areas in the forest plan, creating an opportunity to provide better direction during revision.

Status and Trends

Legislation by Congress in the 1960s established systems of designated areas that included, in part, the National Wilderness Preservation System, National Wild and Scenic Rivers, and National Trails System. These designated areas established a national system of connected areas providing: ecological, geological, scientific, educational, scenic, recreational, and historical values. The role of designated areas is important in protecting: air quality, water quality, wildlife habitat, unique wild plant and animal species, and in providing a unique legacy to future generations.

The Bridger-Teton has a large percentage of land represented in designated and protected area types. Congressionally designated areas represent 41 percent of the Forest, while administratively protected areas represent an additional 41 percent of the Forest (See Table 61). Eligible wild and scenic rivers, national natural landmarks, and other special areas contribute additional acres of protected lands (See Figure 64). Not all designated or administratively protected areas carry the same restrictions. Congressionally designated areas are managed in accordance with an “umbrella” (foundational) law and generally offer the most protection from development, as only Congress can add or remove an area from the national system. Of special note is the Wyoming Range Withdrawal which Congress passed as part of the Omnibus Public Land Management Act of 2009 (Title III, Subtitle C). This law withdrew a large portion of the Wyoming Range from mineral extraction and geothermal leasing, but did not designate the area as part of a larger national system. For this reason, the Wyoming Range Withdrawal area is not included in this section of the assessment but is discussed in the Energy and Minerals section. Administratively protected areas are generally less restrictive and are managed in accordance with a rule established through the federal register or specific site plan. Both congressional and administratively protected areas greatly contribute to the resource values and human experiences the Bridger-Teton is known for. The designated and protected areas on the Bridger-Teton are listed in Table 61.

Table 61. Congressionally designated and administrative special areas on the Bridger-Teton

Designation Type	Total Size	Percent of Plan Area
Designated Wilderness - congressional	1,297,789 acres	37%
Wilderness Study Areas - congressional	111,700 acres	3%
Recommended Wilderness - administrative	0 acres	0%
Wild and Scenic Rivers - congressional	98,185 acres	3% (some overlap with Wilderness)
National Scenic and Historic Trails - congressional	205 miles (CDNST); 26 miles (Lander Historic trail)	Not Applicable
National Recreation Trails - administrative	75 miles (WY NRT); 17 miles (Sheridan NRT)	Not Applicable
Scenic and Backcountry Byways - administrative	19 miles (Big Spring BB); 62 miles (Scenic highway)	Not Applicable
Research Natural Areas; Special Interest Areas - administrative	15,597 acres (4 RNAs, 2 SIAs)	0.4%
National Natural Landmark; National Geological Site - administrative	2,118 acres (NNL); 2,104 acres (NGS)	0.1%
Inventoried Roadless Areas - administrative	1,417,493 acres	41%

Congressionally Designated Areas

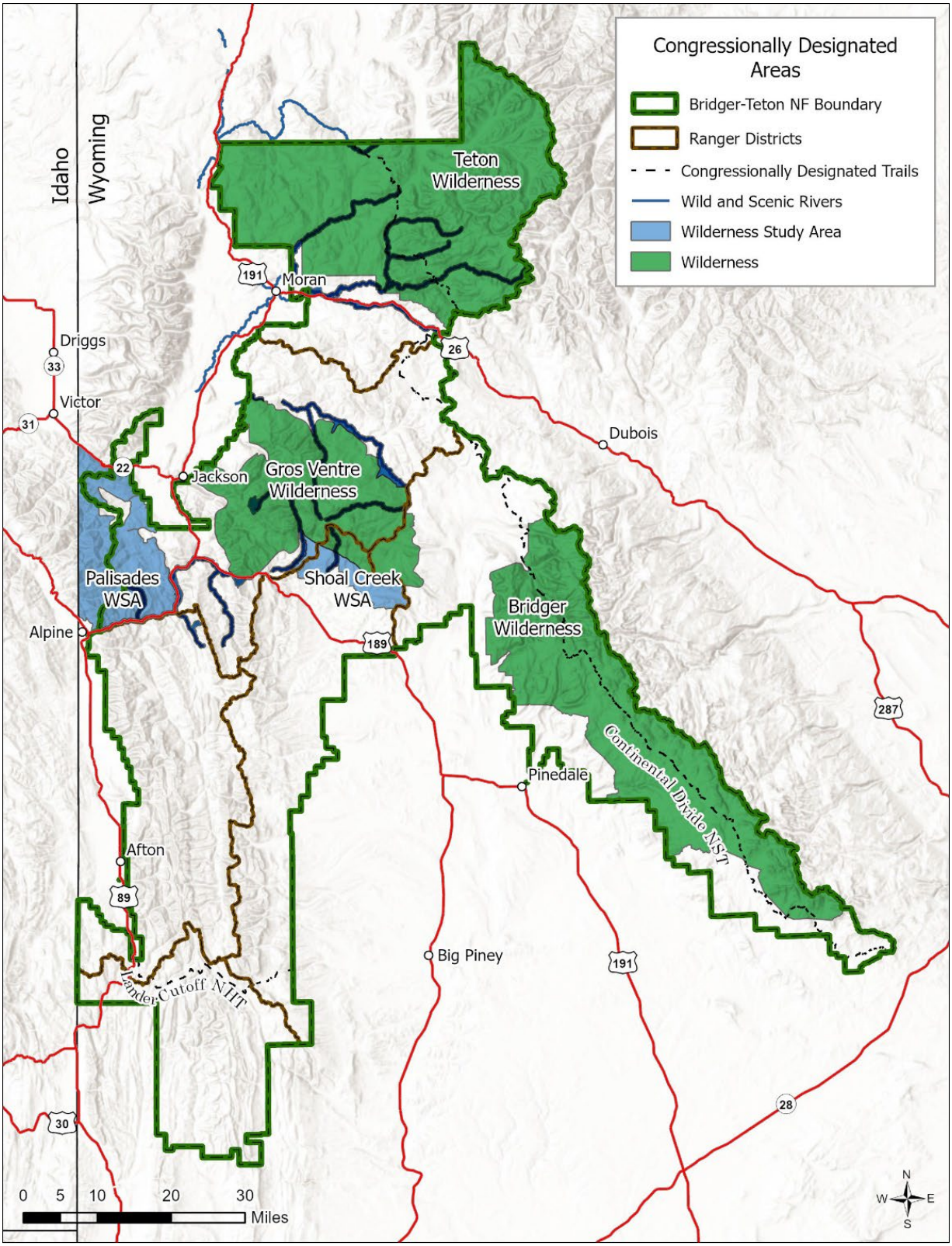


Figure 64. Congressionally designated areas

Congressionally Designated Wilderness

Introduction

The Wilderness Act of 1964 (Public Law 88-577) created a National Wilderness Preservation System, defined wilderness and the purpose of the national system, and established prohibited uses and stewardship requirements. Fifty-four areas were immediately designated wilderness along with a mechanism for Congress to add additional areas to the system. Nationally, the USFS manages nearly 37 million acres of wilderness representing about 19 percent of the entire National Forest System.

Relevant to stewardship, a key provision is the requirement to “preserve wilderness character” for each area in the system. Wilderness character is a holistic concept based on the interaction of (1) biophysical environments primarily free from modern human manipulation and impact; (2) personal experiences in natural environments relatively free from the encumbrances and signs of modern society; and (3) symbolic meanings of humility, restraint, and interdependence that inspire human connection with nature. Historic writings strongly reinforce the idea that wilderness character is fundamentally about the capacity of an area to elicit humility; to awaken a sense of relationship and interconnectedness with the community of life; and to evoke a feeling of restraint and obligation towards nature (Landres, et al. 2015). Five interrelated qualities, tiered to the definition of wilderness in the Act, can be used to track progress towards meeting the law: (1) untrammeled, (2) natural, (3) undeveloped, (4) outstanding opportunities for solitude or a primitive and unconfined type of recreation, and (5) other features of value.

Two of the original areas designated under the Wilderness Act of 1964 are located on the Bridger-Teton -- the Bridger Wilderness and the Teton Wilderness. The subsequent Wyoming Wilderness Act of 1984 (P.L. 98-550) designated the Gros Ventre Wilderness, added 28,156 acres to the Teton Wilderness, and added 36,000 acres to the Bridger Wilderness. Currently, there is a total of 1,297,789 acres of designated wilderness on the Bridger-Teton or 37 percent of the Bridger-Teton.

Current Plan Direction

Direction for the management of designated wilderness can be found in the: 1964 Wilderness Act, the 1984 Wyoming Wilderness Act, Forest Service Handbook and Manual 2320, and in the forest plan.

In addition, each Wilderness has a wilderness action plan from the mid-1990s, as well as a 2019 Wilderness Character Baseline Assessment and Wilderness Character Narrative. These documents are not amendments to the forest plan, but they provide useful information for developing updated direction in the revised forest plan.

Existing Condition

Bridger Wilderness

One of the first areas in the country to be designated as a “primitive area” by the USFS in 1931, the Bridger Wilderness was recognized early as a place where natural conditions prevail. The primitive area was expanded in 1937 and subsequently designated as wilderness under the Wilderness Act of 1964 and then increased in 1984. This wilderness lies within the Wind River Mountains and it offers 426,750 acres with more than 600 miles of trails and a rich history associated with fishing and mountaineering.

The Bridger Wilderness is a vast landscape filled with: alpine lakes, granite walls and peaks, spectacular scenery, large glaciers, and wide-open meadows. Ecological processes that shape the wilderness are predominately geology, fire, and water.

Two of the largest glaciers in the lower-48 states are located within the Bridger Wilderness. With such a rugged landscape, the plant communities in the Bridger Wilderness are unique and dynamic from large, dry meadows to extensive alpine tundra. The whitebark pine communities in the Bridger Wilderness are some of the healthiest and most intact in the Nation. Fires are allowed to play their natural role when values outside the Wilderness are not at risk and the fire can be managed successfully based on long-term weather projections. The Bridger Wilderness is particularly known for its watershed value, containing the headwaters of the Green River, countless other rivers, and over 2,900 mountain lakes and ponds. Not only do these lands and waters provide important habitat, but they also serve as a migration corridor for wildlife.

With over 12,000 years of human history, the Bridger Wilderness contains highly significant cultural and archaeological sites. Livestock grazing has declined over the years, but there are still 13 active grazing allotments that overlap with portions of the Bridger Wilderness covering approximately 24 percent of the total Bridger Wilderness acreage. There are four dams that still exist in the Bridger Wilderness, three of them are privately owned.

Gros Ventre Wilderness

The Gros Ventre Wilderness, designated in 1984, is located east of Jackson, Wyoming. It contains 286,309 acres of wild lands and waters. It provides a critical link between the Wind River Range to the south and the Teton, Washakie, and Absaroka Wildernesses to the north. The wilderness character of this landscape is defined by: iconic scenery, outstanding opportunities for quiet and solitude, crucial wildlife habitat and migration corridors, diverse geology, and sacred lands.

The Gros Ventre Wilderness is a landscape sculpted by geologic processes such as landslides, faulting, and glaciation. With a large concentration of landslides, the changing topography is visible on a human time scale. The “unique expressions of geology” was a contributing reason for the area’s designation. The specific geological features that offer high scientific, educational, and scenic value include the Gros Ventre Geological Slide, Crystal Creek landslide, and karst formations that contain unique caves and fossils, particularly within the Tosi Basin area.

A chain of rugged mountain peaks, some of which are over 11,000 feet, tower over meandering rivers and lush meadows. Fire also has a long history of shaping plant communities within the Gros Ventre Wilderness. Over 48 miles of designated Wild and Scenic Rivers include the headwaters of Crystal Creek, Granite Creek, and Gros Ventre River, all of which feed into the Snake River.

The subdued landscape and rough dirt access roads contribute to the area receiving less visitor use compared with the more visually striking Teton Range. With 224 miles of primitive trails, the opportunity for unconfined recreation, solitude and quiet remain high. The fall season brings hunters, especially those seeking bighorn sheep.

The Gros Ventre Wilderness holds over 12,000 years of human history, remaining sacred for nearby tribal members, and it contains highly significant cultural and archaeological sites. There are portions of 10 active grazing allotments covering approximately 34% of the Wilderness, which is 18% less than what was present in the early 1990s. There are also four cabins associated with historic livestock grazing, fence lines, and one State-owned inholding.

Teton Wilderness
The Teton Wilderness (584,730 acres) was one of the first protected areas in the United States as part of the: 1891 Yellowstone Timber Land Reserve, 1897 Teton Forest Reserve, 1934 Primitive Area, and then 1955 Wilderness classification. The Teton Wilderness was officially added to the National Wilderness Preservation System in 1964 with an addition in 1984.

The embodiment of “big wild”, the wilderness character of the Teton Wilderness is defined by the area’s ability to absorb a multi-day horse packing trip, elk hunting, and the presence of: grizzly bears, long distance ungulate migration routes, a pioneering natural fire program, large meadows, breccia cliff formations, big rivers with cutthroat trout fishing, and sweeping willow complexes.

Ecological processes that shape the Teton Wilderness are predominately fire and water. There is over 45 years of fire managed to promote natural processes and 100 miles of designated free-flowing wild and scenic rivers. The headwaters of both the Snake and Yellowstone River are in the Teton Wilderness as well as Two Ocean Pass, a National Natural Landmark, where the creeks split and one empties into the Pacific Ocean and the other empties into the Atlantic Ocean.

With landscapes ranging from mountain meadows and timbered slopes to high alpine plateaus, 450 miles of trails provide access to a large variety of summer packtrips, hunting and fishing opportunities. There is very minimal development for such a vast landscape. There are remnants of old trapping cabins, but only four cabins, one historic fire lookout, and three bridges are maintained. Outfitting, especially hunting, is very important and most of the use is stock based.

Status and Trends

Two key metrics are used to track progress towards ensuring wilderness is well managed and wilderness character for each area is preserved – wilderness stewardship performance and wilderness character monitoring. Currently, the Gros Ventre Wilderness meets the minimum stewardship performance standard with the Bridger Wilderness close to meeting the standard. In general, the three Wildernesses are performing well with the: natural fire program, monitoring recreation sites, administering outfitter-guide permits and completing the wilderness character baseline assessment and boundary certification. Improvement is needed to assess and to improve trail conditions, implement more robust monitoring, expand educational programs, and develop a structured program to track motorized intrusions and trammeling actions.

Clear trends in wilderness character from monitoring data will not be available until 5 years of data is available and verified. However, since many attributes of wilderness character have been monitored for years, some preliminary observations on trends can be made where legacy data exists.

Bridger Wilderness
The data suggest mixed results for the natural quality as less permitted livestock use indicates a likely improvement but increasing haze indicates a decline in air quality. Most striking has been a decline in the undeveloped quality due to frequent search and rescue incidents that result in emergency authorizations for motorized use. There has likely been a decline in opportunities for solitude due to increasing visitation and an increasing number of campsites and associated human waste issues in the most popular locations.

Teton Wilderness
The data do not suggest any clear trend, but there likely has been a slight increase in the natural quality due to the extent of natural fires, removal of non-native fish, and expansion of wildlife species such as grizzly bears and wolves. The undeveloped quality has slightly declined due to search and rescue incidents that result in emergency motorized authorizations, but not to the same degree as within the Bridger Wilderness.

Gros Ventre Wilderness
The data suggest some improvement in the natural quality due to less fish stocking and less livestock grazing, but this is offset by an increase in the spread of invasive weeds and a slight decline in air quality due to haze. Campsite conditions have improved and encounters between groups are mostly well below thresholds.

Conclusions

Current forest plan direction was written prior to the development of wilderness character frameworks that provide improved guidance to meet the intent of the Wilderness Act (Landres et al. 2015). In general, the attributes that make the Bridger, Gros Ventre, and Teton Wilderness distinctive and contribute to their wilderness character are still present and being maintained and, in some respects, enhanced. However, clear stewardship opportunities exist, such as trail work, to improve sustainability and to help visitors be better prepared so that the need for search and rescue is reduced and impacts associated with camping and human waste are minimized to the extent possible. Other aspects will be more challenging to address, notably around: increasing visitation, declining air quality, invasive plants, snowmobile trespass, and the increasing number of proposals that request some type of administrative motorized use. The focus on preserving wilderness character as the central tenet of wilderness stewardship and the challenges ahead necessitate updated forest plan direction that builds on existing action plans, the wilderness character work, and the legacy of monitoring data.

There is currently no recommended wilderness on the Bridger-Teton. This is due to language in the 1984 Wyoming Wilderness Act that stipulated further review and evaluation of lands potentially suitable for wilderness consideration shall only be done when the forest plan is revised, not prior to revision (Section 401[b]). Now that the forest plan revision process has begun, inventorying and evaluating areas potentially suitable for inclusion in the National Wilderness Preservation System is required, but only Congress can designate Wilderness. The inventory and evaluation of potential areas will be provided in a separate document available for public comment later in the planning effort.

Wilderness Study Areas

Introduction

The Wyoming Wilderness Act of 1984 (P.L. 98-550) designated three WSAs in Wyoming, two of which are completely or largely on the Bridger-Teton. The Shoal Creek WSA is 32,386 acres and it is entirely within the Bridger-Teton. The Palisades WSA is 134,446 acres, with 79,314 acres on the Bridger-Teton and 55,132 acres on the Caribou-Targhee National Forest. WSAs are not managed the same as wilderness, since WSAs allow for the continuation of some pre-existing uses prohibited in wilderness. Per the Wyoming Wilderness Act, WSAs must be managed to “maintain their presently existing wilderness character and potential for inclusion in the National Wilderness Preservation System” while also allowing snowmobiling to continue in

the same “manner and degree” as was occurring prior to 1984. Both WSAs have a certified boundary and a map of record as required by the Wyoming Wilderness Act.

Current Plan Direction

The Bridger-Teton Forest Plan has a management emphasis for both Palisades and Shoal Creek WSAs to protect wilderness attributes and a management standard to not allow activities that will jeopardize their eligibility for future wilderness designation. Existing uses of the WSAs, such as snowmobiling and mountain biking, are allowed to continue. The Palisades WSA allows oil and gas activity with conditional no-surface occupancy while the Shoal Creek WSA is withdrawn from mineral entry and oil and gas leasing per the 2009 Wyoming Range legislation.

Existing Condition

Shoal Creek WSA is contiguous with the Gros Ventre Wilderness. It forms the scenic lower-elevation front for the Gros Ventre Mountains when viewed from Bondurant Basin. There are spectacular geologic features within the WSA including steep limestone faces, flatiron dip slopes, and waterfalls (notably Shoal Falls and West Dell Falls). The diverse terrain provides valuable habitat conditions that support for wildlife and fish.

With approximately 40 miles of primitive trail, summer use include: backcountry camping, hiking, hunting, and fishing. Existing visitation is low with plentiful opportunities for solitude. A few outfitters provide summer pack trips, fishing, and hunting services. Existing motorized and mechanized recreation in the WSA includes vehicle use on two routes that pre-date designation, snowmobiling, and occasional mountain bike use. Shoal Creek is a designated wild river (4 miles).

There are no current oil and gas leases or active wells. There is one plugged and abandoned well that was drilled in the1980s and plugged in 1984 (Granite Creek). There is no known leasable or salable mineral activity and no active or pending mining claims. There are four active cattle range allotments covering most of the WSA – Granite, Hoback, Jack Creek and Fisherman Creek. One historic cabin exists.

Palisades WSA includes the crest and eastern portion of the Snake River Range. It is part of a larger, roughly 350,000-acre landscape that extends into Idaho and encompasses two national forests and four counties. The WSA only includes the Wyoming portion of the area and it is jointly managed by the Bridger-Teton and Caribou-Targhee National Forests. Within the Bridger-Teton, portions of two areas were not included in the WSA due to past timber harvest (Mosquito Creek and North Fork of Fall Creek). This Assessment includes information regarding the entire Palisades WSA, encompassing both the Caribou-Targhee National Forest and Bridger-Teton National Forest, but it does not include information about the Idaho portion of the larger landscape.

The Palisades WSA includes: high peaks, abundant subalpine terrain, scenic limestone cliffs, and photogenic red and orange autumn colors. A variety of plant communities and vegetation types are present, including some that are not common within the Bridger-Teton (curl-leaf mahogany and bigtooth maple). The area is considered too rugged and geologically unstable (landslides) to lend itself to development, thus it retains a remote and undeveloped feel. Wolf Creek is a designated Wild and Scenic River within the WSA and there is important habitat that supports a variety of wildlife and fish species throughout the area. The potential for solitude, primitive recreation, and challenge is very high by virtue of the area’s size and 185 miles of

primitive trails, dissected topography, and vegetative screening. Although the area is close to Jackson and many trailheads originate along paved highways or short spur roads, the area receives low visitor use (except for the Teton Pass area). Outfitting services include: horse-packing, hunting, hiking/backpacking, wilderness therapy, and some cross-country skiing. Three outfitters have established stock-based hunting camps at trailheads. A winter heli-skiing operation was established prior to the area's designation and it is now annually limited to 65 service days. No guided snowmobile or mountain bike operations are permitted, but some filming occurs (typically related to hunting).

With the WSA abutting against private property and major highways, non-wilderness uses and improvements occur along the fringe, most of which pre-date the area's designation (e.g. powerlines, water systems, timber harvest units, and trailhead access roads). Non-native mountain goats were introduced in the late 1970s, and the population has expanded. Mountain biking increased with use concentrated in the Teton Pass area and 17 miles of seasonal motorcycle trail is present in the Indian Creek area on the Caribou-Targhee National Forest. Snowmobiling occurs throughout much of the area. The rugged terrain, lack of commercial use, and more powerful machines attract local riders seeking challenge in a backcountry mountain setting. Winter access is more limited and, unlike summer, primary access points originate on the Caribou-Targhee National Forest at Pine Creek Pass and Indian Creek. On the Bridger-Teton, Mosquito Creek and Pritchard Pass serve as primary winter access points.

Three oil and gas wells were drilled since 1978, all of which have no production. Portions of eight sheep allotments are within the WSA, all of which are administered by the Caribou-Targhee National Forest.

Conclusions

The Wyoming Wilderness Act of 1984 requires the Shoal Creek and Palisades WSA be reviewed for their suitability for preservation as wilderness upon revision of the forest plan. In 1990, when the original Bridger-Teton Forest Plan was approved, there was general agreement between the two Bridger-Teton and Caribou-Targhee National Forest and congressional staff that the suitability review should be conducted when the Bridger-Teton revised their plan (USDA memo). The Targhee National Forest revised its plan in 1997 providing direction that the area must be managed as a WSA per the Wyoming Wilderness Act of 1984 but deferring the suitability review.

The future status of the WSA is a topic of high public interest as both areas became the center of substantial controversy during the 2016-2018 county-led Wyoming Public Land Initiative to develop a citizen-based recommendation regarding the area's future status. Both Teton and Sublette Counties opted to participate in the initiative with Teton County focusing on the Teton County portion of the Palisades WSA and Sublette County focusing on the Shoal Creek WSA. No consensus among committee members emerged from either effort. Points of contention for the Palisades centered on the availability of the area for continued snowmobile, heli-ski, and mountain bike access, although there was general agreement that the area should prioritize wildlife protection and not be available for: timber harvest, oil and gas leasing, mineral extraction, and roads. The Teton County Board of Commissioners adopted a resolution to affirm these conservation principles. Points of contention for Shoal Creek included the availability of the area for both summer and winter motorized access, the ability of livestock permittees to use motorized equipment and transport to manage cattle operations. And how much of the area should be added to the Gros Ventre Wilderness. Due to the lack of consensus, the Board of

Commissioners approved a motion to recommend the WSA be released for multiple use. With no subsequent congressional action, public interest has turned towards the forest plan revision effort on the Bridger-Teton. A recommendation regarding the area's future status would be made as part of the Record of Decision for the forest plan. A report would then be submitted to the President who would have 3 years to submit a recommendation to Congress for action (Wyoming Wilderness Act). Until Congress acts on the recommendation, the WSAs must be managed in accordance with the Wyoming Wilderness Act.

Current forest plan direction provides very little guidance for management of the WSAs and guidance in USFS directives is largely absent. As a result, there is an opportunity to provide better direction for stewardship of the WSAs in the updated forest plan, notably around: trail standards, wildfire risk reduction, oil and gas leasing, mineral entry and access for motorized and mechanized uses including the potential to establish a spectrum of visitor experience settings.

Wild and Scenic Rivers

Introduction

In 1968, Congress passed the National Wild and Scenic Rivers Act (P.L. 90-542) establishing a nationwide system of outstanding free-flowing rivers. The primary purpose of the National Wild and Scenic Rivers Act is to complement national river development with river protection and conservation to preserve rivers with outstanding natural, cultural, and recreational values in a free-flowing condition. The National Wild and Scenic Rivers Act specifically requires administering agencies to protect and enhance those values for which the river was designated.

In 2009, the passage of the Craig Thomas Snake Headwaters Legacy Act (P.L. 11-111) added all or segments of 13 rivers and 25 separate river segments totaling 414 miles in the Snake River Headwaters to the National Wild and Scenic Rivers System. Wild and scenic river designated management boundaries generally average 0.25 mile on either bank to protect river-related values in a corridor. For management purposes, river segments are classified as wild, scenic, or recreational. Classifications of river segments, as described in the National Wild and Scenic Rivers Act, must be retained limiting development and roaded access on National Forest System lands to that which would not exceed the following descriptions listed below.

- Wild River Areas: Those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted. These represent vestiges of primitive America.
- Scenic River Areas: Those rivers or sections of rivers that are free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads.
- Recreational River Areas: Those rivers or sections of rivers readily accessible by road or railroad, that may have some development along their shorelines and may have undergone some impoundment or diversion in the past.

Section 5(d)(1) of the WSR Act directs Federal agencies to consider the potential for national wild, scenic, and recreational rivers in all planning (P. L. 90-542). The foundation for planning for wild and scenic rivers is to clearly articulate Outstandingly Remarkable Values (ORVs), water quality, and free-flowing condition. ORVs must be river-related, and they must be rare, unique, or exemplary in a regional or national context.

Current Plan Direction

Bridger-Teton Plan Amendment 2 in 1992 identified 31 river segments and 602 miles of eligible Wild and Scenic Rivers. Then Amendment 11 in 2013 added the 19 river segments and 315 miles of designated rivers in the Craig Thomas Snake Headwaters Legacy Act.

There are specific plan components for both designated and eligible river segments in the existing Bridger-Teton Forest Plan both in Bridger-Teton-wide components and specific DFCs. Rivers intersect multiple Management Areas and many segments are also in Designated Wilderness or WSAs. The Snake River Recreation Management Plan and the Snake River, Wyoming, a Potential Wild and Scenic River Study, are also incorporated into the existing Bridger-Teton forest plan.

Existing Condition

In 2009, the passage of the Craig Thomas Snake Headwaters Legacy Act added all or segments of 13 rivers and 25 separate river segments totaling 414 miles in the Snake River Headwaters to the National Wild and Scenic Rivers System. Of the total designated, 12 rivers, 19 segments and 315 miles, and 98,185 acres are on the Bridger-Teton while the rest flow through the NPS, USFWS lands, and a small portion of State and private lands (See Table 62).

Table 62. Designated wild and scenic rivers

River	Number of segments	Mileage	Classification
Bailey Creek	1	6.9	wild
Blackrock Creek	1	21.7	scenic
Buffalo Fork of the Snake River	2	70.3 (14.1)	wild (scenic)
Crystal Creek	2	14.2 (5.0)	wild (scenic)
Granite Creek	2	12.5 (9.7)	wild (scenic)
Gros Ventre river	2	16.5 (40.1)	wild (scenic)
Hoback River	1	10.7	recreational
Pacific Creek	2	22.5 (6.8)	wild (scenic)
Shoal Creek	1	8.5	wild
Snake River	3	6.9 (2.7) (23.1)	wild (wild) (recreational)
Willow Creek	1	16.2	wild
Wolf Creek	1	7.0	wild

The Comprehensive River Management Plan, required by the Wild and Scenic River Act, was completed in 2014 with a new desired condition, standards and guidelines amended into the current forest plan.

Conclusions

Current forest plan direction is relatively recent, however, ensuring the current plan components meet the requirements of management direction for Eligible Wild and Scenic Rivers in FSH 1909.12 chapter 80 and they are incorporated in the new forest plan is necessary.

The 2012 Planning Rule requires a comprehensive examination of all named rivers on a USGS 7.5-minute topographic map that have not been previously studied. A draft eligibility report will be provided in a separate document available for public comment later in the forest planning effort.

National Scenic and Historic Trails

Introduction

Congress passed the National Trails System Act in 1968, which established a nationwide system of scenic, historic, and recreation trails "to promote the preservation of, public access to, travel within, and enjoyment and appreciation of the open-air, outdoor areas and historic resources of the Nation" (P.L. 90-543). National Scenic Trails (NST) and National Historic Trails (NHT) are designated by Congress and they have specific legislative requirements including: publishing the corridor/right-of-way in the Federal Register, a comprehensive plan, an advisory council, cooperative agreements, engagement with volunteers and partners, education and visitor information, and cultural and historic requirements.

NSTs are of particular national scenic beauty and they are among the nation’s most iconic trails. They typically are continuous, extended trails that provide opportunities for long-distance, non-motorized recreation. The Continental Divide National Scenic Trail (CDT), which stretches between the borders of Mexico and Canada, crosses the Bridger-Teton for 205 miles out of its 3,100-mile length. The CDT is administered by Region 2 of the USFS.

NHTs follow as closely as possible the original trails or routes of national historical significance and proved appreciation, interpretive, and recreation opportunities. They can be corridors comprised of historic sites or linked segments instead of a continuous on the ground trail. There are 26 miles of the 250-mile Lander Cutoff Historic Trail, which is designated as part of the California National Historic Trail on the Bridger-Teton. The NPS is the administering agency.

NHTs and NSTs are a unique congressional designation as they may be mostly on non-Federal lands. Coordination with local governments, tribes, and private landowners is necessary. There is one administering agency responsible for coordination along the entire length of each NST or NHT, however, there are multiple managing agencies that are the agencies or landowners with the authority for making decisions on specific lands under its jurisdiction.

Current Plan Direction

The Lander Cutoff NHT overlaps with multiple DFCs and Management Approaches (MAs). There is a standard for Historic Trails to evaluate for historic significance as well as a lease standard within the corridor of the Lander Cutoff.

The Continental Divide National Scenic Trail Comprehensive Plan is considered as an existing plan incorporated into the Bridger-Teton Forest Plan.

The CDT overlaps with multiple DFCs and MAs and there are forest plan components for trails in general, but the Forest Plan does not contain the 2016 USFS recommended forest plan components.

Existing Condition

Lander Cutoff National Historic Trail

The California NHT, designated in 1992, provided a 2,000-mile path for emigrants to the West in in the 19th century. More than 200,000 people traversed the California NHT between 1841 and 1860. The legislated length is approximately 5,700 miles because it includes all routes and cutoffs extending from Missouri to Iowa to various points in California and Oregon (P.L. 102-328).

The California NHT follows the Oregon NHT, with some variations, until southeastern Idaho. The Oregon NHT was designated in 1978 in Public Law 95-625. Only the primary route of the Oregon Trail has been authorized as an NHT.

The Lander Cutoff NHT was the first federally funded road project west of the Mississippi constructed in 1858. Over 13,000 emigrants traveled the road in its first year of use. The Lander Cutoff NHT gave travelers on the Oregon NHT and the California NHT a straight path through the mountain ranges in southwestern Wyoming and southeastern Idaho. It provided a safer and easier route for emigrants to travel west, reducing the mileage and travel days. The section on the Bridger-Teton can be traced along roads and trails with trail ruts and emigrant graves still visible.

Most of the Lander Cutoff NHT has been recorded with a few off-shoots that still need to be recorded. The entire trail is considered eligible for the NRHPs. There is one segment, the New Fork River Crossing, that was listed on the NRHP in 2017.

The Comprehensive Management Plan (CMP) for the Oregon NHT was completed in 1981 and amended in 1998 to include the California NHT. The NPS administers both the California NHT and Oregon NHT.

Continental Divide National Scenic Trail

P. L. 95-625 designated the Continental Divide National Scenic Trail in 1978. At that time, the Continental Divide National Scenic Trail was more like a patchwork than a continuous footpath. There were many gaps where the Continental Divide National Scenic Trail only existed as a line on the map. In the decades since, the gaps between existing trails have been filled in to create a continuous path on the ground, however, there is still work needed in locating, developing and maintaining some sections. The Chief of the USFS approved the first Comprehensive Plan in 1985, which was later amended in 2009.

The Continental Divide National Scenic Trail was designated because of many special qualities including: geologic importance (Continental Divide), remoteness, high elevation, rich history, and diverse ecosystems and trail segments. The majority of the 205-mile portion crossing the Bridger-Teton primarily travels along the crest of the Wind River Range, Mt. Leidy Highlands, and Absaroka Range in the Teton Wilderness before it crosses into Yellowstone National Park.

An optimal location review resulted in relocating a portion of the Continental Divide National Scenic Trail from the Shoshone National Forest to the Bridger-Teton through a 2019 decision memo to better meet criteria in the Comprehensive Management Plan. The decision relocated

the route from open roads to trails, which are closer to the actual Continental Divide and in a primitive or semi-primitive ROS. The decision included constructing 4.1 miles of new trail.

Conclusions

There is somewhat conflicting and confusing information regarding the Lander Cutoff NHT and its association with the California NHT and/or the Oregon NHT. Information needs to be consistent across documents produced. The Bridger-Teton Forest Plan and website state it is part of the Oregon NHT, while the Wyoming History.org, NPS website and the Comprehensive Management Plan state it is part of the California NHT.

Current plan direction was written prior to the 2022 USFS recommended forest plan components for the CDT (USDA 2022a). These forest plan components should be considered in the new Forest Plan.

Administratively Protected Areas

Unlike congressionally designated areas, administrative protected areas are not governed by umbrella legislation, but rather they are managed in accordance with the resource values outlined in the site-specific designation report. Such designations typically involve smaller areas and protect specific features that contribute to the: distinctive wildlife, wildlands, and cultural heritage role of the Bridger-Teton. Administrative protected areas include: National Recreation Trails, Scenic Byways, Research Natural Areas, National Natural Landmarks, Geological Areas, and Special Interest Areas (See Figure 65).

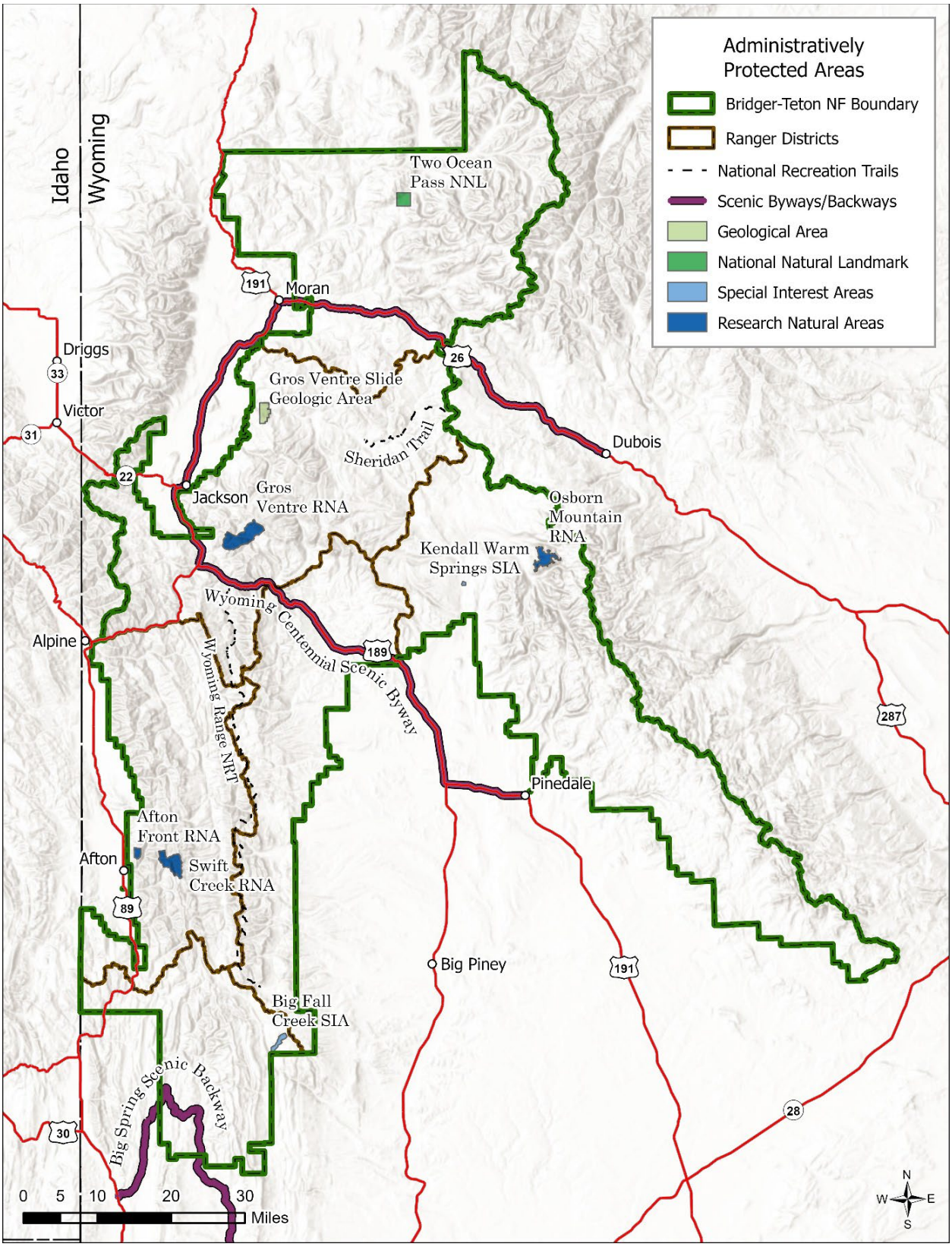


Figure 65. Administratively protected areas

National Recreation Trails

Introduction

National Recreation Trails (NRTs) were established under the National Trails System Act (P.L. 90-543.1968). They are intended to provide outdoor recreation opportunities accessible to urban areas and/or provide connecting or side trails, which provide access to the other types of trails. NRTs and connecting and side trails may be designated by Congress or administratively protected by the Secretaries of the Interior and Agriculture.

Designation criteria and evaluation processes are in FSM2350. The Bridger-Teton has two NRTs that were both administratively protected by the Chief of the USFS in 1979, the Wyoming National Recreation Trail and the Sheridan National Recreation Trail. National recreation trails benefit from the prestige and increased visibility of being a part of the National Trail System and they often compete well for additional funding or state/Federal grant opportunities.

Existing Condition

The Wyoming Range National Recreation Trail (WRNRT), protected in 1979, is a 75-mile long multiple-use trail system that travels the length of the Wyoming Range from Snyder Basin/South Piney Creek Drainage to Bryan Flats Guard Station. The WRNRT has many access points from either side of the Wyoming Range. The WRNRT is also part of the Wyoming Forests Gateway Communities trail priority area. It connects multiple communities across western Wyoming. There are multiple sections of the WRNRT that are difficult to find. Recent funding through the Great American Outdoors Act enabled the USFS to reestablish the trail tread and complete much needed deferred maintenance.

The Sheridan National Recreation Trail (SNRT) provides a 17-mile connector from Breakneck Creek to the Continental Divide National Scenic Trail. In a 2019 DM, 4.4 miles of the SNRT was protected as part of the CDNST through an optimal relocation review.

Conclusions

Current forest plan direction provides very little guidance for the management of the NRTs. Therefore, there is an opportunity to provide better direction in the updated Forest Plan, notably around trail standards and access for motorized and mechanized uses.

National Geologic Site

Introduction

Geological areas are administratively protected for their unique or outstanding geologic formations or historical features of the earth’s development. The 2,104 acres Gros Ventre Slide Geological Area was protected by the Regional Forester in 1962 and it includes the slide scarp face, natural dam across the river, and terminal debris. The protection report specifies that the area be maintained in an undisturbed condition with only interpretive facilities provided. The area is withdrawn from mineral activity (USDA 1962).

Existing Condition

On June 23, 1925, the mile-wide Gros Ventre Slide carried 50 million cubic yards of debris down the mountain and then another 300 feet up the opposite slope. The Gros Ventre Slide blocked the Gros Ventre River and it formed a 5-mile-long body of water known today as Lower Slide Lake. Today the Gros Ventre Slide is a large geologic scar about 600 acres in size marking the north side of Sheep Mountain and it can be seen from miles around.

Conclusions

There is no current forest plan direction for the Gros Ventre Geologic Site, thus there is an opportunity to provide better direction.

National Natural Landmarks

Introduction

The National Natural Landmarks (NNL) Program was established in 1962 by administrative action relying on authority provided by the Historic Sites Act of 1935. Three other laws subsequently referenced the program. The first national natural landmarks were protected by the Secretary of the Interior in 1964.

The NNL Program recognizes and encourages the conservation of sites that contain outstanding biological and geological resources. Sites are designated based on their: condition, illustrative character, rarity, diversity, and value to science and education. The NPS administers the program and works cooperatively with landowners, managers, and partners to promote conservation and appreciation of our nation's natural heritage.

The goals of the NNL Program are: to encourage the preservation of sites illustrating the geological and ecological character of the United States; to enhance the scientific and educational value of sites thus preserved; to strengthen public appreciation of natural history; and to foster a greater concern for the conservation of the nation's natural heritage.

There are currently 602 protected national natural landmark sites within: 48 states, American Samoa, Guam, Puerto Rico, and the U.S. Virgin Islands. One site, Two Ocean Pass, is located on the Bridger-Teton.

Current Plan Direction

There is a general protection standard and a goal relating to special areas in the current forest plan, but there is no specific management direction for Two Ocean Pass NNL. However, Two Ocean Pass NNL is located within the Teton Wilderness, designated WSR (Pacific Creek), and eligible WSR (Atlantic Creek). There is management direction for those designations in the current forest plan.

The current forest plan lists 15 proposed NNLs, but it has no other information about the proposed sites or management of those sites.

Existing Condition

Situated on the Continental Divide, Two Ocean Pass is in the Bridger-Teton. Waters from the meadow at Two Ocean Pass divide to flow in opposite directions toward the Gulf of Mexico and

toward the Pacific Ocean. The site is the immigration route of the cutthroat trout from the Snake River (Pacific drainage) to Yellowstone Lake of the Missouri River Drainage (Atlantic drainage) and it was first documented by B.W. Evermann in 1891 (DOI 1965). It illustrates a natural phenomenon of animal distribution and dispersal. Two Ocean Pass includes 2,124 acres located within the Teton Wilderness and it was protected as an NNL in 1965.

Conclusions

Management direction for the Two Ocean Pass NNL could be incorporated into the new Forest Plan. Additional information is needed on proposed NNLs as well as a potential review of additional proposed NNLs. The 15 proposed NNLs were likely identified in Keith Rigby's 1981 report on NNLs. Per the NPS, some of these may have had an evaluation done. If evaluations were completed, NPS would have stored them in hard copy format in Tucson, Arizona. A request was sent to NPS to search their records and if any are found, management direction will be updated.

National Scenic and Backcountry Byways

Introduction

The National Scenic Byway program was established by Congress in 1991. It is administered by the Federal Highways Administration. Byways are designated by the Secretary of Transportation after consultation with the Departments of the Interior, Agriculture, and Commerce. They are roads that are recognized for one or more qualities: archaeological, cultural, historic, natural, recreational, and scenic. One of the requirements for nomination into the program is that the road must first be officially designated by a state, Indian tribe or Federal land management agency as a scenic byway (USDOT 2021).

The USFS developed a National Forest Scenic Byway system in 1987, which is administratively protected by the Chief of the USFS (USDA No date). The goals are to: showcase outstanding national forest and grassland scenery; increase public understanding of National Forest System activities as well as a recreation provider; support and enhance rural community tourism and economic development; and contribute to the nation's overall scenic byways effort.

The Wyoming Scenic Byways and Backways Program goal is to identify Wyoming's most scenic and/or culturally significant routes in the State. The determination is made by the Wyoming Scenic Byways Advisory Committee after receiving a nomination (WYDOT 2009). Wyoming had over 1,640 miles of roads protected by 1995.

Current Plan Direction

The current Bridger-Teton Forest Plan has a Scenic Byway Guideline that eligible highways that pass through the Bridger-Teton should be nominated for the National Scenic Byway System. In addition, the Scenic Byways travel through multiple DFCs and MAs, but there are no other plan components specific to Scenic Byways.

Existing Condition

There are no National Scenic and Backcountry Byways that travel across the Bridger-Teton, however, there are two routes identified as Wyoming Scenic Byways and Backways, one of

which is the Wyoming Centennial Scenic Byway (WCSB) that is also administratively protected as a USFS Scenic Byway.

The WCSB is renowned for its historic, recreation, and scenic areas and it travels 163 miles between Pinedale and Dubois, Wyoming. It spans: USFS lands, a National Park, BLM lands, and three Wyoming counties. There are 62 miles that travel across the Bridger-Teton. It is a combination of highways including U.S. 26/287 and U.S. 26/89/191. The WCSB was protected as a Forest Service Byway in 1989.

Big Spring Scenic Backway is 68 miles, 19 of which are on the Bridger-Teton. The Big Spring Scenic Backway travels across part of the Oregon Trail where more than 350,000 emigrants headed to Utah, Oregon and California from 1841-1868. Ruts from early pioneer wagons are still visible in places. The road is a combination of State highways WYO233, WYO232, and Forest Service Road 10062.

Research Natural Areas (RNAs) and Special Interest Areas

Introduction

RNAs are addressed in FSM 4063. They were created to protect natural ecosystems for the purposes of scientific study and education and for maintenance of biological diversity. RNAs are primarily for non-manipulative research, observation, and study of the environment and ecosystems in their natural state. Areas selected exemplify minimally disturbed ecosystems representative of the range of widespread and unique natural vegetation types on Federal lands. Regional Foresters have the authority to approve new RNAs with the concurrence of Research Station Directors. The RNA program was initiated in 1927 and there are over 430 areas and 500,000 acres nationally protected.

Special Interest Areas (SIAs) may be protected for: scenic, geologic, botanic, zoologic, paleontological, archaeological/historic, or recreational values, or combinations of these values. The SIA protection allows forests to meet internal and public interest in recognizing special values of certain areas and to tailor land uses to interpret, maintain and enhance those special features.

The purpose for SIAs (FSM2372) is to provide long-term protection to an area for scientific research and interpretation opportunities. Objectives for the establishment of special interest areas include the area's protection and, where appropriate, to foster public use and enjoyment of areas with: scenic, historical, geological, botanical, zoological, paleontological, or other special characteristics. The objectives also include classifying areas that possess unusual recreation and scientific values so that these special values are available for public study, use, or enjoyment.

SIA protection is different from RNA protection because SIAs are not designed to be a plant community reference area for research. Also, land uses in RNAs are typically restricted to preserve the plant community type.

Current Plan Direction

There are lease standards for the management areas where the RNAs and SIAs are located. For Kendall Warm Springs, MA72, there is a standard to recommend withdrawal from all mineral entry.

Existing Condition

In April 1999, the Bridger-Teton established four RNAs (totaling 14,280 acres) and two SIAs (totaling 800 acres). The amendment decision noted that the plant community types found in the four RNAs will contribute to the overall representation goals in the national RNA system, contribute to natural community types and encourage monitoring and research. The two SIAs will protect the unique flora, geologic and hydrologic features as well as provide habitat for the Kendall Warm Springs dace, a listed endangered fish species in the Intermountain Region (USDA 1999).

A brief description of current conditions in each RNA and SIA is described below.

- Afton Front RNA (715 acres) is an important repository of native biological diversity with coniferous forest, shrubland and sagebrush grassland plant community variation in the Salt River Range. A portion of the area is located in an active grazing allotment, but livestock access is limited by steep slopes. No roads exist within the area. Within the past decade, cheatgrass invaded south facing aspects and it was aerially treated with herbicide (indaziflam) in 2023 to protect intact native plant communities from competition and potential changes to the fire regime.
- Swift Creek RNA (4,170 acres) protects several under-represented subalpine forb and riparian community types. The area is a municipal watershed with no livestock grazing since the 1970s. An 11-acre wildfire (Rock fire) occurred in 2012. A subalpine forb reference site was monitored (1989, 1996, and 2009) with no clear trends. Invasive species have not been documented or treated in the area. The Rock Lake Peak Alternate recreation trail had a NEPA document completed in 2023. The long-established Swift Creek access road dissects the eastern portion of the area.
- Gros Ventre RNA (6,565 acres) represents several riparian community types as well as coniferous forest types. The area is not part of a livestock grazing allotment, but it is within 2 miles of an established elk feedground and it provides important mule deer habitat, including a migration corridor through the northeast portion. Summer and hunting outfitters utilize the area, and horse grazing is associated with this use. The Horse Creek wildfire occurred in 2006, burning a small acreage along the southern boundary of the area. Located in the Gros Ventre Wilderness, it is roadless with limited access via trails. Invasive species have not been documented in the area.
- Osborn Mountain RNA (2,830 acres) represents alpine fellfield, meadow and turf, and alpine riparian pond community types. The area is not part of livestock grazing allotment, but it provides important year-round habitat for bighorn sheep. The Natural Bridge wildfire burned less than 20 percent of the area, mainly forested areas in the Clear Creek drainage in 1988. Invasive species have not been documented in the area. The area is roadless with no established trails.
- Kendall Warm Springs SIA (160 acres) has unusual and highly threatened biological values. It represents rare species and riparian communities of the warm springs, such as the Kendall Warm Springs Dace. The area is located within the Upper Green River grazing allotment, but it has been fenced to exclude livestock and it is no longer grazed. Watercress, an aquatic invasive species introduced during fur-trapping days (mid-1800s), is thought to be causing negative effects to dace habitat and survival, and removal efforts, by hand-pulling, were recently implemented in consultation with the USFWS. Monitoring will determine treatment efficacy and inform future management actions. The Green River Lakes

Road dissects the area, which is signed to inform the public that the Kendall Warm Springs SIA is closed to public entry.

- Big Fall Creek SIA (640 acres) has unusual geologic, hydrologic and biologic features. It represents thermal features, rate species and unusual plant communities. The area is located within the LaBarge Creek grazing allotment, but a combination of steep, rocky terrain and unmaintained drift fencing limit livestock access to portions of the area. An access road dissects the area with a few dispersed campsites. A light infestation of Canada thistle occurs, mainly small populations associated with roadsides and dispersed campsites. No fires occurred in the area.

Existing conditions are similar to when these areas were protected, and management actions have been limited to invasive species treatments where necessary. Opportunities exist to establish additional vegetation monitoring and to evaluate alternative actions to manage invasives species and natural ecological processes such as fire.

Inventoried Roadless Area

Introduction

Inventoried roadless areas (IRAs) are areas that are generally undeveloped without roads. IRAs are managed by regulations known as the roadless rule that limits commercial timber harvest and road construction. The Roadless Rule allows some exceptions to road construction, reconstruction, and timber harvesting in specific circumstances (36 CFR 294). IRAs are valued for many resource benefits including wildlife and fisheries habitat, biological diversity, and backcountry recreation such as hunting, fishing, and snowmobiling.

The USFS has been identifying such lands under various names (RARE I and RARE II) for decades, but since the adoption of the 2001 Roadless Rule they have been called IRAs (See Figure 66). The 2001 Rule both defined and designated IRAs, which were partially based on RARE I and II areas not designated as wilderness. Management of IRAs has been a controversial issue with various sides supporting or opposing the 2001 Roadless Rules' current provisions.

The IRAs for the Bridger-Teton have a long history starting in the late 1960s and early 1970s during the Roadless Area Review and Evaluation (RARE) I, and then again in the late 1970s and early 1980s during RARE II. The effort sought to identify lands across the National Forest System that could be selected for possible inclusion in the National Wilderness Preservation System. In 1984, parts of the RARE II areas were designated as wilderness after passage of the Wyoming Wilderness Act. In 2001, the Roadless Area Conservation Rule was signed, and the USFS was directed to provide its' most recent RARE map. The 2001 Roadless Rule was driven by three primary concerns: (1) the long-term loss of roadless area values and characteristics, (2) budgetary constraints that limited the agency's ability to adequately manage the size of the existing road system, and (3) on-going controversy around roadless area management that generated costly and time-consuming appeals and litigation. No changes to the mapped IRA boundaries occurred after the enactment of the Wyoming Wilderness Act and in 2001 the areas were adopted by the 2001 Roadless Rule (36 CFR Part 294).

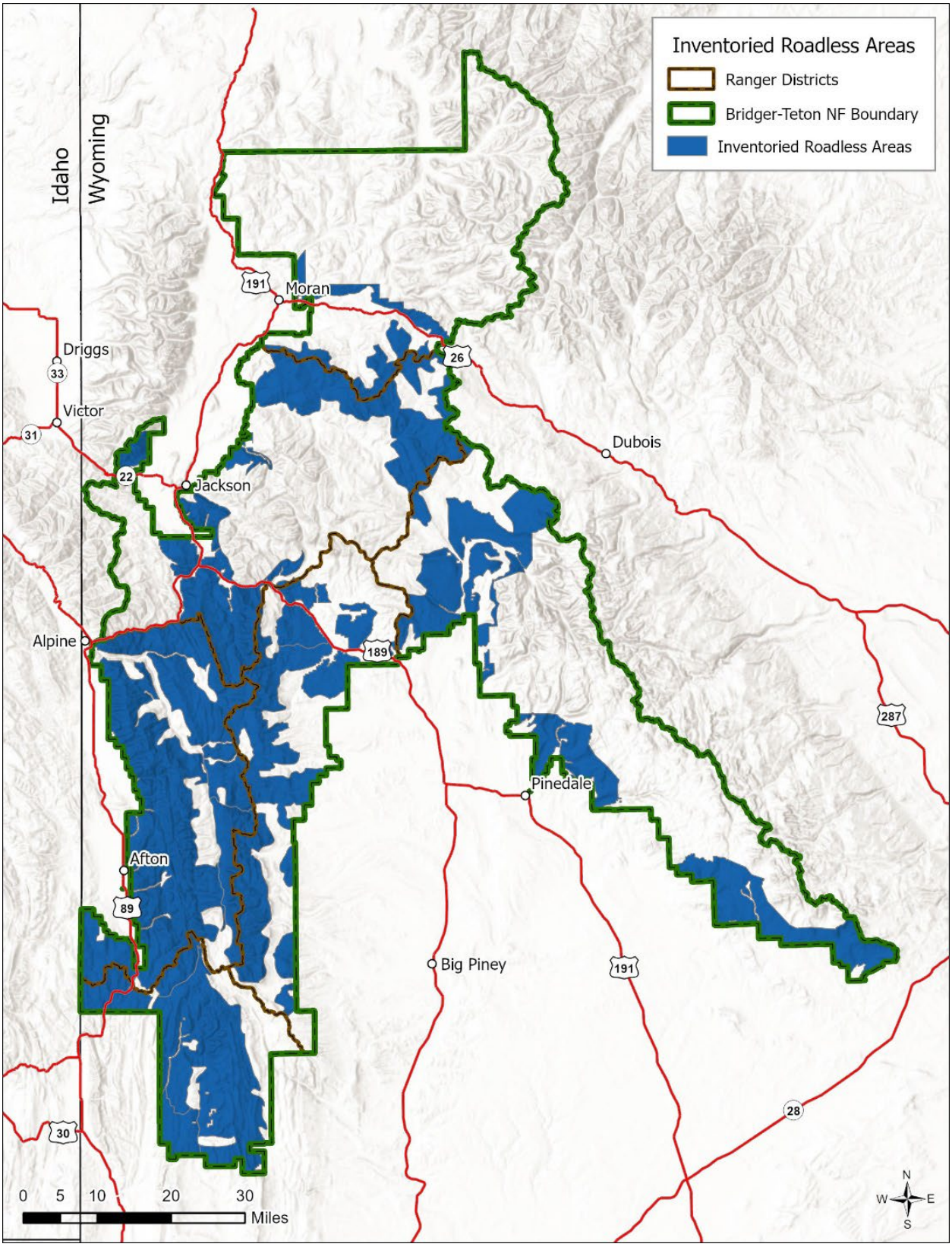


Figure 66. Bridger-Teton National Forest inventoried roadless areas

Current Plan Direction

The IRAs on the Bridger-Teton are in a variety of management areas in the 1990 forest plan. Specific management direction was established for inventoried roadless areas under the 2001 Roadless Area Conservation Rule (36 CFR Part 294).

Existing Condition

Several areas on the Bridger-Teton were erroneously included as IRAs in the Roadless Rule partially due to GPS and GIS technology at the time. Mapping errors were identified through a combination of GIS analysis, a review of historic timber harvests and road building, and 1967 air photo interpretation. After correcting the mapping errors in accordance with established procedures established in the Roadless Rule, the total inventoried roadless acres on the Bridger-Teton is 1,417,493 acres. (See **Error! Not a valid bookmark self-reference.** for the corrected IRA acreage). There may be opportunities future corrections with further analysis. Of the 1,417,493 acres, 117,045 acres were identified as suitable timber prior to the Roadless Rule and 1,300,448 acres were not considered suitable for timber production. Additional information regarding timber is in the Production of Natural Resources Section.

Table 63. Bridger-Teton inventoried roadless areas

Roadless Name	Original GIS Acres	Errors identified	Corrected GIS Acres
Gannet Hills - Spring Creek	46,400	-939	**45,461**
Grayback Ridge	315,647	-20,535	**295,112**
Gros Ventre Mountains	435,320	-328,902	**106,418**
Lake Alice - Commissary Ridge	179,920	-13,214	**166,706**
Little Cottonwood	4,874	+594	**5,468**
Little Sheep Mountain	17,300	-3,108	**14,192**
Monument Ridge	17,380	+340	**17,720**
Mosquito Lake - Seven Lakes	30,014	+21,935	**51,949**
Munger Mountain	12,900	-74	**12,826**
North Mountain	8,564	+1,234	**9,798**
Nugent Park - Hams Fork Ridge	21,590	-349	**21,241**
Pacific Creek - Blackrock Creek	26,370	-1,712	**24,658**
Phillips Ridge	9,900	+208	**10,108**
Riley Ridge	17,600	-12,835	**4,765**
South Wyoming Range	259,270	-23,610	**85,776**
Salt River Range	76,191	+9,585	**235,660**
Spread Creek - Gros Ventre River	172,821	-6,725	**166,096**
Teton Corridor Trailheads	28,156	-27,870	**286**
West Slope Winds	0	+143,251	**143,251**
Palisades	81,872	-81,872	**0**
Total	**1,762,089**	**-344,596**	**1,417,493**

Conclusions

The current forest plan was written prior to the 2001 Roadless Rule so there is opportunity to identify additional areas for management activities while incorporating management direction from the Roadless Rule. Also, because much of the: WRNRT, Lander Cutoff NHT, RNAs and portions of the CDT, designated and eligible wild and scenic rivers are within inventoried roadless areas, and there is an opportunity to ensure consistency across multiple designations.

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Glossary

Board foot (bd ft, bf) – the amount of wood contained in an unfinished board 1 inch thick, 12 inches long, and 12 inches wide (2.54 x 30.5 x 30.5 cm) in trees or logs board foot volume is a measure of merchantability, and, therefore, the number of board feet in a cubic foot depends on tree diameter, amount of slab, and saw kerf. Commonly, 1,000 bd ft is written as 1 MBF and 1,000,000 bd ft is written as 1 MMBF.

Coppice – the production of new stems from the stump or roots. A silvicultural system frequently used to regenerate aspen stands in the West. Coppice with reserves is when trees are intentionally left standing.

Diameter (at) **breast height** (DBH, dbh) – the diameter of the stem of a tree measured at breast height (4.5 ft or 1.37 m) from the ground on the uphill side of the tree.

Diameter inside bark (DIB, dib) – the diameter of the wood portion of a stem or log cross section.

Forwarder – a self-propelled machine, usually self-loading, that transports trees or logs by carrying them completely off the ground.

Group tree selection – a method of harvest where trees are removed and new age classes are established in small groups to maintain an uneven-aged stand.

Harvester – a machine that falls trees and performs processing functions at the stump.

Natural range of variation or Variability (NRV) is a description of the change over time and space in the ecological condition of potential natural vegetation types and the ecological processes that shape those types

Processor – (harvesting) a machine that performs two or more functions on a felled tree, including the following: delimbing, debarking, bucking, measuring, or chipping.

Seed tree – (silviculture) a method of regeneration harvest whereby seed trees are left standing for the sole or primary purpose of providing seed to establish a new even-aged stand.

Shelterwood – (silviculture) a method of regeneration harvest by cutting of most trees, leaving those needed to produce sufficient shade to produce a new age class in a moderated microenvironment.

Single (individual) tree selection – a method of regeneration harvest by cutting individual trees of all size classes more or less uniformly throughout the stand, to promote growth of remaining trees and to provide space for regeneration and to maintain an uneven-aged stand.

Silvicultural System – a planned series of treatments for tending, harvesting, and re-establishing a stand. The system name is based on the number of age classes (coppice, even-aged, two-aged, and uneven-aged) or the regeneration method (clear-cutting, seed tree, shelterwood, selection, coppice, and coppice with reserves) used.

Skidder – a self-propelled machine used in timber harvesting, often articulated (hinged) in the center, for dragging trees or logs. A skidder may be cable (using a main winch cable and chokers to assemble and hold a load) or grapple (using a grapple or bottom-opening jaws to assemble and hold a load).

Stand (forest) structure – horizontal and vertical distribution of components of a forest stand including: height, diameter, crown layers, and stems of trees.

Tethered harvesting systems – equipment used to harvest, process and yard timber attached with a winch and cable to assist on steep slopes.

Timber stand improvement (TSI) – non-commercial, intermediate treatment made to improve the: composition, structure, conditions, health, and growth of stands.

Utilization (merchantability) standards – minimum specifications (diameter, length and soundness) of forest products to be sold and utilized via contract or permit.

Acronyms

Acronym	Definition
1990 forest plan	Bridger-Teton Forest Plan (1990)
2012 Planning Rule or planning rule	Planning Rule (2012)
ACHP	Advisory Council on Historic Preservation
ADS	aerial detection surveys
AIS	aquatic invasive species
AMP	Allotment Management Plan
ANC	acid neutralizing capacity
ANS	aquatic nuisance species
AQRV	air quality related value
ASQ	Allowable Sale Quantity
Assessment	Draft Report of Ecological, Socioeconomic, and Economic Conditions, Bridger-Teton National Forest
ATV	all-terrain vehicles
BF	board feet
BHS	bighorn sheep
BLM	Bureau of Land Management
BOR	Bureau of Reclamation
BpS	Biophysical setting
Bridger-Teton	Bridger-Teton National Forest
BWA	woolly balsam adelgid
CAL	common assessment level
CCC	Civilian Conservation Corps
CDT	Continental Divide National Scenic Trail
CE	categorical exclusion
CF	cubic feet
CFR	Code of Federal Regulations
cfs	cubic feet per second

Acronym	Definition
CL	critical load
CMP	Comprehensive Management Plan
CWD	chronic wasting disease
CWPP	Community Wildfire Protection Plan
dbh	diameter breast height
DFC	desired future condition
dib	diameter inside bark
DOI	U.S. Department of the Interior
EA	environmental assessment
EDRR	early detection and rapid response
EIS	environmental impact statement
EO	Executive Order
ESA	Endangered Species Act
ESD	ecological site description
FA & O	fire, administrative and other
FAA	Federal Aviation Administration
FIA	Forest Inventory and Analysis
FLREA	Federal Lands Recreation Enhancement Act
FMP	Fire Management Plan
FMRS	Fire Management Reference System
FSFREA	Forest Service Facilities Realignment and Enhancement Act (2005)
FSH	Forest Service Land Management Planning Handbook
GAOA	Great American Outdoors Act (2020)
GDE	groundwater dependent ecosystems
GDP	gross domestic product
GHG	greenhouse gas
GIS	geographic information system
GMU	Game Management Unit

Acronym	Definition
GPS	global positioning system
GYA	Greater Yellowstone Area
GYE	Greater Yellowstone Ecosystem
HAP	hazardous air pollutants
HCB	harmful cyanobacteria blooms
HUC	Hydrologic Unit Code
HVAC	heating, ventilation, and air conditioning
HVRA	highly valued resources and assets
INSTAAR	Institute of Arctic and Alpine Research
IPCC	Intergovernmental Panel on Climate Change
IRA	Inventoried Roadless Area
JHMR	Jackson Hole Mountain Resort
KEC	Key Ecosystem Characteristics
KWS	Kendall Warm Springs
LMP	land management plan
Lower 48 states	Lower 48 U.S. states not including Alaska and Hawaii
LRMP	land resource management plan
LWCF	Land and Water Conservation Fund
MBF	thousand board feet
MIM	Multiple Indicator Monitoring
ML	maintenance level
MMBF	million board feet
MPB	mountain pine beetle
MTBS	Monitoring Trends in Burn Severity
MVUM	Motor Vehicle Use Map
N	nitrogen
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act (1990)

Acronym	Definition
NEPA	National Environmental Policy Act
NFMA	National Forest Management Act (1976)
NFS	National Forest System
NFSR	National Forest System Roads
NGO	non-governmental organization
NHD	National Hydrology Dataset
NHT	National Historic Trails
NLA	National Lakes Assessment Surveys
NNL	National Natural Landmark
NO_x	nitrogen oxides
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NRSA	National Rivers and Streams Assessment Survey
NRT	National Recreation Trail
NRV	natural range of variation
NST	National Scenic Trails
NTFP	non-timber forest products
NVC	net value change
NWCG	National Wildfire Coordinating Group
NWI	National Weland Inventories
NYT	New York Times
O_3	ozone
OHAS	other highlighted aquatic species
OHV	off-highway vehicle
ORV	off-road vehicle
OSVUM	Over-snow Vehicle Use Map
P	phosphorus

Acronym	Definition
PBS	Public Broadcasting Service
PFC Assessment	properly functioning condition
PHA	Priority Heritage Assets
PILT	Payments in Lieu of Taxes
P.L.	Public Law
PM	particulate matter
POD	Potential Operational Delineation
PWS	Public Water Systems
QWRA	Quantitative Wildland Fire Risk Assessment
R	rhenium
RARE	Roadless Area Review and Evaluation
RCP	Representative Concentration Pathway
REF	
RHR	Regional Haze Rule
RMRS	Rocky Mountain Research Station
RN	roaded natural
RNA	Research Natural Areas
RO	Regional Office
ROC	risk of contact
ROS	Recreation Opportunity Spectrum
RV	recreational vehicle
S	sulfur
SCC	species of conservation concern
SFP	Spatial Fire Planning
SGCN	Wyoming Species of Greatest Conservation Need
SHG	summer home group
SHP	Strategic Habitat Plan
SHPO	State Historic Preservation Office

Acronym	Definition
SIA	Special Interest Area
SO_2	sulfur dioxide
SMP	smoke management plan
SMS	Scenery Management System
SNRT	Sheridan National Recreation Trail
SPM	semi-primitive motorized
SPNM	semi-primitive nonmotorized
SRSCS	Secure Rural Schools and Community Self-Determination Act (2000)
TCA	Terrestrial Condition Assessment
TCP	traditional cultural properties
TDEP	Total deposition model
TEPC	Threatened, endangered, proposed, and candidate species
TES	Threatened and endangered species
TEUI	Terrestrial Ecological Unit Inventory
TIS	terrestrial invasive species
TN	total nitrogen
TP	total phosphorus
TPFR	Triple Peak Forage Reserve
TSI	timber stand improvement
U	uranium
UDNR	Utah Department of Natural Resources
µg	micrograms
UGRB	Upper Green River Basin
USDA	U.S. Department of Agriculture
USFS or Forest Service	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

Acronym	Definition
UTV	utility terrain vehicle
UWAR	University of Wyoming Archaeological Repository
VMS	Visual Management System
VOC	volatile organic compound
VPD	vapor pressure deficit
WCF	Watershed Condition Framework
WCSB	Wyoming Centennial Scenic Byway
WDEQ	Wyoming Department of Environmental Quality
WDH	Wyoming Department of Health
WUI	wildland urban interface
WGFD	Wyoming Game and Fish Department
WGS	western glacier stonefly
WPM	western pearlshell mussel
WQD	Wyoming Water Quality Division
WRAC	Wyoming Range Complex
WRNRT	Wyoming Range National Recreation Trail
WSA	Wilderness Study Area
WSB	western spruce budworm
WSR	wild and scenic river
WSS	Web Soil Survey
WUI	wildland-urban interface
WYNDD	Wyoming Natural Diversity Database
YNP	Yellowstone National Park

Appendix A: Terrestrial Ecosystem Workshops and Integrity Report

The purpose of this document is to record the thought process behind determining the status and trend of ecosystem integrity, which will inform development of the Bridger-Teton NF (Forest) plan revision assessment. This document is a result of work drafted by select Forest and Regional experts.

Workshops Conducted on February 23, 24 and 28, 2023.

Ecosystems Analyzed

1. Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland.
2. Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland.
3. Middle Rocky Mountain Montane Douglas-fir Forest and Woodland.
4. Northern Rocky Mountain Subalpine Woodland and Parkland.
5. Rocky Mountain Aspen Forest and Woodland.
6. Inter-Mountain Basins Montane Sagebrush Steppe.
7. Subalpine Forb Ecosystem.
8. Rocky Mountain Alpine.

REFERENCE NOTE: *Except for the Subalpine Forb Ecosystem, each Ecosystem Description and Fire Return Interval topic is provided from the "Biophysical Settings (BpS) Models, Descriptions and Related Information" for Map Zone 21 in the Landfire Database (Landfire 2023). There is currently no BpS for the Subalpine Forb Ecosystem. Landfire uses an expert-based development process to create state-and-transition models that describe pre-settlement ecosystem structure and function for every Ecological System present in the current BpS spatial dataset. Each ecosystem (i.e., BpS) has a description document and a quantitative state-and-transition model including succession/growth and disturbance that can be viewed and manipulated in the free modeling platform SyncroSim. In addition, expert-developed models and descriptions are the source of Landfire's historic fire regime information (Landfire 2023).*

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Definition for Ecological Integrity

The 2012 Planning Rule (36 CFR 219.19) defines ecological integrity as: "The quality or condition of an ecosystem when its dominant ecological characteristics (for example, composition, structure, function, connectivity, and species composition and diversity) occur within the natural range of variation (NRV) and can withstand and recover from most perturbations imposed by natural environmental dynamics or human influence."

The NRV is a tool for assessing the ecological integrity and does not necessarily constitute a management target or desired condition. The NRV can help identify key structural, functional, compositional, and connectivity characteristics, for which plan components may be important for either maintenance or restoration of such ecological conditions (FSH 1909.12 zero code, p. 14). However, in a changing world, being within the NRV does not guarantee ecosystem integrity and being outside the NRV may represent a new sustainable, high-integrity state as the ecosystem responds to new conditions.

Criteria for Ranking Level of Ecological Integrity: High, Moderate, Low, and Poor

- *High:* If the ecosystem remains on current trajectory it is expected to continue delivering major functions and services including supporting biodiversity and productivity expected for this ecosystem without human interference. Drivers, stressors, and key ecosystem characteristics exhibit the range of variation that was common in the past.
- *Moderate*: If the system remains on current trajectory it is expected to deliver major functions and services including supporting biodiversity and productivity at a reduced level relative to expectations for this ecosystem. One or more drivers, stressors, and key ecosystem characteristics are compromised in a way that disrupts disturbance regimes or characteristics of the system. However, compromised features are not those that determine the identity of this system or, significant characteristics are only modestly compromised. Drivers, stressors, and key ecosystem characteristics exhibit a range of variation that was not common in the past but within a range that resulted in resilience.
- *Low:* If the system remains on current trajectory it is expected to deliver some major functions and services including supporting a portion of the biodiversity and productivity at a reduced level relative to expectations for this ecosystem without human interference or active restoration. One or more drivers, stressors, and key ecosystem characteristics are significantly compromised. However, compromised features are not those that determine the identity of this system; we don't expect a radical type-change. Drivers, stressors, and key ecosystem characteristics exhibit a range of variation that was not common in the past but within the range; resilience is possible.

- *Poor:* The ecosystem currently is (or is trending toward) experiencing a type-change or is incapable of delivering major functions and services including supporting biodiversity and productivity expected for this ecosystem type without herculean human interference and maintenance. Drivers, stressors, and key ecosystem characteristics exhibit a range of variation rarely or never exhibited in the past.

Ecosystem Services

Ecosystem services are a product of functioning ecosystems that affect social, cultural, and economic conditions within the plan area, in the area(s) of influence and in the broader landscape. Here, we identify the key ecosystem services provided by the plan area; rather than trying to identify and evaluate information about all ecosystem services. Key ecosystem services are the ecosystem services that are important in the area(s) of influence or the broader landscape and that are likely to be influenced by the land management plan. The key ecosystem services that can be found throughout most, if not all of the identified ecosystems include:

Provisioning Services

1. Food – Provides big game habitat that is used by the public for hunting and securing wild game as a food source. Also, foraging, berry picking, and mushroom collection is found in many areas of the Forest. The Forest also provides for permitted livestock grazing in capable and suitable areas.
2. Fiber – Timber removal primarily consists of Lodgepole pine for post/poles and firewood. Some house logs and saw logs are also harvested, primarily from standing dead trees.
3. Genetic resources – Can be important where individual trees, shrubs, forbs, and grasses have developed resistance to insects and disease. Healthy systems can provide native plant seed banking for restoration activities in degraded areas.
4. Biochemicals, natural medicines, pharmaceuticals – Aspen bark is utilized for natural/traditional medicines and has been used for sunscreen and insect repellant. Corn lily, Horsemint, and Fireweed are all examples of natural medicines found in certain parts of the Forest.
5. Fresh water – In low rainfall areas like Wyoming, springs and snowfall in high elevation areas like the BTNF provide critical water supplies. Vegetation holds soil in place which filters water and facilitates groundwater storage.

Regulating Services

1. Air quality regulation – Forest vegetation provides oxygen and filters out pollutants.
2. Water regulation – Provides filtration for water, groundwater storage, and erosion control.
3. Climate regulation – Trees and other vegetation absorb and sequester carbon, helping maintain climate regimes that support life.
4. Erosion regulation – Tree root systems and understory vegetation keep soil in place. Surface organic layer protects mineral soil from erosion.

5. Natural hazard regulation – Trees and understory vegetation provide erosion control and reduce landslide and flood threats.
6. Fire Regulation – Some Forest vegetation can be used to mitigate fire risk. For example, Aspen stands can serve as a natural fuel break.

Cultural Services

1. Aesthetic values – The Forest provides recreation opportunities, including scenic trails and roads, along with habitat for wildlife viewing and photography. Aspen, wildflowers, and waterways are also highly sought out for viewing and photography. Especially in the greater Jackson area, a thriving artistic culture including many art forms from writing and theater to visual arts and music often finds its inspiration in the aesthetic landscape of the BTNF.
2. Recreation and ecotourism – The largest economic driver in the BTNF area of influence, this category provides both private benefits and commercial benefit. Big game habitat offers hunter and outfitter-guide opportunities, as does fishing in streams/rivers/lakes. Trails are used for hiking, horseback trips, and mountain biking. Motorized roads and trails provide opportunity for off-road vehicles; groomed snowmobile trails and “open areas” are popular in the winter. Many natural resources educational, research and non-governmental organizations also benefit from and work within the BTNF landscape. The importance of outdoor recreation is also recognized as a key health benefit for residents and visitors, including not just the physical aspects of outdoor activities but also the mental/emotional benefits.
3. For Tribal communities in the area, this landscape remains part of traditional seasonal patterns of harvesting and collecting, and particular viewsheds or landscape elements may be part of traditional stories or sacred ceremonies that teach members how to relate as kin to the various other actors (plant, animal, rock, water, etc.) in the ecosystems.

Supporting Services

1. Biodiversity – The Forest consists of a multitude of different ecosystems that range from open-to-dense conifer stands, Aspen stands, open sagebrush steppe, tall forb communities and high elevation alpine ecosystems. Each ecosystem provides conditions necessary for plant and animal survival and reproduction, which creates biodiversity across the planning area.
2. Pollination – Openings within forested areas, meadows and understory flowering vegetation provide important habitat for pollinator species, ensuring reproduction of many plants.
3. Nutrient cycling – The movement and exchange of organic and inorganic matter back into the production of living matter. Healthy soils accept, store, and moderate the release of macro (such as carbon, nitrogen and phosphorous) and micronutrients. Available macro and micronutrients are reutilized by vegetation and other organisms.
4. Soil formation – The interactions over time between parent materials, climate, organisms, topography, and vegetation communities create the complex feature called soil. Trees, understory vegetation and microorganisms help form soils by breaking down organic matter and parent material. Roots serve as the “glue” to hold soil particles together and create soil structure. As trees lose leaves or needles, they cover the forest floor and create an organic layer that decomposes and adds nutrients to the soil.

5. Primary production – Plants convert the sun's energy into vegetation, the basis of food webs. As trees grow, they accumulate and store carbon, which results in a net gain in carbon on the landscape.

Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland Ecosystem

Ecosystem Description

Geographic Range

The Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland is found in west-central Wyoming, ranging from the eastern flanks of the Wind River Range, west to the Forest, north to the Gallatin Range and west towards Island Park, Idaho. It encompasses mid and upper elevations of the Forest and makes-up approximately 1,226,862 acres or 35.4% of the Forest (USDA, 2023).

Biophysical Site Description

Subalpine cold climate, relatively moist but usually comes in the winter months as snow, except at the eastern flanks of the Wind River Range where much of the precipitation occurs in the spring months. Soils are usually excessively well-drained, residual, or glacial till and alluvium on valley floors, droughty moderately deep, to deep soils over fractured granodiorite, quartzite, and sandstone bedrock. Coarse fraction 30-50% in soil, soils moderately deep, to deep, to broken rock, or bedrock. Soils are acidic and rarely formed from calcareous parent materials.

Vegetation Description

These forests are dominated by Lodgepole pine with shrub, grass, or barren understories. Sometimes there are intermingled mixed conifer/aspen stands with the latter occurring with inclusions of deeper, typically fine-textured soils. The shrub stratum may be conspicuous to absent. Dominant species include: Lodgepole pine, Subalpine fir, Engelmann spruce, Grouse whortleberry, Heartleaf arnica, Creeping barberry, and Geyer's sedge.

Ecosystem Integrity Evaluation

1. **What ecological drivers and stressors and other key characteristics are most responsible for ecological integrity when the system has high integrity? (Include the level of uncertainty and condition/geographic differences).**

Key ecosystem characteristics when the system exhibits high integrity include succession classes (S-Classes) within the natural range of variation (NRV) (Table 64) and a mixed-cone serotiny. Analysis conducted by the Forest (USDA 2023), concluded there is a deficit of S-Classes B and C, and a surplus of S-Classes A and D. The likely explanation for this S-class distribution is low fire activity through the early and mid-1800's followed by large fires that burned through the Forest during the late 1800's. Young stands and the initiation of fire exclusion in the early 1900's led to a lower number of acres burned through the 1980s. The

exception was the 1930s, characterized by several active years. Warming temperatures now combined with ageing stands to create receptive fuels, leading to increased fire activity.

Following stand-replacing fires, Lodgepole pine will often rapidly colonize and develop into dense, even-aged stands, depending on site characteristics and cone serotiny. In areas with low serotiny, the stands will be less dense and only gradually seed-in.

The mean fire return interval is variable, from 200-400 years, depending on elevation, precipitation, and temperature. Key system drivers is fire return interval within the NRV, and climate changes that push fire outside the NRV is a key stressor. Fire size is also largely dependent on climatic conditions. During periods when summers are rarely dry, the average fire size is about 100 acres, but when dry summers are more common, fires of 1,000-100,000 acres are more frequent. A fire frequency below 300 years and above 30 years will keep Lodgepole pine on the landscape.

Table 64. Description of S-Classes and Current Condition Status with the Reference Condition (i.e., NRV); Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland Ecosystem (Helmbrecht et al. 2012, Landfire 2023, and USDA 2023).

S-Class	Composition/Structure	Reference %	Current %	Status
A: Early development, all structures	Post-replacement disturbance vegetation of grasses, forbs, shrubs, and Lodgepole pine seedlings-saplings. Aspen may also be present. Canopy cover: 0-100%. Tree height: 0-5 meters. Maximum Tree Size Class: Sapling >4.5-feet; <5-inch DBH. Transitions to S-Class B after approximately 20 years.	7%	28.5%	Surplus
B: Mid-development, all structures	Moderate to dense pole-sized trees, sometimes very dense (dog-hair). Aspen is usually not present. Closed canopy is 51-100%. Mid-open stands are at 21-50% canopy cover and would have mature and immature Aspen present. Mid-open stands would have Subalpine fir in the understory. Tree height: 5-10 meters. Maximum Tree Size Class: Pole 5–9-inch DBH. Therefore, this class is considered a mid-development all-structures class. Transitions to S-Class C after approximately 60 years without stand-replacing disturbance.	33%	0.4%	Deficit
C: Late development, all structures	Medium-sized Lodgepole pine. Subalpine fir present in the mid- to upper story. Canopy cover: 10-100%. Tree height: 10-50 meters. Maximum Tree Size Class: Medium 9–21-inch DBH. Class transitions to S-Class D after approximately 270 years without stand-replacing disturbance.	48%	12.1%	Deficit

S-Class	Composition/Structure	Reference %	Current %	Status
D: Late development, all structures	Mature Engelmann spruce/Subalpine fir forest. Canopy cover: 10- 100%. Tree height: 5-50 meters. Maximum Tree Size Class: Large 21–33-inch DBH. This class is distinguished from S-Classes B and C by species composition (Spruce-fir dominance rather than Lodgepole pine).	12%	59.0%	Surplus

Other natural disturbance events within the NRV help maintain the mix of succession classes as well as vegetation diversity. With trees of approximately 80-100 years of age, insects, disease and/or blow-down typically create small openings in forest canopy. Under extreme weather conditions (i.e., 95th percentile), where the herbaceous fuel load is sufficient to carry fire, early successional stands will burn.

Healthy soils provide nutrient exchange, erosion control, an ideal substrate for plant growth and establishment, and functioning soil structure enables water infiltration and storage. The soil orders associated with this ecosystem are typically Entisol, Inceptisol and Alfisol.

Clean air is important for lichens, mycorrhizae, and native plant growth and survival, and ability to compete with invasive species.

The Revision Team considers these key ecosystem characteristics and drivers/stressors typical of high integrity with **High Certainty**.

2. What features of the ecosystem currently compromise (or support) ecological integrity and what are the mechanisms for the trend? Highlight important drivers, stressors, key ecosystem characteristics, and assess the degree to which management can or cannot influence this trend).

Climate Change

With anticipated rising temperatures, extended drought, and precipitation extremes with high variability, these climate variables are likely to serve as significant stressors/drivers and impact plant structure, survivability, reproduction and growth yield.

Changes in relative humidity outside the normal range can affect soils, plants, and lichens as well as seedling survival. Vapor-pressure deficit, a measure which integrates temperature and precipitation, can also negatively affect plant functions as the atmosphere dries. Extreme rain events can cause flooding, landslides and extreme erosion that can alter the vegetation structure, soil quality and function on the site.

Warmer summer temperatures and reduced precipitation can change the fire return interval as well as the intensity and size of fires on the landscape. An increase in the frequency of fires with an increase in severity may eventually change the vegetation structure of this ecosystem to one that is more characteristic of shorter fire regimes such as Douglas fir or even Sagebrush steppe. A more frequent fire interval could result in cones and seedlings being consumed before they are mature enough to respond positively to fire, and larger trees are removed from the system prior to reproducing. In addition, the soil nutrient pool could be reduced due to a more frequent loss of organic matter and soil cover.

Insects and Disease

The mountain pine beetle (MPB) irruption in 2009 was a result of increased daily temperatures that allowed the insects to erupt in a forest with ample large trees desired by the species. A similar event was also documented with spruce beetles. The irruption began at high elevation Whitebark pine trees and then moved down in elevation to impact Lodgepole pine. Winter temperatures are not getting cold enough for long enough periods to impact winter survival of these insects. Large trees that are stressed from drought, high summer temperatures, or diseases like white pine blister rust are less resistant to fight off insect irruptions.

Increase in nutrient deposition from air pollution and increased dust events can add nitrogen and phosphorus to the ecosystem, which can negatively affect certain tree species growth rate and decadal survival, soil health, lichens, mycorrhizae, native plant communities, invasive species colonization, and reduce snowpack retention. This can add stress to trees, again making them more vulnerable to insects or diseases.

Invasive plant species can be an issue in this ecosystem, especially along motorized roads/trailheads where people inadvertently introduce noxious plant seeds accumulated on vehicles, stock, pets or clothing. This can negatively impact understory vegetation where invasives may outcompete native plants.

Dispersed camping impacts include soil compaction and vegetation loss, especially in areas with shallow soils or historic stock use and along sensitive waterways. This can alter the understory vegetation as well as introduce invasive species and displace wildlife.

Deposition from air pollution can negatively affect lichen, mycorrhizae, and native plant growth, survival, and ability to compete with invasive species.

Available management actions on the Forest have little to no influence on major air pollution sources or the climate trajectory associated with these stressors. However, the Forest can utilize prescribed fire, timber removal or fuels projects to alter the vegetation condition and structure. All three of these management actions are a surrogate for “natural disturbance” and can be used to influence trends and conditions. Reducing stress on trees can help with survival during insect irruptions or drought. It is important to note that Lodgepole pine evolved with disturbance and some level of fire and native insect impacts is natural and desirable.

The Forest will continue to manage invasive species although there are typically not enough resources to treat noxious weeds across the entire forest. Additionally, options for recreation management are available to address problem areas.

The Revision Team considers these key ecosystem characteristics and drivers/stressors that can compromise (or support) integrity with **High Certainty**.

3. How does the current status and trend of the ecosystem (ecological integrity and the elements that are compromised) influence delivery of ecosystem services?

The current status of the ecosystem consists of S-Classes lacking in the mid-development phase (B and C) but overrepresented in the early and late development classes (A and D). Insect outbreaks, climate change, air pollution deposition, fire suppression, and invasive species are currently impacting the ecosystem. The trend for integrity will likely continue to be negatively impacted based on climate effects that could result in more wildfires of higher severity and size

transitioning to future shorter fire return intervals on the landscape. Insect irruptions and changes in water availability could create severe stress on trees further impacting the ability of the ecosystem to function within the NRV.

A transition from less forested area to more open space may increase the amount of the Forest that is considered big game winter range and also provide more available acres to livestock grazing. However, this could come at a cost to available cover habitat provided by conifer forests that is important to some big game species. The amount of timber removal, whether for firewood, post and poles or saw logs will likely be impacted with less availability in both quantity and quality. Water, air quality, erosion and natural hazard regulations could all be negatively impacted through large and frequent wildfire events that have become more common with climate change. Stressed, overstory trees succumbing to insect and disease outbreaks in large areas of the Forest will change the dynamic of providing erosion control and reducing landslide threats. Recreation and aesthetics could be negatively impacted if large wildfires, drought, and insect outbreaks change the forested landscape to one that is considered less desirable by humans. Nutrient cycling, soil formation and primary production are likely on a downward trend as a result of climate change and the subsequent impact that may have on the forested landscape in this ecosystem. Drought, wildfire, insects, and disease could change portions of this ecosystem to one that is more adapted to these types of disturbance and more “open”. Trees, and understory vegetation helps form soils and hold soil particles together to create structure and store carbon.

The Revision Team considers the ecological integrity and the elements that are compromised that influence delivery of ecosystem services with **High Certainty**.

4. What is the status of each ecosystem–the level and trend of ecological integrity (High, Moderate, Low, or Poor) in the plan area and surrounding lands; and to what degree can the Forest affect change in this status?

Current integrity rating	Certainty	Long-term integrity trend	Certainty	Short-term ability to affect	Certainty	Long-term ability to effect	Certainty
Moderate	Moderate	Low	Low	Moderate	Moderate	Low	Low

The current status of the integrity of the ecosystem is MODERATE. This is primarily based on the current succession classes differing from the NRV. Insect outbreaks, climate change, air pollution deposition, fire suppression, and invasive species are currently impacting the ecosystem and its ability to respond to these impacts. The Revision Team is MODERATELY certain that this classification is accurate, primarily because of the climate variability experienced to date and the fact that this ecosystem does respond positively to some level of disturbance as long as it is not too extreme.

The long-term trend (to 2050) for integrity is considered LOW. This rating is based primarily on climate impacts that could result in more wildfires of higher severity and size transitioning to future shorter fire return intervals on the landscape. Insect irruptions and changes in water availability could create severe stress on trees. The Revision Team considers this ranking with LOW certainty because of the unknown future climate impacts and if they will become more severe on a regular basis, negatively impacting this disturbance-driven ecosystem.

The degree the Forest can affect change in this ecosystem is MODERATE for the near term and LOW for the long term. Management actions that can provide benefits to the ecosystem include prescribed fire, timber removal, thinning and restoration activities. These actions may provide enhanced ecosystem benefits in the near term but over the long term, climate change may push this ecosystem beyond a point where management activities can occur at a large enough scale to keep ahead of negative impacts. The Revision Team is MODERATELY certain that this classification for the degree the Forest can affect change is accurate for the near term and considers it a LOW certainty that the Forest can affect change over the long term. The low certainty is a result of the unknown severity of future climate impacts.

Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland Ecosystem

Ecosystem Description

Geographic Range

Northern Rockies, including Montana, Idaho, and Wyoming. Adjacent to drier, lower subalpine forests (Lodgepole-Spruce-fir) and to krummholz and alpine vegetation. This system typically has more precipitation and longer winters than lower subalpine types. Typically found on north-facing slopes, high elevation ravines, or other areas where cold, mesic conditions exist. Mapped at approximately 314,606 acres or 9.1% of the Forest (USDA, 2023).

Biophysical Site Description

Subalpine cold climate, relatively moist but usually comes in the winter months as snow, except at the eastern flanks of the Wind River Range where much of the precipitation occurs in the spring months. Soils are usually excessively well-drained, residual, or glacial till and alluvium on valley floors, droughty, moderately deep- to deep soils over fractured granodiorite, quartzite, and sandstone bedrock. Coarse fraction 30-50% in soil, soils moderately deep, to deep, to broken rock, or bedrock. Soils are acidic, and rarely formed from calcareous parent materials.

Vegetation Description

Engelmann spruce and Subalpine fir dominate on most aspects, with Lodgepole pine comprising a greater component on dryer sites or in earlier successional stages. Mesic understory shrubs are common. Dominant species include: Lodgepole pine, Subalpine fir, and Engelmann spruce.

Ecosystem Integrity Evaluation

1. **What ecological drivers and stressors and other key characteristics are most responsible for ecological integrity when the system has high integrity? (Include the level of uncertainty and condition/geographic differences).**

The fire return interval for this ecosystem is classified as 200-500 years. Key ecosystem characteristics when the system exhibits high integrity include succession classes (S-Classes) within the natural range of variation (NRV) (Table 65). Analysis conducted by the Forest (USDA 2023), concluded that there was a surplus of S-Class A, a deficit of S-Classes B and C, and S-Classes D and E were similar to the reference condition. The fire return interval for stand

replacement fire is >300yrs. Most of the fire is modeled as replacement fire. There might be some mixed-severity fire in this system and there is no equilibrium achieved; it fluctuates widely in each class.

Drivers and stressors include climate and fire return interval within the NRV. Climate (severely dry conditions) is the primary driver of fire regimes in this system. Typical fires in this system are small clumps of stand-replacing fires with spots to adjacent clumps. The small clumps allow seeds from neighboring live trees to recolonize burned areas.

Other natural disturbance events within the NRV are important components of maintaining the mix of succession classes as well as tree and ground vegetation diversity. In some areas, spruce beetle can influence successional stage, species composition, and stand density.

Spruce beetle may act to accelerate succession.

Healthy soils provide nutrient exchange, erosion control, an ideal substrate for plant growth and establishment, and functioning soil structure enables water infiltration, and storage. Soil orders associated with this ecosystem are primarily Alfisols and to a smaller extent Entisols and Inceptisols.

Deposition from air pollution can negatively affect lichen, mycorrhizae, and native plant growth, survival, and ability to compete with invasive species.

The Revision Team considers these key ecosystem characteristics and drivers/stressors typical of high integrity with **High Certainty**.

Table 65. Description of S-Classes and Current Condition Status with the Reference Condition (i.e., NRV); Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Ecosystem (Helmbrecht et al. 2012, Landfire 2023, and USDA 2023).

S-Class	Composition/Structure	Reference%	Current %	Status
A: Early development, all structures	Post-replacement disturbance vegetation of grass and Engelmann spruce, Lodgepole pine, and Subalpine fir seedlings. Canopy cover: 0-100%. Tree height:0-5 meters. This stage transitions to S-Class B after approximately 40 years or alternatively to S-Class C.	8%	18.5%	Surplus
B: Mid-development, closed structure	Mix of pole-sized Engelmann spruce, Lodgepole pine, and Subalpine fir. Canopy cover: 40-100%. Tree height: 5- 10 meters. In the absence of stand-replacement fire this class transitions to S-Class E after approximately 110 years. Wind or weather stress may thin this class causing a transition to S-Class C.	19%	0.1%	Deficit
C: Mid-development, open structure	Mix of pole-sized Engelmann spruce, Lodgepole pine, and Subalpine fir. Canopy cover: 40-100%. Tree height: 5- 10 meters. This class transitions to S-Class D after approximately 110 years in the absence of stand-replacement fire.	7%	2.2%	Deficit

S-Class	Composition/Structure	Reference%	Current %	Status
D: Late development, open structure	Mix of medium to large-sized Engelmann spruce, Subalpine fir, and Lodgepole pine. Canopy cover: 10-50%. Tree height: 10-50 meters. This class may persist in the absence of disturbance or transition to S-Class E with increased canopy closure.	43%	50.8%	Similar
E: Late development, closed structure	Mix of medium to large-sized Engelmann spruce, Subalpine fir, and Lodgepole pine. Canopy cover: 50-90%. Tree height: 10-50 meters.	23%	28.4%	Similar

*Currently, 0.1% is categorized in the Uncharacteristic Exotic (UE) Class; which refers to non-native plant communities becoming established in the ecosystem.

2. What features of the ecosystem currently compromise (or support) ecological integrity and what are the mechanisms for the trend? Highlight important drivers, stressors, key ecosystem characteristics, and assess the degree to which management can or cannot influence this trend).

Climate Change

With anticipated rising temperatures, extended drought, and precipitation extremes with high variability, these climate variables are likely to serve as significant stressors/drivers and impact plant structure, survivability, reproduction and growth yield.

Changes in relative humidity outside the normal range can affect soils, plants, and lichens as well as seedling survival. Vapor-pressure deficit, a measure which integrates temperature and precipitation, can also negatively affect plant functions as the atmosphere dries. Extreme rain events can cause flooding, landslides and extreme erosion that can alter the vegetation structure, soil quality and function on the site.

Warmer summer temperatures and reduced precipitation may change the fire return interval as well as the severity of the fire effects. Because of the patchy nature of these stands, fires will still often be limited to the specific stand, although there may be increased spotting from one stand to another. This ecosystem typically experiences small, patchy fires. An increase in the frequency of fires with an increase in severity may eventually change the vegetation structure of this ecosystem to one that is more characteristic of shorter fire regimes such as Douglas fir. A more frequent fire interval could result in cones and seedlings being consumed before they are mature enough to respond positively to fire and larger trees taken-out of the system prior to reproducing. Larger fires in non-serotinous Lodgepole, Spruce and Fir stands result in more burned area that is further from the seed source, which is released from neighboring live trees and is necessary to recolonize burned areas.

Insects and Disease

The MPB irruption in 2009 was a result of increased daily temperatures that allowed the insects to erupt in a forest with ample large trees desired by the species. A similar event was also documented with spruce beetles. Currently, Balsam bark beetle is killing Subalpine fir trees throughout the Rocky Mountain subalpine mesic Spruce fir region. Winter temperatures are not getting cold enough for long enough periods to impact winter survival of these insects.

Large trees that are stressed from drought, high summer temperatures or diseases are less resistant to fighting off insect irruptions.

Air pollution is a concern with increased deposition at higher elevations and on the west side of the mountains where this ecosystem is typically found. Adding nitrogen and phosphorus to the ecosystem can affect certain tree species such as Spruce and Fir, soil health, lichens, mycorrhizae, and increase the ability of invasive species to colonize. Increases in large dust events add nutrients and can reduce snowpack retention by reducing reflectance. This can add stress to trees making them more vulnerable to insects and disease.

Invasive plant species can be an issue in this ecosystem, especially along motorized roads/trails, and trailheads where people inadvertently introduce noxious plant seeds that have accumulated on their vehicle and then drop off. This can negatively impact understory vegetation.

Recreation in this ecosystem can have a negative impact with human disturbance, human waste, and dispersed camping impacts, especially in areas with shallow soils. This can alter the understory vegetation as well as introduce invasive species and displace wildlife.

Available management actions on the Forest have little to no influence on major air pollution sources or the climate trajectory associated with these two issues. The Forest does not do a lot of active vegetation management in this ecosystem because it is located on mesic sites, north-facing slopes, and high elevation. Thus, trying to mimic disturbance through prescribed fire or timber harvest will be minimal. There will be little chance to influence stand or succession dynamics through those type of management actions.

The Forest will continue to manage invasive species although there are typically not enough resources to treat noxious weeds across the entire forest. Additionally, recreation can be managed, and problem areas addressed.

The Revision Team considers these key ecosystem characteristics and drivers/stressors that can compromise (or support) integrity with **High Certainty**.

3. How does the current status and trend of the ecosystem (ecological integrity and the elements that are compromised) influence delivery of ecosystem services?

The current status of the ecosystem consists of S-Classes lacking in the mid-development phase (B and C), overrepresented in the early development class (A), and late development classes (D and E) are similar to the reference condition. Insect outbreaks, climate change, and fire suppression are currently impacting the ecosystem and its ability to respond to these impacts. Because of its association with high elevation, cooler, wetter sites that hold more soil moisture and provide more nutrient cycling, and “shady” north-facing slopes that retain snowpack longer, it is believed the impacts of climate change may not be as severe as other ecosystems on the Forest, but there will still be some impacts. Climate impacts could result in more wildfires on the landscape and of higher severity. Additional stress to trees could result in large-scale die-offs from insect irruptions.

Timber harvest in this ecosystem is not generally appropriate because it is found in mesic sites, and steep, north-facing slopes. However, water, air quality, erosion and natural hazard regulations could all be negatively impacted through large and frequent wildfire events that become more common with climate change. Stressed, overstory trees succumbing to insect

and disease outbreaks in large areas of the Forest will change the dynamic of providing erosion control and reducing landslide threats. Recreation and aesthetics could be negatively impacted if large wildfires, drought, and insect outbreaks change the forested landscape to one that is considered less desirable by humans.

The Revision Team considers the ecological integrity and the elements that are compromised that influence delivery of ecosystem services with **High Certainty**.

4. What is the status of each ecosystem–the level and trend of ecological integrity (High, Moderate, Low, or Poor) in the plan area and surrounding lands; and to what degree can the Forest affect change in this status?

Current integrity rating	Certainty	Long-term integrity trend	Certainty	Short-term ability to affect	Certainty	Long-term ability to affect	Certainty
Moderate	Moderate	Moderate	Low	Low	Moderate	Low	Low

The current status of the integrity of the ecosystem is MODERATE. This is primarily based on the current succession classes differing from the NRV. Insect outbreaks, climate change, and fire suppression are currently impacting the ecosystem and its ability to respond to these impacts. The Revision Team is MODERATELY certain that this classification is accurate, primarily because of the climate variability experienced to date.

The long-term trend (to 2050) integrity is considered MODERATE. This rating is based primarily on the dynamics of where this ecosystem is located. Mostly associated with high elevation, cooler, wetter sites that hold more soil moisture and provide more nutrient cycling, and “shady” north-facing slopes that retain snowpack longer. For these reasons, it is believed the impacts of climate change may not be as severe as other ecosystems on the Forest but there will still be some impacts. Climate impacts could result in more wildfires on the landscape and of higher severity. Additional stress to trees that could be severely impacted by insect irruptions. The Revision Team considers this ranking with LOW certainty because of the unknown severity of future climate impacts.

The degree the Forest can affect change in this status is LOW for the near term and LOW for the long term. Allowing naturally occurring wildland fires to burn in this ecosystem is an option, and prescribed ignitions are also possible, but will require ignition during favorable (warm and dry) conditions. Timber harvest in this ecosystem is not generally appropriate because it is found in mesic sites, and steep, north-facing slopes that are difficult or impossible to operate in. The Revision Team is MODERATELY certain that this classification for the degree the Forest can affect change is accurate for the near term and considers it a LOW certainty that the Forest can affect change over the long term. The low certainty is a result of the unknown future climate impacts.

Middle Rocky Mountain Montane Douglas-fir Forest and Woodland Ecosystem

Ecosystem Description

Geographic Range

This is the most common low-elevation forest type in the Greater Yellowstone Ecosystem and occurs across eastern Idaho, southwestern Montana, and northwestern Wyoming. Mapped at approximately 168,143 acres or 4.9% of the Forest (USDA 2023).

Biophysical Site Description

Douglas-fir forests occupy a broad elevational range, between the limber pine type and grasslands/shrublands on lower foothills and the cool/dry subalpine vegetation types. This ecosystem often occurs at higher elevations on slopes with southern aspects where it can be co- dominant with Whitebark pine or Limber pine. Slopes with northern aspects tend to be more mesic and can support a mixed conifer community including several subalpine tree species. This can also occur in the mid-elevation ranges (6,000-8,000 feet) in southwestern Wyoming.

Vegetation Description

Generally dominated by Douglas-fir with an understory of graminoids, shrubs, and/or other conifer species. Shrub cover varies from sparse to dense. Dominant species include Douglas-fir, Lodgepole pine, Quaking aspen, Common snowberry, Coralberry, Mallow ninebark, Grapeleaf begonia, and White Mountain sedge. Co-dominant species include Limber pine, Rocky Mountain juniper, and Quaking aspen at lower elevations and Lodgepole pine, Subalpine fir, Engelmann spruce, and Whitebark pine at higher elevations. Composition can vary widely based on disturbance history and site conditions. Stand structure ranges from young, even-age stands to multiple age class, old-growth stands to sparsely treed open parklands and woodlands.

Ecosystem Integrity Evaluation

1. **What ecological drivers and stressors and other key characteristics are most responsible for ecological integrity when the system has high integrity? (Include the level of uncertainty and condition/geographic differences).**

Key ecosystem characteristics when the system exhibits high integrity include succession classes (S-Classes) within the natural range of variation (NRV) (Table 66) and a mixed-cone serotiny. Analysis conducted by the Forest (USDA 2023), concluded individual S-Classes still show departure and may provide opportunity for restoration or maintenance. For example, S-Class B is absent to relatively trace indicating a need to recruit more acres into the class. Also, without fire or another form of maintaining an open canopy, S-Class D will succeed to the late, closed S-Class E, which is already over-represented relative to the reference proportion. The fire regime is predominantly mixed severity with a mean fire return interval of 36 to 300 years.

Drivers and stressors include climate and fire return interval within the NRV. Climate is the primary driver of fire regimes in this system. Mixed-severity fires are generally characterized by

spatially heterogeneous burning that results in a complex and dynamic mosaic of low- severity surface fires and high-severity surface or crown fires. Large, stand-replacing fire occurs to a lesser degree, mostly in dense stands and/or with severe fire weather.

Table 66. Description of S-Classes and Current Condition Status with the Reference Condition (i.e., NRV); Middle Rocky Mountain Montane Douglas-fir Forest and Woodland Ecosystem (Helmbrecht et al. 2012, Landfire 2023, and USDA 2023).

S-Class	Composition/Structure	Reference %	Current%	Status
A: Early development, all structures	Post-replacement disturbance vegetation dominated by grasses and seedling/sapling Douglas-fir and possibly Lodgepole pine. Canopy cover 0-100%. Tree height: 0-5 meters. Maximum Tree Size Class: Sapling >4.5-feet; <5-inch DBH. This class transitions to S-Class C or alternately to S-Class B after approximately 40 years.	7%	22.4%	Surplus
B: Mid-development, closed structure	Pole-size to medium Douglas-fir and possibly Lodgepole pine. Canopy cover: 40-100%. Tree height: 5-10 meters. Maximum Tree Size Class: Pole 5-9-inch DBH. In the absence of disturbance this class transitions to S-Class E after approximately 80 years.	12%	0.1%	Deficit
C: Mid-development, open structure	Pole-size to medium Douglas-fir and possibly Lodgepole pine. Canopy cover: 10-40%. Tree height: 5-10 meters. Maximum Tree Size Class: Pole 5-9- inch DBH. In the absence of stand- replacing disturbance this class transitions to S-Class D or alternately S- Class B after approximately 60 years.	14%	2.0%	Deficit
D: Late development, open structure	Medium to large Douglas-fir and possibly Lodgepole pine. Canopy cover: 10-40%. Tree height: 10-50 meters. Maximum Tree Size Class: Large 21-33-inch DBH. In the absence of disturbance this class may transition to S-Class E in approximately 45 years.	47%	27.8%	Deficit
E: Late development, closed structure	Multi-storied mature Douglas-fir stand. Lodgepole pine may be present. Canopy cover: 40-100%. Tree height 10-50 meters. Maximum Tree Size Class: Large 21-33-inch DBH. Insect, weather, or mixed severity fire may transition this class to S-Class D.	20%	47.6%	Surplus

Other natural disturbance events within the NRV are important components of maintaining the mix of succession classes as well as tree and ground vegetation diversity. The most common insects causing mortality include Douglas-fir bark beetle in Douglas-fir and MPBs in Lodgepole pine, Whitebark pine, and Limber pine. Medium to large trees are most susceptible although

poles may be infrequently infected. Whitebark pine and Limber pine are also affected by white pine blister rust. Spruce budworm is present in pockets within the zone. Wind/weather/stress may infrequently affect stands.

Healthy soils provide nutrient exchange, erosion control, an ideal substrate for plant growth and establishment, and functioning soil structure increases water infiltration, and storage.

Soil orders associated with this ecosystem are primarily Alfisols and to a smaller extent Entisols and Inceptisols.

Deposition from air pollution can negatively affect lichen, mycorrhizae, and native plant growth, survival, and ability to compete with invasive species.

The Revision Team considers these key ecosystem characteristics and drivers/stressors typical of high integrity with **High Certainty**.

2. What features of the ecosystem currently compromise (or support) ecological integrity and what are the mechanisms for the trend? Highlight important drivers, stressors, key ecosystem characteristics, and assess the degree to which management can or cannot influence this trend).

Climate Change

With anticipated rising temperatures, extended drought, and precipitation extremes with high variability, these climate variables are likely to serve as significant stressors/drivers and impact plant structure, survivability, reproduction and growth yield.

Changes in relative humidity outside the normal range can affect soils, plants, and lichens as well as seedling survival. Vapor-pressure deficit, a measure which integrates temperature and precipitation, can also negatively affect plant functions as the atmosphere dries. Extreme rain events can cause flooding, landslides and extreme erosion that can alter the vegetation structure, soil quality and function on the site.

Fire regimes in this ecosystem vary based on moisture and aspect. Wetter forests on north aspects burn at high intensity with stand replacing fires every 100-300 years. Warmer summer temperatures and reduced precipitation may result in more frequent and larger stand replacing fires that will be slower to recover due to increased distances for seed dispersal from neighboring live trees. In addition, the soil nutrient pool could be reduced due to a more frequent loss of organic matter and soil cover. The drier forests on south aspects in this ecosystem are more resilient to low intensity ground fires every 25-60 years; however, there has been an absence of fire in the last 100 years, most likely due to successful fire suppression and livestock grazing. This has subsequently resulted in denser stands, making them more susceptible to hotter, larger fires. An increase in the frequency of low intensity fires may benefit portions of this ecosystem by removing the smaller trees and allowing the larger trees that have thick, insulating bark to persist.

Insects and Disease

The MPB irruption in 2009 was a result of increased daily temperatures that allowed the insects to erupt in a forest with ample large trees desired by the species. A similar event was also documented with spruce beetles. The most common insects causing mortality include Douglas-

fir bark beetle in Douglas-fir and MPB in Lodgepole pine, Whitebark pine, and Limber pine. Medium to large trees are most susceptible although poles may be infrequently infected. Whitebark pine and Limber pine are also affected by white pine blister rust. Spruce budworm is present in pockets within the zone. While it often weakens Douglas-fir and may make them more susceptible to bark beetles, direct mortality from budworm is uncommon. The most common disease affecting older Douglas-fir stands is Schweinitzii (*Phaelous schweinitzii*). Dwarf mistletoe is also a parasitic shrub that takes nutrients away from the tree, making it more susceptible to insect mortality. Winter temperatures are not getting cold enough for long enough periods to impact winter survival of these insects. Large trees that are stressed from drought, high summer temperatures or diseases are less resistant to fighting off insect irruptions.

Air pollution is less of a concern in this ecosystem because lower elevations on the Forest tend to have less deposition from air pollution. However, adding nitrogen and phosphorus to the ecosystem through atmospheric deposition can increase invasive plant species' ability to establish and severely impact the understory.

Invasive plant species can be an issue in this ecosystem above and beyond the normal infiltration routes of motorized roads/trails, and trailheads. Invasive plants are naturally distributing and expanding through weather events, and assistance from livestock, and human recreationists. This can negatively impact understory vegetation and the wildlife that depends on native vegetation.

Recreation in this ecosystem can have a negative impact with human disturbance, human waste, and dispersed camping impacts, especially in areas with shallow soils and historic stock use. This can alter the understory vegetation, introduce invasive species, and displace wildlife.

Available management actions on the Forest have little to no influence on major air pollution sources or the climate trajectory associated with these two issues. However, the Forest can utilize prescribed fire and fuels projects to alter the vegetation condition and structure. All three of these management actions are a surrogate for "disturbance" and can be used to mimic natural disturbances and influence trends and conditions. Reducing stress on trees can help with survival during insect irruptions. It is important to note that this ecosystem is very resilient to fire and climate change. It may serve as a climate refugia in the future because of the extremes it can tolerate – it is an adaptable ecosystem. Douglas-fir will often encroach into adjacent shrublands or grasslands with fire exclusion and during moist climatic periods. The Forest will continue to manage invasive species although there are typically not enough resources to treat noxious weeds across the entire forest. Additionally, recreation can be managed, and problem areas addressed.

The Revision Team considers these key ecosystem characteristics and drivers/stressors that can compromise (or support) integrity with **High Certainty**.

3. How does the current status and trend of the ecosystem (ecological integrity and the elements that are compromised) influence delivery of ecosystem services?

The current status of the ecosystem consists of only trace amounts of S-Class B and an over-representation of S-Class E. Insect outbreaks, climate change, invasive plant species and fire suppression are currently impacting the ecosystem. The trend for integrity will likely not be as severe as other ecosystems on the Forest based on its resiliency and its ability to adapt and survive climate shifts, and changes in wildfire frequency and severity. Insect irruptions and

changes in water availability could create severe stress on trees further impacting the ability of the ecosystem to function within the NRV.

Although this ecosystem is resilient to drought and fire, extreme conditions could transition this forested ecosystem to one consisting of more open space, which may increase the amount of the Forest that is considered big game winter range and also provide more available acres to livestock grazing. However, this could come at a cost to available cover habitat provided by conifer forests that is important to some big game species. The amount of timber removal, whether for firewood, post and poles or saw logs may be impacted with less availability in both quantity and quality. Water, air quality, erosion and natural hazard regulations could all be negatively impacted through large and frequent wildfire events that have become more common with climate change. Stressed, overstory trees succumbing to insect and disease outbreaks in large areas of the Forest will change the dynamic of providing erosion control and reducing landslide threats. Recreation and aesthetics could be negatively impacted if large wildfires, drought, and insect outbreaks change the forested landscape to one that is considered less desirable by humans.

The Revision Team considers the ecological integrity and the elements that are compromised that influence delivery of ecosystem services with **High Certainty**.

4. What is the status of each ecosystem–the level and trend of ecological integrity (High, Moderate, Low, or Poor) in the plan area and surrounding lands; and to what degree can the Forest affect change in this status?

Current integrity rating	Certainty	Long-term integrity trend	Certainty	Short-term ability to affect	Certainty	Long-term ability to affect	Certainty
Moderate	Moderate	Moderate	Low	Moderate	Moderate	Moderate	Low

The current status of the integrity of the ecosystem is MODERATE. This is primarily based on the current succession classes differing from the NRV. Insect outbreaks, climate change, invasive plant species and fire suppression are currently impacting the ecosystem and its ability to respond to these impacts. The Revision Team is MODERATELY certain that this classification is accurate, primarily because of the climate variability experienced to date; however, this is a very resilient ecosystem that can respond positively to disturbance events.

The long-term trend (to 2050) integrity is considered MODERATE. This rating is based primarily on the resilience of this ecosystem and its ability to adapt and survive climate shifts, and changes in wildfire frequency and severity. The Revision Team considers this ranking with LOW certainty because of the unknown future severity of climate impacts.

The degree the Forest can affect change in this status is MODERATE for the near term and MODERATE for the long term. Management actions that can provide benefits to the ecosystem include prescribed fire, timber removal, invasive species treatments, thinning, restoration activities, and managing recreation activities and practices. These actions may provide enhanced ecosystem benefits in both the near and long term. The Revision Team is MODERATELY certain that this classification for the degree the Forest can affect change is accurate for the near term and considers it a LOW certainty that the Forest can affect change

over the long term. The low certainty is a result of the unknown severity of future climate impacts and if the Forest can actively manage at a large enough scale to affect change.

Northern Rocky Mountain Subalpine Woodland and Parkland Ecosystem

Ecosystem Description

Geographic Range

The geographic range includes southwest Montana, southeast Idaho, and northwest Wyoming. Mapped at approximately 340,570 acres or 9.8% of the Forest (USDA 2023).

Biophysical Site Description

Upper subalpine zone (7,000-11,000 feet) on moderate to steep terrain (e.g., 40-70% slope). Landforms include ridgetops, mountain slopes, glacial trough-walls and moraines, talus slopes, land and rockslides, and cirque headwalls and basins. Some sites have little snow accumulation because of high winds and sublimation, which increases summer drought. Patchy distribution of this type may be controlled by edaphic conditions, including soil depth and susceptibility to summer drought.

Vegetation Description

This is a subalpine parkland setting with tree clumps or discontinuous forest mixed with meadow. Forest communities range from nearly homogeneous stands of Whitebark pine on the harshest, highest-elevation sites to mixed species including shade tolerant Subalpine fir or Engelmann spruce. Vegetation can be stunted with short, dwarfed trees, including krummholz vegetation on the harshest sites. Historically, Whitebark pine dominated on southerly aspects, while northerly aspects were dominated by Subalpine fir and Engelmann spruce. In this harsh windswept environment, trees are often stunted and flagged from wind damage.

Undergrowth on these sites is usually sparse and at timberline is highly variable. Dominant vegetation includes Whitebark pine, Subalpine fir, and Engelmann spruce. Shrubs that may occur include *Vaccinium* species, Common juniper, Buffaloberry, and Oregon boxleaf. Grasses include Geyer's sedge, Ross' sedge, and Idaho fescue. Herbs include Yarrow, Prairie smoke, Mountain dandelion and Gooseberry currant.

Whitebark pine is a keystone species in many of these forests. Mature Whitebark pine trees ameliorate local conditions on harsh sites and facilitate the establishment of less hardy subalpine species. The seeds of Whitebark pine provide an important food source for grizzly bears and Clark's nutcrackers. Whitebark pine also depends upon Clark's nutcrackers for seed dispersal and subsequent tree establishment. The Clark's nutcracker may distribute seeds eight kilometers from the source tree. Reproduction following 'Disturbance is slow; trees may not produce cones until they are 50yrs or older.

Ecosystem Integrity Evaluation

1. What ecological drivers and stressors and other key characteristics are most responsible for ecological integrity when the system has high integrity? (Include the level of uncertainty and condition/geographic differences).

Key ecosystem characteristics when the system exhibits high integrity include succession classes (S-Classes) within the natural range of variation (NRV) (Table 67). Analysis conducted by the Forest (USDA 2023), concluded that there is a major deficit in the amount of S-Class B, and abundance of S-Class D; the relative amount of other S-Classes is variable. The fire regime in this ecosystem consists primarily of long-interval (e.g., 100-200 years+), mixed severity (25-75% top kill), and stand replacement fires.

Table 67. Description of S-Classes and Current Condition Status with the Reference Condition (i.e., NRV); Northern Rocky Mountain Subalpine Woodland and Parkland Ecosystem (Helmbrecht et al. 2012, Landfire 2023, and USDA 2023).

S-Class	Composition/Structure	Reference %	Current %	Status
A: Early development, all structures	Post-replacement disturbance vegetation of typically Whitebark pine and Engelmann spruce seedlings and saplings. Lodgepole pine, Limber pine, and herbaceous species may also be early pioneers. Canopy cover: 0- 40%. Tree height: 0-5 meters. Maximum Tree Size Class: Sapling >4.5-feet; <5-inch DBH. This class transitions to S-Class B or C after approximately 50 years.	21%	46.6%	Surplus
B: Mid-development, closed structure	Mix of pole sized Whitebark pine, Subalpine fir, Engelmann spruce, and Lodgepole pine. Some sites may exhibit krummholz growth form. Canopy cover: 30-100%. Tree height: 5-10 meters. Maximum Tree Size Class: Pole 5-9-inch DBH. Class transitions to S-Class E after approximately 80 years without disturbance.	35%	1.4%	Deficit
C: Mid-development, open structure	Mix of pole sized Whitebark pine, Subalpine fir, Engelmann spruce, and Lodgepole pine. Some sites may exhibit krummholz growth form. Canopy cover: 10-30%. Tree height: 5-10 meters. Maximum Tree Size Class: Pole 5- 9-inch DBH. Class transitions to S-Class E or alternatively to S-Class B after approximately 80 years without disturbance.	12%	6.8%	Deficit

S-Class	Composition/Structure	Reference %	Current %	Status
D: Late development, open structure	Mix of medium to large diameter Whitebark pine, Subalpine fir, Engelmann spruce, and Lodgepole pine. Limber pine may be present. Generally found in small to moderate size patches on southerly aspects or sites where soil is less developed. Canopy cover: 10-40%. Tree height: 10-50 meters. Maximum Tree Size Class: Medium 9-21-inch DBH. This S-Class is persistent in the absence of disturbance, although a small percentage will eventually transition to S-Class E.	5%	19.9%	Surplus
E: Late development, closed structure	Mix of medium to large diameter Whitebark pine, Subalpine fir, Engelmann spruce, Lodgepole pine, and Limber pine. Generally found in small to moderate size patches on more protected northerly aspects or sites where soil is more developed than in S-Class D. Canopy cover: 40-100%. Tree height: 10-50 meters. Maximum Tree Size Class: Medium 9-21-inch DBH. ThismS-Class is persistent in the absence of disturbance.	27%	25.3%	Similar

Drivers and stressors include climate and fire return interval within the NRV. Fire frequency is largely controlled by climate in this system and there is a relatively long mean fire return interval. Ignitions are frequent due to lightning, though fires seldom carry due to lack of fuel from the slow-growing vegetation and cool, moist conditions. Tree clumps may burn out without carrying through intervening meadows, or spot from one clump to the next.

Individual tree torching is common. Non-lethal surface fires may dominate where continuous light fuel loading (i.e., grasses) exists.

Other natural disturbance events within the NRV are important components of maintaining the mix of succession classes as well as tree and ground vegetation diversity. MPB is a natural agent of mortality affecting five-needle pines. Infestations occur episodically and are a natural agent of disturbance in these systems. Snow, wind, and other weather events may cause damage and cause transitions between classes.

Healthy soils provide nutrient exchange, erosion control, an ideal substrate for plant growth and establishment, and functioning soil structure increases water infiltration, and storage.

This is especially relevant for this system since it is typically found on shallow, rocky soils. The soil orders typically associated with this ecosystem are Entisol and Inceptisol.

Deposition from air pollution can negatively affect lichen, mycorrhizae, and native plant growth, survival, and ability to compete with invasive species.

The Revision Team considers these key ecosystem characteristics and drivers/stressors typical of high integrity with **High Certainty**.

2. What features of the ecosystem currently compromise (or support) ecological integrity and what are the mechanisms for the trend? Highlight important drivers, stressors, key ecosystem characteristics, and assess the degree to which management can or cannot influence this trend).

Climate Change

With anticipated rising temperatures, extended drought, and precipitation extremes with high variability, these climate variables are likely to serve as significant stressors/drivers and impact plant structure, survivability, reproduction and growth yield.

Changes in relative humidity outside the normal range can affect soils, plants, and lichens as well as seedling survival. Vapor-pressure deficit, a measure which integrates temperature and precipitation, can also negatively affect plant functions as the atmosphere dries. Extreme rain events can cause flooding, landslides and extreme erosion that can alter the vegetation structure, soil quality and function on the site.

Warmer summer temperatures and reduced precipitation may shorten the fire return interval as well as the intensity and size of fires on the landscape. Typically, fire sizes range from individual trees, tree clumps and groups. Occasionally, larger patches of fire occur, as in Yellowstone National Park in 1988. An increase in the frequency of fires with an increase in severity may eventually change the vegetation structure of this ecosystem to one that is more characteristic of shorter fire regimes. A more frequent fire interval could result in cones and seedlings being consumed before they are mature enough to respond positively to fire and larger trees taken-out of the system prior to reproducing. For example, on Mount Washburn in Yellowstone National Park, one of the Whitebark pine plots that burned in a crown fire is regenerating entirely to Engelmann spruce. However, this is an occurrence that is likely happening on a small scale and is not necessarily happening everywhere. Understory vegetation may shift in response to decline in canopy and changes in tree species composition.

Insects and Disease

The MPB irruption in 2009 was a result of increased daily temperatures that allowed the insects to erupt in a forest with ample large trees desired by the species. A similar event was also documented with spruce beetles. The irruption began at high elevation Whitebark pine trees and then moved down in elevation to impact Lodgepole pine. The MPB is an important disturbance agent in Whitebark pine and Lodgepole pine forests, and past outbreaks have caused widespread mortality in these forest types throughout the region. The MPB has become increasingly more important (versus historically) in the last five years due to warm temperatures. Spruce budworm may be present on higher density spruce sites. Winter temperatures are not getting cold enough for long enough periods to impact winter survival of these insects. Large trees that are stressed from drought, high summer temperatures or diseases like white pine blister rust are less resistant to fighting off insect irruptions.

White pine blister rust might preferentially affect older trees, possibly retarding succession to older series; however, that is unconfirmed, as others state that it does not preferentially attack older individuals and that the rust will actually kill younger and smaller trees faster than the larger, older ones. Blister rust is, however, becoming more prominent in the Teton Range, Mount Leidy Highlands, Wyoming Range, and Wind River Mountains. There is moderate

mortality from a variety of insects and diseases on all conifer species on the Forest, adding to high levels of mortality in the past twenty years.

Nutrient inputs from air pollution are a concern. Deposition often increases with elevation and adding nitrogen and phosphorus to the ecosystem can affect certain tree species such as Spruce, Fir, and Whitebark pine, soil health, lichens, mycorrhizae, and increase the ability of invasive species to colonize. Increases in large dust events add nutrients and can reduce snowpack retention-by reducing reflectance. This can add stress to trees making them more vulnerable to insects and disease.

Invasive plant species can be an issue in this ecosystem, especially along motorized roads/trails, and trailheads where people inadvertently introduce noxious plant seeds that have accumulated on their vehicle and then drop off. This can negatively impact understory vegetation and the wildlife that depends on native vegetation.

Recreation in this ecosystem can have a negative impact with human disturbance, human waste, and dispersed camping impacts, especially in areas with shallow soils and historic stock use. Soil compaction and spreading noxious weeds can also be a result of human activity. This can alter the understory vegetation as well as introduce invasive species and displace wildlife.

Available management actions on the Forest have little to no influence on major air pollution sources or the climate trajectory associated with these two issues. The Forest does not do a lot of active vegetation management in this ecosystem because it is located at such a high elevation. Thus, trying to mimic disturbance through prescribed fire or timber harvest will be minimal. However, the Forest does actively manage wildfires for resource benefit in this ecosystem. Additionally, Whitebark pine restoration activities are also conducted on the Forest and include small-scale prescribed fire, thinning, cone, scion and pollen collection for seed orchard and reforestation, Verbenone application, plus tree marking, regeneration surveys, and research projects. There will be little chance to influence stand or succession dynamics through those type of management actions.

The Forest will continue to manage invasive species although there are typically not enough resources to treat noxious weeds across the entire forest. Additionally, recreation can be managed, and problem areas addressed.

The Revision Team considers these key ecosystem characteristics and drivers/stressors that can compromise (or support) integrity with **High Certainty**.

3. How does the current status and trend of the ecosystem (ecological integrity and the elements that are compromised) influence delivery of ecosystem services?

The current status of the ecosystem consists of S-Classes lacking in the mid-development phase (B) but overrepresented in the early and late development classes (A and D). The ecosystem is currently being impacted by a dramatic increase in White pine blister rust and subsequent large-scale die-offs of Whitebark pine from MPBs. The trend for integrity will likely continue to be negatively impacted based on climate effects that could result in more wildfires of higher severity and size transitioning to future shorter fire return intervals on the landscape. Insect irruptions and changes in water availability could create severe stress on trees further impacting the ability of the ecosystem to function within the NRV.

Because of the high elevation, extreme environment this ecosystem typically occupies, the Forest is hindered in its ability to conduct active management in the form of prescribed fire, thinning and timber harvest practices that can provide benefits to the ecosystem. Thus, timber removal is not a major service in this ecosystem. Water, air quality, erosion and natural hazard regulations could all be negatively impacted through large and frequent wildfire events that have become more common with climate change. Stressed, overstory trees succumbing to insect and disease outbreaks in large areas of the Forest will change the dynamic of providing erosion control and reducing landslide threats. Recreation and aesthetics could be negatively impacted if large wildfires, drought, and insect outbreaks change the forested landscape to one that is considered less desirable by humans. Nutrient cycling, soil formation and primary production are likely on a downward trend as a result of climate change and the subsequent impact that may have on the forested landscape in this ecosystem. Trees, and understory vegetation helps form soils and hold soil particles together to create structure and store carbon.

The Revision Team considers the ecological integrity and the elements that are compromised that influence delivery of ecosystem services with **High Certainty**.

4. What is the status of each ecosystem–the level and trend of ecological integrity (High, Moderate, Low, or Poor) in the plan area and surrounding lands; and to what degree can the Forest affect change in this status?

Current integrity rating	Certainty	Long-term integrity trend	Certainty	Short-term ability to affect	Certainty	Long-term ability to affect	Certainty
Low	Low	Low	Low	Low	Moderate	Low	Low

The current status of the integrity of the ecosystem is LOW. This is primarily based on the dramatic increase in White pine blister rust and subsequent large-scale die-offs of Whitebark pine from MPBs. The soils in this ecosystem are shallow and prone to erosion from extreme weather events as well as natural and human-induced ground disturbance. The Revision Team has LOW certainty that this classification is accurate, primarily because of the climate variability experienced to date. It is believed the forest may be on a trajectory of lower impacts from MPBs but that is still uncertain. Whitebark pine restoration is on-going, but it is at a small-scale when compared to the size of this ecosystem; it is still uncertain if the forest can have landscape-scale improvement.

The long-term trend (to 2050) integrity is considered LOW. This rating is based primarily on climate impacts that could result in more wildfires on the landscape and of higher severity.

Additional stress to trees that could be severely impacted by insect irruptions. The Revision Team considers this ranking with LOW certainty because of the unknown future climate impacts and if Whitebark pine restoration will result in landscape-scale enhancement. The degree the Forest can affect change in this status is LOW for the near term and LOW for the long term. Because of the high elevation, extreme environment this ecosystem typically occupies, the Forest is hindered in its ability to conduct active management in the form of prescribed fire, thinning and timber harvest practices that can provide benefits to the ecosystem. The Forest will continue Whitebark pine restoration activities and managing the increased impacts from recreationists could also be an action the Forest undertakes.

Managing wildfire for resource benefits could become more common in this system. The issue with these activities is “scale” and if the Forest can do enough to impact large landscapes.

The Revision Team is MODERATELY certain that this classification for the degree the Forest can affect change is accurate for the near term and considers it a LOW certainty that the Forest can affect change over the long term. The low certainty is a result of the unknown future climate impacts and Whitebark pine mortality.

Rocky Mountain Montane Aspen Forest and Woodland Ecosystem

Ecosystem Description

Geographic Range

This ecological system is widely distributed within a mosaic of other communities in the Northern Rockies. Communities are usually of small spatial extent, generally <25 acres in size in the northern portions of this zone, in contrast to larger communities in the central and southern Rockies. Patches may be linear along riparian areas and the forest/grassland ecotone. Nonlinear patches are often localized in swales, depressions, and toe slopes. Aspen stands tend to be dynamic in size and distribution and interact with adjacent communities. Because patch sizes tend to be small, and because one state in the disturbance model can include aspen in the understory of a predominantly coniferous stand, they may be difficult to map and identify.

Mapped at approximately 322,024 acres or 9.3% of the Forest (USDA 2023).

Biophysical Site Description

Most Aspen occurs at elevations from 5,000-7,500 feet in the northern portion of the zone and up to 8,500 feet in the southern portion of the zone. Aspen typically occurs between sagebrush steppe and the subalpine forest zone, usually in close association with Douglas-fir forest as well as other conifer forests. Aspen is occasionally found at lower and higher elevations, but these stands are often isolated and small. Generally, Aspen stands that have low amounts of conifer cover are associated with mollisols. Distribution of this ecological system is primarily limited by adequate soil moisture required to meet its high evapotranspiration demand and secondarily is limited by the length of the growing season or low temperatures. In the long-term absence of fire, these sites may transition to Douglas-fir or sagebrush, so there is likely some overlapping with those ecosystems.

Vegetation Description

These are upland forests and woodlands dominated by Aspen both with and without a significant conifer component (less than five percent to over 40% relative conifer tree cover). Conifer species include Douglas-fir, Lodgepole pine, Subalpine fir, Limber pine, and Engelmann spruce. The understory structure may be complex with multiple shrub and herbaceous layers, or simple with just an herbaceous layer. The herbaceous layer may be dense or sparse, dominated by graminoids or forbs. Dominant species include Aspen, Douglas-fir, Lodgepole pine, Big sagebrush, and Engelmann spruce.

Ecosystem Integrity Evaluation

1. What ecological drivers and stressors and other key characteristics are most responsible for ecological integrity when the system has high integrity? (Include the level of uncertainty and condition/geographic differences).

Aspen forests are the richest and most diverse ecosystems on Forest. Key ecosystem characteristics when the system exhibits high integrity include succession classes (S-Classes) within the natural range of variation (NRV) (Table 68). Analysis conducted by the Forest (USDA 2023), concluded there is a deficit of S-Class B and C, and over-representation of S- Class A and E. S-Class D is a transitional state where overstory recruitment is inhibited by herbivory, insects, disease, or a combination of these factors and with a continued absence of fire will transition to S-Class E or to a non-forested existing vegetation type – resulting in such stands being mapped as S-Class A or UN. Replacement fire and patchy replacement fires were moderately frequent historically and helped maintain this ecological system on the landscape. The overall mean fire interval for replacement fires is considered 100 years, but fire sizes may be highly variable given the widely ranging vegetation composition and topography.

Drivers and stressors include climate and fire return interval within the NRV. Climate is the primary driver of fire regimes in this system. This ecosystem can display varying fire severities depending on tree species composition. Fire return intervals in aspen are heavily influenced by adjacent community disturbance dynamics and could vary dramatically on a landscape and through time as conditions change (20-150 years between disturbances). The clonal Aspen root system can persist through long periods of disturbance-free conditions.

This root system is also able to rapidly respond by sprouting or root suckering after disturbances. Fires may have been more frequent (e.g., <25 years) where Aspen was adjacent or closely associated with grassland or shrubland communities. They occurred approximately every 40 years in the montane Aspen-conifer mix. When adjacent to the subalpine zone Lodgepole pine or closed-canopy Douglas-fir, fires occurred least frequently, at approximately 100-300 years, which could maintain most seral Aspen stands.

Other natural disturbance events within the NRV are important components of maintaining the mix of succession classes as well as tree and ground vegetation diversity. Disease and insect mortality probably influenced the stand structure (degree of canopy closure, age classes, etc.) in this ecosystem. Outbreaks would thin older trees, >40 years. Disturbance effects would also have varied from clone to clone. Many Aspen clones situated on steep slopes are prone to disturbance caused by avalanches and mud/rockslides. Riparian Aspen is prone to flooding and beaver clear-cutting.

Table 68. Description of S-Classes and Current Condition Status with the Reference Condition (i.e., NRV); Rocky Mountain Aspen Forest and Woodland Ecosystem (Helmbrecht et al. 2012, Landfire 2023, and USDA 2023).

S-Class	Composition/Structure	Reference%	Current%	Status
A: Early development, all structures	Post-replacement disturbance dominated by Aspen suckers, grasses, forbs, and shrubs. Canopy cover: 0-100%. Tree height:0-5 meters. Maximum Tree Size Class: Seedling <4.5-feet. After 15-years, succeeds to S-Class B (unless inhibited by overbrowsing).	7%	32.6%	Surplus
B: Mid-development, all structures	Sapling to pole-sized Aspen dominates. Canopy cover: 10-100%, although usually closed. Tree height: 5-10 meters. Maximum Tree Size Class: Pole 5-9-inch DBH. Transitions to S-Class C after approximately 25-years without stand-replacement disturbance.	24%	4.2%	Deficit
C: Late development, closed structure	Medium-sized Aspen dominate. Canopy cover: 40-100%. Tree height: 10-50 meters. Maximum Tree Size Class: Medium 9-21-inch DBH. This stage may persist indefinitely with continued regeneration and overstory recruitment. Canopy die-off and lack of recruitment from herbivory may result in transition to S-Class D. In the absence of disturbance, this class may transition to mixed-conifer, S-Class E.	27%	3.2%	Deficit
D: Late development, open structure	Medium-sized Aspen dominate with conifers in the low to mid-canopy. Canopy cover: 10-40%. Tree height: 10-50 meters. Maximum Tree Size Class: Medium 9-21-inch DBH. This class transitions to S-Class E after approximately 100 years in the absence of disturbance, or in some cases, to a shrub/herbaceous community as a result of mortality without recruitment due to high herbivory.	27%	37.5%	Similar
E: Late development, closed structure	Conifer or Aspen-mixed conifer overstory. Canopy cover: 40-100%. Tree height: 10-50 meters. Maximum Tree Size Class: Very Large >33-inch DBH. This class is distinguished from S-Class C by species composition (Aspen is being replaced by conifer or other vegetation).	15%	22.2%	Surplus

*Currently, 0.3% is categorized in the Uncharacteristic Exotic (UE) Class; which refers to non-native plant communities becoming established in the ecosystem.

Healthy soils provide nutrient exchange, erosion control, an ideal substrate for plant growth and establishment, and functioning soil structure increases water infiltration and storage.

Soils in Aspen stands are characterized by having more organic matter, as a result they have an increase in water-holding capacity when compared to conifer stands. Due to a higher amount of organic matter inputs within Aspen stands, these soils form thick and dark A horizons. The soil order typically associated with Aspen stands are Mollisols.

Herbivory (consumption of plants by animals) also affects the growth rates of Aspen sprouts or suckers and at high levels, has the potential to overwhelm the sprouting or suckering response and prevent overstory recruitment from occurring. Varying ungulate populations affect the integrity of this NRV.

Deposition from air pollution can negatively affect lichen, mycorrhizae, and native plant growth, survival, and ability to compete with invasive species.

The Revision Team considers these key ecosystem characteristics and drivers/stressors typical of high integrity with **High Certainty**.

2. What features of the ecosystem currently compromise (or support) ecological integrity and what are the mechanisms for the trend? Highlight important drivers, stressors, key ecosystem characteristics, and assess the degree to which management can or cannot influence this trend).

Climate Change

With anticipated rising temperatures, extended drought, and precipitation extremes with high variability, these climate variables are likely to serve as significant stressors/drivers and impact plant structure, survivability, reproduction and growth yield.

Changes in relative humidity outside the normal range can affect soils, plants, and lichens as well as seedling survival. Vapor-pressure deficit, a measure which integrates temperature and precipitation, can also negatively affect plant functions as the atmosphere dries. Extreme rain events can cause flooding, landslides and extreme erosion that can alter the vegetation structure, soil quality and function on the site.

Warmer summer temperatures and reduced precipitation can change the fire return interval as well as the intensity and size of fires on the landscape. Aspen decline varies across the region. Factors affecting Aspen currently include drought, fire suppression and ungulate browsing. These factors have reduced Aspen patch sizes and composition, and/or created senescent stands lacking suckers for regeneration of tree-sized Aspen. Disturbance regimes, particularly regarding measures surrounding fire size, are highly variable, and dependent on information obtained from different but adjacent vegetation types. This ecosystem responds positively to fire in most cases; fire is a primary driver spurring Aspen regeneration in clones dominated by larger, older trees. However, there have been some impacts from fire exclusion in the last 100 years, most likely due to successful fire suppression and livestock grazing.

This has subsequently resulted in smaller patch sizes, lack of regeneration and a higher percentage of late seral (S-class D and E) with an increase in conifers within the stand. An increase in the frequency of fires with an increase in severity may be beneficial to Aspen; however, if that frequency involves a subsequent burn-over of small, regenerating aspen in a recently burned stand, it could kill off the resprouts.

Insects and Disease

Insects that affect Aspen do not seem to be a major driver or stressor on the Forest, but diseases are endemic and naturally occurring across aspen stands on the Forest. Diseases such as Aspen blight, heart-rot and Ganoderma conks can have impacts at the stand or clone level but usually do not develop into landscape scale concerns. Trees that are stressed from drought, high summer temperatures, excessive browsing or soil compaction are less resistant to fighting off disease impacts.

Air pollution is less of a concern in this ecosystem because higher depositions are occurring at higher elevations. However, adding nitrogen and phosphorus to the ecosystem can invite invasive plant species to get a foothold into this ecosystem, which can severely impact the understory.

Invasive plant species can be an issue in this ecosystem above and beyond the normal infiltration routes of motorized roads/trails, and trailheads. Disturbance events such as wildfire or prescribed fire can result in an invasion of Canada thistle and/or Musk thistle into regenerating Aspen clones; there has been some specific cases of cheatgrass also moving into recently disturbed Aspen stands. This is not a landscape scale issue yet and is isolated to specific stands. This can negatively impact regenerating Aspen and understory vegetation.

Recreation in this ecosystem can have a negative impact with human disturbance, human waste, and dispersed camping impacts, especially in areas with shallow soils. This can alter the understory vegetation as well as introduce invasive species. Human presence can provide a deterrence to ungulate use of Aspen stands and the negative effects of over-browsing.

Over-browsing and trampling by wild and domestic ungulates can have a negative impact on aspen regeneration and understory plants, if not properly managed. Browsing may result in the loss of multi-layer stand structures (sometimes complete stand collapse) important to local biodiversity. Single-story aspen stands are highly vulnerable to stand collapse as mature trees age and die. Periodic wildfire may rejuvenate seral aspen, though intense browse pressure may eliminate such gains following disturbance (Rogers 2017). Both cattle and sheep browse on aspen leaves and twigs, but sheep typically eat four times as many aspen sprouts as cattle (Sampson 1919 as cited in DeByle). However, sprout height controls impacts from cattle and sheep grazing. By the time sprouts reach 45 inches, damage by sheep is no longer a problem. Thus, after 3 years, sprouts are not damaged extensively by sheep and for cattle, the period would be 4 or 5 years. It is important to note that grazing is not necessarily harmful to the young sprouts and removal of the terminal shoot once or twice will not kill the plant because lateral shoots can develop (Tew 1981). Several management options may be effective to reduce the negative impacts of browsing on aspen regeneration, such as herding and utilizing a rest-rotation cycle for allotment pastures, especially in late summer (Shinneman et al., 2015); both of which are implemented on the Forest.

Deer and moose can impact aspen regeneration, but elk are usually the most damaging because elk typically winter in or near mid-elevation zones where aspen forests are most common. This is especially problematic in aspen stands in the vicinity of elk feedgrounds. Additionally, elk populations in Wyoming have dramatically increased over the last century. Moose, which can spend the entire winter within a single aspen patch, can also cause significant, localized damage.

Removal of beaver along Aspen dominated riparian areas essentially “takes-out” a disturbance mechanism that can directly influence the ability of those corridors to regenerate. Beavers chew/gnaw on larger trees or take them down completely which triggers a suckering response like any disturbance event. Additionally, beavers create the moist, soil conditions desired by the species to meet their high evapotranspiration demand. Loss of beavers can also result in incised stream channels and loss of natural flood plains. Available management actions on the Forest have little to no influence on major air pollution sources or the climate trajectory associated with these two issues. However, the Forest can utilize prescribed fire, livestock grazing, conifer removal and fuels projects to alter the vegetation condition and structure. All of these management actions are a surrogate for “disturbance” and can be used to mimic natural disturbances and influence trends and conditions. Reducing stress on trees can help with survival during disease outbreaks. It is important to note that this ecosystem is very resilient to fire and may benefit from more fire on the landscape.

The Forest will continue to manage invasive species although there are typically not enough resources to treat noxious weeds across the entire forest. Additionally, recreation and livestock grazing can be managed, and problem areas addressed.

The Revision Team considers these key ecosystem characteristics and drivers/stressors that can compromise (or support) integrity with **High Certainty.**

3. How does the current status and trend of the ecosystem (ecological integrity and the elements that are compromised) influence delivery of ecosystem services?

The current status of the ecosystem consists of a deficit of S-Class B and C, and over-representation of S-Class A, D and E. This is mainly a result of fire suppression activities over the last 100 years. Both ungulate and livestock grazing/browsing is a concern and can negatively affect regenerating Aspen as well as an overall lack of beaver on the landscape because of removals. The trend for integrity will likely not be as severe as other ecosystems on the Forest based on its resiliency and its ability to adapt and survive climate shifts, and changes in wildfire frequency and severity, which may be beneficial in stimulating suckering and removing conifer competition.

Aspen forests are the richest and most diverse ecosystems on Forest. Future shifts in more frequent wildfires of higher severity could benefit this ecosystem through stimulating Aspen regeneration and removing competing conifers. However, extreme drought could limit any future Aspen expansion or even maintaining what is on the landscape; extreme conditions could transition this forested ecosystem to one consisting of more open space. Aspen stands provide both summer and winter foraging habitat for big game animals and domestic livestock utilize these stands for foraging and thermoregulation during periods of warm temperatures. It is likely this ecosystem will continue to provide foraging habitat under the current conditions and may actually expand under a more active wildfire scenario. The amount of timber removal in this ecosystem is relatively minor unless it is associated with conifer removal as part of an Aspen restoration project, that should continue. Water, air quality, erosion and natural hazard regulations could all be negatively impacted in the short- term through large and frequent wildfire events that become more common with climate change. However, this could result in stimulating Aspen regeneration, expanding the size of current stands, and removing competing conifer, which over the long term, would result in beneficial impacts to water, air quality, erosion, and natural hazard regulations. Recreation and aesthetics could be negatively impacted if large wildfires, drought, and insect outbreaks change the forested landscape to one that is considered

less desirable by humans. Aspen stands are regularly sought-after for viewing and photography in the fall when the leaves turn color. Nutrient cycling, soil formation and primary production are likely to be on a steady trend if climate impacts are not extreme or common. Fire is generally considered a natural disturbance that maintains and/or enhances this ecosystem; however, if it is to frequent, there is the potential to lose Aspen if it reburns young, regenerating shoots.

The Revision Team considers the ecological integrity and the elements that are compromised that influence delivery of ecosystem services with **High Certainty**.

4. What is the status of each ecosystem–the level and trend of ecological integrity (High, Moderate, Low, or Poor) in the plan area and surrounding lands; and to what degree can the Forest affect change in this status?

Current integrity rating	Certainty	Long-term integrity trend	Certainty	Short-term ability to affect	Certainty	Long-term ability to affect	Certainty
Moderate	Moderate	Moderate	Moderate	High	High	High	High

The current status of the integrity of the ecosystem is MODERATE. This is primarily based on the current succession classes differing from the NRV. This is mainly a result of fire suppression activities over the last 100 years. Both ungulate and livestock grazing/browsing is a concern and can negatively affect regenerating Aspen as well as an overall lack of beaver on the landscape because of removals. However, the management efforts the Forest is implementing to enhance Aspen is a priority and continues across the Forest. The Revision Team is MODERATELY certain that this classification is accurate, primarily because of the climate variability and fire suppression activities experienced to date but also because the Forest actively pursues management actions to enhance Aspen.

The long-term trend (to 2050) integrity is considered MODERATE. This rating is based primarily on the resilience of this ecosystem and changes in wildfire frequency and severity may be beneficial. The Revision Team considers this ranking with MODERATE certainty because of the unknown future severity of climate impacts.

The degree the Forest can affect change in this status is HIGH for the near term and HIGH for the long term. Management actions that can provide benefits to the ecosystem include prescribed fire, conifer removal, invasive species treatments, sound livestock grazing practices, thinning, restoration activities and discouraging beaver removal in riparian Aspen corridors. These actions may provide enhanced ecosystem benefits in both the near and long term. The Revision Team is HIGHLY certain that this classification for the degree the Forest can affect change is accurate for the near term and considers it a HIGH certainty that the Forest can affect change over the long term. Aspen communities are a priority for enhancement and will likely be in the future.

Inter-Mountain Basins Montane Sagebrush Steppe Ecosystem

Ecosystem Description

Geographic Range

Scattered throughout the Greater Yellowstone Ecosystem, this ecosystem ranges from 6,000-8,500 feet (Forest) in the southern portion of the zone. In southwest Montana, it could occur up to 9,600 feet. Mapped at approximately 355,618 acres or 10.3% of the Forest (USDA 2023).

Biophysical Site Description

It is scattered in forest openings and benches along mountain foothills throughout the zone, and adjacent to lower forested areas. Low sagebrush is found in areas where clay layers cause a perched water table with saturated soils during parts of the year alternating with very dry soils.

This vegetation type is found on all aspects, although it rarely occurs on northerly slopes. Pure stands are found in areas with deeper soils and less topographic relief, but it is also common on slopes with a gradual shift to a mixed, mountain shrub community on steeper slopes and in drainages. Precipitation ranges from 12-20 inches/year. Soils are deep, and well drained. Soil moistures are udic (not dry for as long as 90 cumulative days) and soil temperatures cryic (very cold soils of the Rocky Mountain Region).

Vegetation Description

Mountain sagebrush steppe is dominated by Mountain big sagebrush, with a frequent presence of Mountain snowberry, and with a continuous grass and forb understory is believed to be a major pre-settlement vegetation type, although the exact composition of the community before settlement is unknown. Dominant vegetation includes Mountain sagebrush, Bluebunch wheatgrass, Idaho fescue, Sandberg bluegrass, Mountain snowberry, and Great Plains false willow. Other common shrubs include Serviceberry, Chokecherry, Rose, Currant, and Rabbitbrush; other shrubs may be locally common. Herbaceous cover is moderate to abundant, ranging from 40-85%. This vegetation type may occur as inclusions within forested types.

Ecosystem Integrity Evaluation

1. **What ecological drivers and stressors and other key characteristics are most responsible for ecological integrity when the system has high integrity? (Include the level of uncertainty and condition/geographic differences).**

Key ecosystem characteristics when the system exhibits high integrity include succession classes (S-Classes) within the natural range of variation (NRV) (Table 69). Analysis conducted by the Forest (USDA 2023), concluded there is a deficit of S-Class B. The relative amount of S-Class A and C is similar to the NRV across the Forest. There is a limited amount of information available on fire regimes and reference conditions in sagebrush due to overgrazing (the herbaceous component is severely impacted, and current information cannot exclude the effects of cattle and sheep). Nearly all sagebrush communities today have been grazed – there are few known refugia to use as reference conditions.

Table 69. Description of S-Classes and Current Condition Status with the Reference Condition (i.e., NRV); Inter-Mountain Basins Montane Sagebrush Steppe Ecosystem (Helmbrecht et al. 2012, Landfire 2023, and USDA 2023).

S-Class	Composition/Structure	Reference%	Current %	Status
A: Early development, all structures	Post-replacement disturbance vegetation dominated by grasses and forbs. Shrub cover less than 10%. Herbaceous cover 0-30%. This S-Class will transition to S-Class B after approximately 13 years.	23%	27.6%	Similar
B: Mid-development, open structure	Shrub cover: 10-30%. Herbaceous cover: 0-40%. After 30-40 years this S-Class usually transitions to S-Class C in the absence of disturbance. On very dry sites, however, a closed structure may never be attained.	47%	18.4%	Deficit
C: Late development, closed structure	Shrub cover 30-50%. Herbaceous cover is variable. Other disturbances such as drought stress and insects may cause this S- Class to transition to S-Class B.	30%	40.4%	Similar

*Currently, 0.9% is categorized in the Uncharacteristic Exotic (UE) Class; which refers to non-native plant communities becoming established in the ecosystem. There is also 12.7% categorized in the Uncharacteristic Native (UN) Class. The UN designation is primarily due to exceeding the S-Class A mapping thresholds; thus, if the herbaceous cover threshold for S-Class A were higher most of the UN would be in S-Class A (Helmbrecht et al. 2012).

Drivers and stressors include climate and fire return interval within the NRV. Climate is the primary driver of fire regimes in this system. Fire is a major disturbance factor for Mountain big sagebrush, but the fire return interval is poorly understood and can only be estimated using either the duration of the succession process post fire or fire scars found on adjacent trees. The latter is problematic because trees tend to burn mid-summer before sagebrush is sufficiently cured to carry a fire, so using the scars could be an over-estimation of the frequency of fire in the surrounding sagebrush. It is likely that different sagebrush communities have a highly variable fire history. Fires burn in patchy mosaics in this type, and scales ranged from small (tens of acres) to very large (possibly hundreds of thousands of acres) fires contingent on sufficient understory fuel continuity.

Other natural disturbance events within the NRV are important components of maintaining the mix of succession classes as well as grass and forb diversity. Drought stress, insects, and native grazing were present under pre-settlement conditions in this ecosystem. Most of these disturbances were mixed severity, resulting in thinning of sagebrush. Deer and elk, at high density, can use sagebrush on winter ranges. Gophers tunnel underground and browse on sagebrush roots possibly giving an advantage to forb species.

Healthy soils provide nutrient exchange, erosion control, an ideal substrate for plant growth and establishment, and functioning soil structure enables water infiltration, and storage.

This ecosystem contains a variety of legume species that serve as nitrogen fixers that benefit other plant species and can lead to higher diversity. Soil orders typically associated with this ecosystem are inceptisol and mollisol.

Deposition from air pollution can negatively affect lichen, mycorrhizae, and native plant growth, survival, and ability to compete with invasive species.

The Revision Team considers these key ecosystem characteristics and drivers/stressors typical of high integrity with **High Certainty**.

2. What features of the ecosystem currently compromise (or support) ecological integrity and what are the mechanisms for the trend? Highlight important drivers, stressors, key ecosystem characteristics, and assess the degree to which management can or cannot influence this trend).

Climate Change

With anticipated rising temperatures, extended drought, and precipitation extremes with high variability, these climate variables are likely to serve as significant stressors/drivers and impact plant structure, survivability, reproduction and growth yield.

Changes in relative humidity outside the normal range can affect soils, plants, and lichens as well as seedling survival. Vapor-pressure deficit, a measure which integrates temperature and precipitation, can also negatively affect plant functions as the atmosphere dries. Extreme rain events can cause flooding, landslides and extreme erosion that can alter the vegetation structure, soil quality and function on the site.

Warmer summer temperatures and reduced precipitation can change the fire return interval as well as the intensity and size of fires on the landscape. Mountain big sagebrush was probably not as abundant in pre-settlement conditions, since the original vegetation of sagebrush-grass consisted of a dense cover of perennial grasses among scattered moderate-sized shrubs.

Sagebrush might be denser now in these communities due to fire exclusion, overgrazing by livestock, and/or climate change. Fire exclusion is a major effect of livestock grazing in dynamic sagebrush/grassland systems.

Some grassland systems are invaded by sagebrush today in larger quantities. These grassland systems might today have Mountain big sage and, previously, might have had only a very small amount of Mountain sage. Currently, there is probably a higher proportion of the landscape in the late development stage than would have been expected under the reference condition, but this may not be captured well in mapping. Class C does not always have to have the densest cover; it has older and larger sagebrush plants, that may look like class B when mapped with remote sensing. Therefore, class B may be over-represented on the mapped landscape.

Fire suppression in this ecosystem may increase conifer encroachment, most commonly from Douglas-fir and sometimes Lodgepole pine. Douglas-fir trees have encroached into sagebrush-grasslands from historically stable tree islands, and tree density has increased on the tree islands.

Insects and Disease

Insects and disease that affect sagebrush do not seem to be a major driver or stressor on the Forest, but there is evidence of western tent caterpillars invading this ecosystem and completely defoliating Bitterbrush shrubs on certain sites along the Wind River Front. This outbreak was isolated and not witnessed in other areas of the Forest or in higher elevations. It is possible that

with climate change we may start to see grasshopper and Mormon cricket outbreaks impact this ecosystem. Both insects have been observed in hay meadows just off Forest. Shrubs that are stressed from drought, high summer temperatures, excessive browsing or soil compaction are less resistant to fight off insect outbreaks.

Air pollution is less of a concern in this ecosystem because lower elevations on the Forest tend to have less deposition from air pollution. However, adding nitrogen and phosphorus to the ecosystem through atmospheric deposition can increase invasive plant species ability to establish and severely impact native plant communities in this ecosystem.

Invasive plant species can be an issue in this ecosystem above and beyond the normal infiltration routes of motorized roads/trails, and trailheads. Disturbance events such as wildfire or prescribed fire can result in a Cheatgrass invasion and has been a major issue across the entire Forest. Cheatgrass typically gets a foothold on the south facing slopes that contain interspersion between shrubs and grasses after a disturbance. Cheat grass invasion will dramatically shorten the fire return interval and may result in type conversion from sagebrush steppe.

Recreation in this ecosystem can have a negative impact with human disturbance, human waste, and dispersed camping impacts, especially in areas with shallow soils. This can alter the understory vegetation as well as introduce invasive species. Soils are more susceptible to erosion and “crusting” in this ecosystem, which can create gullies and washouts after heavy rain events. Illegal off-road activity can crush sagebrush and create new routes that people use. This typically results in poor soil retention and high rates of erosion and runoff into nearby streams since that is where most of these routes are located – in or near riparian corridors. Soil compaction is a characteristic of heavily used dispersed camping sites.

Recreational horse use and overnight use can lead to overgrazing, eroding soil, compaction and animal waste that can negatively affect the plants and nearby water resources.

Ungulates (i.e., elk and deer) and livestock (cattle and sheep), can be a stressor on the ecosystem on both the shrub component and grass/forb component if overutilized. Most big game winter range is in this ecosystem and ungulate populations that are on the high-end or above population objectives can over browse sagebrush in the winter which could make the area more vulnerable to invasive species and/or confer encroachment.

Available management actions on the Forest have little to no influence on major air pollution sources or the climate trajectory associated with these two issues. However, the Forest can utilize prescribed fire, sound livestock grazing practices, conifer removal and fuels projects to alter the vegetation condition and structure. All of these management actions are a surrogate for “disturbance” and can be used to mimic natural disturbances and influence trends and conditions. Reducing stress on the shrub component can help with survival during insect outbreaks.

The Forest will continue to manage invasive species although there are typically not enough resources to treat noxious weeds across the entire Forest. To date, the Forest has seen very good results aerially treating Cheatgrass with a relatively new herbicide (Rejuvra) in partnership with County Weed and Pest Agencies. One problem area is Wilderness and the ability to treat Cheatgrass aerially. Currently, the Forest is not authorized to conduct that activity and will need to do NEPA to add Wilderness into the coverage area for aerial treatments. Additionally, recreation and livestock grazing can be managed, and problem areas addressed.

The Revision Team considers these Key ecosystem characteristics and drivers/stressors that can compromise (or support) integrity with **High Certainty**.

3. How does the current status and trend of the ecosystem (ecological integrity and the elements that are compromised) influence delivery of ecosystem services?

The current status of the ecosystem consists of a deficit of S-Class B. The relative amount of S-Classes A and C are similar to the NRV across the Forest. This is mainly a result of fire suppression activities over the last 100 years. Both ungulate and livestock grazing/browsing is a concern and can negatively affect sagebrush. Additionally, invasive species are a continual problem, especially after fire events. The trend for integrity will likely not be as severe as other ecosystems on the Forest based on its resiliency and the successes the Forest has had treating invasive annual grasses.

Although this ecosystem is resilient to drought and fire, extreme conditions could transition this shrub-dominated ecosystem to one consisting of less sagebrush and more of a grass/forb cover type. Many areas of the Forest that make-up this ecosystem are considered big game winter range. Additionally, this ecosystem provides suitable and capable acres for livestock grazing. That will likely continue into the future and depending on the impact of climate change and fire return interval, could expand into nearby forested areas. Water, air quality, erosion, and natural hazard regulations could all be negatively impacted through large and frequent wildfire events that become more common with climate change and the subsequent flush of invasive annual grasses we see in this ecosystem following fire. Recreation and aesthetics could be negatively impacted if large wildfires, drought, and invasive plants change this shrub community to one that is considered less desirable by humans.

The Revision Team considers the ecological integrity and the elements that are compromised that influence delivery of ecosystem services with **High Certainty**.

4. What is the status of each ecosystem–the level and trend of ecological integrity (High, Moderate, Low, or Poor) in the plan area and surrounding lands; and to what degree can the Forest affect change in this status?

Current integrity rating	Certainty	Long-term integrity trend	Certainty	Short-term ability to affect	Certainty	Long-term ability to affect	Certainty
Moderate	High	Moderate	High	High	High	High	High

The current status of the integrity of the ecosystem is MODERATE. This is primarily based on the current succession classes differing from the NRV. This is mainly a result of fire suppression activities over the last 100 years. Both ungulate and livestock grazing/browsing is a concern and can negatively affect sagebrush. Additionally, invasive species are a continual problem, especially after fire events but the Forest is having good success with aerially treating large areas of Cheatgrass infestations with excellent results. The Revision Team is HIGHLY certain that this classification is accurate, primarily because of the climate variability and fire suppression activities experienced to date but also because the Forest actively pursues management actions to treat the ecosystem from its biggest threat – invasive annual grasses.

The long-term trend (to 2050) integrity is considered MODERATE. This rating is based primarily on the resilience of this ecosystem and the successes the Forest has had treating invasive annual grasses. The Revision Team considers this ranking with HIGH certainty – although the future severity of climate impacts is not fully known, the Forest is extremely proactive in dealing with invasive grasses and that effort will be maintained.

The degree the Forest can affect change in this status is HIGH for the near term and HIGH for the long term. Management actions that can provide benefits to the ecosystem include prescribed fire, conifer removal, invasive species treatments, sound livestock grazing practices, and restoration activities. These actions may provide enhanced ecosystem benefits in both the near and long term. The Revision Team is HIGHLY certain that this classification for the degree the Forest can affect change is accurate for the near term and considers it a HIGH certainty that the Forest can affect change over the long term.

Subalpine Forb Ecosystem

Landfire does not have an adequate BpS description for this ecosystem.

Ecosystem Description

Geographic Range

Unique among the forest and rangeland ecosystems in the western United States is one broadly referred to as the Subalpine Forb Ecosystem, which includes a complex of 15 identified subalpine forb community types (Gregory 1983), including a unique subset of plant community types broadly referred to as “tall forb” community types (Baigas 2009). While subalpine forb ecosystems occur throughout the subalpine zone in North America, tall forb community types occur on a smaller scale, extending from the southern Wasatch range in Utah northward into Montana, east and west slopes of the Teton Range on the Idaho-Wyoming border, eastward into the Big Horn Mountains, along the southern border of the Jarbridge Mountains in Idaho-Nevada, the Ruby Mountains of Nevada, and the Uinta Mountains in Utah (Spaeth 2022a). Tall forb community types occur in subalpine areas of the Bridger-Teton, primarily in the Wyoming, Salt River, and Gros Ventre Ranges.

Subalpine forb community types are unique from other cover types in that successional processes on these sites reach their potential by supporting a vast array of colorful flowering forb species while the surrounding lands support a variety of trees, shrubs, and/or graminoids. Subalpine forb habitats may occur as small openings in forests or large open parklands in the subalpine zone. Although minor on the landscape, their ecological importance is disproportionately high because of the ecosystem services they provide, including: wildlife and pollinator habitat, watershed function, biodiversity, and biomass. Many plant species that occur on these sites are important to indigenous peoples, and plant communities contribute to the seedbank and biodiversity. Forb sites provide forage for wildlife and hunting opportunities for upland game species. The wide variety of forbs, which bloom from early summer until fall, have an aesthetic value that appeals to recreationists.

Tall forb community types are exemplified by high plant diversity and a wide variety of luxuriant wildflowers (Winward 1998), and they are arguably some of the most important types within the subalpine forb ecosystem and on the Bridger-Teton because when healthy, they store water and contribute to watershed health (Zobell et al. 2023). Situated in the upper portions of watersheds,

their condition affects the entire downstream ecosystem. Intact tall forb communities provide hydrologic services including water retention, storage, and slow runoff release from spring snowmelt and intense summer thunderstorms (Winward 2011) which in turn support aquatic habitat. In addition, plant biomass contributes to soil formation, air quality, and erosion control as well as proper water and nutrient cycling.

Biophysical Site Description

The subalpine zone of the Bridger-Teton is generally between 6,000-10,000 feet elevation and exhibits incredibly diverse flora. Subalpine Forb plant communities have evolved in a montane climate characterized by cool, dry summers and cold, wet winters. Average annual precipitation of this site typically ranges from 22 inches or more. About three-quarters of the moisture is received during the plant dormant winter period (October – May). About half of the total site precipitation occurs as snow and usually remains in place during the winter with some drifting. Annual snowfall averages 150 to 200 inches per year (Spaeth 2022b). According to the Bridger-Teton's most recent vegetation data, there is a total of 72,102 acres, or approximately 2 percent of the Bridger-Teton, classified as subalpine forb community types.

Vegetation Description

Subalpine forb plant communities are found on all aspects and slope gradients, near springs, along streams, in small forest openings and large open high elevation parklands with a variety of soil conditions. On average, perennial forb species comprise about 70-80 percent of the species composition, 20-30 percent grasses and grass-likes, and shrubs (0-2) percent (Spaeth 2022b).

Stands vary in number of species present and in those that are visually prominent (USDA 1997).

Common species of the subalpine forb ecosystem on the Bridger-Teton, as described by Gregory (1983) include: white marsh marigold (*Caltha leptosepala*), tall fringed bluebells (*Mertensia ciliata*)*, false hellebore (*Veratrum californicum*), spearleaf arnica (*Arnica longifolia*), fireweed (*Chamerion angustifolum*), goldenrod (*Solidago* spp.)*, cutleaf balsamroot (*Balsamorhiza macrophylla*)*, fern-leaf licorice-root (*Ligusticum filicinum*)*, western coneflower (*Rudbeckia occidentalis*)*, showy goldeney (*Heliomeris multiflora* var. *multiflora*), nettleleaf giant hyssop (*Agastache urticifolia*)*, common cowparsnip (*Heracleum maximum*)*, arrowleaf balsamroot (*Balsamorhiza sagittata*), mule-ears (*Wyethia amplexicaulis*)*, tall larkspur (*Delphium x occidentale*)*, oneflower helianthella (*Helianthella uniflora*)*, owl's-claws aka sneezeweed (*Hymenoxys hoopesii*), silvery lupine (*Lupinus argenteus*)*, Virginia strawberry (*Fragaria virginiana*), and tobacco root (*Valeriana edulis)** (Gregory 1983). Other species include: sticky purple geranium (*Geranium viscosissimum*)*, alpine leafybract aster (*Symphyotrichum foliaceum*)*, thickstem aster (*Eurybia integrifolia*)*, western sweetroot (*Osmorhiza occidentalis*)*, Engelmann's aster (*Eucephalus engelmannii*), Columbian monkshood (*Aconitum columbianum*)*, aspen fleabane (*Erigeron speciosus*)*, stickseed (*Hackelia* spp.)*, Porter's licorice-root (*Ligusticum porteri*)*, lousewort (*Pedicularis* spp.), tall cinquefoil (*Potentilla arguta*)*, slender cinquefoil (*Potentilla gracilis*)*, groundsel aka ragwort (*Senecio* spp.)*, meadow-rue (*Thalictrum* spp.), and western valerian (*Valeriana occidentalis*)*. Certain grass and sedge species occur as a minor component of subalpine forb communities, particularly mountain brome (*Bromus marginatus*) (Gregory 1983), Raynolds sedge (*Carex raynoldsii*), slender wheatgrass (*Elymus trachycaulus*) and oniongrass (*Melica* spp.) (Zobell 2023; USDA 2023e; Gregory 1983; Winward 1998).

Please note: * Denotes species dominant or associated with tall forb community types (Gregory 1983; Winward 1998).

Ecosystem Integrity Evaluation

1. What ecological drivers and stressors and other key characteristics are most responsible for ecological integrity when the system has high integrity? (Include the level of uncertainty and condition/geographic differences).

The Natural Range of Variability (NRV) of the subalpine forb ecosystem is characterized by the dominance of perennial forbs and low amounts of unprotected bare ground. Although 15 distinct subalpine forb community types have been identified on the Bridger-Teton (Gregory 1983), management actions and objectives are focused on a smaller subset of tall forb community types. Each community type is described and can be recognized by the dominant plants that occur (Gregory 1983). However, the successional status, ecological dynamics, and site potential for each type are only briefly described and poorly understood. Therefore, the Bridger-Teton is working toward utilizing the Ecological Site Description (ESD) framework to describe important site concepts that occur on the forest.

The USDA defines an ecological site as a distinctive kind of land with specific soil and physical characteristics that differs from other kinds of land in its ability to produce distinctive kinds and amounts of vegetation and in its ability to similarly respond to management actions and natural disturbances (Caudle et al., 2013). Unlike other vegetation classification systems, ecological site descriptions (ESDs) use: climate, soil, geomorphology, hydrology, and vegetation potential to describe the ecological potential and dynamics. ESDs describe ecological processes, called states, resulting in various plant communities, described as plant community phases, on the same ecological site because of natural processes (i.e. disturbance regimes such as fire) or management actions. Ecological drivers and stressors are a key element of describing ecological dynamics on an ecological site. Once developed, ESDs will provide expected species composition, foliar and ground cover, and productivity for the dominant ecological sites and their Reference State (site potential within the NRV), alternate States (process-based) and plant community phases (plant dominance-based). ESDs are not prescriptive of the Desired Plant Community (DPC), but they provide descriptions of plant communities that are possible given the existing ecological processes on the site for managers to choose from as their DPC on a site-specific basis. Until ESDs are developed, ecological drivers and stressors can only be discussed generally as they relate to all subalpine forb community types.

Drivers and stressors within the NRV are primarily climate driven or associated with herbivory and pocket gophers. Climate, in particular temperature, precipitation and snowpack duration that fall within the NRV maintain subalpine forb communities in their Reference State and contribute to a high integrity system. Herbivory and the subsequent soil impacts that result from ungulates or domestic sheep herbivory can still contribute to high integrity conditions if those actions are within the NRV and do not alter key processes such as nutrient and water cycling through forage removal beyond sustainable levels or soil erosion caused by heavy trampling and utilization.

Herbivory continues to be a potential driver for ecological dynamics that requires continued careful management. Another aspect of subalpine forb ecological dynamics is the common occurrence of native pocket gophers, which create burrow systems, eskers, and mounds in the upper 8-10 inches of the soil profile (Zobell et al 2023). While the role of pocket gophers is not completely understood, they can provide benefits to properly functioning communities through the aeration of soil. However, there is evidence to suggest that they may also influence species composition and the amount of ground cover (Zobell et al. 2023). Available management actions on the Forest have little to no influence on major air pollution sources or the climate trajectory associated with these two issues. However, the Forest can manage livestock grazing, invasive species, recreation impacts and implement restoration activities when appropriate in this ecosystem.

The Revision Team considers these Key ecosystem characteristics and drivers/stressors typical of high integrity with **HIGH certainty**.

2. What features of the ecosystem currently compromise (or support) ecological integrity and what are the mechanisms for the trend? Highlight important drivers, stressors, key ecosystem characteristics, and assess the degree to which management can or cannot influence this trend).

With anticipated rising temperatures, rain replacing snow events, extended drought, and variable precipitation extremes, these climate variables are likely to serve as significant stressors/drivers and impact plant structure, survivability, reproduction and growth yield.

Changes in relative humidity outside the normal range can affect soils, plants, and lichens as well as seedling survival. Vapor-pressure deficit, a measure which integrates temperature and precipitation, can also negatively affect plant functions as the atmosphere dries. Extreme rain events can cause flooding, landslides and extreme erosion that can alter the vegetation structure, soil quality and function on the site. Additionally, climate change scenarios may exacerbate the current decline in pollinators in this ecosystem and lead to increased occurrences of temporal mismatch between plants and pollinators. Both these issues can lead to loss of plant biodiversity and seed banks needed to recover from disturbances.

Fire is currently not an important driver or stressor of this ecosystem since it seldom burns, and plant growth forms quickly return after fire. However, warming trends could result in the snowpack melting-out earlier and drastically affect forb species composition. Without precipitation after melting off, soil moisture would be reduced, and soil temperatures would increase at the expense of the plant species trying to survive in this high elevation environment. This could subsequently lead to alteration of the plant community, increase bare ground, and make the site more vulnerable to invasive plant species. Climate changes could impact the timing of major rain events, altering them to timeframes when the ground cover on these sites is not adequate to protect the soil surface. Without adequate cover providing soil protection, significant erosion could occur from these events, which would decrease the site's ability to maintain plant communities with NRV.

Recreation in this ecosystem can have a negative impact with human disturbance, human waste, and dispersed camping and off trail hiking impacts, especially in areas with shallow soils. This can alter the vegetation as well as introduce invasive species. When the soil surface is bare, the fine soil textures in this ecosystem are more susceptible to structural crusting after rain events. The structural soil crust seals the soil surface, preventing water infiltration and

increasing erosion. Increased soil erosion leads to the formation of gullies and washouts after heavy rain events. Illegal off-road activity and heavily used dispersed camping causes soil compaction, reduces the density and structure of the vegetation and increases the percentage of bare ground. Soil compaction increases the natural susceptibility of erosion of these soil types, resulting in poor soil retention and high rates of erosion. Recreational overnight and horse use can lead to overutilization of forage resources, eroding soil, invasive plant species introduction and spread, compaction and animal waste that can negatively affect the plants and nearby water resources.

Ungulates (i.e., elk and deer) and livestock (primarily domestic sheep), can be a stressor on the ecosystem on both the soil resource and grass/forb component if overutilized. Elk and deer will use subalpine forb sites in the summer. Ungulate populations that are above population objectives can overgraze and cause significant soil loss and a reduction in species diversity.

Historically, domestic sheep stocking rates on the Bridger-Teton were approximately 4-5 times current levels. Range allotment files document historic resource concerns of soil erosion, mainly associated with trailing, and excessive utilization of subalpine forb communities. These documented concerns, in addition to changes in wool markets post-World War II, resulted in decreased stocking and changes in management over time. For example, allotments and grazing permits were implemented beginning in the early 1900s, livestock numbers reduced from hundreds of thousands of domestic sheep in the 1930s to less than 40,000 currently permitted, and current day sheep grazing on subalpine forb areas does not occur until July, reducing the negative effects of early foliar cover removal. Since 1990, the Bridger-Teton has significantly reduced stocking levels and employed grazing management that controls intensity, frequency, duration, and distribution is employed to minimize soil loss and maintain appropriate utilization levels. Once-over and rotational grazing practices replaced season long grazing and best management practices have been implemented through annual operating instructions and allotment management plans.

The Revision Team considers these Key ecosystem characteristics and drivers/stressors that can compromise (or support) integrity with **HIGH certainty.**

3. How does the current status and trend of the ecosystem (ecological integrity and the elements that are compromised) influence delivery of ecosystem services?

Forest Service guidelines to evaluate the current status and trends of upland rangelands include presence of invasive plants, species composition, and ground cover, which is defined by the Forest Service as basal vegetation, litter, moss/lichen, and rock greater than ¾-inch diameter (USDA 2005b). The minimum ground cover for proper functioning tall forb cover types was determined to be 80% in *Indicators of Rangeland Health and Functionality in the Intermountain West* (O'Brien 2003). However, guidelines allow for a deviation from this standard if more site-specific information is available (USDA 2005b). The Bridger-Teton does not currently have more site-specific guidance, and there are no guidelines for subalpine forb community types that are not considered tall forb communities. Individual allotment management plans utilize standard guidance of 80% ground cover or identify other objectives, including but not limited to utilization levels, bare ground, frequency, species composition (cover), and species richness. Trend information is based on a combination of the above metrics and repeated photo points.

The Wyoming Range Allotment Complex (WRAC) and Triple Peak Forage Reserve (TPFR) were established in 2004 and 2008 to address concerns with overlap of bighorn sheep core

area (WRAC) and to improve watershed health in Colorado River Cutthroat Trout (CRC) critical areas (Sublette County Conservation District 2019a, 2019b). Three of the allotments in the WRAC are a result of the permittee waving the permit back to the Forest Service without preference and remaining vacant while the remaining allotments are closed to grazing. Closed allotments are closed to scheduled grazing and require a NEPA analysis to open them to any grazing while vacant allotments allow for a temporary permit and require NEPA analysis to obtain a 10-year permit.

Objectives for the WRAC and TPFR include 80% ground cover for all tall forb community types and 5% canopy cover for at least one listed key plant species (sticky purple geranium, fernleaf licorice-root, one flower helianthella, tobacco root, or mountain brome) (Sublette County Conservation District 2019a, 2019b). There are 11 monitoring locations in the WRAC and TPFR, where domestic sheep grazing was removed over 20 years ago, with 55% of sites showing a stable or upward trend, defined as similar or increasing ground cover over the monitoring timeframe of 1983 to 2019 (Sublette County Conservation District 2019a, 2019b). Most sites (82%) met the objective of 5% or greater cover of at least one of the identified key plant species. None of the sites meet established ground cover objectives of 80 percent. However, the mean ground cover for all sites is 63 percent, with all but three sites exceeding Forest Service guidance indicating 60 percent ground cover required to protect soil resources (O'Brien 2003). Mean bare ground for all sites is 12 percent, and all but one site has less than 20 percent bare ground. Mean foliar cover for all sites is 79 percent, and all but two sites have greater than 60 percent foliar cover, an indicator of soil protection from rain events (Sublette County Conservation District 2019a, 2019b). A significant number of sites (45%) show a downward trend since grazing was removed from the area, indicating variables other than livestock grazing affecting these sites. However, the long-term trend compared to the 1950s and 1960s is upward. In addition, Colorado River Cutthroat Trout (CRC) have responded positively, with re-establishment in Mule and Silver Mine creeks since the establishment of the WRAC (Rhea 2016).

There are 30 active sheep allotments that intersect subalpine forb community types on the Bridger-Teton, and their management objectives include providing livestock forage, roads, trails, and driveways to manage livestock grazing, meeting or exceeding state water quality standards, providing suitable and adequate habitat for game and fish, protecting sensitive plant and animal species, retaining or improving forage and range conditions, retaining or enhancing riparian areas, coordinating livestock management with recreation, preventing human interference with livestock operations, controlling the spread of noxious weeds, and implementing predator-control programs where intolerable losses to livestock are demonstrated (USDA 1990).

Range staff have established hundreds of subalpine forb monitoring studies in grazed allotments where various sampling methods are used to determine condition and trend. Based on a sample size of 13 allotments representing 72% of the monitoring locations, approximately 30% of the allotments are upward, 60% apparently stable, and 10% downward trending. Mean ground cover as defined by the Forest Service is 53% for a sample size of 45 monitoring locations (n = 45), while mean ground cover as defined by the *Monitoring Manual for Grassland, Shrubland and Savanna Ecosystems Volume II: Design, supplementary methods and interpretation* (Herrick et al., 2009), which includes vegetation foliar cover in addition to litter, moss/lichen, and rock greater than ¾-inch diameter, is 81 percent (n = 96). Mean foliar cover is 70% and mean bare ground is 14% (n = 137) and species richness is 25 (n = 117). Sampled locations (n = 25) average 18% utilization with less than 3% of sites exceeding established utilization objectives. In addition, there are many photo points illustrating trend over time and

highlighting a reduction in soil loss and stabilization in gullies with fewer active gullies compared to conditions prior to 1990. Best management practices used to manage domestic sheep grazing include once over grazing, one night per bedding ground, open herding, and placement of mineral locations.

Analysis and discussion of condition and trends point to several key issues when setting realistic objectives, selecting monitoring locations and methods, and analyzing the data. The currently identified community types for the forest occur on a variety of soils, aspects, slopes, landscape positions, and precipitation and elevation ranges. They include tall forb as well as subalpine forb community types not considered tall forb sites. Therefore, the site potential in terms of species composition, foliar and ground cover, and productivity likewise vary. Even the subset of community types considered “tall forb” types occur on a variety of sites with different effective moisture which affects their site potential. When setting objectives, there is a need for more site-specific guidance that considers site potential.

When selecting monitoring locations, it is important for managers to choose sites representative of the dominant ecological sites that occur and are described on the forest, and monitoring methods will need to conform to the metrics described in the ESD. When analyzing the data, using metrics identified in the objectives and described in the ESD will ensure consistency that is currently lacking for the Bridger-Teton range monitoring program.

In addition to vegetation monitoring, the Bridger-Teton is monitoring other resources on the forest that rely upon subalpine forb communities. In response to a 1997 PFC Assessment of the Bridger-Teton, which indicated some sensitive, disjunct or isolated colonies of butterflies are at risk of disappearing (USFS 1997), baseline monitoring has been established with nearly 200 species/genera of pollinators documented to date (DeLong unpublished). Once a baseline is established, the Bridger-Teton can monitor pollinator trends into the future.

Threats to floral resources include changes in precipitation and temperature that impact nutrient cycling, soil formation and primary production, which may negatively impact pollinator habitat as well as water and air quality and erosion. Other potential threats include unmanaged grazing and impacts from recreational activities, mainly roads, trails, and the introduction of invasive species. Activities currently used to address threats to the subalpine forb ecosystem include invasive species treatments as well as managed grazing and recreation. Seed collection and planting has not been used for these systems in recent years but remains a viable restoration activity if appropriate plant materials are used for existing soil conditions.

The Revision Team considers the ecological integrity and the elements that are compromised that influence delivery of ecosystem services with **HIGH certainty**.

4. What is the status of each ecosystem–the level and trend of ecological integrity (High, Moderate, Low, or Poor) in the plan area and surrounding lands; and to what degree can the Forest affect change in this status?

The current level of ecological integrity for this ecosystem is MODERATE. This is the result of historic overgrazing by domestic sheep and recreational activities, which resulted in vegetation alteration and soil loss at localized subalpine forb sites combined with the subsequent changes to current day management that have improved conditions over the past 30 years. Additionally, livestock numbers have been reduced from hundreds of thousands of domestic sheep to approximately 40,000; currently sheep grazing on subalpine forb communities does not occur

until July, reducing the negative effects of early foliar cover removal. Changes in management on the Forest have resulted in upward trends at many monitoring locations (Sublette County 2019a, b). The Revision Team is HIGHLY certain that this classification is accurate, primarily because of the work the Forest and partners have done over the years monitoring subalpine forb sites in active allotments and allotments that have not experienced sheep grazing for a long period of time.

The long-term trend (to 2050) for the integrity of this ecosystem is also considered MODERATE based on current trend monitoring, which shows that most sites are stable or in an upward trend in response to current management efforts, but there are still a small proportion of sites trending downward. The Revision Team considers the level of certainty HIGH for this ranking. Long-term trends from the 1950s to present show dramatic response and recovery. However, few opportunities for ecological restoration of altered sites exist at a meaningful scale.

The degree to which the Forest can affect change in the status of this ecosystem is MODERATE for the near and long term. Management actions that provide benefits to the ecosystem include invasive species treatments, managed grazing, seed collection and planting when appropriate, and managing recreation impacts. Climate change is anticipated to decrease the chances of successful restoration. The Revision Team is MODERATELY certain that this classification for the degree the Forest can affect change is accurate for both the near and long term.

Alpine Ecosystem

Ecosystem Description

Geographic Range

The Alpine Ecosystem is made up of three different, but similar biophysical settings: (1) Rocky Mountain Alpine Dwarf-Shrubland, (2) Rocky Mountain Alpine Turf, and (3) Rocky Mountain Alpine – Mountain Sparsely Vegetated Systems; there is no description in Landfire (2023) for the

“Sparsely Vegetated Systems”, but it consists primarily of high-elevation rocky outcrops and granite above timberline with little vegetation. This widespread ecological system occurs above upper timberline throughout the Rocky Mountain cordillera, including alpine areas of ranges in Colorado, New Mexico, Arizona, Utah, Nevada, Idaho, Montana, Wyoming and north into Canada. Alpine areas occupy a relatively small area within the Forest. Although the total acreage is small, the Forest has a larger proportion of Alpine than typically found in other areas of the Region. Alpine exists at high elevations of the Wind River Range, Teton Wilderness and Gros Ventre with smaller pockets found in the Salt River Range (USDA 1997). The Alpine Ecosystem is mapped at approximately eight percent of the Forest.

Biophysical Site Description

Alpine communities occur above timberline and are characterized by herbs and dwarf shrubs. They may be densely vegetated to almost entirely barren rock. In most cases where vegetation exists, total ground cover is high. Species and community diversity is limited by such harsh growing conditions as: heavy winds, cold temperatures, and ultraviolet radiation. Vegetation structure rarely exceeds 4 inches in height with occasional low-growing shrubs 2-3 feet in height. Large woody debris is scarce. Found on gentle to moderate slopes, flat ridges, valleys, and basins, where the soil has become relatively stabilized and the water supply is constant.

Lower elevation Alpine communities, in general, tend to contain more vegetation cover than those found in higher elevations. Elevation, aspect, soil, and geology vary among the mountain ranges. The Wind River Range is composed of granitic material, the mountains of the Teton Wilderness are comprised of volcanic material, the Gros Ventre is made up of dolomite and limestone, and the Salt River Range, which has lesser amounts of Alpine, is part of the Overthrust Belt which is composed of a more sedimentary material. This difference in parent materials, along with elevation and aspect, have contributed to the large variability in the diversity and density found among Alpine communities of the Forest (USDA 1997).

Vegetation Description

Vegetation in these areas is controlled by snow retention, wind desiccation, permafrost, and a short growing season. Dry summers associated with major drought years (mean return interval of 100 years) would favor grasses over forbs, whereas wet summers cause a more diverse mixture of forbs and graminoids. This ecological system is characterized by a semi-continuous layer of ericaceous dwarf-shrubs, or dwarf willows which form a heath type ground cover less than 0.5m in height. Dense tuffs of graminoids and scattered forbs occur. Dominant vegetation includes Western moss heather, Entireleaf mountain-avens, Eightpetal mountain-avens, Arctic willow, Netleaf willow, Pink mountainheath, Blueberry, Fleabane, Boreal sagebrush, Blackroot sedge, Dryspike sedge, Northern singlespike sedge, Spike sedge, Curly sedge, Tufted hairgrass, and Alpine fescue.

Ecosystem Integrity Evaluation

1. **What ecological drivers and stressors and other key characteristics are most responsible for ecological integrity when the system has high integrity? (Include the level of uncertainty and condition/geographic differences).**

Key ecosystem characteristics when the system exhibits high integrity include areas where human use or pressures from recreational activities are limited. Accelerated erosion is the main concern. Such erosion is cumulative and will continue to accelerate and move downward through other parts of the watersheds. Biotic soil crusts (which can have a combination of lichens, cyanobacteria, moss, green algae, fungi, and bacteria) can be important components of alpine ecosystems and prevent erosion, retain moisture, nutrient cycling and contribute to soil formation. They are fragile and do not hold up well to disturbance such as recreation. Increased recreation in the Wind River Range (if this is true of the whole Forest then just say that) is damaging Alpine ecosystems and will continue to do so. Fire return interval is approximately 500yrs+. It has been suggested that it might be as high as 2,000 years as there is little evidence of spreading fire in this system. Ignitions are often limited to a single snag or small group of trees.,

Drivers and stressors are primarily climate driven. Climate, in particular temperature, wind, precipitation, glacier extent, and snowpack duration that fall within the NRV would be consistent with contributing to a high integrity system. Herbivory and the subsequent soil impacts that result from ungulates or domestic sheep moving through and utilizing alpine sites contribute to high integrity conditions if those actions are within the NRV and do not negatively impact vegetative cover and soil conditions. Native herbivores (Rocky Mountain bighorn sheep, mule deer, elk, and pica) are common in the Alpine, but do not greatly affect vegetation cover because animals move frequently in this environment.

Deposition from air pollution can negatively affect lichen, mycorrhizae, and native plant growth, survival, and ability to compete with invasive species.

Ground cover within the NRV provides shade, erosion control and food for wildlife and consists of krummholz trees, shrubs, forbs, and grasses. Soils have weak development, often shallow to bedrock with high percentages of rock fragments, primarily located in areas of dense vegetation and water supply. Vegetated areas provide natural erosion control and reduces the threat of slumping or landslides. The soils that are associated with alpine ecosystems are primarily Entisols and Inceptisols.

The Revision Team considers these Key ecosystem characteristics and drivers/stressors typical of high integrity with **High Certainty**.

2. What features of the ecosystem currently compromise (or support) ecological integrity and what are the mechanisms for the trend? Highlight important drivers, stressors, key ecosystem characteristics, and assess the degree to which management can or cannot influence this trend).

Climate change is a significant stressor/driver and can impact plant structure, survivability, phenology, reproduction and growth yield with rising temperatures, extended drought, and precipitation extremes. Relative humidity can affect soils, plants, and lichens as well as seedling survival. Vapor-pressure deficit, which integrates temperature and precipitation can also affect plant functions through drying of the atmosphere. Extreme rain events can cause flooding, landslides and extreme erosion that can alter the vegetation structure, soil quality and function on the site. Additionally, climate change scenarios will likely exacerbate the current decline in pollinators (specifically western bumblebee) in this ecosystem, and lead to increased occurrences of temporal mismatch between plants and pollinators. Both these issues can lead to loss of plant biodiversity and seed banks needed to recover from disturbances.

If temperatures fluctuate and warming trends move upward, this could result in the snowpack melting-out earlier. If there is no follow-up precipitation after that melt-off, soil moisture would be reduced, and soil temperatures would increase at the expense of the plant species trying to survive in this high elevation environment. Melting glaciers directly impact those species that depend on glaciers for their survival. Glaciers typically hold a higher concentration of chemicals than perennial snowpack. Glaciers that were cored in the Wind River Range found concentration of nitrates in the glacier that corresponded with the industrial revolution. As these Glaciers melt, they release stored chemicals into the systems downhill. Alpine lakes that are glacially fed usually have a different chemistry and pH than adjacent alpine lakes fed by perennial snowpack. Also, could see an upslope movement of insects and diseases as warming temperatures create an environment these species can colonize and survive.

Deposition of air pollutants can damage lichens and affect community composition over time. In alpine systems air pollution and climate can affect crustose lichens, macrolichens growing on soil, and biotic soil crusts. Crustose lichens on rocks are part of the weathering cycle and contribute to soil formation. Excess nitrogen tends to give an edge to the sedges, especially Carex species at the expense of forbs. Dust storms that originate from agricultural centers with common-practice pesticide and herbicide us, will likely contain chemicals such as glyphosate. It is possible these chemicals may negatively affect native plants, pollinators, and aquatic organisms. Recreation in this ecosystem can have a negative impact with human disturbance, human waste, and dispersed camping and off-trail hiking impacts, especially in areas with

shallow soils. This can alter the vegetation as well as introduce invasive species. Soils are more susceptible to erosion and "crusting" in this ecosystem, which can create gullies and washouts after heavy rain events. Saxicolous crustose lichens, small lichens that adhere to rocks, exude chemicals that break down rocks over time. They also provide housing and food for small insects. Recreation use has increased significantly over the past few decades. Expanded trail networks, both system and user created, have contributed to increases in bare ground. Although impacts occur throughout the Forest, some of the most severely impacted areas due to recreation use and the fragile alpine system, occur at Alpine winter recreation areas (displaced wildlife) and in the Wind River Range (trampling alpine vegetation and rock lichens).

Teton Range Bighorn Sheep

Because of habitat lost to development, these sheep cling to existence in rugged high country, enduring brutal winter conditions above timberline in the Alpine ecosystem. A primary threat includes the loss of crucial winter range due to recreational (skier and snowmobile) disturbance. In some cases, sheep effectively lost up to 30% of the available winter habitat in their home range because of displacement by skiers. In other places, sheep were forced to move to avoid skiers, burning precious energy during winter, which can result in poor reproduction and starvation.

Available management actions on the Forest have little to no influence on major air pollution sources or the climate trajectory associated with these two issues. However, the Forest can manage livestock grazing, invasive species, recreation impacts and implement restoration activities in this ecosystem. Other management activities which have influenced these areas are State fish-stocking practices. Many of the Alpine lakes, including those within Wilderness, have had non-native fish introduced. In addition to introducing and/or changing the fish species, influences on invertebrates and amphibians are suspected. While amphibian populations seem to be declining, fish continue to populate lakes which have historically been fishless (USDA 1997).

The Revision Team considers these key ecosystem characteristics and drivers/stressors that can compromise (or support) integrity with **High Certainty**.

3. How does the current status and trend of the ecosystem (ecological integrity and the elements that are compromised) influence delivery of ecosystem services?

The current status of the integrity across the Forest is of concern if recreation use (i.e., trails, backcountry use, and ski area development, etc.) continues to increase and reaches a critical threshold impacting the shallow soil structure characteristic of this ecosystem. The trend for integrity is likely dependent on recreational activity in the future and the impacts that result from that activity. Climate change will continue to stress the area, especially through glacier melting and reduced snowpack. Air pollution deposition of nitrogen could invite invasive species to get a foothold in this system as well as increase the number of waterbodies infected with cyanobacteria blooms.

This ecosystem does not play a major role in livestock use because of the relatively low stature of the available vegetation and amount of bare ground and rock that is a characteristic. However, bighorn sheep use these Alpine areas, primarily in the summer but also in the winter by the Teton Range Herd. Any reduction in available forage could result in negative impacts to bighorn sheep, whether that is over-winter survival or reduced reproductive output. Water, air

quality, erosion and natural hazard regulations could all be negatively impacted through increases in soil loss from human traffic associated with backcountry recreation.

Human waste could further degrade water resources. Recreation and aesthetics could be negatively impacted if changes to the system result in a landscape that is considered less desirable by humans. Nutrient cycling, soil formation and primary production are likely on a downward trend as a result of climate change and the subsequent impact that may have on the shrubs, forbs, and grasses in this ecosystem, which are critical in holding the soil in place in this extreme environment.

The Revision Team considers the ecological Integrity and the elements that are compromised that influence delivery of ecosystem services with **High Certainty**.

4. What is the status of each ecosystem–the level and trend of ecological integrity (High, Moderate, Low, or Poor) in the plan area and surrounding lands; and to what degree can the Forest affect change in this status?

Current integrity rating	Certainty	Long-term integrity trend	Certainty	Short-term ability to affect	Certainty	Long-term ability to affect	Certainty
Moderate	High	Low	Moderate	Moderate	High	Moderate	High

The current status of the integrity of the ecosystem is MODERATE. Overall, the hydrologic functioning of Alpine communities seems to be intact. The risk associated with this ecosystem is of concern if recreation use (i.e., trails, backcountry use, and ski area development, etc.) continues to increase and reaches a critical threshold impacting the shallow soil structure characteristic of this ecosystem. The Revision Team is HIGHLY certain that this classification is accurate, primarily because the ecosystem is still functioning across much of its range in a good condition but there are issues compromising it, especially in the Wind River Range and the ever-increasing numbers of recreationists stressing the system.

The long-term trend (to 2050) integrity is considered LOW. This rating is based on the continued increase in recreational activity in the future and the impacts that result from that activity. Climate change will continue to stress the area, especially through glacier melting and reduced snowpack. Air pollution deposition of nitrogen could invite invasive species to get a foothold in this system as well as increase the number of waterbodies infected with cyanobacteria blooms. The Revision Team considers this ranking with MODERATE certainty because of the uncertainty surrounding future climate impacts and numbers of recreationists.

The degree the Forest can affect change in this status is MODERATE for the near term and MODERATE for the long term. Management actions that can provide benefits to the ecosystem include invasive species treatments, sound livestock grazing practices, managing recreation impacts and restoration activities. The Revision Team is HIGHLY certain that this classification for the degree the Forest can affect change is accurate for both the near and long term.

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Appendix B: Biophysical Setting Departure Analysis – Landfire 2020

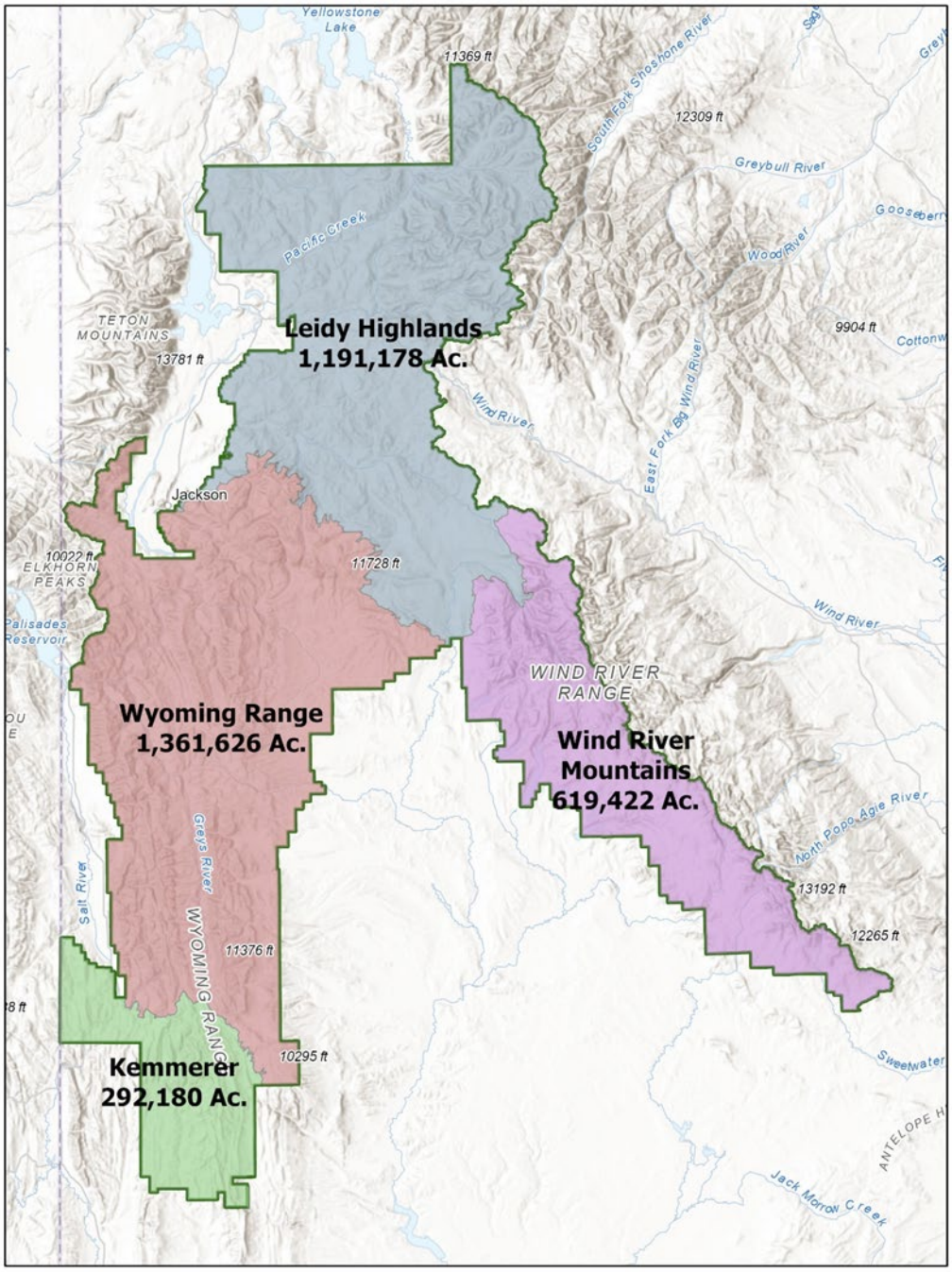


Figure 67. Bridger-Teton Landscapes

Table 70. Acres of the 6 primary Biophysical settings across the forest

Biophysical Setting - Forestwide	Sum of Acres	% Of Forest
Inter-Mountain Basins Montane Sagebrush Steppe	355,618	10.3%
Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	168,143	4.9%
Northern Rocky Mountain Subalpine Woodland and Parkland	340,570	9.8%
Rocky Mountain Aspen Forest and Woodland	322,024	9.3%
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	1,226,862	35.4%
Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland	314,606	9.1%
Sub Total	2,727,823	78.7%
Other BPS, Open Water, Rock, etc.	737,032	21.3%
Grand Total	**3,464,855**	**100%**

Table 71. Acres within each major biophysical setting, by landscape

Biophysical Settings by Landscape	Sum of Acres
Kemmerer	**270,030**
Inter-Mountain Basins Montane Sagebrush Steppe	51,636
Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	20,204
Northern Rocky Mountain Subalpine Woodland and Parkland	7,701
Rocky Mountain Aspen Forest and Woodland	40,272
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	132,233
Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland	17,984
Leidy Highlands	**951,020**
Inter-Mountain Basins Montane Sagebrush Steppe	108,160
Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	11,162
Northern Rocky Mountain Subalpine Woodland and Parkland	152,533
Rocky Mountain Aspen Forest and Woodland	79,494
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	497,472
Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland	102,200
Wind River Mountains	**404,189**
Inter-Mountain Basins Montane Sagebrush Steppe	43,083
Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	16,920
Northern Rocky Mountain Subalpine Woodland and Parkland	95,400
Rocky Mountain Aspen Forest and Woodland	30,773
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	215,369
Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland	2,644
Wyoming Range	**1,102,584**
Inter-Mountain Basins Montane Sagebrush Steppe	152,740

Biophysical Settings by Landscape	Sum of Acres
Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	119,856
Northern Rocky Mountain Subalpine Woodland and Parkland	84,937
Rocky Mountain Aspen Forest and Woodland	171,486
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	381,787
Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland	191,777
Grand Total	**2,727,823**

Departure Analysis – Succession Class (S-Class) Departure:

The S-Class relative amount metric indicates individual S-Classes that are departed within a given BpS and landscape. This metric is especially informative because it indicates whether the current amount of an individual S-Class is deficient or excessive relative to the reference proportion and therefore provides information on whether a particular S-Class needs to be reduced, maintained, or recruited to move the BpS towards the reference condition. S-Class relative amount is divided into three categories: Deficit, Similar, and Surplus (Table 72).

Table 72. S-Class relative amount definitions

Current S-Class Relative Amount	Range of Percent Different from Reference Portion
Deficit	-100% and -33%
Similar	-33% and 33%
Surplus	33% and 100%

Inter-mountain Basin Montane Sagebrush Steppe – S-Classes

Class A 23% Early Development 1 - All Structures

Table 73. Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
FEID	*Festuca idahoensis*	Idaho fescue	Lower
PSSP6	*Pseudoroegneria spicata*	Bluebunch wheatgrass	Lower
Forbs	<NOT FOUND IN NRCS>	<NOT FOUND IN NRCS>	Lower
ARTRV	*Artemisia tridentata ssp. vaseyan*a	Mountain big sagebrush	Lower

Description

Herbaceous cover is dominant but cover is variable. Shrub cover is low and typically ranges from 0-10%; 5% shrub cover indicates good establishment of a post-fire cohort. Purshia tridentata may resprout rapidly after a fire with fairly low percent cover. In drought conditions the survival of these resprouts is low. Grazing is common but rarely severe enough to set back succession.

Historically, this BpS in MZ21 was likely dominated by grassland such as that in succession Class A along the forest ecotone (Houston 1973; Arno and Gruel 1983). Since this type is largely interspersed with forest or occupies a narrow band adjacent to lower timberline, Class A is likely to have dominated the landscape.

In this environment (and a number of the other grassland, shrub steppe types), forb density and cover are most responsive to climatic conditions. Hence, fire response will vary according to precipitation patterns before and immediately after the fire. Forbs are less conducive to fire spread, and they have a high proportion of the overall cover for a couple of years post-fire, especially at higher elevations.

Maximum Tree Size Class - None

Class B 47% Mid Development 1 - Open

Table 74. Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
ARTRV	*Artemisia tridentata ssp. vaseyana*	Mountain big sagebrush	Upper
FEID	*Festuca idahoensis*	Idaho fescue	Lower
PSSP6	*Pseudoroegneria spicata*	Bluebunch wheatgrass	Lower
ARTR4	*Artemisia tripartita*	Threetip sagebrush	Upper

Description

Developing shrubs. Reaching 20% sagebrush cover following a stand-replacing fire takes between 10-33yrs (Tart, personal correspondence). There is a 40% herbaceous canopy cover across this class. *Purshia tridentata* may be present and takes at least 20-30 years to recover pre-burn percent cover. Presence of Purshia tridentata seems to depend on soil type. Native grazing on winter ranges by elk and deer typically decreases sagebrush cover.

Maximum Tree Size Class - None

Class C 30% Late Development 1 - Closed

Table 75. Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
ARTRV	*Artemisia tridentata ssp. vaseyana*	Mountain big sagebrush	Upper
PSSP6	*Pseudoroegneria spicata*	Bluebunch wheatgrass	Lower
FEID	*Festuca idahoensis*	Idaho fescue	Lower
ARTR4	*Artemisia tripartita*	Threetip sagebrush	Upper

Description

Shrubs are dominant. Sagebrush cover rarely exceeds 40% cover. Mountain big sagebrush canopy cover is constrained by competition from herbaceous vegetation on all but the wettest sites (Tart 1996). Competition between herbs and sagebrush is less pronounced on cooler,

wetter sites. High canopy cover of mountain big sagebrush only develops after removal of herbaceous vegetation. Some researchers believe that mountain big sagebrush can never exceed 25% cover (Pedersen et al. 2003), but reviewer Abendroth stated that she has measured over 60% cover. Understory vegetation has low cover in this class. *Purshia tridentata* may be present and may have over 20% cover. Insects and drought stress can thin sagebrush.

Table 76. S-Class Departure for Inter-Mountain Basins Montane Sagebrush Steppe, Forestwide

Row Labels	Reference Percent	Current Percent	Status	Sum of Acres
A	23.0%	27.6%	Similar	98,159
B	47.0%	18.4%	Deficit	65,348
C	30.0%	40.4%	Similar	143,801
UE	0.0%	0.9%	Surplus	3,328
UN	0.0%	12.7%	Surplus	44,982
Grand Total	**100.0%**	**100.0%**		**355,618**

Table 77. S-Class Departure for Inter-Mountain Basins Montane Sagebrush Steppe, by Landscape

Row Labels	Reference Percent	Current Percent	Status	Sum of Acres
Leidy Highlands		**30.4%**		**108,160**
A	23.0%	30.6%	Similar	33,127
B	47.0%	19.3%	Deficit	20,874
C	30.0%	36.4%	Similar	39,377
UE	0.0%	1.4%	Surplus	1,498
UN	0.0%	12.3%	Surplus	13,285
Wyoming Range		**43.0%**		**152,740**
A	23.0%	30.9%	Similar	47,260
B	47.0%	15.5%	Deficit	23,631
C	30.0%	39.4%	Similar	60,217
UE	0.0%	1.1%	Surplus	1,691
UN	0.0%	13.1%	Surplus	19,941
Wind River Mountains		**12.1%**		**43,083**
A	23.0%	18.8%	Similar	8,110
B	47.0%	17.8%	Deficit	7,675
C	30.0%	51.2%	Surplus	22,040
UE	0.0%	0.1%	Surplus	54
UN	0.0%	12.1%	Surplus	5,203
Kemmerer		**14.5%**		**51,636**
A	23.0%	18.7%	Similar	9,662
B	47.0%	25.5%	Deficit	13,169
C	30.0%	42.9%	Similar	22,167

Row Labels	Reference Percent	Current Percent	Status	Sum of Acres
UE	0.0%	0.2%	Surplus	85
UN	0.0%	12.7%	Surplus	6,553
Grand Total		**100.0%**		**355,618**

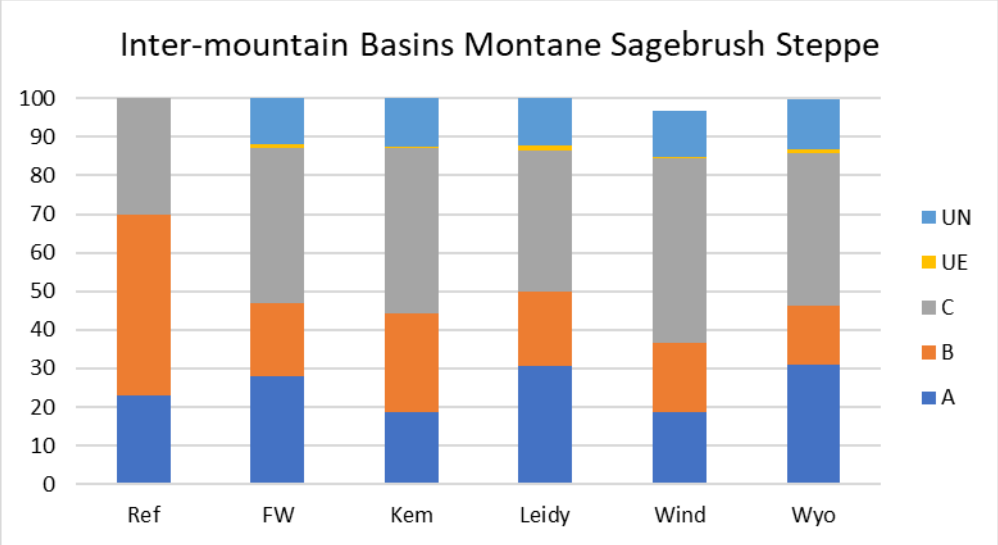


Figure 68. Bar graph displaying intermountain basins montane sagebrush steppe S-classes

Middle Rocky Mountain Montane Douglas-fir Forest and Woodland – S-Class

Class A 7% Early Development 1 - All Structures

Table 78. Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PSME	*Pseudotsuga menziesii*	Douglas-fir	Upper
PICO	*Pinus contorta*	Lodgepole pine	Upper
SYAL	*Symphoricarpos albus*	Common snowberry	Lower
CARU	*Calamagrostis rubescens*	Pinegrass	Lower

Description

Dominated by graminoids and seedling/sapling Douglas-fir and possibly lodgepole pine. Understory may be dominated by *Calamagrostis rubescens* and/or *Carex* spp. Shrub species such as *Symphoricarpos* spp. may be present.

Maximum Tree Size Class - Sapling >4.5ft; <5" DBH

Class B 12% Mid Development 1 - Closed

Table 79. Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PSME	*Pseudotsuga menziesii*	Douglas-fir	Upper
PICO	*Pinus contorta*	Lodgepole pine	Upper
SYAL	*Symphoricarpos albus*	Common snowberry	Lower
CARU	*Calamagrostis rubescens*	Pinegrass	Lower

Description

Relatively dense pole and some medium Douglas-fir and possibly lodgepole pine. The understory is open and relatively depauperate. Understory may be dominated by *Calamagrostis rubescens* and/or *Carex* spp.

Although LANDFIRE National reviewers recommended removing insects/disease from this class, it was decided by Region 1 insect experts that some insect damage is likely for the Class B forest types. The insects to be concerned about at low levels are Douglas-fir pole beetle and western spruce budworm.

Maximum Tree Size Class - Pole 5-9" DBH

Class C 14% Mid Development 1 - Open

Table 80. Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PSME	*Pseudotsuga menziesii*	Douglas-fir	Upper
PICO	*Pinus contorta*	Lodgepole pine	Upper
SYAL	*Symphoricarpos albus*	Common snowberry	Lower
CARU	*Calamagrostis rubescens*	Pinegrass	Lower

Description

Open pole and medium Douglas-fir that may have lodgepole pine with patchy graminoid cover and dispersed shrubs such as *Symphoricarpos* spp. Understory may be dominated by *Calamagrostis rubescens* and/or *Carex* spp. Conifer heights range between 5-20m but adjusted to eliminate class overlap.

Maximum Tree Size Class - Pole 5-9" DBH

Class D 47% Late Development 1 - Open

Table 81. Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PSME	*Pseudotsuga menziesii*	Douglas-fir	Upper
PICO	*Pinus contorta*	Lodgepole pine	Upper
SYAL	*Symphoricarpos albus*	Common snowberry	Lower
CARU	*Calamagrostis rubescens*	Pinegrass	Lower

Description

Open canopy of medium to large Douglas-fir with a graminoid and shrub understory with highly variable understory cover. Lodgepole pine may be present. Understory may be dominated by *Symphoricarpos* spp., *Calamagrostis rubescens*, and/or *Carex* spp. Heights can exceed 25m up to ~30m.

Maximum Tree Size Class - Large 21-33" DBH

Class E 20% Late Development 1 - Closed

Table 82. Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PSME	*Pseudotsuga menziesii*	Douglas-fir	Upper
PICO	*Pinus contorta*	Lodgepole pine	Upper
SYAL	*Symphoricarpos albus*	Common snowberry	Lower
CARU	*Calamagrostis rubescens*	Pinegrass	Lower

Description

Multi-storied Douglas-fir, sometimes with lodegpole pine present. Understory with variable cover often dominated by *Calamagrostis rubescens*, *Carex* spp., *Symphoricarpos* spp., and/or *Physocarpus malvaceous*. Heights can exceed 25m up to ~30m.

Maximum Tree Size Class - Large 21-33" DBH

Table 83. S-Class Departure for Middle Rocky Mountain Montane Douglas-fir Forest and Woodland, Forestwide

Row Labels	Reference Percent	Current Percent	Status	Sum of Acres
A	7.0%	22.4%	Surplus	37,721

Row Labels	Reference Percent	Current Percent	Status	Sum of Acres
B	12.0%	0.1%	Deficit	238
C	14.0%	2.0%	Deficit	3,339
D	47.0%	27.8%	Deficit	46,714
E	20.0%	47.6%	Surplus	80,072
UE	0.0%	0.0%		59
Grand Total	**100.0%**	**100.0%**		**168,143**

Table 84. S-Class Departure for Middle Rocky Mountain Montane Douglas-fir Forest and Woodland, by Landscape

Row Labels	Reference Percent	Current Percent	Status	Sum of Acres
Leidy Highlands				**11,162**
A	7.0%	20.9%	Surplus	2,336
B	12.0%	0.1%	Deficit	12
C	14.0%	2.8%	Deficit	307
D	47.0%	21.9%	Deficit	2,446
E	20.0%	54.2%	Surplus	6,049
UE	0.0%	0.1%	Surplus	12
Wyoming Range				**119,856**
A	7.0%	23.0%	Surplus	27,600
B	12.0%	0.1%	Deficit	72
C	14.0%	1.7%	Deficit	1,985
D	47.0%	29.2%	Deficit	35,016
E	20.0%	46.0%	Surplus	55,146
UE	0.0%	0.0%	Surplus	37
Wind River Mountains				**16,920**
A	7.0%	21.9%	Surplus	3,702
B	12.0%	0.8%	Deficit	142
C	14.0%	3.6%	Deficit	614
D	47.0%	27.9%	Deficit	4,715
E	20.0%	45.8%	Surplus	7,746
UE	0.0%	0.0%	Surplus	1
Kemmerer				**20,204**
A	7.0%	20.2%	Surplus	4,083
B	12.0%	0.1%	Deficit	12
C	14.0%	2.1%	Deficit	432

Row Labels	Reference Percent	Current Percent	Status	Sum of Acres
D	47.0%	22.5%	Deficit	4,537
E	20.0%	55.1%	Surplus	11,131
UE	0.0%	0.0%	Surplus	9
Grand Total	**100.0%**	**100.0%**		**168,143**

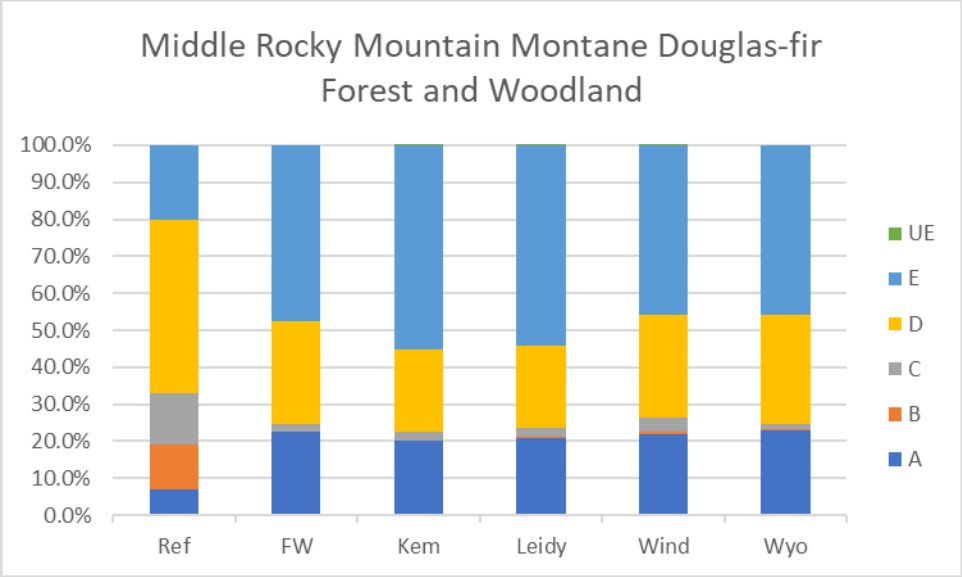


Figure 69. Bar graph displaying Middle Rocky Mountain Montane Douglas-fir Forest and Woodland S-classes

Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland – S-Class

Class A 8% Early Development 1 - All Structures

Upper Layer Lifeform: Tree

Table 85. Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PIEN	*Picea engelmannii*	Engelmann spruce	Upper
PICO	*Pinus contorta*	Lodgepole pine	Upper
ABLA	*Abies lasiocarpa*	Subalpine fir	Mid-Upper

Description

This is an early succession stage after long-interval replacement fire. There can be extended periods of grass/seedling stage after fire-replacement events. This stage may occupy 3-50% of the landscape, depending upon climatic conditions and variability of FRIs.

Class B 19% Mid Development 1 - Closed

Upper Layer Lifeform: Tree

Table 86. Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PIEN	*Picea engelmannii*	Engelmann spruce	Upper
PICO	*Pinus contorta*	Lodgepole pine	Upper
ABLA	*Abies lasiocarpa*	Subalpine fir	Upper

Description

Shade-tolerant and mixed conifer saplings to poles. High-density saplings to poles. May occupy 5-50% of the landscape.

Class C 7% Mid Development 1 - Open

Upper Layer Lifeform: Tree

Table 87. Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PIEN	*Picea engelmannii*	Engelmann spruce	Upper
PICO	*Pinus contorta*	Lodgepole pine	Upper
ABLA	*Abies lasiocarpa*	Subalpine fir	Upper

Description

Low-density saplings to poles. Primarily occurs after weather stress thins denser stands. It might be possible that this could occur from insects and disease.

Class D 43% Late Development 1 - Open

Upper Layer Lifeform: Tree

Table 88. Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PIEN	*Picea engelmannii*	Engelmann spruce	Upper
ABLA	*Abies lasiocarpa*	Subalpine fir	Upper
PICO	*Pinus contorta*	Lodgepole pine	Upper

Description

Poles and larger diameter, moderately shade-tolerant conifer species in small to moderate patches. Patches would include subalpine fir seedlings. This stage occupies 15-50% of the landscape.

Class E 23% Late Development 1 - Closed

Upper Layer Lifeform: Tree

Table 89. Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PIEN	Picea engelmannii	Engelmann spruce	Upper
ABLA	Abies lasiocarpa	Subalpine fir	Upper
PICO	Pinus contorta	Lodgepole pine	Upper

Description

Pole and larger diameter moderately to shade-tolerant conifer species, in moderate to large patches, all aspects.

Table 90. S-Class Departure Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland, Forestwide

Row Labels	Reference Percent	Current Percent	Status	Sum of Acres
A	8.0%	18.5%	Surplus	58,154
B	19.0%	0.1%	Deficit	233
C	7.0%	2.2%	Deficit	6,922
D	43.0%	50.8%	Similar	159,734
E	23.0%	28.4%	Similar	89,345
UE	0.0%	0.1%	Surplus	218
Grand Total	**100.0%**	**100.0%**		**314,606**

Table 91. S-Class Departure Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland, by Landscape

Row Labels	Reference Percent	Current Percent	Status	Sum of Acres
Leidy Highlands		**32.5%**		**102,200**
A	8.0%	21.9%	Surplus	22,420
B	19.0%	0.1%	Deficit	56
C	7.0%	2.6%	Deficit	2,629
D	43.0%	42.1%	Similar	43,033
E	23.0%	33.3%	Similar	33,991

Row Labels	Reference Percent	Current Percent	Status	Sum of Acres
UE	0.0%	0.1%	Surplus	71
Wyoming Range		**61.0%**		**191,777**
A	8.0%	16.5%	Surplus	31,626
B	19.0%	0.1%	Deficit	131
C	7.0%	1.8%	Deficit	3,470
D	43.0%	56.1%	Similar	107,495
E	23.0%	25.5%	Similar	48,924
UE	0.0%	0.1%	Surplus	130
Wind River Mountains		**0.8%**		**2,644**
A	8.0%	43.6%	Surplus	1,153
B	19.0%	0.7%	Deficit	19
C	7.0%	7.3%	Similar	194
D	43.0%	38.4%	Similar	1,016
E	23.0%	9.9%	Deficit	262
UE	0.0%	0.0%	Surplus	0
Kemmerer		**5.7%**		**17,984**
A	8.0%	16.4%	Surplus	2,955
B	19.0%	0.2%	Deficit	27
C	7.0%	3.5%	Deficit	629
D	43.0%	45.5%	Similar	8,190
E	23.0%	34.3%	Similar	6,168
UE	0.0%	0.1%	Surplus	16
Grand Total	**100.0%**	**100.0%**		**314,606**

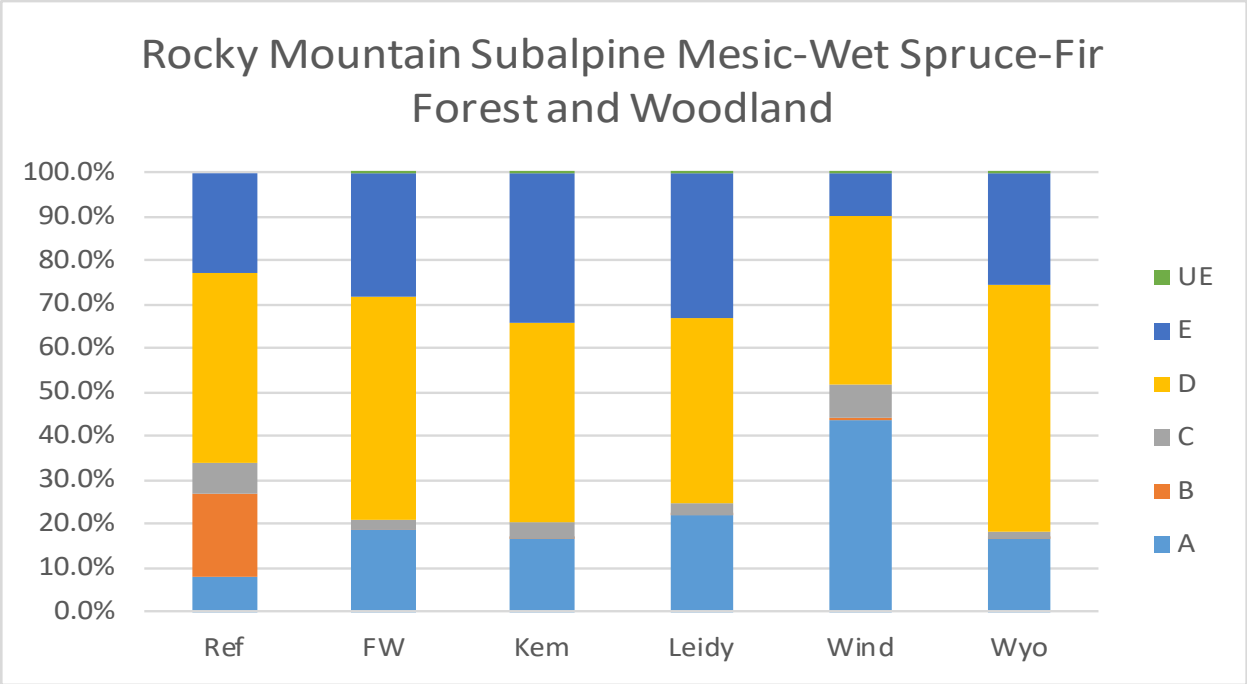


Figure 70. Bar graph displaying Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland – S-Classes

Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland – S-Class

Class A 7% Early Development 1 - All Structures

Table 92. Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
VASC	*Vaccinium scoparium*	Grouse whortleberry	Lower
RIVI	*Ribes viburnifolium*	Island gooseberry	Lower
CAGE2	*Carex geyeri*	Geyer's sedge	Lower
PICO	*Pinus contorta*	Lodgepole pine	Upper

Description

Grasses, forbs, low shrubs and lodgepole seedlings-saplings. Young lodgepole grows fast and succeeds quickly to the mid-development stage. If aspen is present, it grows faster and dominates lodgepole during this stage only. Cover of trees (seedlings-saplings) varies widely. This could be considered a grass stage unless there is a lodgepole seed source nearby.

Maximum Tree Size Class - Sapling >4.5ft; <5"DBH

Class B 33% Mid Development 1 - All Structures

Table 93. Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PICO	*Pinus contorta*	Lodgepole pine	Upper
VASC	*Vaccinium scoparium*	Grouse whortleberry	Lower
CAGE2	*Carex geyeri*	Geyer's sedge	Lower
ABLA	*Abies lasiocarpa*	Subalpine fir	Middle

Description

Moderate to dense pole-sized trees, sometimes very dense (dog-hair). Aspen usually not present. Closed canopy is 51-100%. Mid-open stands are at 21-50% canopy cover and would have mature and immature aspen present. Mid-open stands would have subalpine fir in the understory. Therefore, this class is considered a mid-development all-structures class.

Maximum Tree Size Class - Pole 5-9" DBH

Class C 48% Late Development 1 - Closed

Table 94. Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PICO	*Pinus contorta*	Lodgepole pine	Upper
ABLA	*Abies lasiocarpa*	Subalpine fir	Mid-Upper
VASC	*Vaccinium scoparium*	Grouse whortleberry	Lower
CAGE2	*Carex geyeri*	Geyer's sedge	Lower

Description

Many mature lodgepole pine, somewhat patchy, a variety of lodgepole size classes and open canopies overall but patches of denser trees.

Maximum Tree Size Class - Medium 9-21"DBH

Class D 12% Late Development 2 - Closed

Table 95. Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
ABLA	*Abies lasiocarpa*	Subalpine fir	Upper
PIEN	*Picea engelmannii*	Engelmann spruce	Upper

Symbol	Scientific Name	Common Name	Canopy Position
VAME	*Vaccinium membranaceum*	Thinleaf huckleberry	Lower
VASC	*Vaccinium scoparium*	Grouse whortleberry	Lower

Description

Mature spruce/fir forest with a variety of size classes from seedling to mature. Insect and disease usually affects only one species; survivor trees of other species remain in the stand. This class is distinguished from C by species, not canopy closure or tree height.

Maximum Tree Size Class - Large 21-33"DBH

Table 96. S-Class Departure Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland, Forestwide

Row Labels	Reference Percent	Current Percent	Status	Sum of Acres
A	7.0%	28.5%	Surplus	350,044
B	33.0%	0.4%	Deficit	4,761
C	48.0%	12.1%	Deficit	148,446
D	12.0%	59.0%	Surplus	723,376
UE	0.0%	0.0%		235
Grand Total	**100.0%**	**100.0%**		**1,226,862**

Table 97. S-Class Departure Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland, by Landscape

Row Labels	Reference Percent	Current Percent	Status	Sum of Acres
Leidy Highlands		**40.5%**		**497,472**
A	7.0%	28.6%	Surplus	142,105
B	33.0%	0.3%	Deficit	1,344
C	48.0%	12.0%	Deficit	59,545
D	12.0%	59.2%	Surplus	294,348
UE	0.0%	0.0%	Surplus	131
Wyoming Range		**31.1%**		**381,787**
A	7.0%	30.2%	Surplus	115,366
B	33.0%	0.3%	Deficit	971
C	48.0%	8.8%	Deficit	33,435
D	12.0%	60.7%	Surplus	231,916
UE	0.0%	0.0%	Surplus	100
Wind River Mountains		**17.6%**		**215,369**
A	7.0%	27.2%	Surplus	58,548
B	33.0%	0.9%	Deficit	1,982

Row Labels	Reference Percent	Current Percent	Status	Sum of Acres
C	48.0%	18.9%	Deficit	40,655
D	12.0%	53.0%	Surplus	114,185
UE	0.0%	0.0%	Surplus	0
Kemmerer		**10.8%**		**132,233**
A	7.0%	25.7%	Surplus	34,025
B	33.0%	0.4%	Deficit	465
C	48.0%	11.2%	Deficit	14,812
D	12.0%	62.7%	Surplus	82,928
UE	0.0%	0.0%	Surplus	4
Grand Total		**100.0%**		**1,226,862**

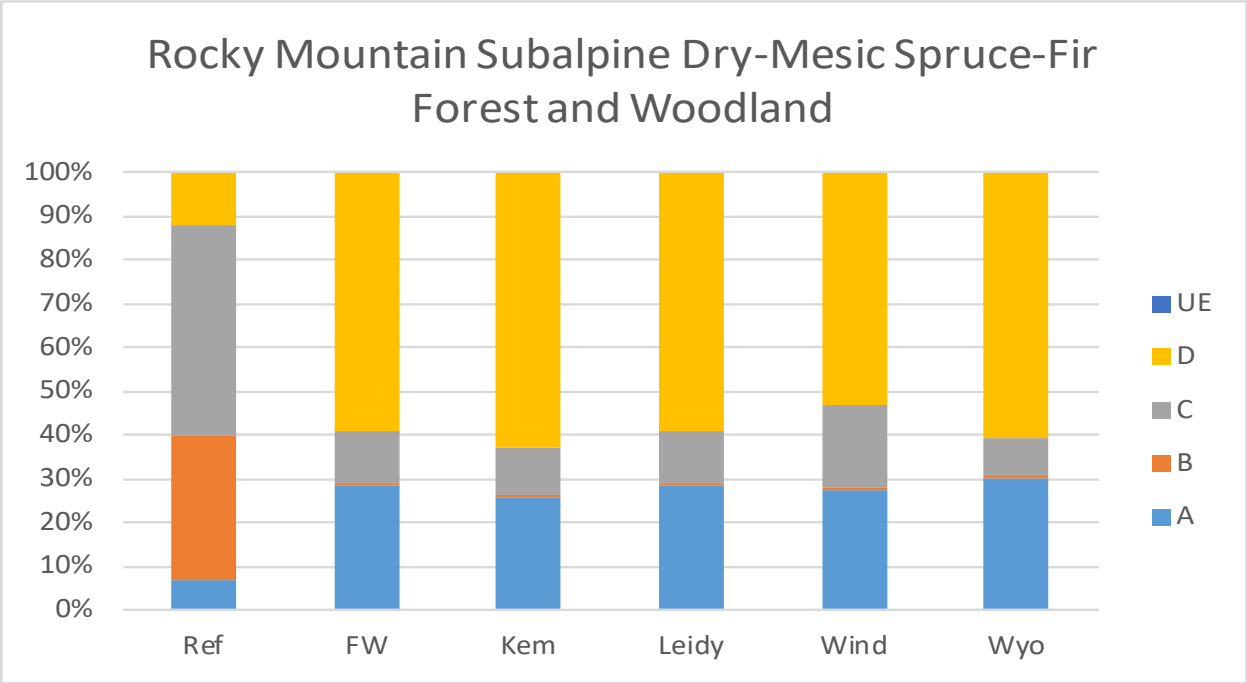


Figure 71. Bar graph displaying Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland – S-Classes

Northern Rocky Mountain Subalpine Woodland and Parkland – S-Class

Class A 21% Early Development 1 - All Structures

Table 98. Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PIAL	*Pinus albicaulis*	Whitebark pine	Upper

Symbol	Scientific Name	Common Name	Canopy Position
PICO	*Pinus contorta*	Lodgepole pine	Upper
PIEN	*Picea engelmannii*	Engelmann spruce	Upper
PIFL2	*Pinus flexilis*	Limber pine	Upper

Description

Early succession after moderately long to long interval replacement fires, and highly variable interval mixed severity fires. Whitebark pine, Engelmann spruce and rarely lodgepole pine will typically be early pioneers. Higher elevation sites will be dominated by herbaceous species.

In some areas in MZ21, PIEN and PIAL may colonize a site in close temporal proximity. It is possible that some areas are characterized by spruce first colonizing a site with whitebark coming in soon thereafter. PIFL2, although an indicator in other mapzones, might be rare in MZ21.

As an anomaly, in Yellowstone National Park a whitebark pine site is regenerating post-fire entirely by Engelmann spruce.

This class will transition to the mid-closed stage, after approximately 50-100yrs, although limited resources may cause this class to persist longer.

Maximum Tree Size Class - Sapling >4.5ft; <5"DBH

Class B 35% Mid Development 1 - Closed

Table 99. Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PIAL	*Pinus albicaulis*	Whitebark pine	Upper
ABLA	*Abies lasiocarpa*	Subalpine fir	Upper
PIEN	*Picea engelmannii*	Engelmann spruce	Mid-Upper
PICO	*Pinus contorta*	Lodgepole pine	Upper

Description

Stands dominated by small-diameter with a mix of shade tolerant and intolerant species. High elevation or harsh sites may exhibit krummholz growth form. Whitebark pine, Engelmann spruce or lodgepole pine will typically be early pioneers on harsh sites.

Maximum Tree Size Class - Pole 5-9" DBH

Class C 12% Mid Development 1 - Open

Table 100. Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PIAL	*Pinus albicaulis*	Whitebark pine	Upper
LALY	*Larix lyallii*	Subalpine larch	Upper
PICO	*Pinus contorta*	Lodgepole pine	Upper
PIFL2	*Pinus flexilis*	Limber pine	Upper

Description

Stands dominated by small-diameter with a mix of shade tolerant and intolerant species. High elevation or harsh sites may exhibit krummholz growth form.

Whitebark pine (especially on southerly aspects) and subalpine larch (especially on northerly aspects) will typically be early pioneers on harsh sites. Limber pine may also occur on these sites. Subalpine larch is uncommon in the Greater Yellowstone Ecosystem. And although limber pine is rare, some PIFL2 individuals were found intermixed in a nearly pure PIAL forest in the Wind River Range, but that has not been seen often in the Greater Yellowstone Ecosystem.

Maximum Tree Size Class -Pole 5-9" DBH

Class D 5% Late Development 1 - Open

Table 101. Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PIAL	*Pinus albicaulis*	Whitebark pine	Upper
PICO	*Pinus contorta*	Lodgepole pine	Upper
PIFL2	*Pinus flexilis*	Limber pine	Upper

Description

Mid to large diameter mixed conifer species in small to moderate size patches generally on southerly aspects. Open canopy conditions occur on sites where soil is less developed or on wind-exposed, south-facing aspects. Whitebark pine, subalpine fir, Engelmann spruce and lodgepole pine will typically dominate.

Maximum Tree Size Class - Medium 9-21"DBH

Class E 27% Late Development 1 - Closed

Table 102. Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PIAL	*Pinus albicaulis*	Whitebark pine	Upper
ABLA	*Abies lasiocarpa*	Subalpine fir	Upper
PIEN	*Picea engelmannii*	Engelmann spruce	Upper
PIFL2	*Pinus flexilis*	Limber pine	Upper

Description

Mid to larger diameter mixed conifer species in small to moderate size patches generally on southerly aspects. Subalpine fir is likely to be initiating in the understory on these sites. Closed canopy conditions occur on sites that are more protected (i.e., northerly aspects) or have better soil development. This class will persist until a disturbance causes a transition.

Maximum Tree Size Class - Medium 9-21"DBH

Table 103. S-Class Departure Northern Rocky Mountain Subalpine Woodland and Parkland, Forestwide

Row Labels	Reference Percent	Current Percent	Status	Sum of Acres
A	21.0%	46.6%	Surplus	158,824
B	35.0%	1.4%	Deficit	4,712
C	12.0%	6.8%	Deficit	23,016
D	5.0%	19.9%	Surplus	67,711
E	27.0%	25.3%	Similar	86,306
UE	0.0%	0.0%		1
Grand Total	100.0%	100.0%		340,570

Table 104. S-Class Departure Northern Rocky Mountain Subalpine Woodland and Parkland, by Landscape

Row Labels	Reference Percent	Current Percent	Status	Sum of Acres
Leidy Highlands		**44.8%**		**152,533**
A	21.0%	45.5%	Surplus	69,436
B	35.0%	0.7%	Deficit	1,082
C	12.0%	4.7%	Deficit	7,220
D	5.0%	18.7%	Surplus	28,463
E	27.0%	30.4%	Similar	46,331

Row Labels	Reference Percent	Current Percent	Status	Sum of Acres
UE	0.0%	0.0%		1
Wyoming Range		**24.9%**		**84,937**
A	21.0%	48.4%	Surplus	41,102
B	35.0%	1.5%	Deficit	1,275
C	12.0%	8.7%	Similar	7,399
D	5.0%	20.3%	Surplus	17,213
E	27.0%	21.1%	Similar	17,947
UE	0.0%	0.0%		0
Wind River Mountains		**28.0%**		**95,400**
A	21.0%	47.2%	Surplus	45,060
B	35.0%	2.4%	Deficit	2,272
C	12.0%	8.5%	Similar	8,089
D	5.0%	21.0%	Surplus	20,025
E	27.0%	20.9%	Similar	19,954
Kemmerer		**2.3%**		**7,701**
A	21.0%	41.9%	Surplus	3,226
B	35.0%	1.1%	Deficit	82
C	12.0%	4.0%	Deficit	309
D	5.0%	26.1%	Surplus	2,010
E	27.0%	26.9%	Similar	2,074
Grand Total		**100.0%**		**340,570**

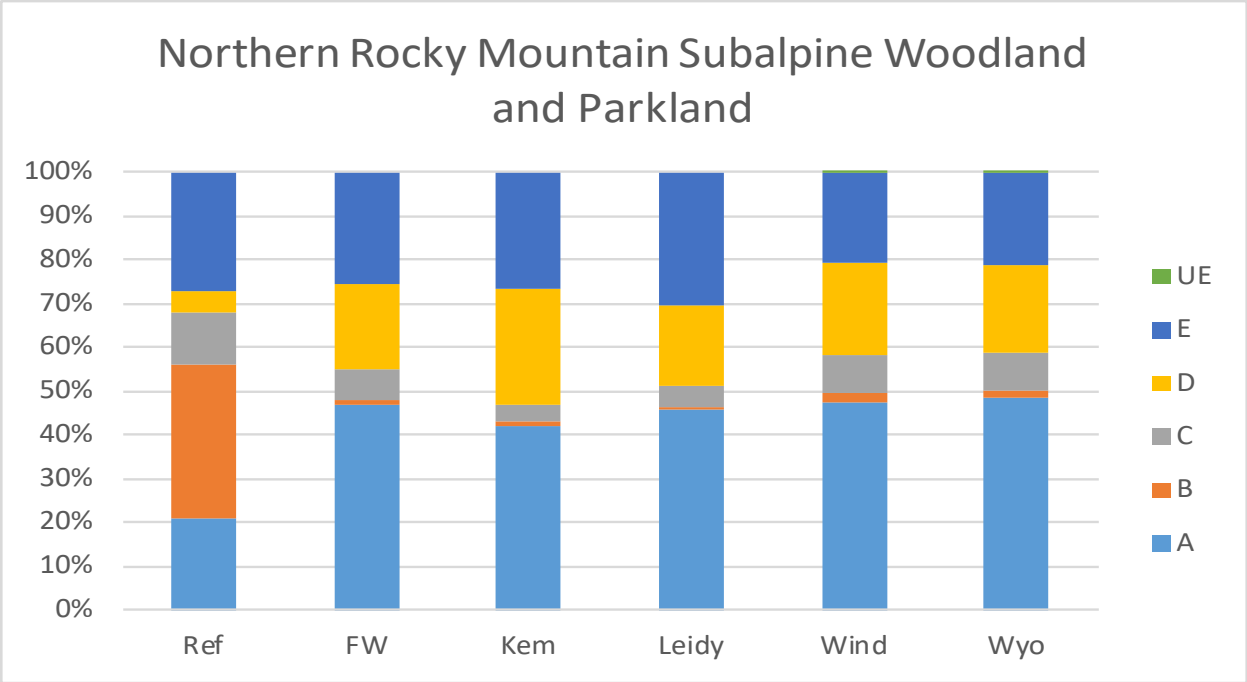


Figure 72. Bar graph displaying Northern Rocky Mountain Subalpine Woodland and Parkland – S-Class

Rocky Mountain Aspen Forest and Woodland - SClass

Class A 7% Early Development 1 - All Structures

Table 105. Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
POTR5	*Populus tremuloides*	Quaking aspen	Upper

Description

Aspen suckers less than two meters tall. Understory species include a wide variety of shrubs, forbs and grasses.

This structure is an established, persistent, shrub-type aspen clone that is maintained in this state either because of continual browsing or suboptimal site conditions. As such, it was the starting point in which to model asexual regeneration in the face of disturbance. A reviewer suggested that this class would be eliminated and returned to grass in three years under intense browsing; however, that scenario is not an accurate depiction of this class. This condition does not represent site establishment via sexual reproduction that would revert to grass three years after seedling establishment. Also, although aspen suppression by herbivores is important in the Greater Yellowstone Ecosystem (which would more likely be a current condition, not the reference condition scenario being described), there seems to be insufficient evidence that this process can extirpate a patch in three years. Aspen appears relatively persisting and although it certainly can be extirpated, it is believed that this occurs far less frequently.

Maximum Tree Size Class - Seedling <4.5ft

Class B 24% Mid Development 1 - All Structures

Table 106. Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
POTR5	*Populus tremuloides*	Quaking aspen	Upper

Description

Aspen 2-10m tall dominate. Canopy cover usually closed, but might be more open at times, representing dense sapling stand. Fire frequency is highly variable because of site conditions and adjacent vegetation.

Maximum Tree Size Class - Pole 5-9" DBH

Class C 27% Late Development 1 - Closed

Table 107. Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
POTR5	*Populus tremuloides*	Quaking aspen	Upper

Description

Closed-canopy, relatively pure aspen stand with large overstory trees. Fire frequency highly variable depending upon site location and adjacent vegetation.

Aspen always suckers. Suckering and recruitment might be impeded because of overstory auxin transport, but is infrequently eliminated, unless there are other root problems with the clone. Existing data suggest that aspen can persist in the understory of conifers as a shrub for relatively long periods of time (Dan Kashian, personal communication).

Any reduction of canopy auxin transport because of mixed or replacement fire will stimulate the suckering response.

Maximum Tree Size Class - Medium 9-21"DBH

Class D 27% Late Development 2 - Open

Table 108. Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
POTR5	*Populus tremuloides*	Quaking aspen	Upper
ARTR2	*Artemisia tridentata*	Big sagebrush	Lower
GRASS	<NOT FOUND IN NRCS>	<NOT FOUND IN NRCS>	Lower
PSME	*Pseudotsuga menziesii*	Douglas-fir	Low-Mid

Description

Aspen widely spaced, open canopy existing until the over-story succumbs to mortality. This is a transitional state caused by insects, disease, herbivory or interactions among these factors.

Mean FRIs for fire are highly variable.

Outside reviewer commented that 25% in class D historically seemed too high, and that it should rather be approx 10-15%.

Maximum Tree Size Class - Medium 9-21"DBH

Class E 15% Late Development 3 - Closed

Table 109. Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PSME	*Pseudotsuga menziesii*	Douglas-fir	Upper
PICO	*Pinus contorta*	Lodgepole pine	Upper
PIEN	*Picea engelmannii*	Engelmann spruce	Upper
ARTR2	*Artemisia tridentata*	Big sagebrush	Low-Mid

Description

A catch-all category that represents aspen replaced by other vegetation types or a mixed aspen-conifer overstory that is changing to a conifer dominated forest. If aspen persists in the understory, parent root material remaining on site allows aspen regeneration after fire.

Maximum Tree Size Class - Very Large >33"DBH

Table 110. S-Class Departure Rocky Mountain Aspen Forest and Woodland, Forestwide

Row Labels	Reference Percent	Current Percent	Status	Sum of Acres
A	7.0%	32.6%	Surplus	104,844
B	24.0%	4.2%	Deficit	13,544
C	27.0%	3.2%	Deficit	10,345
D	27.0%	37.5%	Similar	120,832
E	15.0%	22.2%	Surplus	71,597
UE	0.0%	0.3%	Surplus	862
Grand Total	100.0%	100.0%		322,024

Table 111. S-Class Departure Rocky Mountain Aspen Forest and Woodland, by Landscape

Row Labels	Reference Percent	Current Percent	Status	Sum of Acres
Leidy Highlands		**24.7%**		**79,494**
A	7.0%	36.8%	Surplus	29,244

Row Labels	Reference Percent	Current Percent	Status	Sum of Acres
B	24.0%	5.4%	Deficit	4,269
C	27.0%	3.4%	Deficit	2,685
D	27.0%	34.7%	Similar	27,560
E	15.0%	19.4%	Similar	15,383
UE	0.0%	0.4%	Surplus	351
Wyoming Range		**53.3%**		**171,486**
A	7.0%	32.3%	Surplus	55,460
B	24.0%	3.4%	Deficit	5,780
C	27.0%	2.8%	Deficit	4,763
D	27.0%	40.3%	Similar	69,073
E	15.0%	20.9%	Similar	35,920
UE	0.0%	0.3%	Surplus	491
Wind River Mountains		**9.6%**		**30,773**
A	7.0%	27.5%	Surplus	8,459
B	24.0%	7.0%	Deficit	2,153
C	27.0%	7.4%	Deficit	2,288
D	27.0%	37.1%	Similar	11,426
E	15.0%	20.9%	Similar	6,443
UE	0.0%	0.0%	Surplus	2
Kemmerer		**12.5%**		**40,272**
A	7.0%	29.0%	Surplus	11,680
B	24.0%	3.3%	Deficit	1,341
C	27.0%	1.5%	Deficit	609
D	27.0%	31.7%	Similar	12,772
E	15.0%	34.4%	Surplus	13,851
UE	0.0%	0.0%	Surplus	17
Grand Total		**100.0%**		**322,024**

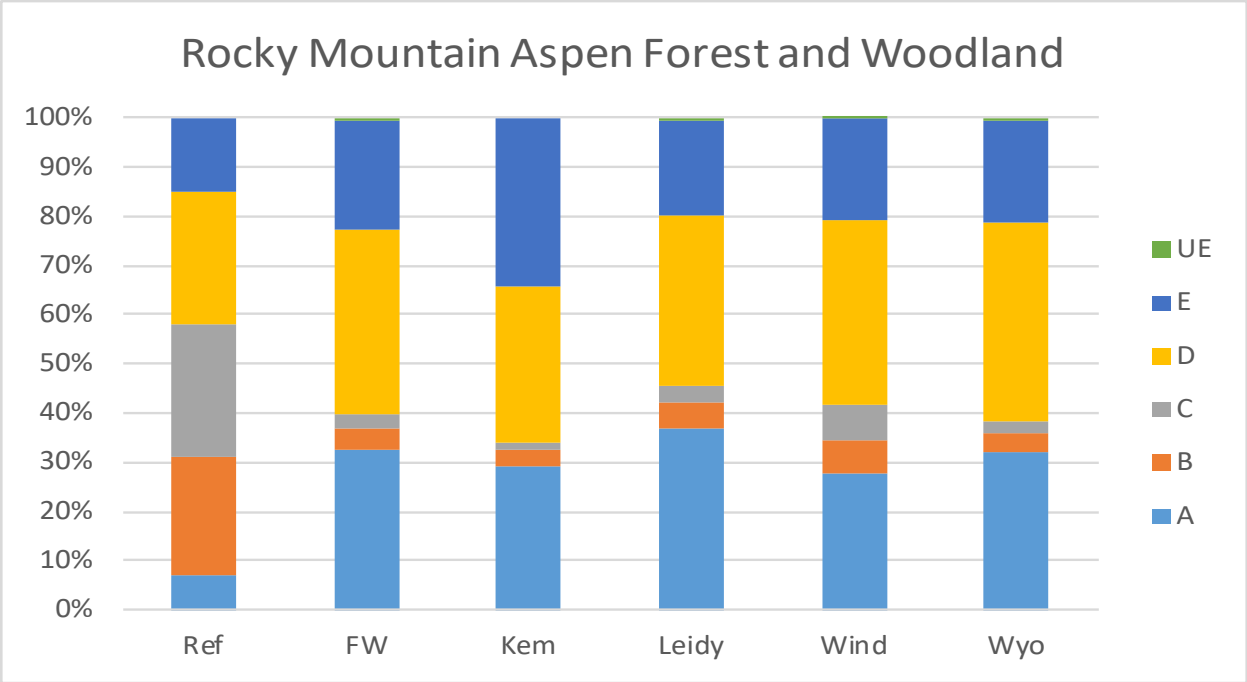


Figure 73. Bar graph displaying Rocky Mountain Aspen Forest and Woodland S-classes

Appendix C: Aquatic Ecosystem Workshops and Integrity Report

The purpose of this document is to record the thought process behind determining the status and trend of ecosystem integrity, which will inform development of the Bridger-Teton National Forest (BTNF) plan revision assessment. This document is a result of work drafted by select Forest and Regional experts.

Workshops Conducted on March 1, 2023.

Ecosystems Analyzed

1. Perennial/Intermittent/Ephemeral Rivers and Streams and Associated Riparian Areas
2. Lakes/Ponds/Reservoirs and associated riparian areas
3. Wetlands/Fens/Springs/Groundwater Dependent Ecosystems and associated riparian areas

Participants

1. Randall Griebel (BTNF Ecosystem Staff Officer): Facilitator
2. Justin Peterson (BTNF Fisheries): Note Taker/Contributor
3. Patrick Barry (BTNF Watershed Program Manager)
4. James Wilder (BTNF Wildlife Program Manager)
5. Paul Hood (NPS Fuels and Prescribed Fire)
6. Sidney Woods (BTNF Strategic Communications & Planning)
7. Chad Hayward (BTNF Range Program Manager)
8. Katie Chambers (BTNF Soil Scientist)
9. Brian Goldberg (BTNF Resource Information Manager)
10. Christopher McCollister (BTNF GIS Specialist)
11. Ben Soderquist (R4 Information Management)
12. Raul Alonso (R4 Planning, Appeals & Litigation)
13. Kelly Owens (BTNF Forest Hydrologist)

Ecosystem Services

Ecosystem services are products of functioning ecosystems that affect social, cultural, and economic conditions within the plan area, in the area(s) of influence and in the broader landscape. Four types are considered below.

Provisioning Services

1. Food – Provides aquatic habitat used by the public for fishing or foraging for food.
2. Biochemicals, natural medicines, pharmaceuticals – Little is currently documented regarding aquatic habitat contributions to these key provisions, but focused inquiry could reveal important elements from these limited ecosystems.
3. Fresh water – In low rainfall areas like Wyoming, springs and snowfall in high elevation areas like the BTNF provide critical water supplies.

Regulating Services

1. Water regulation – Healthy aquatic ecosystems provide filtration for water, groundwater storage, and erosion control.
2. Climate regulation – Groundwater dependent ecosystems like fens have been found to absorb and sequester carbon at high rates, helping maintain climate stability that supports life.
3. Erosion and Natural Hazard regulation – Aquatic vegetation root systems mitigate excessive erosion during high flow events.
4. Fire Regulation – Waterways and aquatic ecosystems can serve as natural fuel breaks.

Cultural Services

1. Aesthetic values – The Forest provides recreation opportunities, including scenic trails and roads, along with habitat for wildlife viewing and photography. Waterways are highly sought out by humans for viewing and photography, and wildlife also concentrates here.
2. Recreation and ecotourism – The largest economic driver in the BTNF area of influence, this category provides both private benefits and commercial benefit. Fishing and boating in streams/rivers/lakes is popular. Trails used for hiking, horseback trips, and mountain biking, as well as motorized roads and trails often follow waterways through the mountainous landscape. Many natural resource, educational, research and non- governmental organizations also benefit from and work within the BTNF landscape.
3. Health – The importance of natural landscapes as a key health benefit for residents and visitors is just beginning to be studied. This includes not just the physical aspects of outdoor activities but also the mental/emotional benefits, which many people feel are connected to live water and waterways.
4. For Tribal communities in the area, this landscape remains part of traditional seasonal patterns of harvesting and collecting, and landscape elements such as waterways and springs may be part of traditional stories or sacred ceremonies that teach members how to relate as kin to the various other actors (plant, animal, rock, water, etc) in the ecosystems.

Supporting Services

1. Biodiversity – The different aquatic ecosystems in this report provide various conditions necessary for plant and animal survival and reproduction. This biodiversity across the planning area creates stronger resilience in the face of changing trends.
2. Genetic resources – Especially where aquatic species have developed resistance to diseases or climatic changes, these systems can offer reservoirs that may be needed in the future for restoration activities in areas that suffer losses.
3. Nutrient cycling – The movement and exchange of organic and inorganic matter back into the production of living matter occurs in both aquatic and terrestrial systems.
4. Soil formation – While excessive erosion creates dysfunctional aquatic systems, some amount of sediment transport is needed to provide soil from high bedrock elevations and replenish soils in lower gradient areas.
5. Primary production – Aquatic plants convert the sun's energy into vegetation, the basis of aquatic food webs.

An interdisciplinary team considered which of the various benefits from both terrestrial and aquatic systems should be considered the key ecosystem services provided by the plan area. These would be most important to consider when evaluating potential management changes. As a headwaters forest, the BTNF considered water itself the most important of all ecosystem services.

Perennial/Intermittent/Ephemeral Rivers and Streams and Associated Riparian Areas

Ecosystem Description

Perennial Rivers and Streams and Associated Riparian Areas

These systems are characterized by single and multi-thread channels, adjacent riparian habitats, and associated floodplains varying substantially in width, gradient, and length across the BTNF. Riparian integrity along perennial channels prevents channel degradation and mitigates flood potential through floodplain interaction, sediment sequestration, and ground water recharge. These ecosystems and corridors facilitate gene flow of fish populations, habitat connectivity for all life stages of fish, crucial spawning and rearing habitats, terrestrial migration corridors, terrestrial bird nesting habitats, and diverse aquatic and terrestrial species assemblages. Perennial rivers and streams comprise approximately 4,975 miles of waterways on the BTNF (USGS National Hydrography Dataset).

Ephemeral/Intermittent Rivers and Streams and Associated Riparian Areas

These systems typically encompass higher elevation channels with relatively small watersheds capable of receiving snow melt and to some extent, groundwater/surface water conveyance early to the middle of the calendar year. Riparian integrity along intermittent channels prevents channel degradation and mitigates flood potential through floodplain interaction, sediment sequestration, and ground water recharge. These systems comprise approximately 7,335 miles of waterway on the BTNF.

Geographic Range

Perennial/Ephemeral/Intermittent Rivers and Streams and their associated riparian areas span the entire BTNF. These systems include the headwaters of the Yellowstone, Gros Ventre, Snake, Hoback, Greys, Salt, Bear, Green, and New Fork rivers. These lotic habitats encompass all elevations of the BTNF with riparian areas (lotic and lentic) covering an estimated 293,311 acres or 8.5 percent of the BTNF.

Vegetation Description

The extent, productivity, and composition of riparian vegetation is highly variable across the landscape due to differences in stream flow, stream channel type, elevation, gradient, valley width, aspect, geology, and soils. However, some generalizations can be made regarding riparian community composition. Riparian areas associated with high elevation first and second order streams are typically narrow and dominated by conifers with an understory of woody shrubs and forbs. Mid and lower elevation valleys with lower gradient stream channels typically have wider riparian areas dominated by hydrophytic vegetation such as aspen, cottonwoods, willows, and sedges.

Ecosystem Integrity Evaluation

1. **What ecological drivers and stressors and other key characteristics are most responsible for ecological integrity when the system has high integrity? (Include the level of uncertainty and condition/geographic differences).**

Ecological integrity is supported by a connected floodplain, which provides flood mitigation, groundwater recharge, late-season flow provision through groundwater storage, temperature mitigation, riparian vegetation (e.g., cottonwoods, aspen, willows, and other hydrophytic vegetation), and a source of large woody debris (LWD) recruitment. Stream channels are typically at their full potential for supporting ecosystem functions when they are in a stable state. According to Rosgen (1996), stream channel stability is achieved when a stream has a stable dimension, pattern, and profile that over time maintains channel features. This occurs when the sediment supply is in balance with the stream's capability to transport it. Instability occurs when the supply of sediment exceeds the stream's capacity to transport it (aggradation or dropping sediment) or the stream's energy exceeds the sediment supply (erosion and degradation-downcutting). Natural disturbance including fire, floods, and landslides can destabilize channels. However, these episodic events contribute important pulses of large woody debris and substrate of varying sizes that provide a critical contribution to the long- term complexity and productivity of aquatic habitats. The rate of evolution of stream channels to a stable state following natural disturbance is dependent upon the rate of vegetative recovery in the watershed, degree of floodplain connectivity, and the extent and vigor of riparian vegetation. As an example, mainstem rivers with high integrity have wide, unconstrained floodplains that allow channels to migrate in response to high sediment supply as well as healthy riparian areas that promote channel stability.

Riparian areas exhibiting high integrity are those that have reached their potential for vegetation extent (riparian area width), native riparian plant species diversity, and vigor given the site capability. According to Wyoming Game and Fish (2017), "These riparian areas provide critically important breeding, feeding, and sheltering opportunities, as well as habitat connectivity and movement corridors for a wide range of terrestrial, semi-aquatic, and avian

wildlife species. Less than 2% of the surface area of Wyoming, Nevada, and Montana consists of wetland and riparian systems, yet a majority of species depend upon them (McKinstry et al. 2004). Within Wyoming, 61% of 445 terrestrial vertebrate species are believed to show preference for riparian habitats (Olson and Gerhart 1982). This is especially true for birds. In fact, many of Wyoming's bird species are wetland or riparian obligates (Nicholoff et al. 2003, Copeland et al. 2010). These habitats also serve as migration and dispersal corridors. Bats, in particular, use riparian habitats for commuting, migrating, roosts, and foraging habitat."

Riparian soils with high integrity generally exhibit hydric characteristics whereby surface and subsurface flow contribute to anaerobic conditions in the upper part of the soil profile. However, the extent of hydric soils in lotic riparian areas is generally proximal to stream channels due to a gradient of decreasing moisture extending away from stream channels.

Aquatic habitat complexity is indicative of high integrity and is driven by a range of physical characteristics. These include: a) healthy riparian vegetation that provides stream shading and temperature regulation while stabilizing stream banks; b) stable, undercut banks that provide overhead cover for fish; c) coarse in-channel woody debris that dams and scours pools and sorts sediment; d) a diversity of substrate sizes from boulders that scour pools and provide low velocity resting areas for fish, to small gravel that provides spawning habitat for fish; and e) a diversity of habitat types including pools (fish wintering and rearing habitat), pool tail-outs (spawning habitat), and riffles (macroinvertebrate food production for fish), and runs. Collectively, these features provide productive aquatic habitat that supports all life stage requirements for fish and other aquatic organisms while maintaining a thermal regime within the historic range of variability.

High ecological integrity is also described by the absence of invasives (aquatic as well as terrestrial riparian invasives) and pathogens with the presence of a healthy macroinvertebrate community. High water quality consists of low e-coli levels, proper pH, and dissolved organic and mineral materials. High integrity also requires upland health and adjacent inputs (e.g., erosion/pollutants), and the need for riparian and/or upland buffers to those inputs.

The presence of beavers is not always correlated with high ecosystem integrity; however, beaver dams capture and sequester sediment, dissipate stream energy, increase surface water residence longer into the year (late summer months), contribute to groundwater recharge, and restore/maintain floodplain connectivity. A beaver dam complex acts like a filter by sequestering fine sediment and contaminants. For these reasons, beavers have been described as ecosystem engineers and their tactics are being increasingly emulated by stream restoration practitioners, through process-based restoration approaches.

Gradient, valley width, elevation, aspect, and geology all influence the desired condition of stream channels and the diversity and productivity of their associated riparian areas. High-gradient, high integrity perennial streams will not necessarily function in the same way or exhibit the same characteristics as those higher discharge, low gradient streams. An example of an overarching characteristic could be floodplain connectivity; those systems with connected floodplains would have higher integrity than systems disconnected from their floodplains.

The Revision Team considers these KECs and drivers/stressors typical of high integrity with **High Certainty**.

2. What features of the ecosystem currently compromise (or support) ecological integrity and what are the mechanisms for the trend? Highlight important drivers, stressors, key

ecosystem characteristics, and assess the degree to which management can or cannot influence this trend).

Climate change is a significant stressor/driver and can impact plant structure, survivability, reproduction and growth yield with rising temperatures, extended drought, and precipitation extremes. Relative humidity can affect soils, plants, and lichens as well as seedling survival. Vapor-pressure deficit, which integrates temperature and precipitation can also affect plant functions through drying of the atmosphere. Climate change can cause snowmelt and spring runoff to occur earlier and over a shorter time frame than normal; thus, reducing groundwater recharge. This contributes to increased peak flows, flood events, and decreased summer base flows. Moreover, extreme rain events can cause flooding, landslides, and extreme erosion that can alter the vegetation structure on the site and excess accumulation of sediment into aquatic ecosystems. Warming stream temperatures will considerably reduce the extent of thermally suitable habitat for cold-water dependent salmonids; especially native cutthroat trout. Where this occurs, nonnative salmonids will replace native cutthroat trout. In most cases, these longitudinal shifts in fish species distributions cannot be prevented.

There are a variety of past and ongoing land management actions and human activities that compromise integrity of perennial, intermittent, ephemeral rivers and streams and associated riparian areas. These stressors include but are not limited to:

- Recreation effects: Dispersed camping next to streams and rivers, roads/trails also contribute to soil compaction and loss of hydric soil function. Moreover, unauthorized travel routes, higher numbers of recreators in water, travel routes through riparian areas, and stock corrals adjacent to streams contribute to soil compaction and nutrient inputs to aquatic systems.
- Undersized culverts: Improperly-sized road crossing structures negatively affect channel morphology and sediment transport, which may ultimately lead to structural failure and discharge of large quantities of road fill into stream channels. Undersized culverts restrict movement of terrestrial animals under the road prism, forcing them to cross over the road where they are subject to increased mortality from vehicle collisions.
- Beaver extirpation/beaver removal/beaver absence: Increases the potential for disrupted sediment management within aquatic ecosystems, reduces ground water recharge, diminishes river/stream interaction with associated floodplains, and limits the extent and vigor of riparian vegetation.
- Riparian habitat fragmentation: According to Wyoming Game and Fish 2017, “Due to the limited size and distribution of riparian habitats relative to other landscape features and their critical role as corridors for both aquatic and terrestrial species, fragmentation of this habitat can severely compromise its value for wildlife.”
- Altered fire regimes: May increase the frequency and severity of timber stand replacing wildfires, and contribute high sediment loads with orders of magnitude higher than normal; thus, destabilizing stream channels. Excessive buildup of fuels in riparian areas outside the normal range of variability can contribute to stand-replacing fire in riparian zones.
- Improper grazing implementation: Riparian livestock grazing at an intensity and duration that exceeds the capability of a site to resist or recover from grazing disturbance can, as described in Wyoming Game and Fish (2017), “eliminate vegetation and associated wildlife, widen stream channels, cause soil erosion, increase water sediments loads, raise water

temperature, encourage the spread of invasive species, change stream bank configuration, and lower surrounding water tables (Chaney et al. 1991, Nicholoff 2003). Uncontrolled livestock can congregate in riparian areas where they find water, succulent forage, and favorable microclimates including shade, wind reduction, and higher humidity (Clary and Webster 1989, Belsky et al. 1999)."

- Water use: Reservoir management and irrigation diversions reduce instream flows that support a myriad of ecosystem processes. Irrigation diversion density/presence can play a role in dewatering and those water uses cannot be accurately measured. Unscreened diversions entrain fish and other aquatic organisms in irrigation ditches leading to direct mortality.
- Sediment delivery from road maintenance and construction activities: Roads lacking proper slope and drainage features (best management practices) deliver fine sediment directly into aquatic ecosystems. This sediment can negatively affect ecosystem integrity by entombing incubating fish eggs and fry and reducing primary (algae growth) and secondary productivity (macroinvertebrate density). To minimize effects to trout recruitment, the timing of road maintenance and construction activities should occur outside the fish spawning and egg/fry incubation period between March 15 and August 15.
- Introduction of invasive species and pathogens: Both terrestrial and aquatic invasive species and pathogens degrade aquatic ecosystem integrity. These invasive species decrease forage, increase fire frequency, decrease soil moisture, and decrease overall ecosystem biodiversity. Noxious weeds of concern for degrading riparian areas on the Bridger-Teton include leafy spurge, Dalmatian toadflax, whitetop, Canada thistles, black henbane, and spotted knapweeds.
- Loss of riparian habitat: Loss of riparian habitat degrades stream and floodplain function and constitutes a loss of avian and terrestrial wildlife habitat.
- Streambank modification: Improperly armored stream banks (those with materials that are improperly sized or not keyed-in) are prone to failure and accelerated bank erosion, which can destabilize stream channels and degrade aquatic habitat. Stream banks that are armored with rip/rap often do not provide sufficient hydraulic roughness and as a result, increase stream power and potential for downstream bank erosion.
- Available management strategies to the aforementioned stressors include: refining grazing practices, addressing placement of future roads, constructing and maintaining drainage features on existing roads, replacing undersized culverts with structures that meet stream simulation and aquatic organism passage criteria, managing dispersed recreation in riparian habitats, managing off road vehicle use in and adjacent to aquatic ecosystems, establishing riparian standards and guidelines to maintain coarse woody debris in stream channels and on floodplains, and utilizing bioengineering approaches (where feasible) for stabilizing streambanks where erosion adjacent to infrastructure is a concern.

There is little the Forest can do to alter the climate trajectory and effects associated with those issues. However, encouraging the persistence of beavers on the landscape can help with late summer water retention and instream flows with temperatures within the historic range of variability and can help to mitigate some of the climate stressors on aquatic ecosystem integrity. Moreover, large scale process-based restoration to restore streams and riparian areas serves as a stepping-stone to increasing climate change resistance until beavers can become established. Conserving and restoring the integrity of those cold-water aquatic habitats that are

projected to remain thermally suitable for native cutthroat trout is the best management strategy to minimize longitudinal changes in fish species distribution from stream warming. This may require mechanical or chemical removal of competing nonnative fish species in the highest priority habitats for long-term cutthroat trout conservation. Finally, according to Wyoming Game and Fish (2017), "Maintaining the integrity of riparian areas will become increasingly important in preparing for the possible influence of climate change to enable species to travel to more suitable habitats as ecosystems change (see Wyoming Leading Wildlife Conservation Challenges – Climate Change). Riparian areas in relatively lower elevation areas in Wyoming (e.g., around Cheyenne, Star Valley, and the Snake River) are at greatest risk for future change due to rural development (Copeland et al. 2010)."

The Forest will continue to manage invasive species, although there are typically not enough resources to treat noxious weeds or aquatic invasive species across the entire forest. Additionally, recreation can be managed, and problem areas addressed.

The Revision Team considers these KECs and drivers/stressors that can compromise (or support) integrity with **High Certainty**.

3. How does the current status and trend of the ecosystem (ecological integrity and the elements that are compromised) influence delivery of ecosystem services?

The most relevant ecosystem services include:

Provisioning Services

1. Food – Provides cutthroat trout and big game habitat that is used by the public for hunting and securing wild game as a food source. Also, berry picking, and mushroom collection is found in this ecosystem.
2. Genetic resources – Important for three species of cutthroat trout, several other non-game fish species, and amphibians.
3. Fresh water – These systems are essential for irrigation and drinking water supplies.

Regulating Services

1. Air quality regulation – Ecosystem provides oxygen and filters-out pollutants.
2. Water regulation – Ecosystem provides filtration for water and erosion control.
3. Climate regulation – Can impact climate through carbon sequestration where trees absorb carbon.
4. Erosion regulation – Riparian root systems and understory vegetation help keep the soil in place and promote stream channel stability.
5. Natural hazard regulation – Riparian and understory vegetation provides erosion control and reduced landslide threats. Connection to floodplains mitigate the intensity of flood events. High functioning aquatic ecosystems provide important fire breaks that mitigate the risk of catastrophic wildfires.

Cultural Services

1. Aesthetic values – Provides recreation opportunities to include fishing, rafting, and kayaking. Also, provides habitat for wildlife viewing and photographing.
2. Recreation and ecotourism – Fish and big game habitat provides fishing and hunter opportunities. Scenic photography is another opportunity in this ecosystem.

Supporting Services

1. Nutrient cycling – Vegetation recycles carbon, nitrogen and phosphorus and natural decomposition is a natural process. Nutrients in water is utilized throughout the ecosystem spiraling through uptake and release many times from headwaters to confluence with other rivers or lakes.
2. Soil formation – Riparian, understory vegetation and living organisms helps form soils by breaking down parent material. Roots serve as the "glue" to hold soil particles together and create soil structure. Hydric soils function to oxidize iron and sequester carbon.
3. Primary production – Plants convert energy into vegetation. Fish store energy through forage resources and provide a valuable resource to humans and other species within the ecosystem.

The Revision Team considers the ecological integrity and the elements that are compromised that influence delivery of ecosystem services with **High Certainty**.

4. What is the status of each ecosystem–the level and trend of ecological integrity (High, Moderate, Low, or Poor) in the plan area and surrounding lands; and to what degree can the FS affect change in this status?

Current integrity rating	Certainty	Long-term integrity trend	Certainty	Short-term ability to affect	Certainty	Long-term ability to affect	Certainty
Moderate	High	Low	Moderate	Low-High	Moderate	Moderate	Moderate

The current status for the current integrity for perennial/ephemeral/intermittent streams and rivers with associated riparian habitats is: MODERATE; there are contemporary drivers and stressors currently disrupting the balance of temperature, sediment flow, and water permanence. There is still current ecosystem function. The overall balance of highly functioning watersheds and highly impacted leads to an overall MODERATE INTEGRITY ranking. The major functions and services are functional. HIGH CERTAINTY for this trend.

2050: LOW integrity ranking assessment; Service delivery is expected to decline. Although the Bridger Teton watersheds provide headwaters for multiple drainages, climate change projections are expected to disrupt established and historical water use needs. Future irrigation needs will exacerbate invasive species/native species interactions as well as the potential for further invasive introductions. Increased recreation impacts will also continue.

The confidence of this assessment is MODERATE mainly due to the uncertainty of covariates leading to increased recreational use by adjacent regions. Note: The GYE climate assessment has similar assessments of certainty and could be referenced to provide a higher level of certainty specific to climate change.

Degree USFS management can affect change (CURRENT): LOW to HIGH. Management influence in impounded regions with water rights requirements and delivery schedules is LOW, free flowing systems is HIGH. With high investment, management can improve riparian condition. Climate change can be mitigated by improvement of beaver distribution and extensive process-based stream restoration, but the threat of large-scale disturbance exhibited by climate change, forest wide is a persistent threat. Warming stream temperatures will considerably reduce the extent of thermally suitable habitat for cold-water dependent salmonids, especially cutthroat trout. Where this occurs, nonnative salmonids will replace native cutthroat trout. In most cases these longitudinal shifts in fish species distributions cannot be prevented. Therefore, conserving and restoring the integrity of those cold-water aquatic habitats that are projected to remain thermally suitable for native cutthroat trout is the best management strategy.

2050 management ability to affect change: Climate change mitigation is MODERATE because of the inability to manage for threats or problems such as persistent drought in combination with mandated irrigation water delivery. Management strategies could be implemented to manage for climate change effects such as substantially increasing beaver density and spatial extent. Other management options to influence sustainable recreation and sustainable grazing practices are also available. The certainty of our ability to affect change is MODERATE.

Lakes/Ponds/Reservoirs

Ecosystem Description

Geographic Range

These ecosystems are characterized by lentic waterbodies and surrounding riparian/terrestrial habitats contained within the watershed. These include both naturally formed lakes and artificially constructed impoundments with capacity to store water perennially on the BTNF. These ecosystems support cold water refugia, amphibian breeding habitat, unique fish species habitats, and avian and terrestrial wildlife while providing source water for connected lotic river and stream ecosystems lower in elevation. Water depth and permanence in ponds is variable depending on topography, geology/soils, snowmelt, precipitation, and elevation of the water table. In response to these factors, the surface area of some ponds may be comprised of open water while the surface of others is dominated by emergent vegetation. Still other ponds may vary seasonally from open water dominance to emergent vegetation dominance, to becoming completely dry. The driving characteristics of these features are important and begs the question – is the water body being driven by precipitation or by groundwater recharge. If the same stressors affecting ponds also affect lakes, then ponds should be assigned accordingly. Ponds will be defined as having no groundwater input as a method of definition for this summary.

Vegetation Description

Surrounding vegetation varies greatly from conifer to hydrophytic vegetation, aquatic macrophytes, to bare sand.

Ecosystem Integrity Evaluation

1. **What ecological drivers and stressors and other key characteristics are most responsible for ecological integrity when the system has high integrity? (Include the level of uncertainty and condition/geographic differences).**

Key ecosystem characteristics include sediment management, soil integrity, water depth heterogeneity, absence of aquatic and terrestrial invasive species, lack of human disturbance, and sustainably managed human recreation.

Sediment will negatively affect water quality. High integrity will have a natural sedimentation regime and could settle or filter sediment from adjacent aquatic ecosystems lower in elevation or downstream.

Soil makeup will contain hydric/saturated soils at perimeter and overall lower particle size (silt) that will be supportive of specific kinds of vegetation. Healthy, functioning soil structure provides erosion control, an ideal substrate for plant growth and establishment, and better water infiltration. Soil depth and health, slope of catchment, and percent barren rock all affect how nutrients and air pollution deposition move through the catchment and into a pond or lake.

Habitat diversity with available depth to support all life history stages of fish (e.g., roundtail chub spawns in < 20 feet of water, lake trout require much deeper depths). Deeper water provides thermal refugia for cold water fisheries and sustains stream temperatures within the historic range of variability for connected river systems.

Absence of invasives (aquatic as well as terrestrial riparian invasives) and pathogens facilitates many, if not all the ecosystem processes. A balanced ecosystem will support a healthy macroinvertebrate community that feeds other species at higher trophic levels. High water quality is also a key ecosystem characteristic including low e-coli, proper pH (6-8), and dissolved organic matter and minerals in water. Adjacent upland health and adjacent inputs (erosion/pollutants) and the need for riparian buffer or upland buffer to those inputs are also key to ecosystem integrity facilitating healthy terrestrial interaction with riparian vegetation surrounding lakes/ponds.

Lack of human-tampered armoring/bank stabilization/dike and preventing soil compaction is important. Often improperly placed infrastructure transports toxicants directly into the waterbodies via surface water or via groundwater and impairs ecosystem integrity. Disturbance regimes, water depth, and water temperature should be within the historic range of variation.

Additional drivers and stressors include prolonged periods of drought and increased demand on irrigation volume and timing. Climate (e.g., severely dry conditions) is the primary driver of water demand, availability, and storage in these ecosystems.

Pollutants from air can directly deposit on a waterbody or enter an aquatic system through melting snowpack or via glacial meltwater. When enough pollutants enter a lentic system, acidification or eutrophication can occur. This can affect productivity, aquatic food webs, and aquatic community composition.

Deposition from air pollution, particularly nitrogen, phosphorus, and calcium can affect plant and aquatic macrophyte growth, cyanobacteria abundance, macroinvertebrate, zooplankton, and diatom diversity, and the presence and persistence of aquatic and terrestrial invasive species.

Dust on snow events have been increasing and not only add nutrients and other pollutants to the system but due to darker appearance, affects snowmelt rates.

The Revision Team considers these KECs and drivers/stressors typical of high integrity with **Moderate Certainty**.

2. What features of the ecosystem currently compromise (or support) ecological integrity and what are the mechanisms for the trend? Highlight important drivers, stressors, key ecosystem characteristics, and assess the degree to which management can or cannot influence this trend).

Climate change is a significant stressor/driver and can impact plant structure, survivability, reproduction and growth yield with rising temperatures, extended drought, and precipitation extremes. Relative humidity can affect soils, plants, and lichens as well as seedling survival. Vapor-pressure deficit, which integrates temperature and precipitation can also affect plant functions through drying of the atmosphere. Extreme rain events can cause flooding, landslides and extreme erosion that can alter the vegetation structure on the site and excess accumulation of sediment into aquatic ecosystems.

The timing of precipitation events and amount of runoff may shift due to climate change and compromise the integrity of these systems. Earlier ice-off and warmer than average summer temperatures also affect nutrient cycling in these lentic systems leading to potential fish kills, increased benthic algae growth, or blooms of harmful cyanobacteria. Algae and cyanobacteria blooms are naturally occurring, but density and frequency have been increasing over the last decade due to more favorable growing conditions including increased water temperature, longer growing seasons, elevated phosphorus and nitrogen inputs, and decreases in precipitation.

The integrity of these lentic systems may be compromised by excess sediment and other anthropogenic factors including:

- Recreation effects: Dispersed camping next to lakes, ponds or reservoirs, roads, and trails all contribute to soil compaction and loss of hydric soil function. unauthorized travel routes, increased water-based recreation, high riparian road density, and stock corrals adjacent to lakes, ponds and reservoirs contribute to soil compaction and direct nutrient inputs. Wind River Range specific lakes are becoming highly susceptible to E. coli and other components of human waste leaching into the water bodies.
- Beaver extirpation/beaver removal/beaver absence: Increases the potential for disrupted sediment management within aquatic ecosystems, reduces ground water recharge, and diminishes river/stream interaction with associated floodplains. This can affect water quality and water depth/permanence in connected lentic waterbodies.
- Altered fire regimes, specifically timber stand replacing wildfires: May contribute high sediment loads, elevated dissolved organic carbon, and increased nutrients (total nitrogen and total phosphorus) to lentic systems.
- Improper grazing implementation and lack of allotment specific monitoring due to staff shortages: Improperly managed livestock grazing of an intensity and duration that exceeds the capability of shoreline habitats to resist and recover quickly from impacts can degrade lentic ecosystem integrity.

- Establishment of aquatic invasive species: Increases in water-based recreation and water handling equipment for construction and wildfire suppression increase potential for spread of aquatic invasive plants, animals, and pathogens to lentic systems. Lakes and ponds with high calcium levels are at increased risk for shelled aquatic invasive species to become established when unintentionally introduced. Introduction of aquatic invasive species can completely and permanently disrupt aquatic food webs to the detriment of native and sportfish populations and other native aquatic species.
- Introduction of terrestrial invasive species: decreased forage, increase wildfire frequency and severity, decreased soil moisture, and may decrease biodiversity. High tree mortality from invasive species alters how nutrients cycle through terrestrial and thus aquatic ecosystems.
- Decreased pond/lake surface water elevation: Changes in precipitation and increased water demand associated with climate change can negatively affect the integrity of lentic systems by decreasing water volume. A decrease in surface water elevation and surface area outside the range of natural variation decreases the extent and vigor of shoreline riparian and wetland habitat and open water habitat to the detriment of avian, amphibian, and terrestrial wildlife. Decreased water depth and volume in lakes and ponds can also affect fish species abundance through increased competition for limited food and space, winter mortality from anoxic conditions, or summer mortality from water temperatures that exceed species thermal tolerances.

Available management strategies include: a) adaptively managing livestock grazing, through partnerships if necessary, to maintain desired conditions in and adjacent to lentic habitats; b) relocating problem road segments and properly locating new roads outside of riparian areas and away from lentic waterbodies; c) adaptively managing recreation practices to minimize effects to ponds and lakes; d) supporting interagency Aquatic Invasive Species (AIS) prevention efforts (internal and external education, watercraft check stations/monitoring, engaging wildfire operations to increase compliance with PMS 444 national prevention guidance); e) managing water levels in reservoirs and downstream habitats to minimize effects to fish populations. Raising water levels can flood vegetation or remove available spawning habitats for roundtail chub. Decreasing dam outflows to increase reservoir storage can dewater important spawning and rearing habitat for fish including native cutthroat trout (e.g., Snake River below Jackson Dam).

There is little the Forest can do to alter air pollution, or climate trajectory and the impacts associated with those issues, but management actions such as road/trail location and density near sensitive resources can help reduce cumulative impacts.

The Revision Team considers these key ecosystem characteristics and drivers/stressors that can compromise (or support) integrity with **High Certainty**.

3. **How does the current status and trend of the ecosystem (ecological integrity and the elements that are compromised) influence delivery of ecosystem services?**

The most relevant ecosystem services include:

Provisioning Services

1. Food – Provides cutthroat trout and big game habitat that is used by the public for hunting and securing wild game as a food source. Also, berry picking, and mushroom collection is found in this ecosystem.
2. Genetic resources – Important for three species of cutthroat trout, several other non-game fish species, and amphibians.
3. Fresh water – These systems are essential for irrigation and drinking water supplies.

Regulating Services

1. Air quality regulation – Ecosystem provides oxygen and filters-out pollutants.
2. Water regulation – Ecosystem provides filtration for water and erosion control.
3. Climate regulation – Can impact climate through carbon sequestration where aquatic systems absorb carbon.
4. Erosion regulation – Riparian root systems and understory vegetation help keep the soil in place.
5. Natural hazard regulation – Riparian and understory vegetation provides erosion control and reduced landslide threats. Connection to floodplains mitigate the intensity of flood events. High functioning aquatic ecosystems provide important fire breaks that mitigate the risk of catastrophic wildfires.

Cultural Services

1. Aesthetic values – Provides recreation opportunities to include fishing, rafting, and kayaking. Also, provides habitat for wildlife viewing and photographing.
2. Recreation and ecotourism – Fish and big game habitat provides fishing and hunter opportunities. Scenic photography is another opportunity in this ecosystem.

Supporting Services

1. Nutrient cycling – Vegetation recycles carbon, nitrogen and phosphorus and natural decomposition is a natural process. Nutrients in water is utilized throughout the ecosystem spiraling through uptake and release many times from headwaters to confluence with other rivers or lakes.
2. Soil formation – Riparian, understory vegetation and living organisms helps form soils by breaking down parent material. Roots serve as the “glue” to hold soil particles together and create soil structure. Hydric soils function to oxidize iron and sequester carbon.
3. Primary production – Plants convert energy into vegetation. Fish store energy through forage resources and provide a valuable resource to humans and other species within lentic ecosystems.

The Revision Team considers the ecological integrity and the elements that are compromised that influence delivery of ecosystem services with **High Certainty**.

4. What is the status of each ecosystem–the level and trend of ecological integrity (High, Moderate, Low, or Poor) in the plan area and surrounding lands; and to what degree can the FS affect change in this status?

Current integrity rating	Certainty	Long-term integrity trend	Certainty	Short-term ability to affect	Certainty	Long-term ability to affect	Certainty
Moderate	Moderate	Moderate	High	Moderate	Low	Low	Low

The status for the current integrity for Lakes/Ponds/Reservoirs with associated riparian habitats is: MODERATE INTEGRITY. Current plans for reservoir management and water needs will stress the condition of the lake, pond, and reservoir systems. This is further combined with requirements for irrigation water provisions to downstream water rights holders. Recreational influences and boating/rafting/kayaking is monitored to track AIS presence/absence. There are contemporary drivers and stressors currently disrupting the balance of temperature, sediment flow, nutrient loading, and water elevation. Air quality concerns leading to water quality shifts and subsequent algal blooms is occurring. Although there is still current ecosystem function, the overall balance of highly functioning water bodies and highly impaired water bodies leads to an overall MODERATE INTEGRITY ranking. The major functions and services are functioning. MODERATE CERTAINTY for this trend.

2050: MODERATE INTEGRITY ranking assessment; Service delivery is expected to decline. Loss of species such as the roundtail chub has moderate potential resulting from possible infrastructure changes to New Fork Lake, or other lakes where roundtails are currently found. Infrastructure changes are proposed to increase water storage capacity, and those changes may lead to habitat alterations that roundtail currently rely on for life history requirements. Climate change projections are expected to disrupt established and historical water use needs. Future irrigation needs will exacerbate invasive species/native species interactions as well as the potential for further invasive introductions. Increased recreation impacts will also continue. The confidence of this assessment is HIGH CERTAINTY mainly due to observed increases in impairment covariates and increased recreational use by adjacent regions.

Degree USFS management can affect change (CURRENT): MODERATE. Management influence in impounded waterbodies (e.g., reservoirs) with water rights requirements and delivery schedules is LOW. However, consideration of other waterbodies in this category is MODERATE, largely driven by consistent observable air quality concerns leading to water quality shifts and subsequent algal blooms. Recreational use is well established, consistent, and expected to persist or increase. The confidence of this assessment is LOW CERTAINTY mainly due to the uncertainty of covariates and atmospheric influence in these systems.

2050 management ability to affect change: The degree to which the USFS can affect change in the future is LOW. The BTNF cannot affect the air quality/inputs that drive high elevation lake threats to ecosystem function. Similarly, the BTNF cannot influence the agricultural water delivery requirement that can affect water levels in reservoirs. The BTNF can manage recreation, actively manage invasive species through prevention and eradication efforts, and

adaptively manage livestock grazing. The certainty of this assessment is LOW because of persistent known stressors from air quality, irrigation demand, and recreational use.

Wetlands, Kendall Warm Spring, other Springs, and Groundwater Dependent Ecosystems (GDEs)

Ecosystem Description

Fens are included in this category as well as Kendall Warm Springs and all other hot, warm, and cold springs. The reliability of geospatial tools to predict the presence of these ecosystems across the landscape is limited. Therefore, project level surveys are needed to ground truth wetlands and GDEs. A more rigorous description of these systems could help in classifying them when they are encountered on the ground.

These systems are comprised of predominantly lentic aquatic habitats but in some cases have lotic parts of the ecosystem connecting them to other ponds/wetlands/GDEs or other surface water systems such as rivers/streams or lakes/reservoirs. They are generally characterized by hydric soil types and support many unique processes such as nutrient sequestration, sediment sequestration, carbon sequestration, groundwater recharge, pH stabilization, and species habitats for many life stages of both aquatic and terrestrial organisms. These ecosystems support species not found elsewhere on the BTNF and are dependent on proper ecosystem function that influences/supports the function of adjacent ecosystems.

Vegetation Description

Surrounding vegetation varies greatly from conifer to obligate hydrophytic vegetation, facultative wetland vegetation, riparian vegetation, aquatic macrophytes, to adjacent upland vegetation.

Ecosystem Integrity Evaluation

1. **What ecological drivers and stressors and other key characteristics are most responsible for ecological integrity when the system has high integrity? (Include the level of uncertainty and condition/geographic differences).**

Key ecosystem characteristics include sediment management, soil integrity, water depth heterogeneity, absence of aquatic and terrestrial invasive species, lack of human disturbance, and sustainably managed human recreation. Fine sediment delivery above natural levels degrades water quality and habitat in these connected aquatic ecosystems. Those systems with high integrity have a sediment supply within the natural range of variation and function as sediment filters that minimize sediment delivery to downstream aquatic habitats.

Soil makeup will contain hydric/saturated soils at perimeter and overall lower particle size (silt) that will be supportive of specific kinds of vegetation. Healthy, functioning soil structure provides erosion control, an ideal substrate for plant growth and establishment, and better water infiltration. Histosols are another soil type found in deep organic matter in fens.

Carbon sequestration of histosols is especially notable and are only 1.2% of all soil types, are unique, and have a large ecosystem function relative to their minority presence on the BTNF. These ecosystems contain 40% of all animal and plant species in these hydric/wetland soils.

Calcareous soils are special in that they do not contain enough iron or organic material. The pH is greater than 8 (alkaline) in some of these ecosystems.

Warm springs are dependent on the geologic strata that the water is forced to permeate before reaching the surface and could be influenced or compromised by any ground disturbance (e.g., mining, drilling, or any mineral extraction). Kendall Warm Spring is unique in that high Sulphur content is present in the water.

Perpetually saturated, anoxic conditions result with less decomposition and build sediment over very long periods of time (hundreds to thousands of years). The importance of these conditions can persist to maintain the very long process by which the formation of these systems was formed is critical for ecosystem function.

Livestock grazing can result in detrimental effects to these ecosystems. The structural composition of wetlands may be influenced by wild ungulate and domestic livestock grazing. Properly functioning wetlands have a sufficient level of grazing, within the natural range of variability, such that wetland functions are maintained and not compromised. Hoof shear by wild ungulates and livestock can structurally alter these ecosystems and contribute to hummocking. A thesis by Smith (2015), investigated the role that ungulates play in hummocking in Utah wetlands. He found that some hummocked areas have significant bare ground and desiccation, even in early summer. Booth et al. (2014) found that hummocking was caused primarily by domestic livestock and that this can decrease water storage in wetland complexes, which is of heightened concern in the face of climate change. This is consequential for amphibians whose larvae can die from desiccation if breeding habitats dry out before metamorphosis occurs.

Absence of invasives (aquatic as well as terrestrial riparian invasive) and pathogens facilitates many if not all the ecosystem processes. A balanced ecosystem will support a healthy macroinvertebrate community that feeds other species at higher trophic levels. High water quality is also a key ecosystem characteristic including low e-coli, proper pH (6-8) and in rare cases pH 8+ and dissolved organic matter and minerals in water. Adjacent upland health and adjacent inputs (erosion/pollutants) and the need for riparian and/or upland buffers to those inputs also are key to ecosystem integrity facilitating healthy terrestrial interaction with riparian vegetation surrounding these habitats.

Lack of human-tampered armoring/bank stabilization/dike and preventing soil compaction is important. Often improperly placed infrastructure too near to the surface water quickly transports toxicants directly into the waterbodies and impairs ecosystem integrity.

Drivers and stressors include prolonged period of drought and increased demand on irrigation volume and timing and diminished groundwater level. Climate change (severely dry conditions) and earlier annual loss of snowpack is the primary driver of water availability and storage in these ecosystems. These stressors can interact with management actions such as livestock grazing to cumulatively degrade these sensitive ecosystems.

The Revision Team considers these key ecosystem characteristics and drivers/stressors that can compromise (or support) integrity with **High Certainty**.

2. What features of the ecosystem currently compromise (or support) ecological integrity and what are the mechanisms for the trend? Highlight important drivers, stressors, key

ecosystem characteristics, and assess the degree to which management can or cannot influence this trend).

Climate change is a significant stressor/driver and can impact plant structure, survivability, reproduction and growth yield with rising temperatures, extended drought, and precipitation extremes. Relative humidity can affect soils, plants, and lichens as well as seedling survival. Vapor-pressure deficit, which integrates temperature and precipitation can also affect plant functions through drying of the atmosphere. Extreme rain events can cause flooding, landslides and extreme erosion that can alter the vegetation structure on the site and excess accumulation of sediment into these ecosystems. Groundwater recharge from snowmelt is important to sustain these ecosystems. Therefore, climate change induced changes in timing and duration of snowmelt and runoff due can also compromise the integrity of these systems. The important role that wetlands and fens play as a carbon sink can be compromised if these ecosystems are degraded or decrease across the landscape in response to these myriad stressors. As a consequence of decreased groundwater recharge from climate change, drying of these systems can promote decomposition of organic material, which could allow sequestered carbon to enter the atmosphere via wind.

Mineral extraction has the potential to disrupt aquifers that feed GDEs. This could be a concern if underground mining operations were to increase on the BTNF. Increased recreational use of hot springs can serve as an emergent and increasing disturbance regime that is unique to warm/hot springs.

These systems can be compromised from excess sediment and other anthropogenic stressors including:

- Recreation effects: Dispersed camping, roads, trails, and unauthorized travel routes in and adjacent to wetlands generates and delivers fine sediment, contributes to soil compaction and the loss of hydric soil function. Increased water-based recreation increases the potential for those wetlands and GDEs adjacent to popular waterways and waterbodies to be degraded. Stock corrals located in wet meadows or adjacent to wetlands and GDEs can contribute to soil compaction and hummocking.
- Beaver extirpation/beaver removal/beaver absence: Increases the potential for disrupted sediment management within aquatic ecosystems, reduces ground water recharge, and diminishes river/stream interaction with associated floodplains and connected wetlands. Cumulatively, these effects decrease the quality and extent of wetlands to the detriment of wetland dependent plant and wildlife species.
- Altered fire regimes: Timber stand replacing wildfires contribute high sediment loads with orders of magnitude higher than normal.
- Improper grazing: Improperly managed livestock grazing of an intensity and duration that exceeds the capability of wetlands and GDEs to resist and recover quickly from impacts can degrade ecosystem integrity.
- Introduction of terrestrial invasive species: Cause a decrease in forage, increase fire frequency, decrease in soil moisture, and decrease in biodiversity.
- Introduction of aquatic invasive species: Can cause a complete disruption of aquatic food webs. Pathogens such as chytrid fungus and ranavirus can be spread unintentionally by humans and can decimate amphibian populations in wetland habitats.

The Revision Team considers these key ecosystem characteristics and drivers/stressors that can compromise (or support) integrity with **High Certainty**.

3. **How does the current status and trend of the ecosystem (ecological integrity and the elements that are compromised) influence delivery of ecosystem services?**

The most relevant ecosystem services include:

Provisioning Services

1. Food – Provides cutthroat trout and big game habitat that is used by the public for hunting and securing wild game as a food source. Also, berry picking, and mushroom collection is found in this ecosystem.
2. Genetic resources – Important for many fish species including Endangered Kendall Warm Spring Dace, many rare and unique plant species, and amphibians.
3. Fresh water – These systems are essential for irrigation and drinking water supplies.

Regulating Services

1. Air quality regulation – Ecosystem provides oxygen and filters-out pollutants.
2. Water regulation – Ecosystem provides filtration for water and erosion control.
3. Climate regulation – Can impact climate through carbon sequestration in soils.
4. Erosion regulation – Riparian and wetland vegetation root systems and understory vegetation help keep the soil in place.
5. Water purification and waste treatment- These systems have the capacity to sequester excess nutrients and filter water serving adjacent ecosystems.
6. Disease regulation- These systems provide diverse habitat and refuge for amphibians seeking chytrid refuge/mitigation.
7. Pollination- These systems support species critical to pollination.
8. Natural hazard regulation – Riparian and understory vegetation provides erosion control and reduced landslide threats. Connection to floodplains mitigate the intensity of flood events. Also high functioning aquatic ecosystems provide important fire breaks that mitigate the risk of catastrophic wildfires.

Cultural Services

1. Aesthetic values – Provides habitat for wildlife viewing and photographing.
2. Spiritual and religious values: These systems may have spiritual and religious values. The Forest Archaeologist should be consulted.
3. Recreation and ecotourism – Kendall Warm Spring is a unique system attracting many visitors, also hot springs are a popular recreational opportunity, and wetlands support waterfowl hunting opportunities.

Supporting Services

1. Nutrient cycling – Vegetation recycles carbon, nitrogen and phosphorus and natural decomposition is a natural process. Nutrients in water is utilized throughout the ecosystem spiraling through uptake and release many times from headwaters to confluence with other rivers or lakes. Wetlands and GDEs play an important role in this process.
2. Soil formation – Riparian, understory vegetation and living organisms helps form soils by breaking down parent material. Roots serve as the "glue" to hold soil particles together and create soil structure. Hydric soils function to oxidize iron and sequester carbon.
3. Primary production- These systems support many species life histories and are important food sources for species at all trophic levels.

The Revision Team considers the ecological integrity and the elements that are compromised that influence delivery of ecosystem services with **High Certainty**.

4. What is the status of each ecosystem–the level and trend of ecological integrity (High, Moderate, Low, or Poor) in the plan area and surrounding lands; and to what degree can the FS affect change in this status?

Current integrity rating	Certainty	Long-term integrity trend	Certainty	Short-term ability to affect	Certainty	Long-term ability to affect	Certainty
Moderate	Moderate	Low	Moderate	Low	Moderate	Low	Moderate

The status for the current integrity for Wetlands/Kendall Warm Springs/other Springs/Groundwater Dependent Ecosystems (GDEs) with associated riparian habitats is: MODERATE INTEGRITY. Climate change is the largest contributing influence on the integrity of these ecosystems. The major functions and services are functioning at risk. The revision team considers this assessment as MODERATE CERTAINTY.

2050: LOW INTEGRITY ranking assessment; Service delivery is expected to decline in the fragile ecosystems. Climate change projections are expected to shift the hydrology of these ecosystems and disrupt established and historical water availability. Increased recreation impacts will also continue. The confidence of this assessment is MODERATE CERTAINTY mainly due observed increases in impairment covariates and the nature of these ecosystems that are susceptible to disturbance.

Degree USFS management can affect change (CURRENT): LOW. Degradation of these ecosystems is largely climate driven, and few management options are available that can or will affect a positive level of change. Since management options are limited; we have MODERATE CERTAINTY because of climate change and the impacts it has on these ecosystems.

2050 management ability to affect change: The degree to which the USFS can affect change in the future is LOW and these systems will likely have LOW INTEGRITY. The BTNF cannot influence the agricultural water delivery requirement that can affect water levels in groundwater. The BTNF can manage recreation, monitor for invasive species, and manage and monitor adjacent livestock grazing. The certainty of this assessment is MODERATE CERTAINTY because of persistent known stressors from air quality, irrigation demand, and recreational use.

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Appendix D: Air Quality, IMPROVE Visibility Graphs

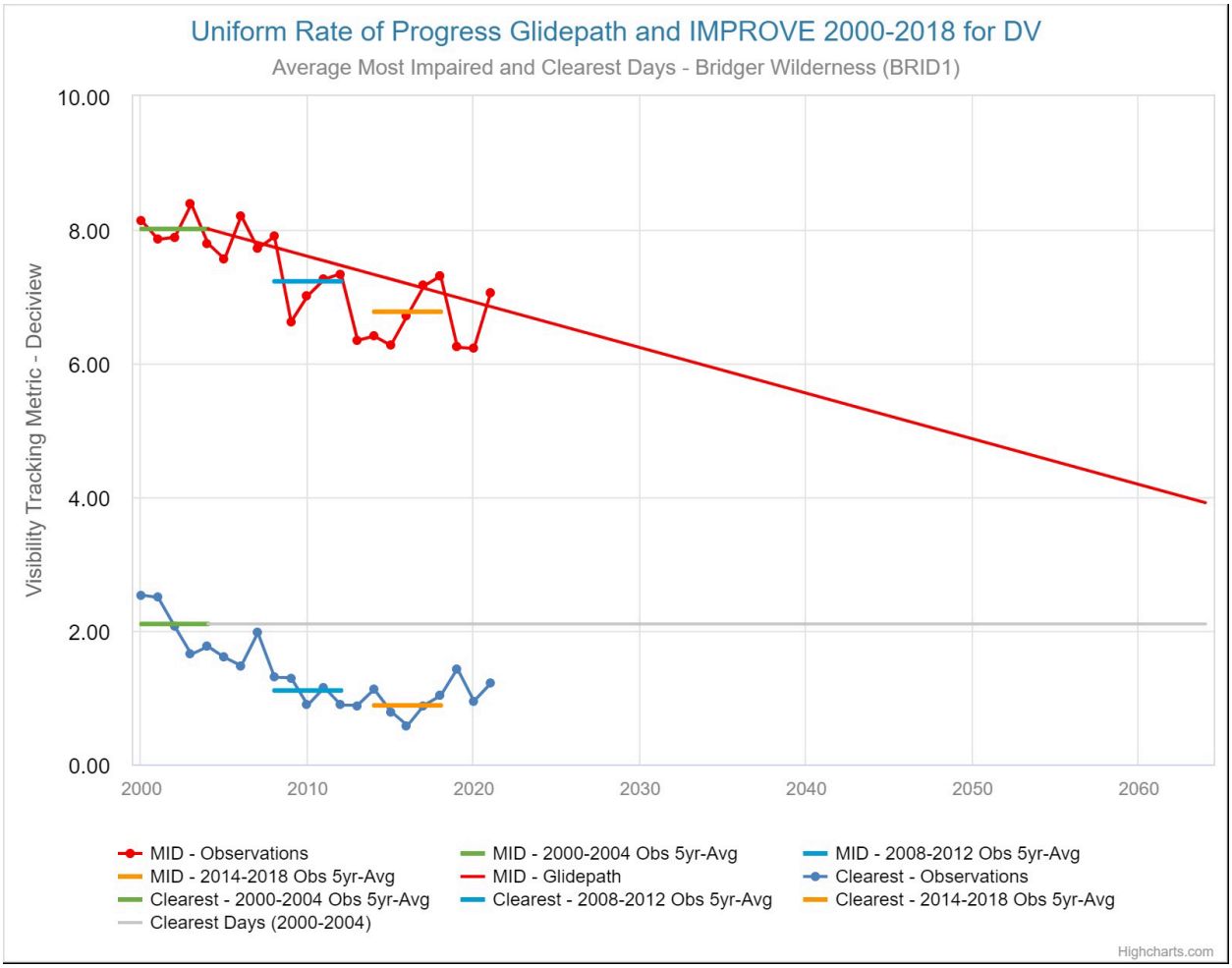


Figure 74. Glidepath for tracking trends in visibility under the Regional Haze Rule for the Bridger Wilderness

Note: Straight red line is used as guidance to track visibility progress of most impaired days towards the goal of achieving natural visibility conditions at designated Class I areas by 2064.

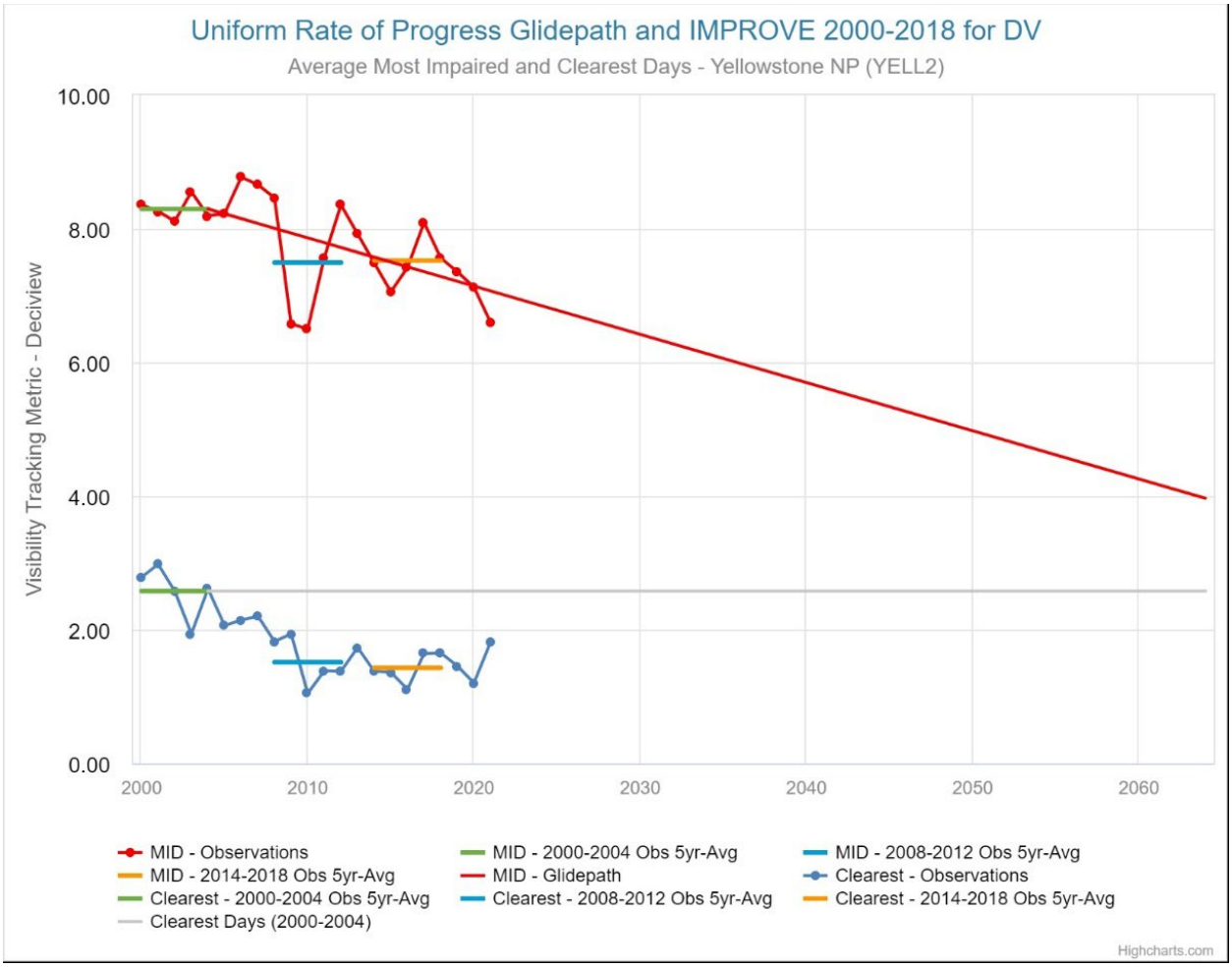


Figure 75. Glidepath for tracking trends in visibility under the Regional Haze Rule for the Teton Wilderness and Yellowstone National Park

Note-Straight red line is used as guidance to track visibility progress of most impaired days towards the goal of achieving natural visibility conditions at designated Class I areas by 2064.

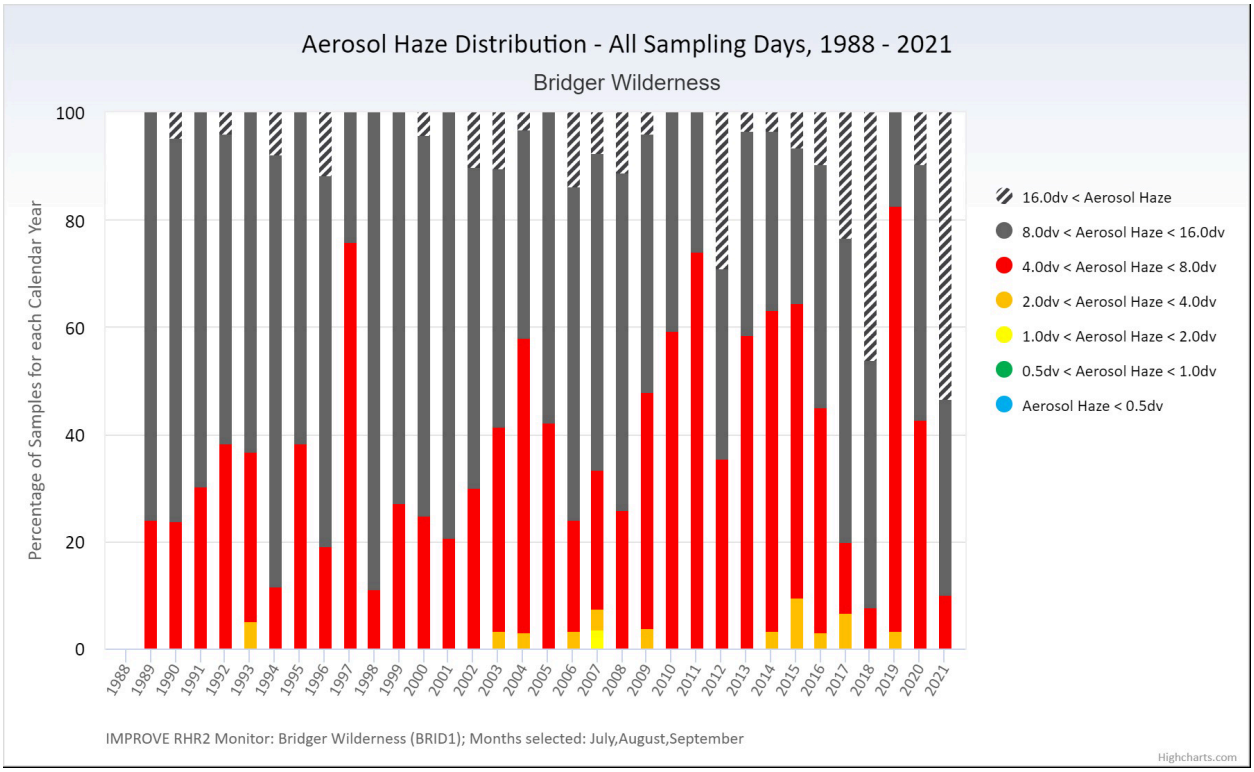


Figure 76. IMPROVE (BRID1) Aerosol haze distribution during fire season, July-September, representative of the Bridger Wilderness
Note: Includes anthropogenic and natural sources.

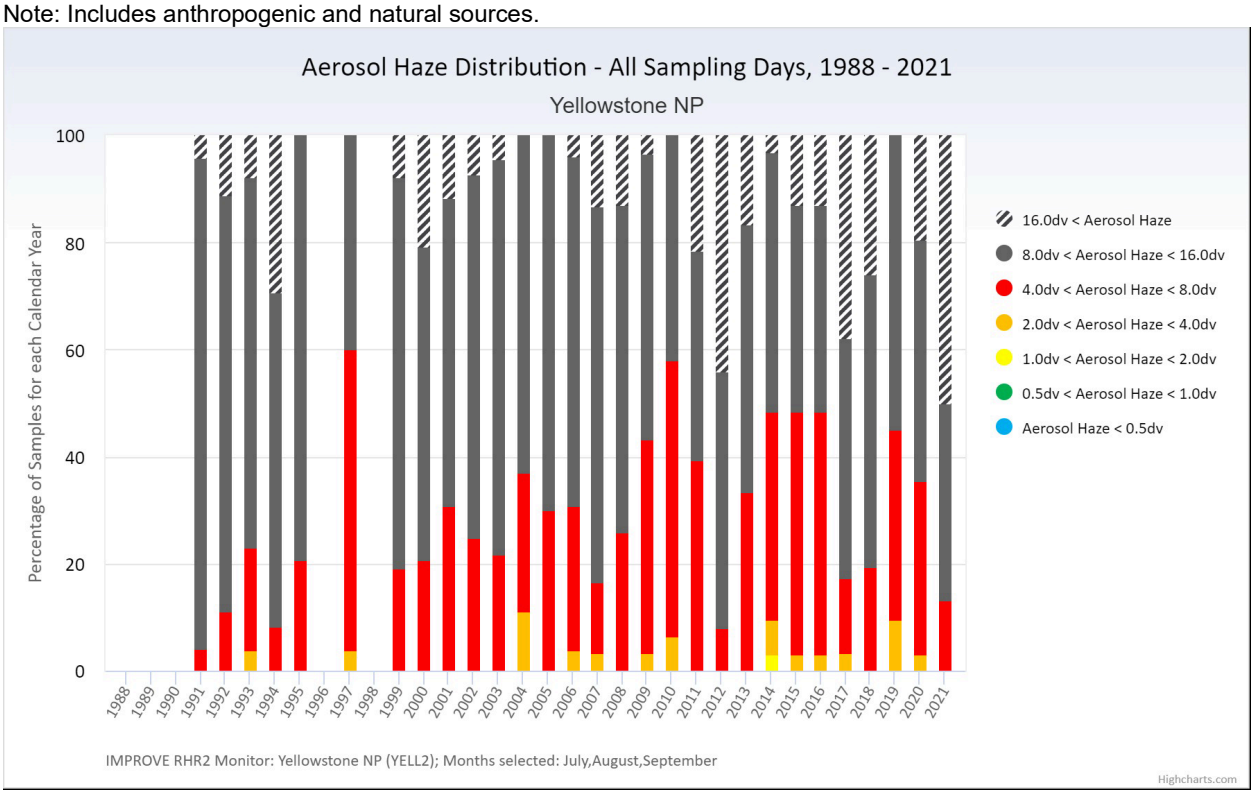


Figure 77. IMPROVE (YELL2) Aerosol haze distribution during fire season, July-September, representative of the Teton Wilderness and Yellowstone National Park
Note: Includes anthropogenic and natural sources.

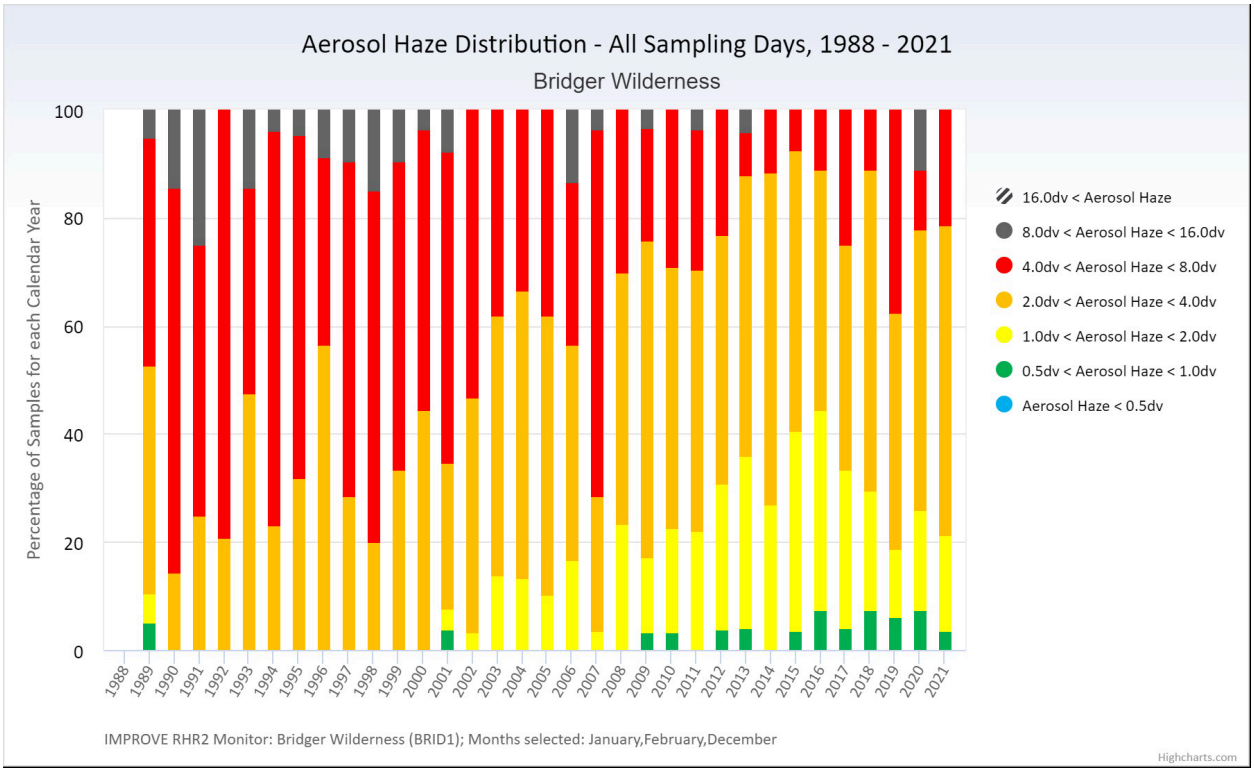


Figure 78. IMPROVE (BRID1) Aerosol haze distribution during winter, December-February, representative of Bridger Wilderness
Note: Includes anthropogenic and natural sources.

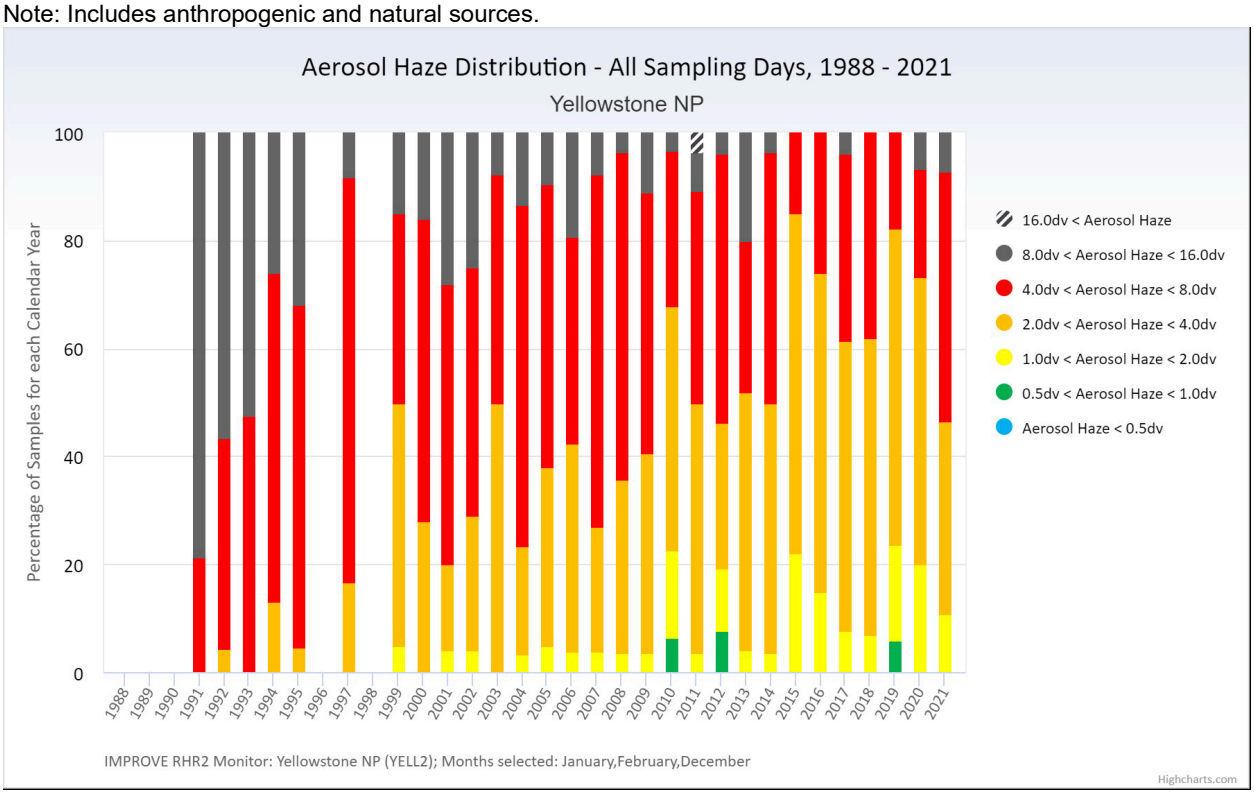


Figure 79. IMPROVE (YELL2) Aerosol haze distribution during winter, December to February, representative of the Teton Wilderness and Yellowstone National Park
Note: Includes anthropogenic and natural sources.

Appendix E: Environmental Protection Agency State of Wyoming Emissions Inventory

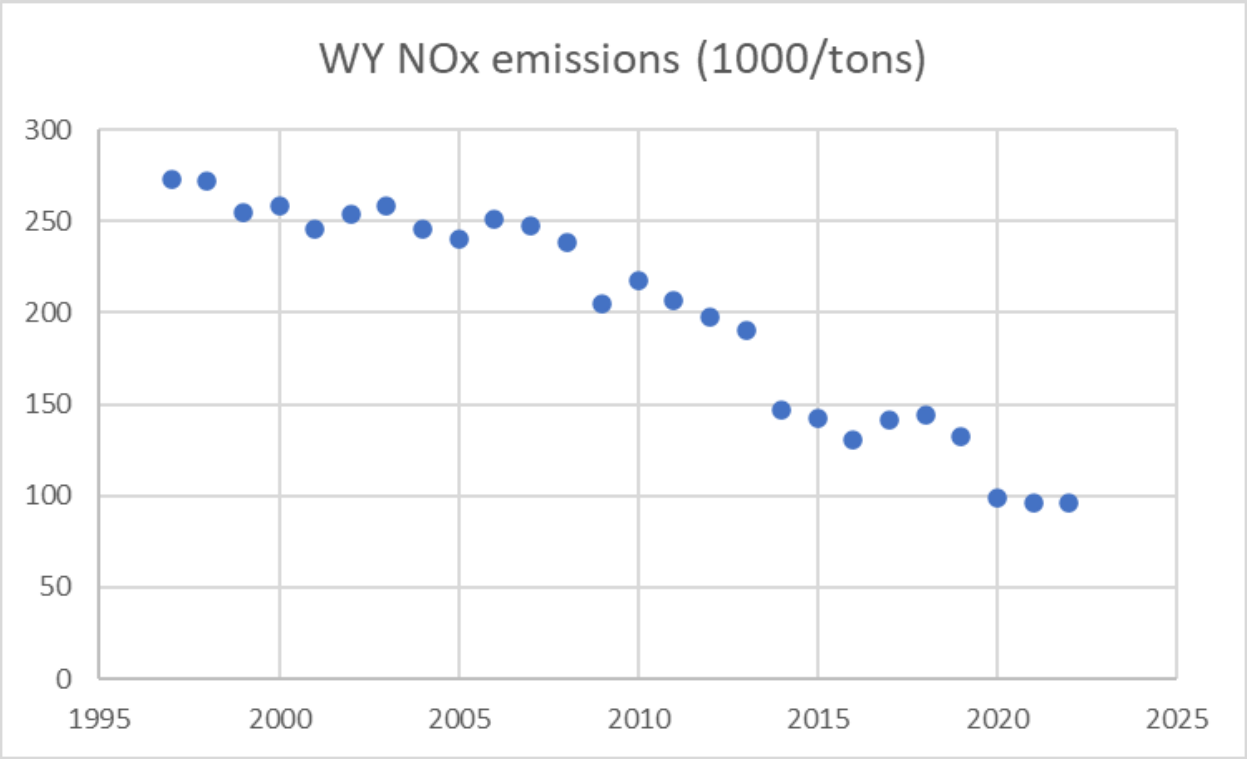


Figure 80. Wyoming annual nitrogen oxide (NOx) emissions in 1,000/tons between 1997-2022

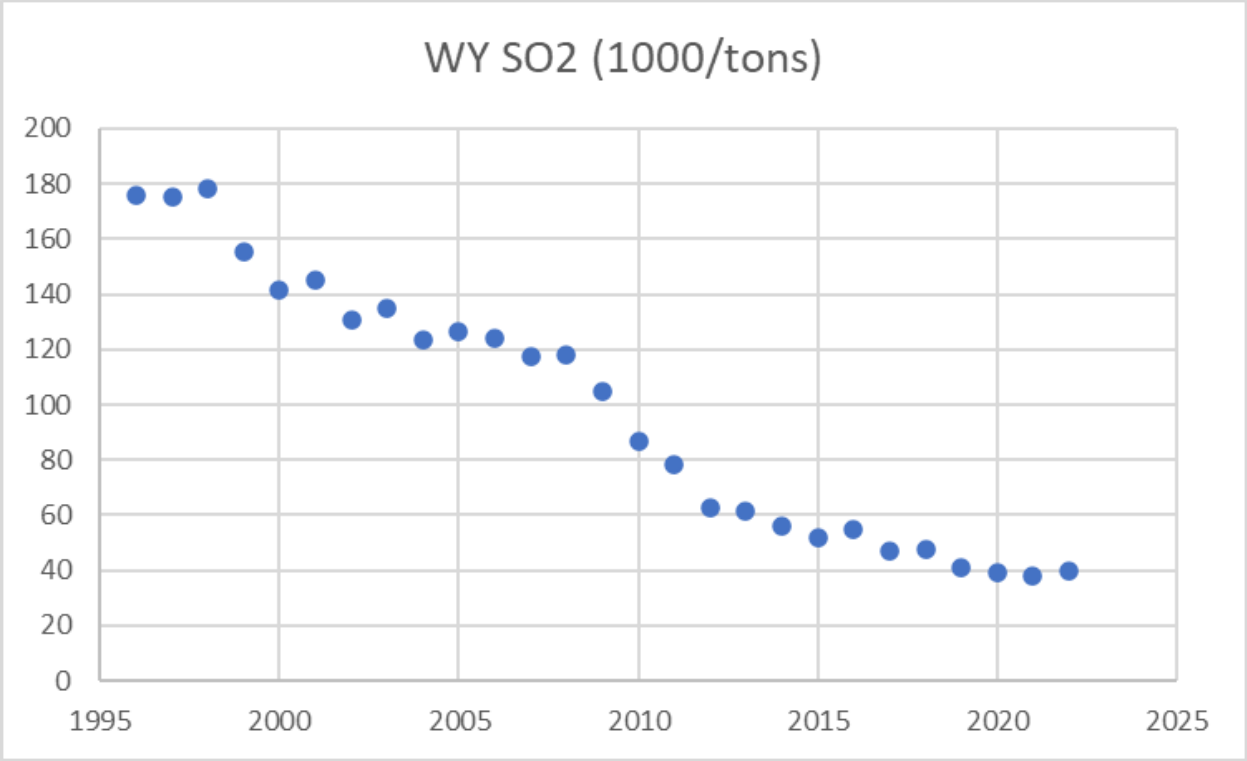


Figure 81. Wyoming annual sulfur dioxide (SO2) emissions in 1,000/tons between 1996-2022

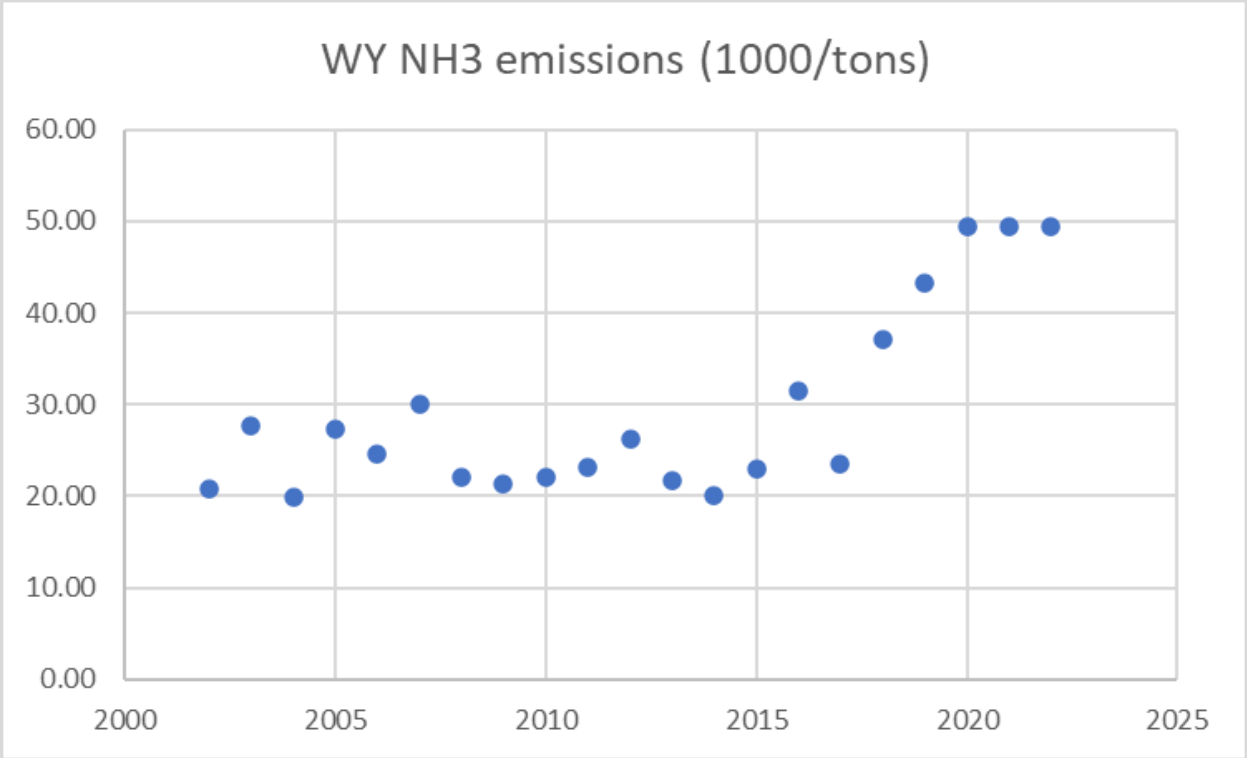


Figure 82. Wyoming annual ammonia (NH3) emissions in 1,000/tons between 2002-2022

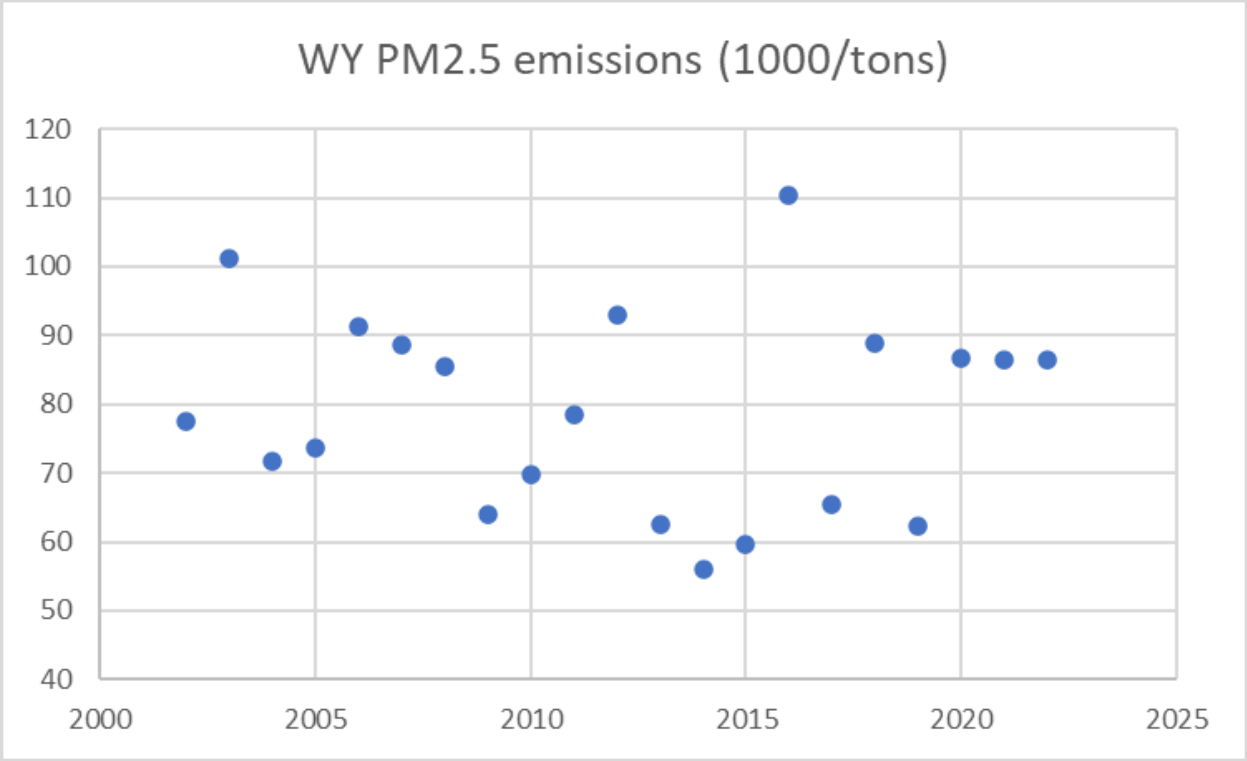


Figure 83. Wyoming annual particulate matter size cut 2.5 microns (PM2.5) emissions in 1,000/tons between 2002-2022

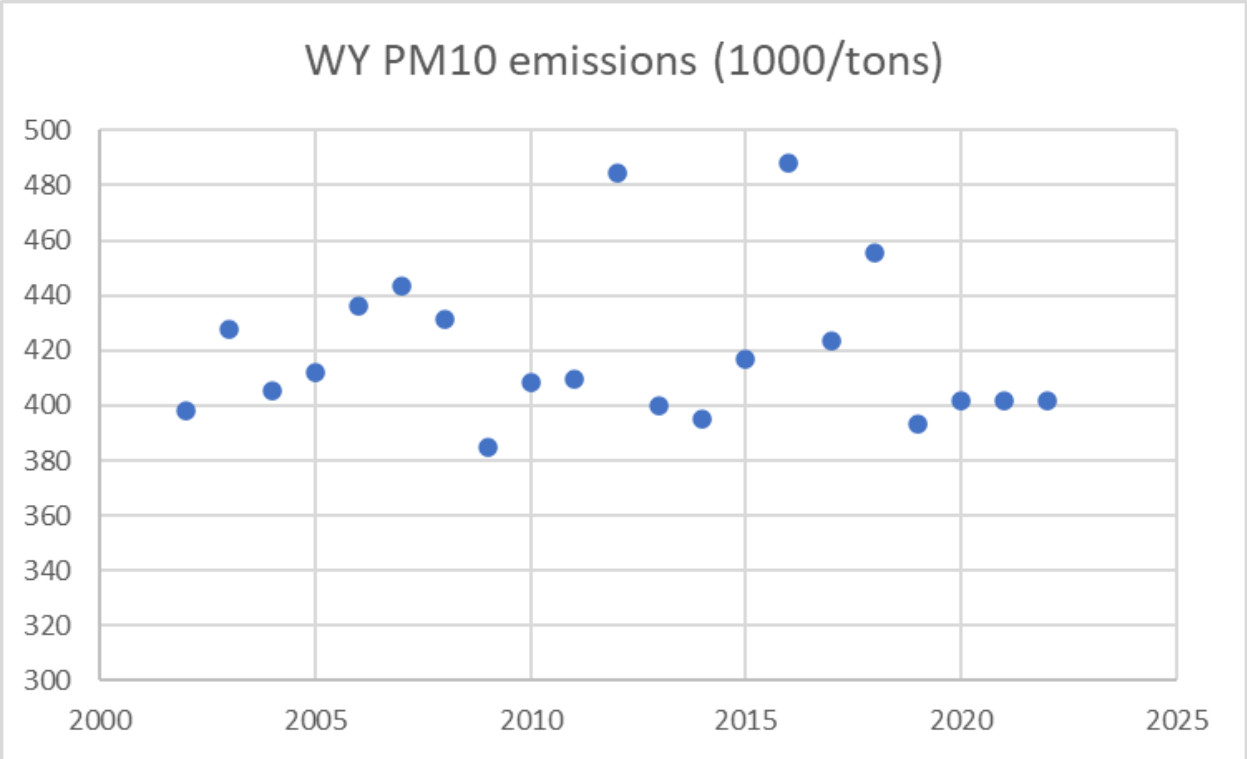


Figure 84. Wyoming annual particulate matter size cut >10 microns (PM10) emissions in 1,000/tons between 2002-2022

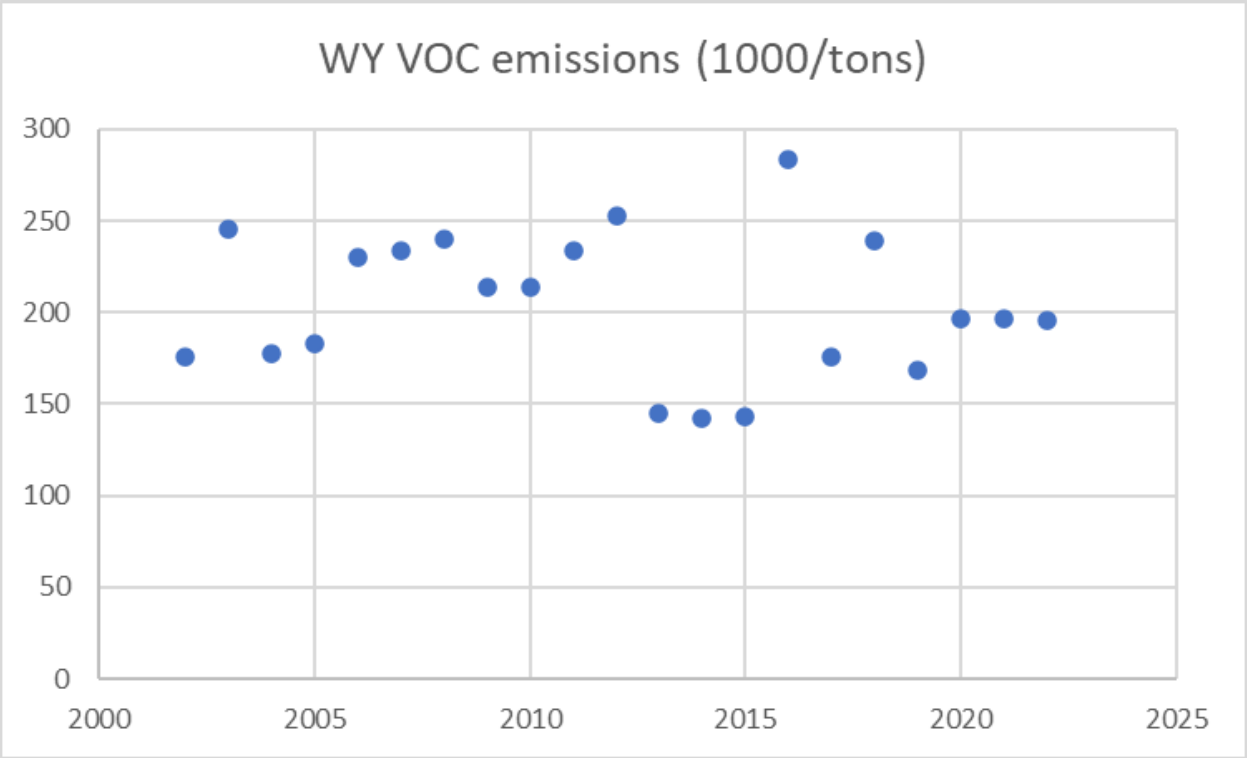


Figure 85. Wyoming annual volatile organic compound (VOC) emissions in 1,000/tons between 2002-2022

Appendix F: Carbon White Paper

Forest Carbon Assessment[10]

Bridger-Teton National Forest

Intermountain Region

Prepared By: Ben Soderquist, Regional Analyst

For:

Date: October 9, 2024

[10] From USFS Office of Sustainability and Climate Carbon White Paper Template Version 2.0, June 2024. Recommended citation for this carbon assessment: USDA Forest Service. 2024. Bridger-Teton National Forest, Intermountain Region, USDA Forest Service.)

Executive Summary

Total ecosystem biogenic carbon in the Bridger-Teton National Forest has remained stable in recent decades. The amount of land in the forested land type in Bridger-Teton National Forest slightly increased from 1990 to 2020 by 7400 ha. Carbon density, the carbon stocks by unit area, in the Bridger-Teton National Forest decreased slightly by 1.5 Mg/ha. Total ecosystem carbon stocks have remained stable over this period. Soil biogenic carbon values have high uncertainty because of data and modeling limitations and are likely underestimated.

Forest stand development dynamics, myriad disturbances, climatic patterns, and environmental fluctuations have impacted ecosystem carbon uptake and storage in the Bridger-Teton National Forest. Forest types are mainly mixed spruce/fir and stand ages principally range from 10-200+ years old and 80–150 year-old age classes predominate. Forest carbon stocks remained stable in recent decades. From 1990 to 2011, the primary disturbances influencing carbon uptake and storage, excluding soil carbon, were insects and fire, respectively. Carbon stocks, excluding soil carbon, in Bridger-Teton National Forest would have been approximately 6 percent higher in 2011 if insect outbreaks and fires had not occurred since 1990.

Disturbances such as insects and fire are likely to increase, with consequent effects on forest carbon. Carbon uptake and storage in the Bridger-Teton National Forest may be increasingly vulnerable to numerous threats related to climate change and its interactions with forest patterns and processes. Through implementation of thoughtful carbon stewardship, the Bridger-Teton National Forest will continue to serve an important role in taking up and storing carbon, contributing to its holistic approach to land management.

Overview

Introduction and Consistency with Relevant Laws, Regulations, and Policy

The Council on Environmental Quality (CEQ) *National Environmental Policy Act (NEPA) Guidance on Consideration of Greenhouse Gas (GHG) Emissions and Climate Change* (published January 9, 2023) provides recommendations that pertain to land and resource management plans and projects, both Environmental Assessments and Environmental Impact Statements, including the recommendation that agencies consider the projected GHG emissions or reductions for proposed actions and their reasonable alternatives (Section IV) and use this information to assess potential climate change effects (Section V). The CEQ guidance also advises agencies to assess the potential future state of the affected environment in NEPA analyses (Section VI), including considering the impacts of climate change on project actions and alternatives (for more information on incorporating climate change into NEPA Environmental Analysis, see Brandt and Schultz 2016). To do so, it recommends the use of the best available information and science, including relevant data and quantification tools where appropriate, to guide these analyses. The CEQ advises that agencies should be guided by a rule of reason and the concept of proportionality in determining the appropriate depth of analysis. This includes recognition of the inherent complexities and uncertainties associated with analyzing projected fluctuations in biogenic carbon associated with land and resource management actions under uncertain future climate conditions. Several components of this guidance were codified within the National Environmental Policy Act Implementing Regulations Revisions Phase 2 (published May 1, 2024). The USDA Forest Service also issued “step-down” guidance to aid in local

applications of the CEQ guidance, Considering Climate Change in USDA Forest Service National Environmental Policy Act Analyses. This carbon assessment report focuses solely on biogenic carbon, hereafter 'carbon'.

This report provides a framework to support carbon reporting at the national forest (or administrative unit) scale. Results and information are derived from a variety of models, data sources, and qualitative analyses. It describes how carbon dynamics relate to environmental factors and human and natural disturbances. It also considers projected future changes in carbon under multiple changing climate scenarios and associated socioeconomic pathways. The stock data sampling design and models whose results are described here were developed for use across broader areas such as the national forest (or administrative unit). This allows for direct comparison among landscapes (national forests or administrative units) that may vary in carbon uptake, storage capacity, and disturbance history. This report provides a broader context for estimating carbon gains or losses at finer scales such as the project level, but direct interpretation of results at these finer scales is not advised.

Analyses performed at broader spatial scales using rigorous, objective methods remain the most robust way to integrate known climate impacts into carbon analyses. These approaches are described in The United Nation's (UN) Climate Change secretariat's Annual Reports and support the long-term objectives of the UN Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, and the Paris Agreement. The USDA Forest Service – in alignment with the CEQ NEPA guidance and regulations, plus the Forest Service Step-Down Guidance – uses carbon assessments at the scale of the national forest (or administrative unit) to inform project-level carbon analysis in a consistent, efficient, and unbiased manner.

The Carbon Cycle in Forest Ecosystems

Forests play an important role in the global carbon cycle. Through photosynthesis, plants absorb carbon dioxide from the atmosphere and store some of it as carbon. Carbon uptake refers to plants taking in carbon through photosynthesis. The rate of carbon uptake is commonly measured as the net amount of carbon uptake per hectare per year. The carbon stock is the amount of carbon stored at any one time. Carbon is stored in different reservoirs or zones, called carbon pools. Forest carbon can be categorized into seven carbon pools: aboveground live tree, belowground live tree, understory, standing dead, downed dead wood, litter, and soil organic carbon. These seven pools together comprise the biologically sourced carbon (biogenic carbon) considered in forest management. Carbon density quantifies forest carbon stocks per unit area. The stability of carbon storage, called the residence time, quantifies the duration carbon is stored in each pool.

The biogenic carbon cycle describes the movement of carbon among carbon pools and between these pools and the atmosphere. Forest carbon stocks are dynamic, with carbon frequently transferring among pools. When plants remove carbon from the atmosphere, they store some of this carbon in live aboveground plant biomass. Much of this carbon remains in the aboveground live tree pool. Some carbon rapidly moves into the belowground live tree pool, where plants use it to build roots and acquire soil nutrients. Carbon stored in live tree and understory pools may migrate via decomposition and disturbance into the standing dead, downed dead wood, litter, and soil carbon pools over time or be emitted to the atmosphere. The balance of carbon storage versus emission to the atmosphere determines the total amount of forest carbon, which fluctuates over longer time periods.

Principles of Carbon Stewardship

Carbon stewardship: Carbon stewardship involves: 1) the intentional analysis of the effects of management actions on carbon uptake, storage, and stability; 2) balancing carbon benefits with other ecosystem benefits; 3) considering landscape-scale ecosystem function and resilience; 4) enhancing net ecosystem carbon uptake and storage; and 5) avoiding emissions from disturbance or tree mortality. These factors contribute to carbon stability.

Carbon stewardship principles align with the Forest Service's holistic approach to land management (Janowiak et al. 2017), which supports its multi-use mission to steward national forests and grasslands for the benefit of current and future generations. Therefore, carbon stewardship would not maximize biogenic carbon storage at the expense of ecosystem health or habitat.

Carbon stewardship requires a broad definition because ecosystem carbon responses to land management actions may differ across site conditions and ecosystems. Evaluation of the following components of carbon stewardship can help managers determine whether proposed actions can reasonably be expected to provide carbon benefits over the life of the project.

Carbon stabilization: Carbon stabilization involves assessing the risk of either carbon emissions or reduced uptake and storage capacity from natural disturbance or biotic stressors in an ecosystem across spatial and temporal scales and taking actions to increase or maintain the residence time, or stability, of carbon in the ecosystem. Forest managers may undertake actions in response to assessments indicating that current conditions are out of alignment with ecosystem dynamics and impinge on carbon stability. Projects in alignment with carbon stewardship actions may involve reducing carbon stocks in the short term to restore and maintain ecosystem conditions in the long term that are consistent with the natural range of variation or that reduce threats to ecosystems from climate change. For example, reducing tree densities in overstocked stands will decrease carbon in the short term, but may lower the risk of carbon losses from mortality and wildfire, thus resulting in greater stability and a longer landscape-level residence time of carbon. Carbon stabilization also involves evaluation of carbon residence times, which vary among pools and according to environmental conditions. Aboveground live tree, belowground live tree, standing dead, and downed dead wood carbon stocks have residence times of decades to centuries. Litter carbon stocks have shorter residence times, of months to decades.

Climate change adaptation: Actions that provide adaptation benefits through reduced risk of unintended climate impacts can provide carbon benefits through avoided carbon emissions (for more information, see the USDA Forest Service Climate Adaptation Plan). Some disturbances may also decrease carbon uptake through reductions in plant growth rates and related carbon uptake and storage. While not all adaptation actions provide carbon benefits, many actions, such as planting climate-resilient, productive species or genotypes, address threats to ecosystem health while sustaining or improving ecosystem carbon uptake and storage capacity.

Carbon Considerations in Forest Ecosystems

Forests are dynamic ecosystems that undergo fluctuations in carbon as forests establish, grow, die, and regenerate. Forest plants remove carbon dioxide from the atmosphere and store some of it as biomass. Forest managers, policymakers, and scientists typically consider 50 percent of wood biomass in trees is carbon. Carbon uptake and storage from the atmosphere help to

modulate greenhouse gas concentrations. The rate of carbon uptake by plants from the atmosphere is influenced by many factors, including natural disturbance, management, forest age, successional pathways, climate, environmental factors, and availability of water and nutrients.

The long-term capacity of forest ecosystems to sequester and store carbon depends in large part on their health, productivity, resilience, and adaptability to changing conditions. Major factors influencing the long-term capacity of forest ecosystems to gain and store carbon include: 1) forest age: younger forests generally have higher rates of carbon uptake and storage, while older forests have greater carbon stocks; 2) forest structure and diversity: forests with more complex structure are generally more resilient and better able to acclimate and adapt to changing conditions; 3) disturbance regimes: disturbance intensity and frequency vary across forest ecosystems, from individual tree-based gap dynamics to landscapes characterized by large, high severity, stand-replacing wildfires at low to high frequencies; a forest's disturbance dynamics will affect its carbon uptake and storage rates and total carbon stocks over time; and 4) land cover type changes: across all ownerships in the conterminous United States, within the land sector, forest land has the greatest capacity to gain and store carbon. Conversion of forest land to non-forest land is the largest source of carbon losses (Vance 2018).

Forest Management for Ecological Integrity and Climate Resilience

Forest management for ecological integrity and climate resilience can help mitigate increasing atmospheric carbon dioxide concentrations while aligning with forest adaptability objectives (Ontl et al. 2020; Kaarakka et al. 2021). Management actions can address vulnerabilities of forest ecosystems to climate change, chronic stressors, or other disturbances such as insect outbreaks or drought (Goodwin et al. 2020) that put sustained forest productivity at risk of decline, with consequences to carbon stewardship and stability. Management can also address effects of previous land uses, such as past clearing with subsequent forest regrowth or fire suppression resulting in dense stands. These past actions may reduce carbon stability via simplified species composition or structural diversity, as well as modify disturbance regimes.

Many management activities may have short-term carbon emissions but yield long-term carbon benefits through enhancing forest resiliency and, therefore, carbon stabilization. For example, timber harvest aimed at removing hazardous fuels and reducing live tree density can yield short-term carbon emissions but ultimately reduce risk of high severity wildfire, yielding long-term increases to carbon stability (Krofcheck et al. 2019). For projects involving forest harvest, some removed carbon can be stored for long time periods if converted to harvested wood products (HWP). Woody biomass for energy production can also decrease greenhouse gas emissions if it is substituted for more fossil fuel-intensive energy sources (Sathre and O'Connor 2010; D'Amato et al. 2011; Oliver et al. 2014). Management activities enhancing species, structural, or age-class diversity can also result in long-term carbon stabilization (Puhlick et al. 2020; Crockett et al. 2023). The use of silvicultural tools such as removing hazardous fuels and reducing live tree density in stands outside the natural range of variation can increase resiliency to disturbance. Timber harvest initially reduces the amount of carbon in a forest stand, but carbon may be transferred to HWP or used for energy production, while increasing longer-term forest productivity and health (Sathre and O'Connor 2010; D'Amato et al. 2011; Oliver et al. 2014). Treatments may have benefits such as reducing the risk of wildfire and tree mortality, thereby contributing to long-term carbon stewardship (Krofcheck et al. 2019). National Forests (or Administrative Units) tend to remain in the forest land cover type, and, thus, may provide a

buffer against land use change and subsequent carbon losses. Factors such as atmospheric carbon dioxide concentrations, climatic variability, and the availability of growth-limiting forest nutrients such as nitrogen can also influence carbon dynamics (Caspersen et al. 2000; Pan et al. 2009).

National Role of Forest Management in Climate Change Mitigation

The Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report summarizes human contributions to climate change by 'sectors' (IPCC 2023). It integrates findings from recent publications (IPCC 2021; IPCC 2022a; IPC 2022b). Forest land, harvested wood products, woodlands, and urban trees in settlements, both individually and collectively, represent a net GHG sink (reduction in atmospheric GHGs by storing them) over the 1990-2020 time series (2022 Resource Update, USDA Forest Service Northern Research Station). These sectors, combined within the land sector, represent the largest net carbon sink in the United States, offsetting the equivalent of more than 12.4 percent of total gross GHG emissions in 2023 (U.S. EPA 2023; Domke et al. 2023). Interannual variability in GHGs was driven primarily by disturbance (e.g., fire, insects/disease, harvest), land conversion (e.g., forest land converted to cropland and settlements, reforestation/afforestation), and changes in HWP stocks in use and transfers to solid waste disposal sites (U.S. EPA 2023; Domke et al. 2023). Forest land, HWP, woodlands, and urban trees in settlements collectively showed a net increase in C stocks in 2020. Forest land is the largest net carbon sink in the land sector, whereas the conversion of forest land to non-forested land is the largest carbon source (IPCC 2022a, b).

About the Bridger-Teton National Forest Carbon Assessment

Report Description

This report relies on models and data to characterize carbon dynamics at the national forest (or administrative unit) level. In general, these analyses use FIA data in combination with validated, data-driven modeling tools to provide nationally consistent evaluations of forest carbon. This report is periodically updated to incorporate advances in data and analytical methods and represents the best information, science, and data available at the time of each update cycle.

This carbon assessment describes a suite of results, some at the national forest (or administrative unit) level and others at the USDA Forest Service region level. At the national forest (or administrative unit) level, this report characterizes carbon stocks and fluxes, drivers of non-soil carbon dynamics, and stand dynamics. Estimates of aboveground live tree, belowground live tree, understory, standing dead, downed dead wood, litter, and soil organic carbon are estimated for the years 2005 to 2023 for key forest ecosystem carbon pools, using FIA data. The impact of disturbances, including harvest, are estimated for 1990 to 2011 using The Forest Carbon Management Framework (ForCaMF; Birdsey et al. 2019; Healey et al. 2014; Raymond et al. 2015; Healey et al. 2016). The long-term, relative effects of disturbance and other factors on the rate of carbon accumulation for the years 1950 to 2011 are estimated using the Integrated Terrestrial Ecosystem Carbon model (InTEC; Chen et al. 2000; Zhang et al. 2012). The most recent FIA inventories were used to analyze stand-age structure (10-year age bins) and net primary productivity by forest type group. At the USDA Forest Service region level, this report characterizes carbon storage in harvested wood products through 2013 and projects

potential future climate change impacts using Climate Vulnerability Assessments (CVAs) and Resource Planning Act (RPA) Assessments.

Bridger-Teton National Forest Description

The Bridger-Teton NF, located in the Rocky Mountains of Wyoming, covers approximately 922,000 ha of forestland as of 2023. Spruce-fir and lodgepole pine forest types are the most abundant across the Bridger-Teton NF, according to FIA data. The carbon legacy of Bridger-Teton NF and other national forests in the region is tied to the history of Euro-American colonization, land management, and disturbances. Exploration of the Intermountain Region by Europeans began in the mid-18th century. After the Civil War, with encouragement by the 1862 Homestead Act and the 1872 Mining Act, settlement expanded, in some places converting forests for mixed agriculture and grazing, and establishing ranching communities with schools, stores, and mills. Many of these homesteads, and sometimes entire communities, were abandoned in the mid to late 19th century, as technology and economies developed and people moved to cities for different opportunities.

As the need for sustainable forest management became evident, the U.S. government began protecting large areas of these overharvested and often submarginal lands in the United States in the mid-20th century as forest reserves. In 1897, the Bridger-Teton Forest Reserve was established. The Bridger National Forest was first protected as part of the Bonneville National Forest in 1908, then separated out in 1911. In 1973, the Teton National Forest was administratively combined with the Bridger. The legacy of timber harvesting and early efforts to restore the forest are visible today, influencing forest age structures, tree composition, and carbon dynamics (Birdsey et al., 2006).

Bridger-Teton National Forest Carbon Stocks and Fluxes

Carbon Stocks and Stock Change

Total carbon stocks in the Bridger-Teton National Forest remained stable from 123.55 teragrams (Tg) of carbon (Tg C) in 2005 to 123.17 ± 11.8 Tg C in 2023, a very small 0.3 percent decrease over this period (Figure 86; see Table 112 for carbon units description) (USDA Forest Service, 2015). This incorporates carbon stocks for all pools, including live and dead vegetation and soils. Carbon stocks in the Bridger-Teton National Forest have remained stable from 2005 to 2023 (Figure 86), with some uncertainty in annual stock estimates. The lack of change in carbon stocks from 2005 to 2023 (Figure 86) over the 19-year period suggests that the forest lands in the Bridger-Teton National Forest may be a carbon sink.

Live and dead vegetation provide a substantial proportion of total carbon stocks in the Bridger-Teton National Forest. Live vegetation, including aboveground live trees, belowground live trees (roots), and understory vegetation comprise about 33 percent of the carbon in the Bridger-Teton National Forest (Figure 87). Standing dead wood, downed dead wood, and litter together make up about 26.7 percent of total forest carbon.

In the Bridger-Teton National Forest, approximately 40.3 percent of forest carbon is stored in mineral soils (Figure 87). This is a modeled estimate using data from FIA soil samples and reflects the total soil organic carbon (SOC) in the soil profile (Domke et al. 2017; Domke et al. 2023; Domke et al. 2016). The current uncertainty associated with the soil carbon estimate is unknown but includes both model uncertainty and sample uncertainty. In most temperate forest

ecosystems, soils represent the largest ecosystem carbon pool (Walters et al. 2023) and offer, through their protection and management, an opportunity to mitigate rising atmospheric carbon dioxide concentrations (Bossio et al. 2020).

Future disturbance events may result in changes to the values in carbon stocks and flux among pools. For example, high severity fire can decrease aboveground live stocks and increase dead wood stocks. Some dead material may be transferred via disturbance to the soil carbon pool (Rothstein et al. 2018; Santos et al. 2017).

Changes in total carbon storage and forested area collectively determine changes in carbon density. Forested area in the Bridger-Teton National Forest was 914,751 ha in 2005 to 922,151 ha in 2023, a net change of 7,400 ha^2 (Table 113). Minor changes in forested area may result from sampling intensity issues or weighting strata rather than actual changes in forested area. Given stable stocks of total ecosystem carbon and slight increasing trends in forested area, in the Bridger-Teton National Forest, carbon density slightly decreased from about 135.07 Mg C/ha in 2005 to 133.57 Mg C/ha in 2023 (Figure 88). This small decrease in carbon density suggests the likely stability of total carbon stocks.

The average carbon density in the national forests and administrative units of Intermountain Region remained relatively stable from 2005 to 2023. Carbon density in the Bridger-Teton National Forest was lower than the average for all National Forests and Administrative Units combined in the Intermountain Region (Figure 88). Differences in carbon density among national forests or administrative units may be related to differences in biophysical factors that influence growth and productivity, such as climate, elevation, and forest type, as well as disturbance and management.

Evaluations of changes to carbon stocks and density are applicable at the national forest (or administrative unit) level, not the project level, given the methods used in this assessment. These results, thus, provide a broad context for potential national forest or administrative unit land management activities. They are also useful for comparison among national forests or administrative units, which typically have different amounts of forested area.

Table 112. Carbon Units.

Tonnes			Grams		
Multiple	Name	Symbol	Multiple	Name	Symbol
			10^0	Gram	g
			10^3	Kilogram	Kg
10^0	Tonne	t	10^6	Megagram	Mg
10^3	Kilotonne	Kt	10^9	Gigagram	Gg
10^6	Megatonne, million metric tonnes	Mt, MMt	10^{12}	Teragram	Tg

1 hectare (ha) = 0.01 km2 = 2.471 acres = .00386 mi2
1 Mg carbon = 1 tonne Carbon = 1.1023 short tons (U.S.) carbon
1 General Sherman Sequoia Tree = 1,200 Mg (tonnes) carbon
1 Mg carbon mass = 1 tonne carbon mass = 3.67 tonnes CO2 mass
A typical traditional combustion engine passenger vehicle emits about 4.6 tonnes of CO2 per year

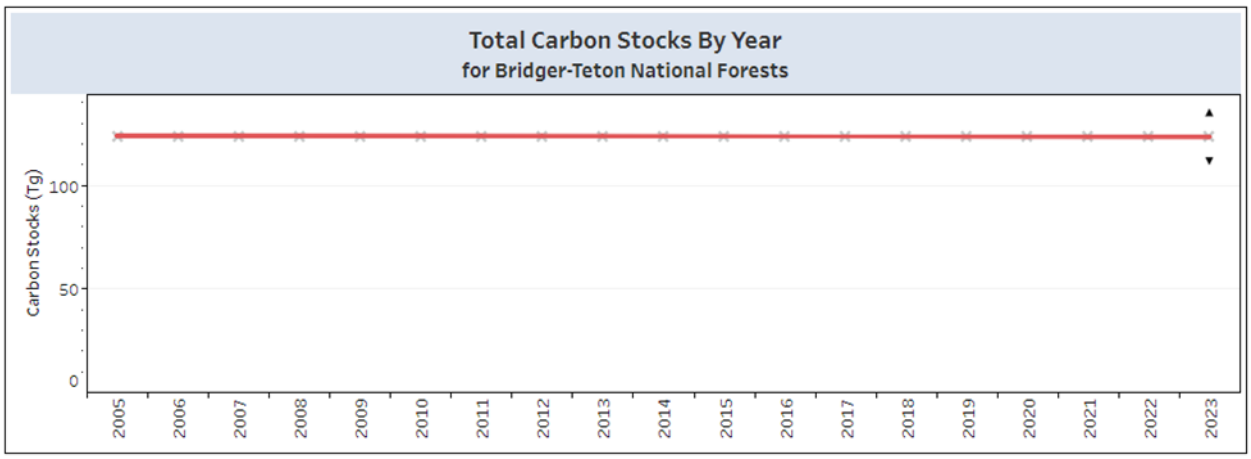


Figure 86. Total forest carbon stocks (Tg) for the years 2005 to 2023. Triangles represent a 95% confidence interval (only available for 2023).

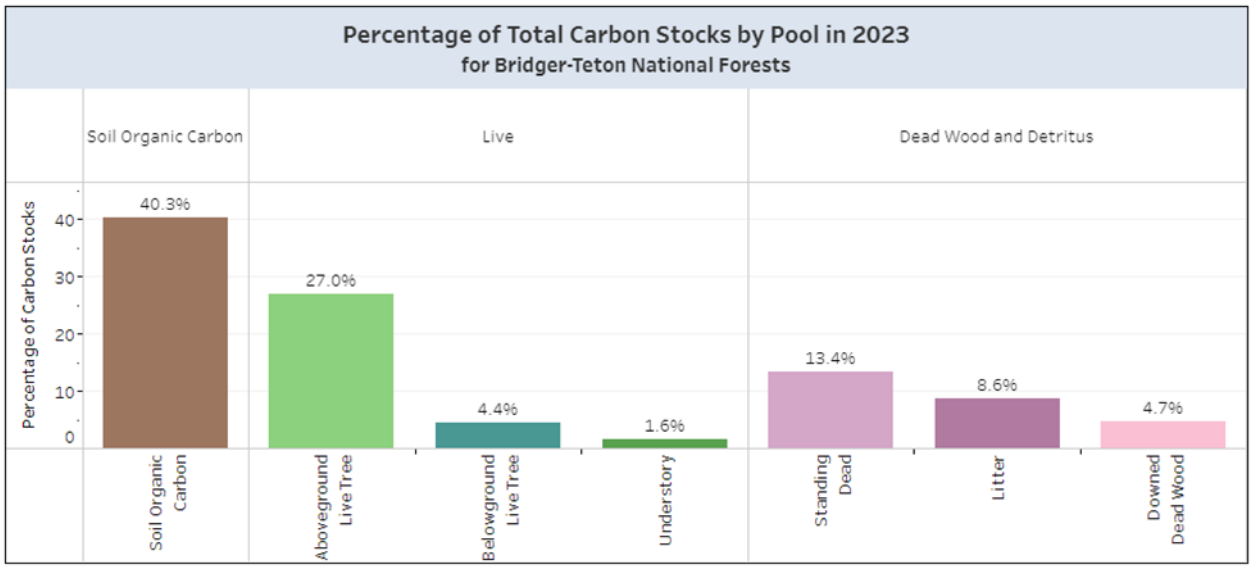


Figure 87. Percentage of total carbon stocks by pool in 2023.

Table 113. Carbon stocks and forested area estimates.

Carbon Stocks and Forested Area Estimates for Bridger-Teton National Forests	
Variable	**Value**
Carbon stocks in 2005	123.55 Tg
Carbon stocks in 2023	123.17 Tg
Standard error (+/-) of carbon stock estimates in 2023	11.80 Tg
Carbon stocks, estimated in million passenger vehicles (MPV), in 2023	98.27 MPV
Percent change in carbon stocks, 2005–2023	-0.31%
Carbon density in 2005	135.07 Mg/ha
Carbon density in 2023	133.57 Mg/ha
Change in carbon density, 2005–2023	-1.50 Mg/ha
Forested area in 2005	914,751 ha
Forested area in 2023	922,151 ha
Change in forested area, 2005–2023	7,400 ha
Percent of 2013 regional carbon stocks in use as harvested wood products	0.57%

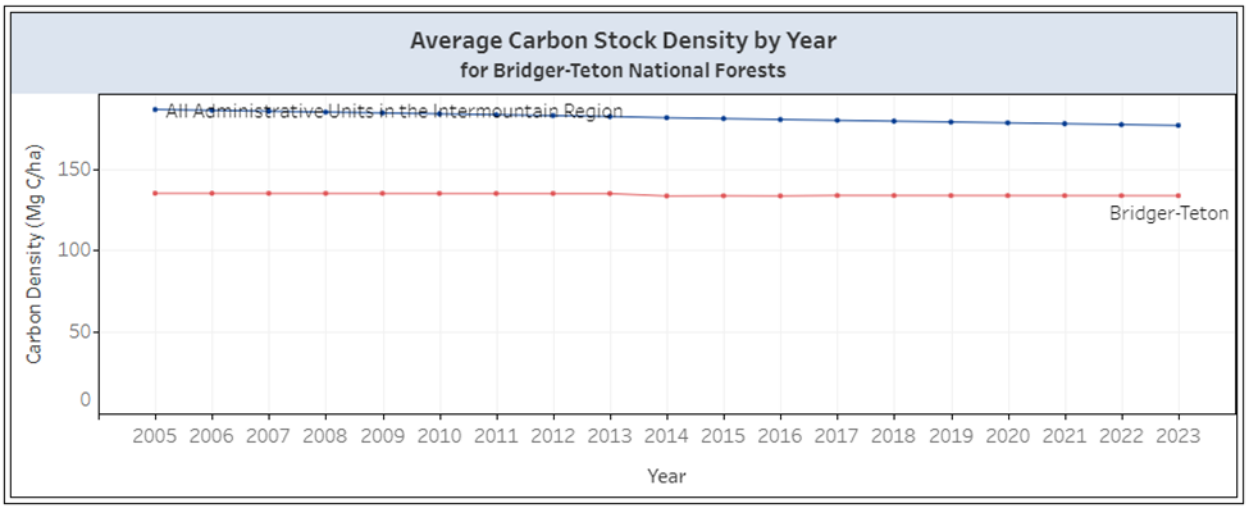


Figure 88. Average carbon stock density (Mg/ha) from 2005 to 2023.

Carbon in Harvested Wood Products

Carbon stored in harvested wood products (HWP) may result in lower net GHG emissions relative to unmanaged forests, if carbon stored in harvested wood products, substitution effects, and forest regrowth are collectively considered (Lippke et al. 2011; McKinley et al. 2011; Skog et al. 2014; Dugan et al. 2018). The IPCC recognizes wood as a renewable resource that when sustainably managed can mitigate climate change (IPCC, 2022b; IPCC 2023). Assessing impacts of harvest on GHGs thus should include carbon storage estimates from wood products.

The duration of carbon persistence in harvested wood products depends on the commodity type. For example, paper, pulp, or small-piece biomass will not retain carbon as long as timber does. Carbon stored in HWP increases with HWP commodity production. Landfills (also known as solid waste disposal sites or SWDS) also store discarded forest products and may continue to store carbon for many decades, as decomposition is slowed under oxygen-poor conditions. Wood products used in place of steel or concrete, as well as wood-derived biomass used in

energy production in place of coal and natural gas, may reduce net GHG emissions as well, via their substitution for higher GHG-emitting products (Gustavsson et al. 2006; Lippke et al. 2011).

In the Intermountain Region, harvest levels remained low until the 1940s when they began to increase, which caused an increase in carbon storage in HWP (Figure 89) (Stockmann et al. 2014). Timber harvesting and subsequent carbon storage accelerated in the 1950s through the 1970s. Storage in products and landfills peaked at about 9.8 Tg C in 1995. However, because of a significant decline in timber harvesting in the late 1990s and early 2000s (to 1940s levels) carbon accumulation in products in use began to decrease. In the Intermountain Region, the contribution of national forest timber harvests to the HWP carbon pool is less than the decay of retired products, causing a net decrease in product-sector carbon stocks. In 2013, the carbon stored in HWP was equivalent to approximately 0.82 percent of total forest carbon storage associated with national forests in the Intermountain Region.

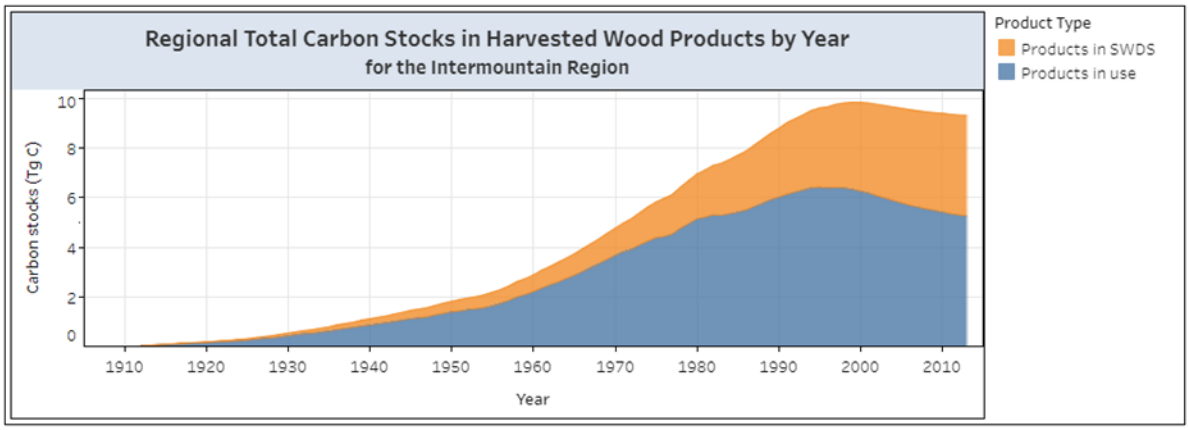


Figure 89. Total region-wide carbon stocks (Tg) in harvested wood products in use and at solid waste disposal sites (SWDS) from 1910 to 2013.

Factors Influencing Forest Carbon Dynamics

Disturbance

From 1990 to 2011, insect disturbance was the most widespread disturbance type in the forested areas of the Bridger-Teton National Forest (Figure 90). Insects affected approximately 20 percent (approximately 201,100 ha) of total forest area (922,151 ha) over this period. In most individual years, insects typically affected less than 6 percent of the total forested area. The percentage of forest harvested remained low over the period. Insects, on average, removed less than 50 percent of canopy cover per year (Figure 91). Insect outbreaks on Bridger-Teton National Forest also had the greatest impact on carbon stocks from 2007-2011. The Bridger-Teton National Forest contained 5.69 Mg C/ha lower carbon stocks in 2011 resulting from insects that occurred from 2007-2011, compared to a hypothetical undisturbed scenario (Figure 92). Carbon stocks may have been approximately 0.06 percent higher without harvest during that time (Figure 93). All estimates of carbon related to disturbance from 1990 to 2011 do not include soil carbon. Lower-severity fires and other low-grade disturbances would also not be detected unless they affected canopy closure given the disturbance estimation methods used (Healey et al. 2018).

Insect-related disturbance impacted approximately 20 percent of forested lands, reaching its peak in 2009 (Figure 90). However, chronic lower-severity forest disturbances (such as insect effects) may be overestimated in this framework because the same incidence may be recorded in multiple years, depending on duration and intensity of canopy impact (Healey et al. 2018).

Across the Intermountain Region, insects, followed closely by fire, had the greatest adverse effects on carbon storage from 1990-2011 (Table 114); carbon stocks were approximately 6.5 percent lower by 2011 (Figure 93) than they might have been in the absence of all disturbance types. By 2011, fire accounted for the reduction of 0.8 percent of these carbon stocks and insects 5.3 percent, relative to the no disturbance scenario (Figure 93). Across the Intermountain Region, fire and insects were also the dominant disturbance types. However, the magnitude of insect effects on carbon on the Bridger-Teton National Forest was approximately double the broader trend across the Intermountain Region (Figure 93). This difference is likely driven by extensive bark beetle (e.g. mountain pine and spruce beetle) outbreaks that affected lodgepole pine, Douglas fir, Engelmann spruce, and other forest types across much of the Bridger-Teton National Forest from 2004-2012.

By comparison, nationally, across all land ownerships, from 1926 to 2017 fire and harvest reduced total forest stocks on average by 14 percent and 51 percent respectively (Magerl et al. 2023). For example, across the western US, from 1940 to 2017, fire, harvest, and other disturbance (e.g., insect, drought) reduced carbon stocks on average by 14%, 81%, and 7%, respectively (Magerl et al. 2023). Harvest rates and subsequent effects on forest carbon on the Bridger-Teton National Forest are currently much lower than these figures. However, the effects of insects are much higher on the Bridger-Teton National Forest compared to broader western United States trends.

The disturbance history information reported here does not describe past disturbance effects on carbon stocks and fluxes over long time periods and, therefore, does not capture the full range of successional processes. Further, conditions such as herbivory, chronic disturbance, and climate fluctuations prior to and after harvest, and the type of harvest (selective vs regeneration harvest, for example) are not assessed, but these factors also affect the timing of recovery of ecosystem carbon. Because of these factors, it may take several decades for carbon emissions to be offset by subsequent uptake and storage (Raymond et al. 2015). This disturbance information also does not account for harvest-related retention of carbon stored in HWP.

Soil Carbon and Disturbance

Disturbance impacts on soil carbon stocks and fluxes are not evaluated within this assessment. National forests can choose to use a national protocol, Forest Soil Disturbance Monitoring Protocol (FSDMP), for collecting data on soils impacted by management activity (Page-Dumroese et al. 2009a, 2009b). However, impacts on soil carbon are not directly quantified unless individual national forests (or administrative units) collect those data. Data collected by individual national forests (or administrative units), following FSDMP may help to augment national soil stock data lacking soil-related disturbance information. In the FSDMP, the presence or absence of the organic horizon and detrimental physical soil disturbance (effect of disturbance on specific soil types to subsequent tree growth) are measured, giving individual national forests and administrative units information on the extent to which biogenic carbon could be impacted by management activities. Recent scientific research suggests that typical disturbance related to harvest operations has little to no effect on soil carbon (Curzon et al. 2022). A recent meta-analysis of research conducted in Great Lakes states points to natural

factors, such as soil texture and parent material, forest type, and climate, as more significant drivers of soil carbon stocks than disturbances such as fire or harvest (Nave et al. 2021b).

Generally, fire decreases litter carbon stocks, though the magnitude and variability of these declines differ across regions (Nave et al. 2011). For example, in the Pacific Northwest, wildfires drive large carbon losses from litter and in mineral soil horizons, while prescribed fires primarily diminish litter carbon (Nave et al. 2022). In most regions, mineral soils are not affected by fire, but fire may impact microbial activity and the quantity and quality of organic matter inputs into the soil, thus potentially affecting soil carbon (Knelman et al. 2015). Different types of fire may influence litter responses variably, with prescribed fire producing smaller carbon losses than unintentional or unmanaged wildfires. For these reasons, prescribed burns conducted under expert guidance can be an effective tool for reducing aboveground fuel loads while mitigating soil carbon and nitrogen losses that would otherwise occur in wildfire (Nave et al. 2011). Implementing existing soil quality standards, protection guidelines, and monitoring protocols is an effective way to promote soil carbon stewardship following disturbance.

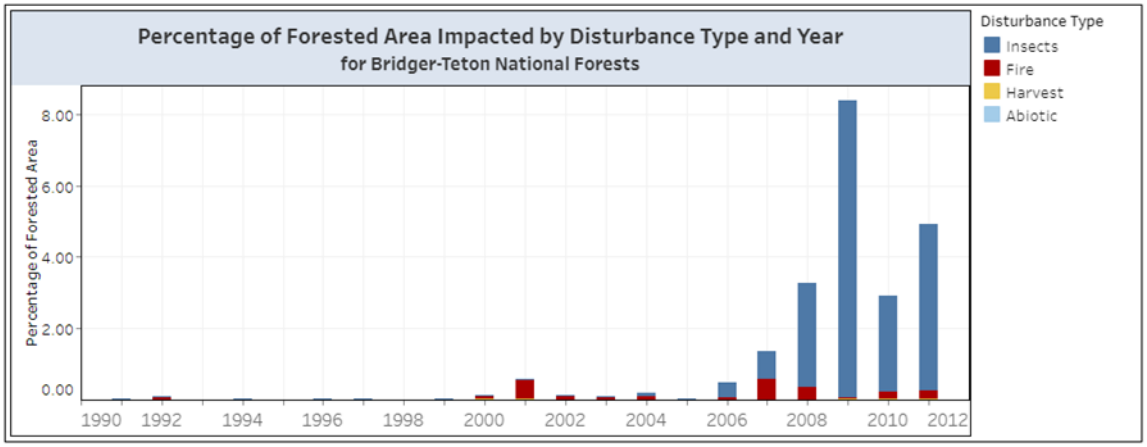


Figure 90. Percentage of forested area disturbed from 1990 to 2011, by disturbance type.

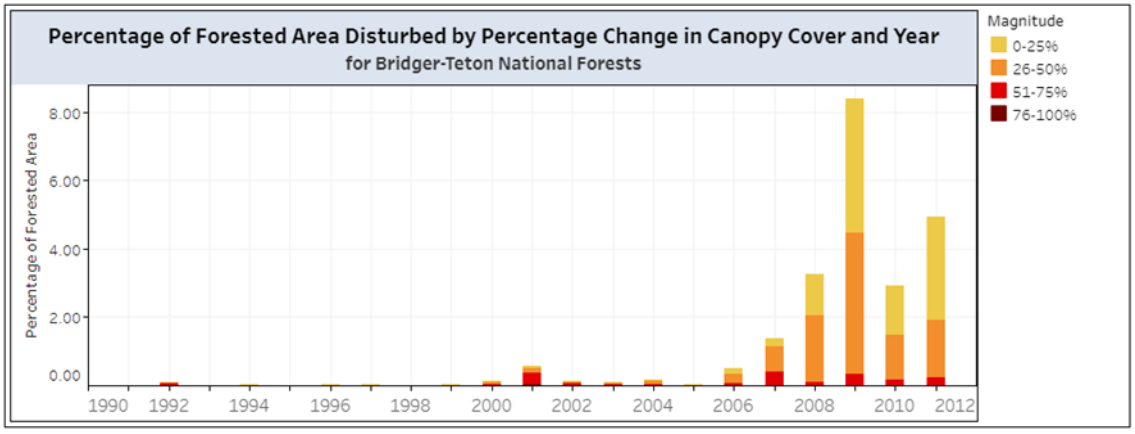


Figure 91. Percentage of forest area disturbed by percentage change in canopy cover and year for Bridger-Teton National Forest.

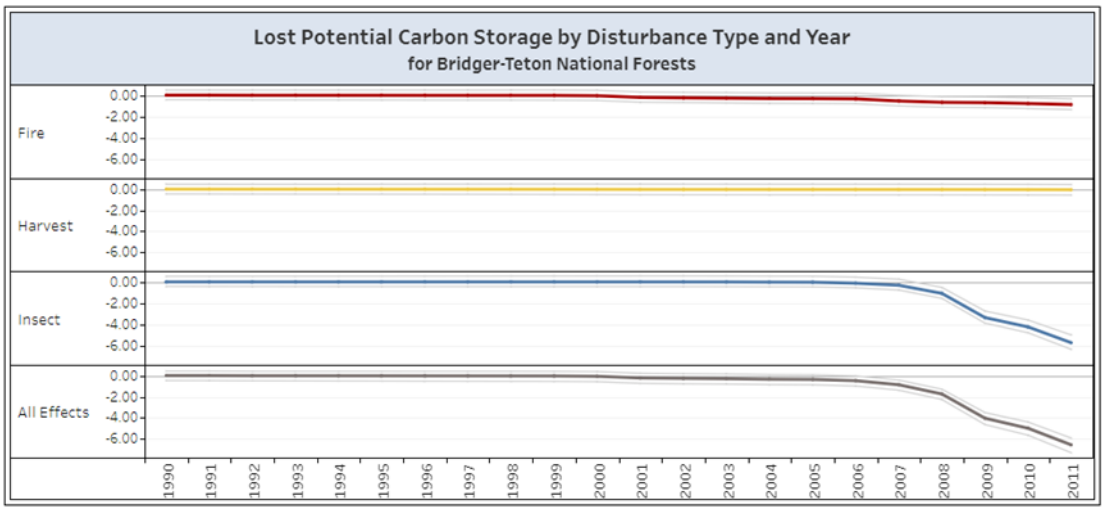


Figure 92. Lost potential storage of carbon (Mg/ha) relative to a hypothetical no-disturbance baseline (zero line), resulting from disturbances from 1990 to 2011. Gray lines are 95% confidence intervals. Soil carbon is not included.

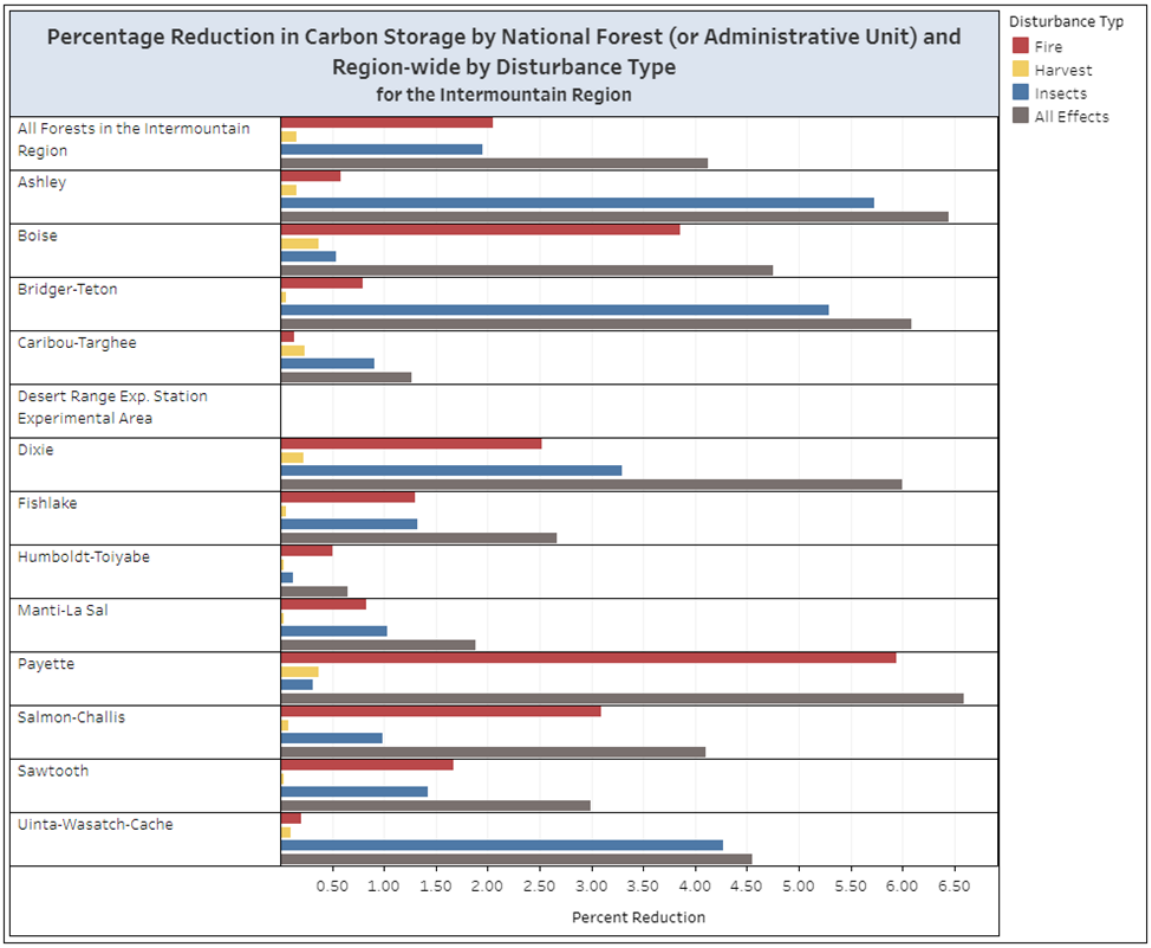


Figure 93. Percentage reduction in carbon storage relative to a hypothetical no-disturbance baseline, by disturbance type, administrative unit, and region-wide, from 1990 to 2011. Soil carbon is not included.

Table 114. Disturbance effects for Bridger-Teton National Forest

Disturbance Effects for Bridger-Teton National Forests		
Category	**Variable**	**Value**
Reduction in carbon (Mg/ha), by disturbance type, 1990-2011*	Disease	
	Fire	-0.86 Mg/ha
	Harvest	-0.06 Mg/ha
	Insects	-5.69 Mg/ha
	All disturbances	-6.55 Mg/ha
Percentage change in carbon, by disturbance type, 1990-2011*	Disease	
	Fire	-0.80%
	Harvest	-0.05%
	Insects	-5.29%
	All disturbances	-6.09%
Total forest area impacted, by disturbance type, 1990-2011	Fire	25,240 ha
	Harvest	2,129 ha
	Insects	201,111 ha
	Abiotic factors	209 ha
	All disturbances	228,689 ha
Percentage of forest impacted, by disturbance type, 1990-2011**	Fire	2.51%
	Harvest	0.21%
	Insects	19.99%
	Abiotic factors	0.02%
	All disturbances	22.72%
Percentage of forest impacted, by percentage canopy loss, 1990-2011**	0-25% canopy loss	10.22%
	26-50% canopy loss	10.60%
	51-75% canopy loss	1.86%
	76-100% canopy loss	0.05%
Other	Forested area***	1,005,816 ha
	Percent of forest <= 80 years old	37.17%
	Percent of forest > 80 years old	62.83%

*Soil carbon was not included.
**Percentage of forest disturbed is the sum of percentage disturbed each year. Some areas may have experienced repeated disturbance over the time period assessed; therefore, total area disturbed may be an overestimate of the actual footprint of the disturbed area.
***Forested landcover type area was held constant from 1990 to 2011.

Stand Development and Dynamics

Forests are generally considered to follow a multi-stage model of progressive stand development after a severe disturbance: stand initiation, stem exclusion, understory re-initiation, and old growth. However, in a stand affected by frequent low- to moderate-severity disturbance (such as frequent fires or insect and disease outbreaks) trees may cycle between intermediate stages for centuries (standing dead trees and/or old living trees of low abundance). While these stands generally follow the four stages of development, progressing from seedling to old growth, the period spent in each stage varies. Setbacks to earlier stages may result from limitations in site conditions (hydrology, soils, or climate) or intermediate disturbances, making the stand origin or endpoint difficult to determine (e.g., Franklin et al. 2007; Palik et al. 2020).

Stand age can serve somewhat as a proxy for past disturbances and management activities (Pan et al. 2011). When a forest stand is disturbed by a high severity disturbance, stand age returns to zero until regeneration commences. Relative percentages of forested area in given age classes might reflect stand-replacing disturbance events in situations where a given stand age class predominates. Uneven-aged stands may reflect lower severity disturbance regimes and have more complex patterns.

Stand-age distribution for the Bridger-Teton NF derived from 2023 forest inventory data indicates fluctuations in stand establishment over the last 200 years creating a mix of both younger and older stands (Figure 94). About 72 percent of the forested stands are older (>80 years old). However, young stands (<30 years old) comprise approximately 17 percent of

forested area, likely establishing after wildfire and insect outbreak events that occurred in the past several decades. Middle aged stands (100-150 years old) also occur on approximately 38 percent of forested lands and indicate higher rates of regeneration throughout the late 1800s and early 1900s, possibly driven by increased disturbances like fire and human settlement at the time.

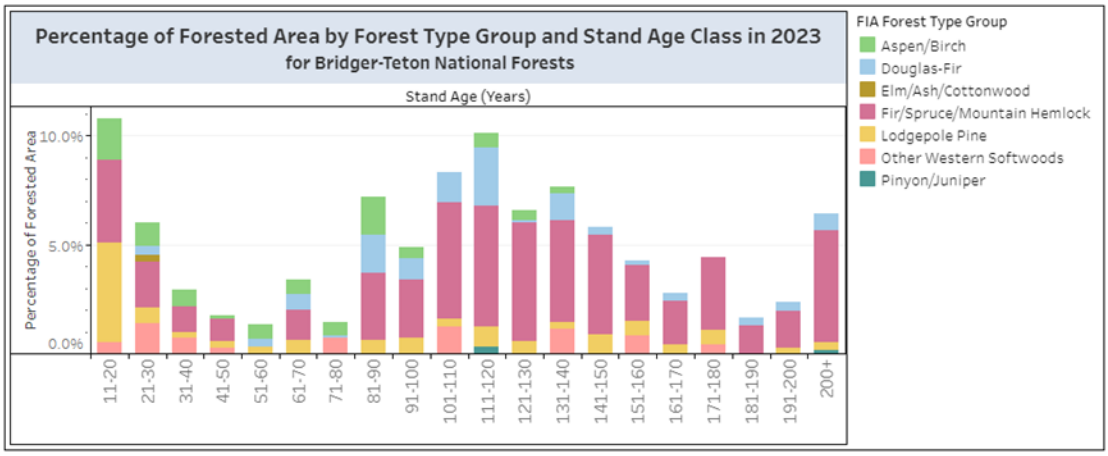


Figure 94. Percentage of forested area by FIA forest type group and stand age class in 2023.

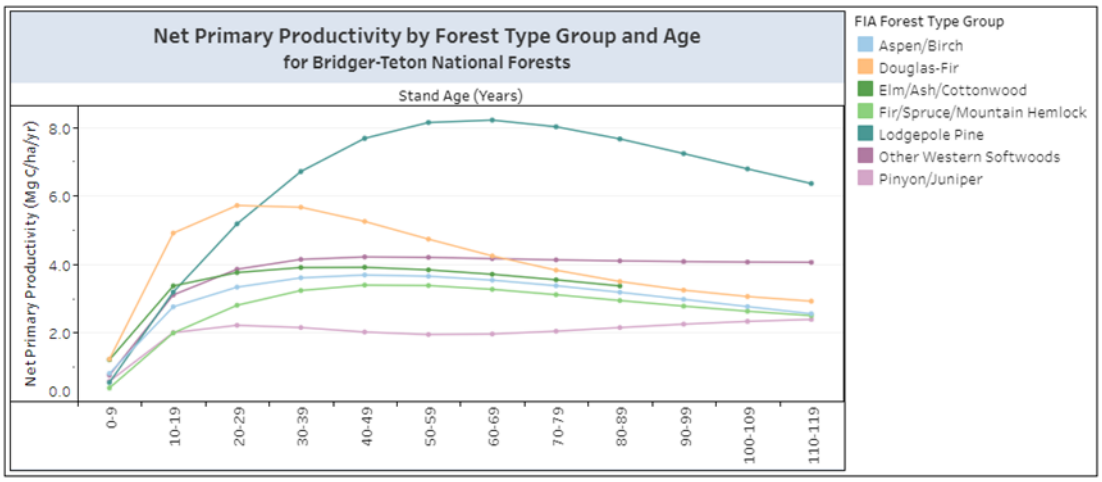


Figure 95. Net primary productivity (Mg C/ha/yr) by FIA forest type group and stand age

Net primary productivity curves describe changes in productivity over time that reflect shifts in growth rates. Stand regrowth rates rely on forest type and site conditions. In general, productivity is highest for young to mid-aged stands across forest types, and then productivity peaks and either declines or stabilizes as the forest canopy closes, respiration rates increase, and some tree mortality occurs (Pregitzer & Euskirchen, 2004; He et al. 2012). While it is not the most common forest type on the BTNF, Lodgepole pine forests on the Bridger-Teton NF have the highest productivity rates after stand ages reach 30 years or older. However, Lodgepole pine productivity declines slightly after stands reach approximately 70 years in age (Figure 95). While not as productive as Lodgepole pine forests, Douglas fir stands follow a similar growth trajectory with young stands (<30 years old) having high productivity rates followed by declining productivity once a stand reaches 40-50 years of age. Other forest types on the Bridger-Teton National Forest maintain lower, but consistent productivity rates after approximatey 40 years.

For example, mixed spruce/fir forests are the most common forest type, but have some of the lowest productivity rates of all forest types considered (Figure 95).

Effects of Climate and Environment on Recent Carbon Dynamics

Disturbance/aging, carbon dioxide fertilization, climate, and nitrogen deposition had combined effects on the accumulation of carbon from 1950 to 2010 in the Bridger-Teton National Forest (Figure 96). Combined effects were modest, with a shift to negative carbon accumulation around 1990. Carbon amounts decreased mainly because of the combined effects of disturbance and forest aging. Modelled effects of CO_2 fertilization and nitrogen deposition suggest some positive increases in carbon accumulation, but these processes are uncertain. Overall, from the period spanning the early 1990s to 2011, combined effects resulted in a net negative accumulation of carbon of about -7.78 Tg.

The effects of climate on carbon stocks in the Bridger-Teton National Forest varied over time, but in general, climate fluctuations since 1950 tended to have negligible effects on carbon accumulation until recent decades. Since approximately 2000, climate change effects have had a negative effect on total accumulated carbon in the Bridger-Teton NF (Figure 96). Climate change can have variable effects on carbon dynamics. Warmer temperatures can increase forest carbon emissions through enhanced soil microbial activity and higher respiration (Ju et al. 2007; Melillo et al. 2017) but warming temperatures may also reduce soil moisture via increased evapotranspiration, leading to slower forest growth and reduced emissions, especially in semiarid and low elevation forests (Xu et al. 2013).

Carbon dioxide fertilization and nitrogen deposition can alter forest growth rates, influencing carbon uptake and accumulation (Caspersen et al. 2000; Pan et al. 2009; Thomas et al. 2010). Carbon dioxide fertilization may result in higher productivity, but this effect is transitory for most forests (Zhu et al. 2016). In the Bridger-Teton National Forest, carbon dioxide fertilization continuously increased carbon stocks (Figure 96). Quantification of the magnitude of the effect of carbon dioxide fertilization on terrestrial carbon storage and forest growth rates has high uncertainty (Jones et al. 2014; Zhang et al. 2015), however, and is also related to soil nutrient availability (Vose et al. 2018). These topics require additional research (Körner et al. 2005; Norby et al. 2010; Zhu et al. 2016). Nitrogen deposition may have had a positive effect on carbon accumulation in the [Forest Name] NF (Figure 96); uncertainty in these estimates is also high.

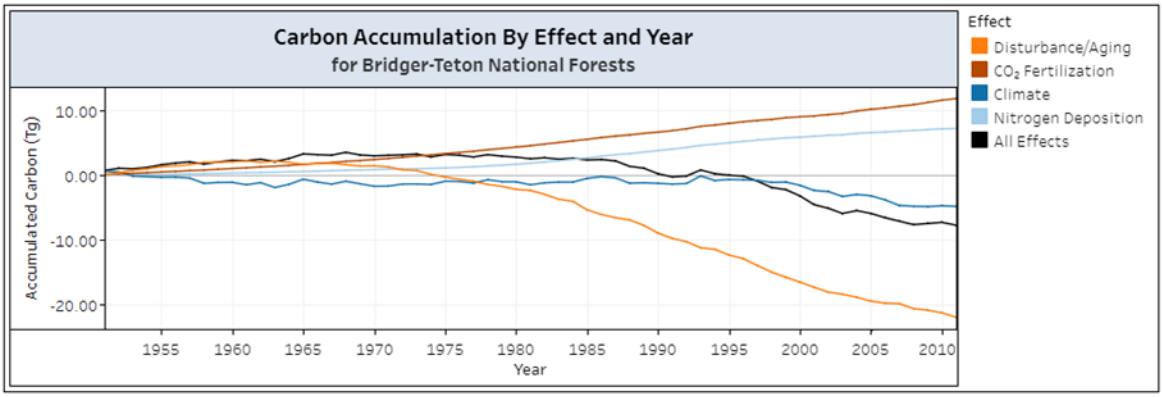


Figure 96. Carbon accumulation (Tg) over time from disturbance/aging, carbon dioxide fertilization, climate, nitrogen deposition, and all effects combined, initialized at zero, from 1950 to 2011.

Factors Influencing Potential Future Carbon Dynamics

Forest Aging

Future carbon uptake, storage, and stability are influenced by forest stand age dynamics. As stands in the Bridger-Teton National Forest age, an increasing proportion of the stands may have slower growth rates as net primary productivity declines as a forest stand ages, across some forest type groups (Figure 95). Landscape-wide, this may result in declining rates of carbon uptake. Although live biomass may approach peak levels and stabilize or decline, ecosystem carbon stocks may continue to increase as dead wood and detritus, as well as soil carbon stocks, accumulate (Pregitzer and Euskirchen 2004). Some forest types may have the tendency to remain carbon sinks for many decades, in the absence of disturbance and with increasing forest age. Stand structural heterogeneity, as individual trees die via gap dynamics, can increase over time, with resulting shifts of carbon among pools, and total carbon stocks. Past and present aging trends can inform future conditions with respect to carbon uptake, storage, and stability. However, the interpretations of past stand and landscape dynamics effects on carbon uptake, storage, and stability may be limited, because potential changes in management activities, disturbance, and future climate variability are likely to affect future stand age distributions and forest growth rates (Davis et al. 2009; Keyser & Zarnoch, 2012) as well as their variability across broader areas.

Over 70 percent of the forests of the Bridger-Teton NF are middle-aged and older (greater than 80 years) (Figure 94). If the Forest continues this aging trajectory, more stands will reach a slower growth stage in coming years and decades (Figure 95), potentially causing the rate of carbon accumulation to decline. Insect and fire mortality, however, could change that trend in the immediate future assuming those areas successfully regenerate. However, continued effects of climate change may further reduce future net primary productivity rates of some forest types (e.g. stands growing in drier locations more prone to drought). Increasing disturbances driven by climate change may also facilitate shifts in forest composition or structure, further altering future carbon dynamics and storage.

Potential Carbon Stock Changes within the Resource Planning Act Assessment-Defined Region of the Administrative Unit

The 2020 Resource Planning Act (RPA) Assessment (Forest Service USDA 2023) is the sixth assessment prepared in response to a mandate by the Forest and Rangeland Renewable Resources Planning Act of 1974 (P.L. 93-378, 88 Stat. 475, as amended). Among other metrics, it provides a snapshot of current forest conditions and projects future trends in forest carbon across all forest land ownerships in the U.S., using the annual FIA inventory to estimate carbon stocks (Woodall et al. 2015). For future trends, the 2020 RPA Assessment uses the annual FIA inventory to estimate carbon stocks for four RPA-defined regions (i.e., North, South, Rocky Mountains, Pacific Coast) in relation to a set of scenarios. The 2020 RPA Assessment incorporates four combinations of alternative future climate and socioeconomic scenarios: High global warming (RCP (Representative Concentration Pathway) 8.5) and high (SSP5) U.S. growth (scenario “HH”); high global warming and moderate (SSP2) U.S. growth (“HM”); high global warming and low (SSP3) U.S. growth (“HL”); and lower global warming (RCP 4.5) and moderate (SSP 1) U.S. growth (“LM”) (Figure 97; Langner et al. 2020; Coulston et al. 2023). High global warming is positively associated with high future emissions. Lower warming is

associated with low future emissions. Because the RPA Regions are very large and represent all types of land ownership and management strategies, this information should be used only as broad context of potential future changes across the quadrant of the U.S. in which a given USDA Forest Service administrative unit resides.

For each scenario, five individual climate models were simulated to capture uncertainty in future climate estimates under different emissions scenarios. Potential future carbon stocks and stock change are described in relation to these four scenarios (HL, HM, HH, LM) for 2019 to 2070 (Figure 98; Coulston et al. 2023). These climate models capture the magnitude of change in precipitation and temperature that occurred across a wider range of climate models assessed for potential use in each RPA Assessment scenario. Responses were similar across individual climate models within the RCP for each scenario for both carbon stocks and carbon stocks change.

The RPA Rocky Mountain Region had lower initial carbon stocks in 2019 than the other RPA Regions, approximately 7.8 billion metric tons or gigatons (Gt) (Figure 98), and total carbon stocks are projected to slowly decline until 2070 (Figure 99) (Coulston et al. 2023). Rates of decline in carbon stocks (MMT C) are projected to increase until about 2040 then remain stable until 2070 (Figure 100) (Coulston et al. 2023). All scenarios showed similar results. Uncertainty in carbon flux estimates is high and increases over time, and differences among scenarios for carbon stocks are not significant. The RPA Rocky Mountain Region is projected to remain a carbon source between 2019 and 2070.

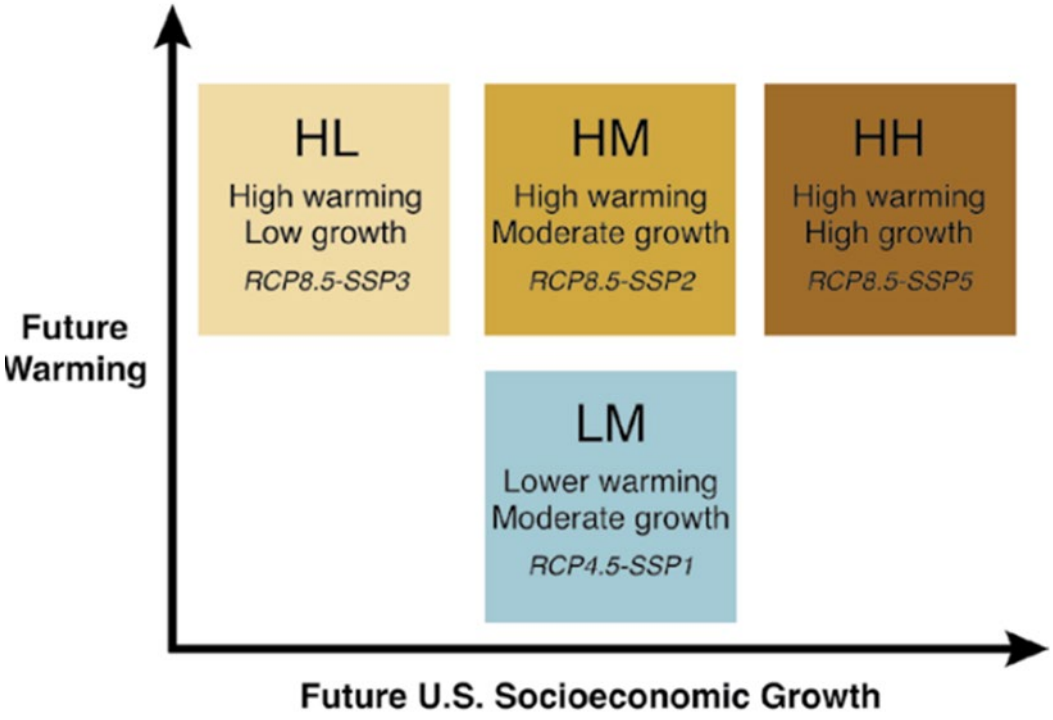


Figure 97. Characterization of global warming and U.S. socioeconomic growth characteristics of the four Representative Concentration Pathway (RCP)–Shared Socioeconomic Pathway (SSP) combinations underpinning the 2020 RPA Assessment scenarios. (Fig. 8 in Langner et al. 2020).

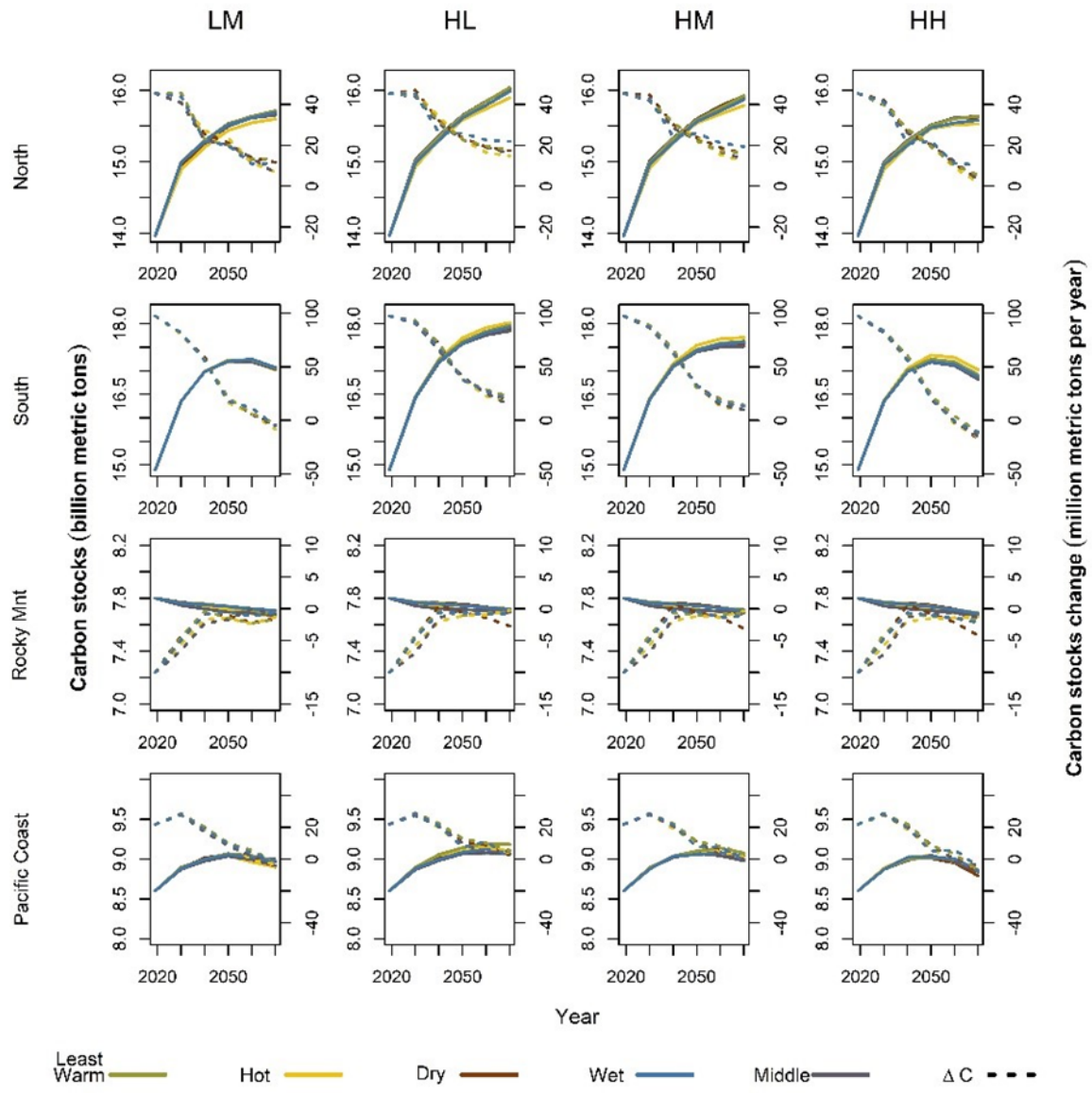


Figure 98. Forest remaining forest total forest ecosystem carbon stocks and stock changes for 2019 and projections to 2070 for each 2020 RPA Assessment scenario-climate future, by RPA region. Projected forest ecosystem carbon stock and stock change are based on averaging decadal projection results by 2020 RPA Assessment scenario-climate future. Multiple solid lines indicate carbon stocks projections for the five individual climate models selected for each RCP; dotted lines indicate carbon stocks change. (Fig. 6-34 in Coulston et al. 2023).

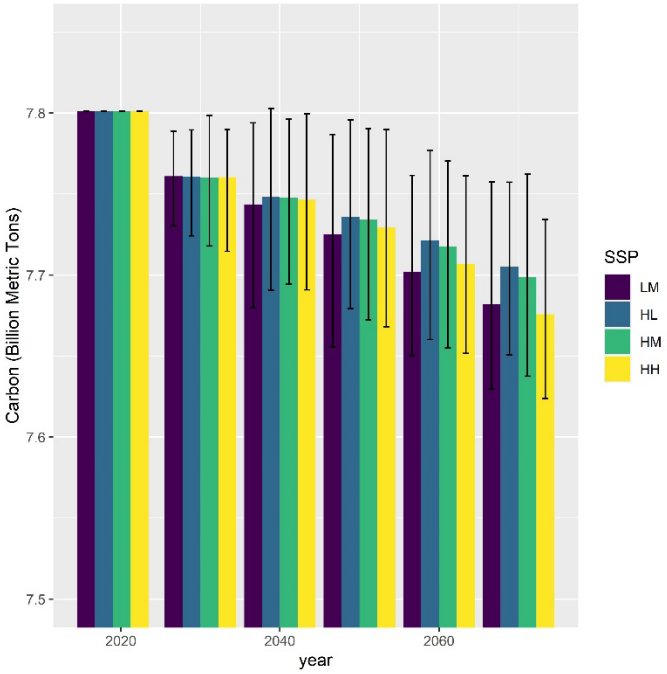


Figure 99. Forest remaining forest total forest ecosystem carbon stocks for 2019 and projections to 2070 for each 2020 RPA Assessment scenario-climate future, for the RPA Rocky Mountain Region.

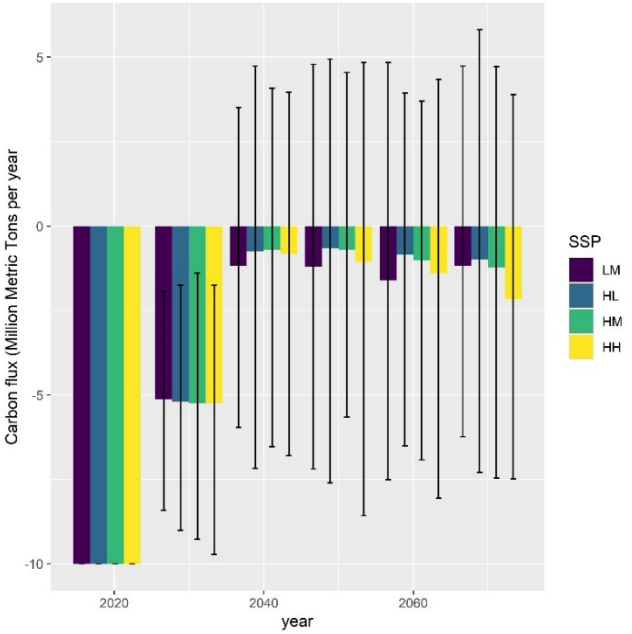


Figure 100. Forest remaining forest total forest ecosystem stock changes for 2019 and projections to 2070 for each 2020 RPA Assessment scenario-climate future, for the RPA Rocky Mountain Region.

Climate Change and Environmental Effects on Potential Future Carbon Dynamics

Climate change introduces additional uncertainty about how forests may change in the future due to climate-exacerbated risks from stress, insects, and fire (Anderegg et al. 2022; Wu et al. 2023), as well as its direct effects on the local environment, such as changes in temperature and precipitation (Matthews et al. 2018), and its indirect changes to many ecosystem processes (Vose et al., 2012). The uncertain levels of resilience of individual tree species to climate change (Baker et al. 2023; Clark et al. 2023) and projected increases in disturbance make future conditions uncertain. In some cases, using past trends to project the effects of disturbance, aging, and tree regeneration on forest carbon dynamics (Anderegg et al. 2020, 2022; Davis et al. 2023) may be erroneous and even irrelevant as there are many pathways to forest change, climate adaptation, and the maintenance of ecosystem integrity.

A climate change vulnerability assessment of the Intermountain Region (Halofsky et al., 2018), which encompasses the Bridger-Teton National Forest, indicates that ecosystems will increasingly be affected by disturbances (drought, wildfires, insects) that will remove living and dead vegetation, and in turn, reduce carbon sequestration. If fires are as frequent as expected, forests may rarely attain mature stand structure at lower elevations, thus limiting potential carbon sequestration. (Halofsky et al., 2018).

Elevated temperatures may increase soil respiration and reduce soil moisture through increased evapotranspiration, which would negatively affect growth rates and carbon accumulation (Ju et al., 2007; Melillo et al., 2017). Modeled results of recent climate effects using the InTEC model indicate that years with elevated temperatures have generally had a negative effect on carbon uptake in the Bridger-Teton National Forest (blue line, Figure 96).

Lower snowpack and increased drought will result in lower base flows, reduced soil moisture, wetland loss, riparian area reduction or loss, and more frequent and possibly more severe wildfire. Carbon content in soils is expected to decrease in areas where decomposition rate and wildfire frequency increase. Increased temperature is expected to cause a gradual change in the distribution and abundance of dominant plant species. Increased ecological disturbance, driven by higher temperatures, is expected to cause near-term effects on vegetation structure and age classes. Drought-stressed trees may be more susceptible to insects and pathogens (Dukes et al., 2009), which can significantly reduce carbon uptake (Kurz et al., 2008; D'Amato et al., 2011). Both insects and fire, already significant stressors, are projected to increase in a warmer climate. Carbon storage may decrease under these projections, and the forest may move toward more consistently being a source of atmospheric carbon.

Changes in climate are expected to drive many other changes in forests through the next century, including changes in forest establishment and composition (Halofsky et al., 2018). Subalpine whitebark pine will be vulnerable because of existing stress from white pine blister rust and mountain pine beetles. Bark beetles are also a stressor for subalpine spruce-fir, and increasing crown fires may eliminate mature trees from the landscape. Douglas fir, while more fire resistant, is not drought-tolerant, so growth will be slower, and lodgepole pine and aspen are also expected to persist. Riparian forests such as key cottonwood galleries will be highly vulnerable.

Climate-driven failures in species establishment further reduce the ability of forests to recover carbon lost after mortality-inducing events or harvests. Although future climate conditions also

allow for other future-adapted species to increase, there is greater uncertainty about how well these species will be able to take advantage of new niches that may become available (Halofsky et al. 2018).

Given the complex interactions among forest ecosystem processes, disturbance regimes, climate, and nutrients, it is difficult to project how forests and carbon trends will respond to novel future conditions. The effects of future conditions on forest carbon dynamics may change over time. As climate change persists for several decades, critical thresholds may be exceeded, causing unanticipated responses to some variables like increasing temperature and CO_2 concentrations. The effects of changing conditions will almost certainly vary by species and forest type. Some factors may enhance forest growth and carbon uptake, whereas others may hinder the ability of forests to act as a carbon sink, potentially causing various influences to offset each other. Thus, it will be important for forest managers to continue to monitor forest responses to these changes and potentially alter management activities to better enable forests to better adapt to future conditions.

According to the Forest Health Advisory System, within the Bridger-Teton National Forest, approximately 722,000 acres are susceptible to a high (>25 percent) of total tree mortality and 25-30 percent of tree biomass is at risk from forest pests (Krist et al. 2014). Carbon dioxide emissions are projected to increase through 2100 under even the most conservative emission scenarios (IPCC 2023). Several models, including the InTEC model (Figure 96), project greater increases in forest productivity when carbon dioxide fertilization is included in modeling (Aber et al. 1995; Ollinger et al. 2008; Pan et al. 2009; Zhang et al. 2012). However, the effect of increasing levels of atmospheric carbon dioxide on forest productivity is transient and can be limited by the availability of nitrogen and other nutrients (Norby et al. 2010). Productivity increases under elevated carbon dioxide could also be offset by losses from climate-related stress or disturbance.

The myriad effects of disturbance, aging, climate change, nitrogen deposition, and CO_2 fertilization are likely to affect carbon uptake and storage amounts of forest carbon and may also modify the rate of change in carbon stocks. Temperature and precipitation fluctuations will also impact carbon stocks and fluxes. Drought-stressed trees may also be more susceptible to insects and pathogens (Dukes et al. 2009), which can both reduce carbon uptake (Kurz et al. 2008; D'Amato et al. 2011) and increase emissions.

Forest regeneration failure associated with climate change, and warming temperatures may also reduce soil carbon stocks (Nave et al. 2022). Changes in temperature and precipitation may impact soil organic carbon as well by affecting organic matter inputs and decomposition rates (Clark et al. 2016; D'Amore and Kane 2016). Soil microbial activity, which contributes to soil organic carbon formation, may alter via shifts in soil temperature and moisture, especially in water-limited ecosystems (Alster et al. 2016). The effects that temperature and precipitation impose on soil carbon vary (Nave et al. 2021b) and depend on local and regional soil type and vegetation composition (Nave et al. 2021a). A Menu of Adaptation and Mitigation Strategies and Approaches for Forest Carbon Management is available to help translate broad carbon management concepts into actionable tactics that help managers reduce risk from expected climate impacts to meet desired management goals (Ontl et al. 2020).

Conclusion

Forests in the Bridger-Teton National Forest have taken up and stored a similar amount of carbon compared to what was emitted during the period covered by this assessment. Forest carbon stocks remained stable between 2005 and 2023, and reductions in carbon stocks caused by insects and fire have matched or exceeded potential increases in forest productivity. Soil biogenic carbon values have high uncertainty because of data and modeling limitations and are likely underestimated in this assessment.

Disturbance has contributed to forest dynamics in the Bridger-Teton National Forest . Insect outbreaks were the most prevalent disturbance type detected between 1990 and 2011, according to the methods used in this assessment. Fire from 1990 to 2011 was the second most influential stressor but had a lesser effect on forest carbon stocks and impacted a smaller proportion of forest area. Forest carbon reductions associated with insects were moderate relative to total landscape carbon stocks. This disturbance type resulted in a reduction of about 5.3 percent of carbon from 1990 to 2011; soil carbon was not included in the disturbance assessment. These estimates of disturbance effects on forest carbon losses represent an upper bound because they do not account for continued storage of carbon in harvested wood products, or the effect of forest products substitution for other more highly-GHG-emitting building materials such as brick or metal. Carbon storage in harvested wood products sourced from national forests (and other administrative units) across the US has increased since the early 1900s. Recent declines in timber harvest rates have slowed the rate of carbon accumulation in the harvested wood products sector.

The biggest influence on recent carbon dynamics in the Bridger-Teton National Forest was the combined effects of disturbance and forest aging. Forest stands of the Bridger-Teton National Forest are now mainly dominated by middle-stands (~80-150 years old) and consist of mixed spruce/fir, lodgepole pine, and aspen forest types. Forest carbon stocks are projected to decrease under future climate and socio-economic scenarios across that part of the U.S., with the broad area projected to serve as a sink by 2070.

Climate and environmental factors, including elevated atmospheric carbon dioxide and nitrogen deposition, have also influenced carbon uptake and storage in the Bridger-Teton National Forest in recent decades. Recent shifts in climate have probably increased forest vulnerability to stressors, and decreased resilience. However, increased carbon dioxide fertilization and nitrogen deposition may have increased growth rates that increased carbon uptake and storage.

The interactions of climate effects with other components of forest dynamics such as disturbance and socioeconomic factors are complex and uncertain. Under changing climate and other conditions, the Bridger-Teton National Forest may be increasingly vulnerable to a variety of stressors. There may also be positive effects of a longer growing season, greater precipitation, and elevated atmospheric CO_2 concentrations, but those effects vary according to site conditions and may be transitory. How interactions among these factors will affect future carbon dynamics of the Bridger-Teton National Forest remains unknown.

The forested land cover type of the Bridger-Teton National Forest likely will be maintained in the future, barring disturbance-related conversions to non-forest cover and shifts in ownership. This is likely to result in continued forest carbon uptake and storage, with effects on broader-scale greenhouse gas levels. Projected continuing land conversion for development on private ownerships remains a potentially negative influence on forest carbon uptake and storage.

The Bridger-Teton National Forest will continue to play an important role in the USDA Forest Service mission to sustain the health, diversity, productivity, and climate resiliency of the Nation's Forests and Grasslands to meet the needs of present and future generations. Careful stewardship of carbon uptake, storage, and stability while assessing multiple uses and benefits is part of an intentional approach to integrating climate adaptation and increasing ecosystem integrity under management that is consistent with the USDA Forest Service mission.

Glossary

Adaptation - Adjustments, both planned and unplanned, in natural and human systems in response to climatic changes and subsequent effects. Ecosystem-based adaptation activities use a range of opportunities for sustainable management, conservation, and restoration.

Biogenic carbon - carbon which cycles through living organisms, such as soil carbon, carbon stored in trees, or other plant parts.

Biomass - The mass of living organic matter (plant and animal) in an ecosystem. Biomass also refers to organic matter (living and dead) available on a renewable basis for use as a fuel; biomass includes trees and plants (both terrestrial and aquatic), agricultural crops and wastes, wood and wood wastes, forest and mill residues, animal wastes, livestock operation residues, and some municipal and industrial wastes.

Carbon flux - The transfer of carbon from one carbon pool to another.

Carbon pool - Different classes of biomass found within forests. The amount of carbon stored in pools changes over time and in response to various factors. Any natural region or zone, or any artificial holding area, containing an accumulation of carbon or carbon-bearing compounds or having the potential to accumulate such substances. Pools can be defined in several ways, but generally include the following: aboveground live biomass (trees, shrubs, herbs, grasses), belowground live biomass (roots), dead wood (standing dead trees, stumps, downed dead wood), forest floor (litter, leaves, small branches), and soil (mineral soil, decomposing organic matter).

Carbon sequestration - The process of plants using sunlight to uptake CO_2 from the air and convert it into plant biomass, including wood, leaves, and roots. The process of increasing the carbon content of a carbon reservoir other than the atmosphere; often used narrowly to refer to increasing the carbon content of carbon pools in the biosphere and distinguished from physical or chemical collection of carbon followed by injection into geologic reservoirs, which is generally referred to as "carbon storage."

Carbon sink - In general, any process, activity, or mechanism that removes a greenhouse gas or a precursor of a greenhouse gas or aerosol from the atmosphere; in this report, a sink is any regime or pool in which the amount of carbon is increasing (i.e., is being accumulated or stored).

Carbon source - In general, any process, activity, or mechanism that releases a greenhouse gas or a precursor of a greenhouse gas or aerosol into the atmosphere; in this report, a source is any regime or pool in which the amount of carbon is decreasing (i.e., is being released or emitted).

Carbon stock - The amount or quantity of carbon contained in the inventory of a pool or reservoir.

Carbon uptake/storage - The amount of carbon retained long-term within the forest, stored in "carbon pools."

Council on Environmental Quality (CEQ) - An advisory council to the President established by the National Environmental Policy Act (NEPA) of 1969. The council reviews federal programs for their effects on the environment, conducts environmental studies, and advises the President on environmental matters.

Climate change - A change in the state of the climate that can be identified (for example, by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external factors, or to persistent anthropogenic changes in the composition of the atmosphere or in land use.

Coarse woody debris - Any piece(s) of dead woody material, including dead boles, limbs, and large root masses, that are on the ground in forest stands or in streams.

Deforestation - the conversion of forest to non-forest use.

Disturbance - Stresses and destructive agents such as invasive species, diseases, and fire; changes in climate and serious weather events such as hurricanes and ice storms; pollution of the air, water, and soil; real estate development of forest lands; and timber harvest. Some of these are caused by humans, in part or entirely; others are not.

Ecosystem - A system of living organisms interacting with each other and their physical environment. The boundaries of an ecosystem are somewhat arbitrary, depending on the focus of interest or study. Thus, the extent of an ecosystem may range from very small spatial scales to, ultimately, the entire Earth.

Emissions scenario - A plausible representation of the future development of emissions of greenhouse gases and aerosols that are potentially radiatively active, based on demographic, technological, or environmental developments.

Forest type - A classification of forest vegetation based on the dominant and commonly occurring associated tree species.

Greenhouse gases - Gases that absorb heat in the atmosphere near the Earth's surface, preventing it from escaping into space. If the atmospheric concentrations of these gases rise, the average temperature of the lower atmosphere will gradually increase, a phenomenon known as the greenhouse effect. Greenhouse gases include, for example, carbon dioxide, water vapor, and methane.

Land-use change - The conversion of forest land into different land use systems, often for anthropogenic uses such as cultivated land or horticulture systems.

Management goal - Broad statements, usually not quantifiable, that express a desired state or process to be achieved. Goals are often not attainable in the short term and provide context for more specific objectives.

Management objective - Concise, time-specific statements of measurable planned results that correspond to preestablished goals in achieving a desired outcome.

Mitigation - In the context of climate change, actions that reduce the amount of heat-trapping greenhouse gases, such as CO2, in the atmosphere to minimize changes in the Earth's climate.

Actions can include avoiding or reducing emissions of greenhouse gases into the atmosphere, as well as removing greenhouse gases that are already present in the atmosphere.

National Environmental Policy Act (NEPA) - An act to declare a national policy which will encourage productive and enjoyable harmony between humankind and the environment, to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of humanity, to enrich the understanding of the ecological systems and natural resources important to the nation, and to establish a Council on Environmental Quality.

Net primary productivity (NPP) - The net increase (i.e., photosynthesis minus respiration) in total plant carbon, including above and below ground.

Projection - An estimate of something in the future, based on data or trends. Projections are distinguished from predictions to emphasize that projections involve assumptions concerning, for example, future socioeconomic and technological developments that may or may not be realized and are therefore subject to substantial uncertainty.

Resilience - The capacity of an ecosystem to respond to a perturbation or disturbance by resisting damage and recovering quickly.

Structural diversity - The amount of three-dimensional variation within a forest stand. This is influenced by a combination of plant species diversity and height classes (vertical structure). It is often used as an indicator for biodiversity of forest ecosystems.

Vulnerability - The degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the impacts and adaptive capacity of a system. A system may be vulnerable if it is at risk of a composition change leading to a new type, or if the system is anticipated to suffer substantial declines in health or productivity.

Primary Forest Carbon Models Used

The following provides a description of the primary forest carbon models used to conduct this carbon assessment. The Carbon Dashboard, hosting all figures within this assessment, also contains descriptions and accompanying publications in support of each model.

Carbon Stocks and Pools

Estimates annual carbon stocks and stock change are estimated for the years 2005 to 2023 by summarizing data from Forest Inventory and Analysis (FIA) plots, using methods also used in the United Nations Framework Convention on Climate Change (EPA 2024). FIA relies on allometric models to convert tree measurements to biomass and carbon.

The carbon pools are described as follows:

1. Live trees - all live woody vegetation at least 1 inch (2.54 cm) in diameter at breast height (d.b.h., 1.3 m). Separate estimates are made for both aboveground and whole-tree biomass, which includes all living biomass of coarse living roots more than 2 mm in diameter.
2. Belowground live-tree carbon - based on the difference between whole trees and above ground only.
3. Understory - all live herbaceous vegetation and woody vegetation up to 1-inch (2.54 cm) d.b.h. Estimates of understory are modeled from NFS Region and forest type as well as plot-level measurements of live-tree carbon density.
4. Standing dead trees - nonliving trees but otherwise follow the same definition as live trees, including coarse nonliving roots more than 2 mm in diameter
5. Downed dead wood (also known as down dead wood or coarse woody debris) - all nonliving woody biomass with a diameter of at least 7.5 cm at transect intersection lying on the ground. Th is pool also includes stumps and coarse roots more than 2 mm in diameter. Nonliving vegetation that otherwise would fall under the definition of understory is included in this pool
6. Litter - the litter layer including all nonliving biomass with a diameter less than 7.5 cm at transect intersection lying on the ground above the mineral soil. The litter estimation uses the FIA litter sample data to build a model relating a suite of biophysical parameters to the observed litter pool at each plot (Domke et al. 2016).
7. Soil organic carbon - all organic material in the soil and excludes the coarse roots of other pools. The soil organic carbon pool estimation utilizes FIA soil sample data to build a model relating a suite of biophysical parameters to observed SOC (Domke et al. 2017). The soil organic carbon pool estimation harmonizes FIA soil samples (0-20 cm) with other national soil carbon data collected at deeper intervals (ISCN 2012a, 2012b) to obtain a modeled SOC to a depth of one meter per FIA plot location.

Carbon Stock and Stock Change Estimates

Summary: Estimates annual carbon stocks and stock change from 2005 to 2023 by summarizing data from Forest Inventory and Analysis (FIA), following methods used in the United Nations Framework Convention on Climate Change (U.S. EPA 2024).

Description: The Forest Inventory and Analysis Program systematically inventories the nation's forested resources, with roughly one plot per 3,000 – 6,000 acres. Sampling intensity is lower for non-tree components (including soil, coarse woody debris, and litter), with a minimum of one plot per 96,000 acres. Although FIA sampling commenced in 1928, significant changes in sampling design began in 1999, making it difficult to reconcile earlier data with recent measurements. The analyses in this assessment include data collected from 2005 onward, when standardized data became available for all states. FIA summarizes data from forested plots within national forest administrative units and federally administered lands. FIA annually estimates total forested area and forest carbon within seven pools (described above).

Note: Many of the underlying models supporting estimates of biomass, volume, and carbon were updated in September 2023, collectively referred to as the National Scale Volume and Biomass Estimators (NSVB; Westfall et al. 2023). Therefore, FIA carbon estimates calculated before versus after this update are not directly comparable. Updated equations were applied retroactively to the entire FIA database, such that the current database now includes updated estimates across the entire time series.

Uncertainty: Potential sources of uncertainty with FIA data include sampling error (e.g., area estimates are based on a network of plots, not a census), measurement error (e.g., species identification, data entry errors), and model error (e.g., associated with volume, biomass, and carbon equations, interpolation between sampling designs). Forest Inventory and Analysis plots are resampled about every five years in the eastern US and every 10 years in the western US; therefore, estimates may lack temporal sensitivity as FIA data is designed for large-scale (e.g., regional) estimation. Additionally, estimates of change in forested area may reflect an actual change in land use due to reforestation or deforestation or may result from variation in weighting schemes and sampling intensity, making it important to consider both carbon stock and density (Woodall et al. 2013). Currently, the estimate of 2023 total ecosystem carbon includes a 95 percent confidence interval; updated confidence intervals for other pools and years are forthcoming. A 95 percent confidence interval reflects that there is a five percent chance that the true value falls outside of the range.

Regional Harvested Wood Products Carbon Model

Summary: Estimates of carbon storage in harvested wood products (HWP) from 1911 to 2013 using the Intergovernmental Panel on Climate Change (IPCC) production accounting approach (USDA Forest Service 2015a-i).

Description: This model tracks the entire cycle of carbon from harvest to timber products to primary wood products to end use to disposal. The analysis incorporates regional harvests documented in detailed cut-and-sold reports that are available online and include the value and volume of timber sold and harvested in the region (USDA Forest Service 2023). The carbon in HWP from timber products to primary products is based upon the methodology in Smith et al. (2006). For the purposes of this report, the HWP carbon pool includes both products in use and products that have been discarded to solid waste disposal sites (SWDS).

Uncertainty: Potential uncertainty in the harvested wood products carbon model include: adjustment of historical harvests to modern national forest boundaries; factors used to convert the volume harvested to biomass; the proportion of harvested wood used for different commodities (e.g., paper products, saw logs); site-specific variation such as how much residue is left onsite and how it is used; product decay rates; and the lack of distinction between

methane and CO_2 emissions from landfills. The approach also does not consider the substitution of wood products for emission-intensive materials or the substitution of bioenergy for fossil fuel energy (Gustavsson et al. 2006). Uncertainty was assessed using a Monte Carlo approach, which indicates a 90 percent confidence interval of ±0.05 percent for 2013, suggesting uncertainty is small at regional scales.

Disturbance Models

Forest Carbon Management Framework (ForCaMF)

Summary: Estimates how much more carbon (non-soil) would be on each National Forest if disturbances (harvest, insects, fire, abiotic, disease) from 1990 to 2011 had not occurred (Birdsey et al. 2019).

*Description***:** ForCaMF relies on three underlying spatial datasets (maps) for each NF:

1. Annual disturbance maps for 1990 to 2011 (Healey et al. 2014), generated using the Vegetation Change Tracker algorithm (Huang et al. 2010) on Landsat data and manually verified using independent data.
2. Initial forest type maps (derived from Ruefenacht et al. (2008)).
3. Aboveground carbon in 1990 maps, based on Landsat imagery from 1992 and FIA data (Healey et al. 2014; 2016).

Based on the range of observed disturbance by region, FIA plots were iteratively simulated in the Forest Vegetation Simulator (FVS) for a variety of likely disturbance pathways. After simulation, similar plots (based on initial carbon/plot conditions) were grouped together to develop region-level carbon storage models for different forest types and disturbance pathways (disturbance types, magnitudes, and timing, as well as no disturbance). Carbon storage models were applied to the map of initial carbon and forest type, and each national forest was modeled forward in time from 1990 to 2011. Disturbance events reset the carbon trajectory of a given pixel to an appropriate post-disturbance pathway.

ForCaMF distinguishes between the effects of 1) individual types of disturbance, 2) cumulative effects of all disturbance, and 3) a hypothetical no-disturbance scenario, which can be used as a reference point to estimate relative carbon lost to different types of disturbance. To contextualize estimates of carbon lost to disturbance, we used estimates of total ecosystem carbon stocks in 2013 from the Carbon Calculation Tool (CCT; Smith et al. 2007) to calculate the percent by which carbon stocks had been reduced by disturbance (USDA FS 2015a-i). Updated estimates of carbon stocks could not be used to compare with results from ForCaMF because ForCaMF was modeled using FIA data accessed prior to 2023, which contain different underlying allometric equations.

There are a few important caveats for this model. Any National Forest, regardless of land management actions, would not experience an undisturbed scenario under any realistic conditions outside of the modelled ForCaMF framework; the model simply provides context for the total percent disturbance values. Factors such as stand age, drought, and climate may affect overall carbon change in ways that are independent of disturbance trends; therefore, ForCaMF is not exhaustive in analyzing all factors which contribute to changes in carbon. ForCaMF also simulates the effects of disturbance and management only on non-soil carbon stocks (i.e., live trees, standing dead trees, understory vegetation, downed dead wood, and

litter). Lastly, carbon losses resulting from disturbance that are estimated by ForCaMF may not be reflected in the carbon stock and flux estimates, due to FIA inventory cycles of 5 years (for eastern states) and 10 years (for western states).

Uncertainty: Various types of errors may exist in the remotely sensed disturbance maps used in the ForCaMF. ForCaMF results may incorporate errors from the inventory data and the FVS-derived carbon accumulation functions (Raymond et al., 2015). To quantify uncertainties, the ForCaMF model employed a Monte Carlo-based approach to supply 95 percent confidence intervals around estimates (Healey et al. 2014).

Integrated Terrestrial Ecosystem Carbon (InTEC) Model

Summary: Estimates the effects of climate, nitrogen deposition, CO_2 fertilization, and disturbance on carbon accumulation from 1950 to 2011 (Birdsey et al. 2019).

Description: The Integrated Terrestrial Ecosystem Carbon model (InTEC; Chen et al. 2000) is a process-based biogeochemical model driven by monthly climate data, vegetation parameters, and forest disturbance information to estimate annual forest C and fluxes in C pools at regional and local scales. InTEC relies on empirical FIA datasets containing variables such as stand age, forest (or dominance) type, and net growth, resulting in a hybrid approach which combines a process-based biogeochemical model with empirical models. Specifically, the FIA-based stand age, dominance (or forest) types, and net primary productivity (NPP)-stand age relationships determine when stands were initially disturbed and, depending on forest (or dominance) type, how the productivity changes with stand age over time. As with ForCaMF, carbon stock and stock change estimates reported by InTEC are likely to differ from estimates of carbon stocks and flux because of the different data inputs and modelling processes.

Uncertainty: Process-based models are known to have considerable uncertainty, particularly in the parameter values used to represent complex ecosystem processes (Zaehle et al. 2005). InTEC is highly calibrated to FIA data and remotely sensed observations of disturbance and productivity, so uncertainties in these datasets are also propagated into the InTEC estimates. National-scale sensitivity analyses of InTEC inputs and assumptions (Schimel et al. 2015), as well as calibration with observational datasets (Zhang et al. 2012) suggest that model results produce a reasonable range of estimates of the total effect. However, the relative partitioning of the effects of disturbance and non-disturbance factors as well as uncertainties at finer scales (e.g., national forest scale) are likely to be considerably higher. Due to significant computational requirements, uncertainty analyses such as the Monte Carlo are not commonly conducted for spatially explicit, process-based models like InTEC.

Net Primary Productivity Estimates

Summary: NPP-stand age curves were fit using methods described in He et al. 2012, combining FIA data on net woody forest growth and He et al. (2012) data on foliage and fine root turnover rates.

Description: FIA data were obtained from tables estimated using EVALIDator (https://apps.fs.usda.gov/fiadb-api/evalidator), where stand age and net woody growth (aboveground and belowground) were estimated by plot, excluding disturbed and treated plots from the population. Nonlinear curves were then fit by forest type group and ecoregion in R (www.R-project.org/). Curves for each National Forest Unit were assigned based on which

ecoregions the Units are located in. Rare forest type groups may not be represented in FIA data (Bechtold and Patterson 2005).

Stand Age Distribution by Forest Type Estimates

Summary: Stand age distribution by forest type group was estimated from FIA data on undisturbed and untreated plots.

Description: Number of plots by forest type group and ten-year stand age class were obtained from EVALIDator (https://apps.fs.usda.gov/fiadb-api/evalidator) using the most recent inventory available in July 2023. Rare forest type groups may not be represented in FIA data (Bechtold and Patterson 2005).

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